DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket Number EERE–2009–BT–STD–0018]

RIN 1904–AC00

Energy Conservation Program: Energy Conservation Standards for Metal Halide Lamp Fixtures

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

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

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including metal halide lamp fixtures. EPCA also requires the U.S. Department of Energy (DOE) to determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this notice, DOE proposes amended energy conservation standards for metal halide lamp fixtures. The notice also announces a public meeting to receive comments on these proposed standards and associated analyses and results.

DATES: DOE will hold a public meeting on Friday, September 27, 2013, from 9 a.m. to 4 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section VIII, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than October 21, 2013. See section, ''VIII Public Participation,'' for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E–089 1000 Independence Avenue SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Edwards to initiate the necessary procedures. Please also note that those wishing to bring laptops into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing laptops, or allow an extra 45 minutes. Persons can attend the public meeting via webinar. For more information, refer to the Public Participation section near the end of this notice.

Any comments submitted must identify the NOPR for Energy Conservation Standards for metal halide lamp fixtures, and provide docket number EE–2009–BT–STD–0018 and/or regulatory information number (RIN) 1904–AC00. Comments may be submitted using any of the following methods:

1. *Federal eRulemaking Portal: www.regulations.gov.* Follow the instructions for submitting comments.
2. *Email: MHLF-2009-STD-0018@ee.doe.gov.* Include the docket number and/or RIN in the subject line of the message.
3. *Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue SW., Washington, DC 20585–0121. If possible, please submit all items on a CD. It is not necessary to include printed copies.
4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza SW., Suite 600, Washington, DC 20024. Telephone: (202) 586–2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

Written comments regarding the burden-hour estimates or other aspects of the collection-of-information requirements contained in this proposed rule may be submitted to Office of Energy Efficiency and Renewable Energy through the methods listed above and by email to *Chad_S_Whiteman@omb.eop.gov*.

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

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

A link to the docket Web page can be found at: *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49*. This Web page will contain a link to the docket for this notice on the regulations.gov site. The regulations.gov Web page will contain simple instructions on how to access all documents, including public comments, in the docket. See section VIII for further information on how to submit comments through *www.regulations.gov*.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Ms. Brenda Edwards at (202) 586–2945 or by email: *brenda.edwards@ee.doe.gov*.

FOR FURTHER INFORMATION CONTACT:

Ms. Lucy deButts, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue SW., Washington, DC 20585–0121. Telephone: (202) 287–1604. Email: *metal_halide_lamp_fixtures@ee.doe.gov.*

Mr. Ari Altman, U.S. Department of Energy, Office of the General Counsel, GC–71, 1000 Independence Avenue SW., Washington, DC 20585–0121. Telephone: (202) 287–6307. Email: *ari.altman@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

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I. Summary of the Proposed 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 the U.S. Department of Energy (DOE) prescribes for certain products, such as metal halide lamp fixtures (MHLFs or ''fixtures''), 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 proposes amended energy conservation standards for metal halide lamp fixtures. The proposed standards, which are the

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

minimum allowable ballast efficiencies[2] based on fixture location, ballast type, and rated lamp wattage, are shown in Table I.1.

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR METAL HALIDE LAMP FIXTURES

Equipment classes	Rated lamp wattage	Indoor/outdoor ***	Test input voltage †	Minimum standard equation %
1	≥50 W and ≤100 W	Indoor	480 V	99.4/(1 + 2.5 * P∧(−0.55)) ‡.
2	≥50 W and ≤100 W	Indoor	All others	100/(1 + 2.5 * P∧(−0.55)).
3	≥50 W and ≤100 W	Outdoor	480 V	99.4/(1 + 2.5 * P∧(−0.55)).
4	≥50 W and ≤100 W	Outdoor	All others	100/(1 + 2.5 * P∧(−0.55)).
5	>100 W and <150 W *	Indoor	480 V	99.4/(1 + 0.36 * P∧(−0.30)).
6	>100 W and <150 W *	Indoor	All others	100/(1 + 0.36 * P∧(−0.30)).
7	>100 W and <150 W *	Outdoor	480 V	99.4/(1 + 0.36 * P∧(−0.30)).
8	>100 W and <150 W *	Outdoor	All others	100/(1 + 0.36 * P∧(−0.30)).
9	≥150 W ** and ≤250 W	Indoor	480 V	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0 * 10∧(−2) * P + 76.0.
10	≥150 W ** and ≤250 W	Indoor	All others	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0 * 10∧(−2) * P + 74.0.
11	≥150 W ** and ≤250 W	Outdoor	480 V	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0 * 10∧(−2) * P + 76.0.
12	≥150 W ** and ≤250 W	Outdoor	All others	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0 * 10∧(−2) * P + 74.0.
13	>250 W and ≤500 W	Indoor	480 V	91.0.
14	>250 W and ≤500 W	Indoor	All others	91.5.
15	>250 W and ≤500 W	Outdoor	480 V	91.0.
16	>250 W and ≤500 W	Outdoor	All others	91.5.
17	>500 W and ≤2000 W	Indoor	480 V	For >500 W to <1000 W: 0.994 * (3.2 * 10∧(−3) * P + 89.9). For ≥1000 W to ≤2000 W: 92.5 and may not utilize a probe-start ballast.
18	>500 W and ≤2000 W	Indoor	All others	For >500 W to <1000 W: 3.2 * 10∧(−3) * P + 89.9. For ≥1000 W to ≤2000 W: 93.1 and may not utilize a probe-start ballast.
19	>500 W and ≤2000 W	Outdoor	480 V	For >500 W to <1000 W: 0.994 * (3.2 * 10∧(−3) * P + 89.9). For ≥1000 W to ≤2000 W: 92.5 and may not utilize a probe-start ballast.
20	>500 W and ≤2000 W	Outdoor	All others	For >500 W to <1000 W: 3.2 * 10∧(−3) * P + 89.9. For ≥1000 W to ≤2000 W: 93.1 and may not utilize a probe-start ballast.

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by Underwriters Laboratories (UL) 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

*** DOE's proposed definitions for ''indoor'' and ''outdoor'' metal halide lamp fixtures are described in section V.A.2.

† Input voltage for testing would be specified by the test procedures. Ballasts rated to operate lamps less than 150 W would be tested at 120 V, and ballasts rated to operate lamps ≥150 W would be tested at 277 V. Ballasts not designed to operate at either of these voltages would be tested at the highest voltage for which the ballast is designed to operate.

‡ P is defined as the rated wattage of the lamp that the fixture is designed to operate.

[2] DOE is proposing to continue using a ballast efficiency metric for regulation of metal halide lamp fixtures, rather than a system or other approach. See section III.B for further discussion.

A. Benefits and Costs to Customers

Table I.2 presents DOE's evaluation of the economic effects of the proposed standards on customers of metal halide lamp fixtures, as measured by the average life-cycle cost (LCC) savings and the median payback period (PBP). The average LCC savings are positive for a majority of users for all equipment classes. For example, the estimated average LCC savings are approximately $30 for fixtures operating a 400 W metal halide (MH) lamp in indoor and outdoor applications.

TABLE I.2—IMPACTS OF PROPOSED STANDARDS ON METAL HALIDE LAMP FIXTURE CUSTOMERS

Equipment class	Average LCC savings 2012$	Median payback period years
70 W (indoor, magnetic baseline)	38.41	4.2
70 W (outdoor, magnetic baseline)	46.44	4.4
150 W (indoor)	10.14	4.7
150 W (outdoor)	112.51	10.5
250 W (indoor)	13.12	11.8
250 W (outdoor)	13.75	14.0
400 W (indoor)	28.23	10.5
400 W (outdoor)	30.47	12.3
1000 W (indoor)	502.21	2.0
1000 W (outdoor)	409.02	3.0

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 (2013 to 2045). Using a real discount rate of 8.9 percent, DOE estimates that the INPV for manufacturers of metal halide ballasts ranges from $77 million in the low shipment-preservation of operating profit markup scenario to $127 million in the high shipment-flat markup scenario in 2012$. Under the proposed standards, DOE expects ballast manufacturers to lose up to 25.0 percent of their INPV, which is approximately $25.9 million, in the low shipment,-preservation of operating profit markup scenario. In the high shipment-flat markup scenario, DOE expects manufacturers to increase their INPV up to 3.7 percent, which is approximately $4.5 million. Using a real discount rate of 9.5 percent, DOE estimates that the INPV for manufacturers of metal halide lamp fixtures ranges from $523 million in the low shipment-preservation of operating profit markup scenario to $695 million in the high shipment-flat markup scenario in 2012$. Under the proposed standards, DOE expects fixture manufacturers to lose up to 3.2 percent of their INPV, which is approximately $17.3 million, in the low shipment-preservation of operating profit markup scenario. In the high shipment-flat markup scenario, DOE expects manufacturers to increase their INPV up to 10.3 percent, which is approximately $64.8 million. Additionally, based on DOE's interviews with the manufacturers of metal halide lamp fixtures, DOE does not expect any plant closings or significant loss of employment.

C. National Benefits

DOE's analyses indicate that the proposed standards would save a significant amount of energy. The lifetime savings for metal halide lamp fixtures purchased in a 30-year period (2016–2045) amount to 0.80–1.1 quads.

The cumulative national net present value (NPV) of total customer costs and savings of the proposed standards in 2012$ ranges from $0.95 billion (at a 7-percent discount rate) to $3.2 billion (at a 3-percent discount rate) for metal halide lamp fixtures. This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment costs for equipment purchased in 2016–2045, discounted to 2013.

In addition, the proposed standards would have significant environmental benefits. The energy savings would result in cumulative emission reductions of 49–65 million metric tons (Mt) [3] of carbon dioxide (CO_2), 214–289 thousand tons of methane (CH_4), 0.89–3.0 thousand tons of nitrous oxide (N_2O), 65–87 thousand tons of sulfur dioxide (SO_2), 66–90 thousand tons of nitrogen oxides (NO_X), and 0.11–0.15 tons of mercury (Hg).[4] [5]

The value of the CO_2 emissions 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.M.1. DOE estimates the net present monetary value of the CO_2 emissions reduction is between $0.33 and $4.7 billion, expressed in 2012$ and discounted to 2013. DOE also estimates the net present monetary value of the NO_X emissions reduction, expressed in 2012$ and discounted to 2013, is $45 million at a 7-percent discount rate, and $91 million at a 3-percent discount rate.[6]

Table I.3 summarizes the national economic costs and benefits expected to result from today's proposed standards for metal halide lamp fixtures.

[3] A metric ton is equivalent to 1.1 short tons. Results for CH_4, SO_2, NO_X and Hg are presented in short tons.

[4] DOE calculates emissions reductions relative to the Annual Energy Outlook (AEO) 2013 Reference case, which generally represents current legislation and environmental regulations for which implementing regulations were available as of December 31, 2012.

[5] DOE also estimated CO_2 and CO_2 equivalent (CO_2eq) emissions that occur by 2030 (CO_2eq includes greenhouse gases such as CH_4 and N_2O). The estimated emissions reductions by 2030 are 15–17 million metric tons CO_2, 1,471–1,627 thousand tons CO_2eq for CH_4, and 63–70 thousand tons CO_2eq for N_2O.

[6] DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it monetizes Hg in its rulemakings.

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF METAL HALIDE LAMP FIXTURE ENERGY CONSERVATION STANDARDS (PRIMARY (LOW SHIPMENTS) ESTIMATE)

Category	Present value million 2012$	Discount rate (percent)
Benefits		
Operating Cost Savings	1,848	7
	3,748	3
CO_2 Reduction Monetized Value ($12.9/t case) *	333	5
CO_2 Reduction Monetized Value ($40.8/t case) *	1,532	3
CO_2 Reduction Monetized Value ($62.2/t case) *	2,436	2.5
CO_2 Reduction Monetized Value (at $117/t case) *	4,689	3
NO_X Reduction Monetized Value (at $2,639/ton) **	45	7
	91	3
Total Benefits†	3,424	7
	5,371	3
Costs		
Incremental Installed Costs	897	7
	1,294	3
Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value	2,528	7
	4,076	3

* The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, 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. The values in parentheses represent the SCC in 2015. The SCC time series used by DOE incorporate an escalation factor.

** The value represents the average of the low and high NO_X values used in DOE's analysis.

† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC value with 3-percent discount rate.

The benefits and costs of today's proposed standards, for equipment sold between 2016 and 2045, can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value of the benefits from customer operation of equipment that meets the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing customer NPV), and (2) the annualized monetary value of the benefits of emissions reductions, including CO_2 emissions reductions.[7]

Although combining the values of operating savings and CO_2 emissions reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. customer monetary savings that occur as a result of market transactions, while the value of CO_2 emissions reductions is a global value. Second, the assessments of operating cost savings and CO_2 emissions savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of metal halide lamp fixtures shipped between 2016 and 2045. The SCC values, on the other hand, reflect the present value of some future climate-related impacts resulting from the emission of 1 ton of CO_2 in each year. These impacts will continue well beyond 2045.

Estimates of annualized benefits and costs of the proposed standards are shown in Table I.4. The results under the primary estimate are as follows. (All monetary values below are expressed in 2012$.) Using a 7-percent discount rate for benefits and costs other than CO_2 emissions reductions, for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of $40.8/ton in 2012$, the cost of the standards proposed in today's rule is $68.0 million per year in increased equipment costs, while the annualized benefits are $139 million per year in reduced equipment operating costs, $76 million in CO_2 emissions reductions, and $3.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $151 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of $40.8/ton in 2012$, the cost of the standards proposed in today's rule is $64 million per year in increased equipment costs, while the benefits are $186 million per year in reduced operating costs, $76 million in CO_2 emissions reductions, and $4.5 million in reduced NO_X emissions. In this case, the net benefit amounts to $202 million per year.

[7] 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 2013, the year used for discounting the NPV of total customer costs and savings, for the time-series of costs and benefits using discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 emissions reductions. For the latter, DOE used a range of discount rates, as shown in Table I.4. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2016 through 2045) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of costs and benefits from which the annualized values were determined is a steady stream of payments.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR METAL HALIDE LAMP FIXTURES

	Discount rate	Monetized Values [*million 2012$/year*]	
		Primary (low shipments) estimate *	High estimate *
Benefits			
Operating Cost Savings	7%	139	169
	3%	186	240
CO_2 Reduction Monetized Value ($12.9/t case) **	5%	21	26
CO_2 Reduction Monetized Value ($40.8/t case) **	3%	76	99
CO_2 Reduction Monetized Value ($62.2/t case) **	2.5%	114	149
CO_2 Reduction Monetized Value $117/t case) **	3%	232	303
NO_X Reduction Monetized Value (at $2,639/ton) **	7%	3.36	4.06
	3%	4.49	5.76
Total Benefits†	7% plus CO_2 range	163 to 375	200 to 476
	7%	218	272
	3%	266	344
	3% plus CO_2 range	211 to 422	272 to 548
Costs			
Incremental Equipment Costs	7%	68	81
	3%	64	80
Net Benefits/Costs			
Total †	7% plus CO_2 range	96 to 307	119 to 396
	7%	151	192
	3%	202	264
	3% plus CO_2 range	147 to 358	192 to 468

* This table presents the annualized costs and benefits associated with fixtures shipped in 2016 and 2045. These results include benefits to customers which accrue after 2045 from the fixtures purchased in 2016 to 2045. Costs incurred by manufacturers, some of which may be incurred prior to 2016 in preparation for the rule, are not directly included, but are indirectly included as part of incremental equipment costs. The Low (Primary) and High Estimates utilize forecasts of energy prices from the Energy Information Administration's 2012 *Annual Energy Outlook (AEO2013)* from the *AEO2013* Reference case, with the Low and High Estimates based on projected fixture shipments in the Low Shipments, Roll-up and High Shipments, Roll-up scenarios, respectively. In addition, all estimates use incremental equipment costs that reflect a declining trend for equipment prices, using *AEO* price trends (deflators). The derivation and application of price trends for equipment prices is explained in section V.F.

** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, 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. The values in parentheses represent the SCC in 2015. The SCC time series incorporate an escalation factor. The value for NO_X 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 series corresponding to average SCC with 3-percent discount rate. 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.

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

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

II. Introduction

The following section discusses the statutory authority underlying today's proposal, as well as some of the historical background related to the establishment of standards for metal halide lamp fixtures.

A. Authority

Title III, Part B of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles,[8] a program covering most major household appliances (collectively referred to as "covered products"). Amendments to EPCA have given DOE the authority to regulate the energy efficiency of several additional kinds of equipment, including certain metal halide lamp fixtures, which are the subject of this rulemaking. (42 U.S.C. 6292(a)(19)) EPCA, as amended by the Energy Independence and Security Act of 2007 (EISA 2007) prescribes energy conservation

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

standards for these products (42 U.S.C. 6295(hh)(1)), and directs DOE to conduct a rulemaking to determine whether to amend these standards. (42 U.S.C. 6295(hh)(2)(A)) (DOE notes that under 42 U.S.C. 6295(hh)(3)(A), the agency must review its already established energy conservation standards for metal halide lamp fixtures. Under this requirement, the next review that DOE would need to conduct must occur no later than January 1, 2019.)

Pursuant to EPCA, DOE's energy conservation program for covered products consists of four parts: (1) Testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6293) Manufacturers of covered products must use the prescribed DOE test procedures 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. The DOE test procedures for metal halide lamp fixtures currently appear at title 10 of the Code of Federal Regulations (CFR) §§ 431.323 and 431.324.

DOE must follow specific statutory criteria for prescribing amended standards for covered products. As indicated above, any amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) For certain products, including metal halide lamp fixtures, if no test procedures have been established for the product, or (2) if DOE determines by rule that the proposed standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must 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 (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 amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6295(o)(1)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of evidence that the standard is likely to result in the unavailability in the United States of any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States. (42 U.S.C. 6295(o)(4))

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedures. 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 that have the same function or intended use if DOE determines that 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. 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 the feature and other factors DOE deems appropriate. (42 U.S.C. 6294(q)(1)) Any rule prescribing such a standard must include an explanation of the basis on which such a 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, standards, and enforcement. (42 U.S.C. 6297(a)–(c)) DOE may, however, grant waivers of Federal preemption for particular state laws or regulations, in accordance with the procedures and other provisions set forth under 42 U.S.C. 6297(d)).

Finally, pursuant to the amendments contained in section 310(3) of EISA 2007, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) 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's current test procedures and standards for metal halide lamp fixtures address standby mode and off mode energy use. However, in this rulemaking, DOE only addresses active mode energy consumption as standby and off mode energy use are not applicable to the proposed scope of coverage.

DOE has also reviewed this regulation pursuant to Executive Order (E.O.) 13563, issued on January 18, 2011. 76 FR 3281, (Jan. 21, 2011). E.O. 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in E.O. 12866. To the extent permitted by law, agencies are required by E.O. 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 E.O. 13563 requires agencies ''to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible.'' In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include ''identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes.'' For the reasons stated in the preamble, DOE believes that today's NOPR 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 rulemaking, the energy efficiency standard proposed herein by DOE achieves maximum net benefits.

B. Background

1. Current Standards

EISA 2007 prescribed the current energy conservation standards for metal halide lamp fixtures manufactured on or after January 1, 2009. (42 U.S.C. 6295(hh)(1)) The current standards are set forth in Table II.1. EISA 2007 excludes from the standards: fixtures with regulated-lag ballasts, fixtures with electronic ballasts that operate at 480 volts (V); and fixtures that (1) are rated only for 150 W lamps; (2) are rated for use in wet locations; and (3) contain a ballast that is rated to operate at ambient air temperatures higher than 50 °C.

TABLE II.1—FEDERAL ENERGY EFFICIENCY STANDARDS FOR METAL HALIDE LAMP FIXTURES *

Ballast type	Operated lamp rated wattage range	Minimum ballast efficiency (percent)
Pulse-start	≥150 and ≤500 W	88
Magnetic Probe-start	≥150 and ≤500 W	94
Nonpulse-start Electronic	≥150 and ≤250 W	90
Nonpulse-start Electronic	≥250 and ≤500 W	92

* (42 U.S.C. 6295(hh)(1)).

2. History of Standards Rulemaking for Metal Halide Lamp Fixtures

DOE is conducting this rulemaking to review and consider amendments to the energy conservation standards in effect for metal halide lamp fixtures, as required under 42 U.S.C. 6295(hh)(2) and (4). On December 30, 2009, DOE published a notice announcing the availability of the framework document, ''Energy Conservation Standards Rulemaking Framework Document for Metal Halide Lamp Fixtures,'' and a public meeting to discuss the proposed analytical framework for the rulemaking. 74 FR 69036. DOE also posted the framework document on its Web site; this document is available at *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49.* The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for metal halide lamp fixtures, and identified various issues to be resolved in conducting this rulemaking.

DOE held a public meeting on January 26, 2010, during which 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. At the meeting and during the period for commenting on the framework document, DOE received comments 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 metal halide lamp fixtures. On April 1, 2011, DOE published in the **Federal Register** an announcement (the April 2011 notice) of the availability of the preliminary technical support document (the preliminary TSD) and of another public meeting to discuss and receive comments on the following matters: (1) The equipment classes DOE planned to analyze; (2) the analytical framework, models, and tools that DOE was using to evaluate standards; (3) the results of the preliminary analyses performed by DOE; and (4) potential standard levels that DOE could consider. 76 FR 1812 (April 1, 2011). In the April 2011 notice, DOE requested comment on issues that would affect energy conservation standards for metal halide lamp fixtures or that DOE should address in this notice of proposed rulemaking (NOPR). The preliminary TSD is available at *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49.*

The preliminary TSD summarized the activities DOE undertook in developing standards for metal halide lamp fixtures, and discussed the comments DOE received in response to the framework document. It also described the analytical framework that DOE uses in this rulemaking, including a description of the methodology, the analytical tools, and the relationships among the various analyses that are part of the rulemaking. The preliminary TSD presented and described in detail each analysis DOE performed up to that point, including descriptions of inputs, sources, methodologies, and results. These analyses were as follows:

• A *market and technology assessment* set the scope of this rulemaking, identified the potential equipment classes for metal halide lamp fixtures, characterized the markets for this equipment, and reviewed techniques and approaches for improving their efficiency;

- A *screening analysis* reviewed technology options to improve the efficiency of metal halide lamp fixtures, and weighed these options against DOE's four prescribed screening criteria;
- An *engineering analysis* estimated the manufacturer selling prices (MSPs) associated with more energy-efficient metal halide lamp fixtures;
- An *energy-use analysis* estimated the annual energy use of metal halide lamp fixtures;
- A *markups analysis* converted estimated MSPs derived from the engineering analysis to customer prices;
- A *life-cycle cost (LCC) analysis* calculated, for individual customers, the discounted savings in operating costs throughout the estimated average life of the equipment compared to any increase in installed costs likely to result directly from the imposition of a given standard;
- A *payback period (PBP) analysis* estimated the amount of time it would take individual customers to recover the higher purchase expense of more energy-efficient products through lower operating costs;
- A *shipments analysis* estimated shipments of metal halide lamp fixtures over the time period examined in the analysis. This was then used in the national impact analysis (NIA);
- A *national impact analysis* assessed the national energy savings, and the national net present value of total customer costs and savings, expected to result from specific, potential energy conservation standards for metal halide lamp fixtures; and
- A *preliminary manufacturer impact analysis (MIA)* began evaluating the effects on manufacturers of amended efficiency standards.

The public meeting announced in the April 2011 notice took place on April 18, 2011 (April 2011 public meeting). At this 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: (1) Alternative approaches to performance requirements and the various related efficiency metrics; (2) the possibility of including design standards; (3) amendments to the test procedures for metal halide ballasts to account for multiple input voltages; (4) the cost and feasibility of utilizing electronic ballasts in metal halide lamp fixtures; (5) equipment class divisions; (6) overall pricing methodology; (7) lamp lifetimes; (8) cumulative regulatory burden; (9) shipments; and (10) the possibility of merging the metal halide lamp fixture and the high-intensity discharge (HID) lamp rulemakings. This NOPR responds to the issues raised in the comments received since publication of the April 2011 notice, including those received at the April 2011 public meeting.

3. Compliance Date

EPCA, as amended by EISA 2007, contains guidelines for the compliance date of the standards amended by this rulemaking. EPCA requires DOE to determine whether to amend the standards in effect for metal halide lamp fixtures and whether any amended standards should apply to additional metal halide lamp fixtures. The Secretary was directed to publish a final rule no later than January 1, 2012 to determine whether the energy conservation standards established by EISA 2007 for metal halide lamp fixtures should be amended, with any amendment applicable to products manufactured after January 1, 2015. (42 U.S.C. 6295(hh)(2)(B))

III. Issues Affecting the Scope of This Rulemaking

A. Additional Metal Halide Lamp Fixtures for Which DOE Is Proposing Standards

As noted in section II.B.1, the existing energy conservation standards for metal halide lamp fixtures are established in EPCA through amendments made by EISA 2007. (42 U.S.C. 6295(hh)(1)(A)) EISA 2007 prescribed energy conservation standards for metal halide lamp fixtures by setting minimum ballast efficiency requirements for fixtures manufactured after January 1, 2009. Currently, coverage is limited to certain rated wattages of lamps used in metal halide lamp fixtures (150 W to 500 W). Such fixtures must be equipped with a ballast that has a designated starting method (pulse-start or probe-start) and electronic configuration (magnetic or electronic). However, the statute excludes from coverage metal halide lamp fixtures with regulated-lag ballasts,[9] electronic ballasts that operate at 480 V, and fixtures that: (1) Are rated only for 150 W lamps, (2) are rated for use in wet locations,[10] and (3) contain a ballast that is rated to operate at ambient air temperatures greater than 50 °C.[11] (42 U.S.C. 6295(hh)(1)(A)).

In the preliminary TSD, DOE requested comment from interested parties on the scope of energy conservation standards rulemaking for metal halide lamp fixtures. DOE received several comments related to expanding the scope to include fixtures exempted by EISA 2007, fixtures designed to be operated with additional rated lamp wattages, and the definition of a general lighting application.

1. EISA 2007 Exempted Metal Halide Lamp Fixtures

DOE considered expanding its energy conservation standards to cover metal halide lamp fixtures exempted by EISA 2007, including fixtures with regulated-lag ballasts; electronic ballasts that operate at 480 V; and ballasts that are rated only for (1) use with 150 W lamps, (2) use in wet locations, and (3) operation in ambient air temperatures higher than 50 °C. (42 U.S.C. 6295(hh)(1)(B))

Fixtures With Regulated-Lag Ballasts

In the preliminary analysis, DOE tentatively decided to continue the exemption for regulated-lag ballasts. Through information gathered in manufacturer interviews and market research, DOE determined that regulated-lag ballasts are mainly used for specialty applications where line voltage variation is large. Regulated-lag ballasts are designed to withstand significant line voltage variation with minimum wattage variation to the lamp, which results in an efficiency penalty compared to ballasts whose output changes more significantly with line voltage variation. To be able to withstand large variations, regulated-lag ballasts are currently designed to be significantly larger than standard ballasts, and as a result exhibit poor efficiency. According to manufacturers and market research, EISA 2007's exemption did not lead to a significant market shift to regulated-lag ballasts.

The Appliance Standard Awareness Project (ASAP) encouraged DOE to consider coverage for regulated-lag ballasts. While ASAP stated that they understood that regulated-lag ballasts may be inherently less efficient, they suggested a separate equipment class with a lower standard might be more appropriate than no standard. They also stated that little information about the market for regulated-lag ballasts is available. (ASAP, Public Meeting Transcript, No. 33 at p. 24)[12] DOE

[9] 'Regulated lag ballast' means ballasts designed to withstand significant line voltage variation with minimum wattage variation to the lamp.

[10] Specifications for ''wet locations'' are from the National Electrical Code 2002, section 410.4(A).

[11] Specifications for ballasts that operate at ambient air temperatures above 50 °C are found in UL 1029–2001.

[12] A notation in the form ''ASAP, Public Meeting Transcript, No. 33 at p. 24'' identifies a comment that DOE has received and included in the docket of this rulemaking. This particular notation refers to a comment: (1) Submitted by ASAP during the

conducted additional research on regulated-lag ballasts and found none of these products available in major manufacturers' catalogs. DOE assumed that absence from catalogs indicates a very small market share, and concluded that there was no potential for significant energy savings through inclusion of these products in the scope of coverage. In addition, DOE continues to agree with the preliminary analysis that the size and weight of regulated-lag ballasts prohibit their use as substitutes in traditional applications. For the NOPR, DOE proposes to continue exempting from energy conservation standards fixtures that include regulated-lag ballasts and requests comment on this proposal.

Fixtures With 480 V Electronic Ballasts

In the preliminary analysis, DOE also considered continuing the exemption of 480 V electronic ballasts based on their unavailability in the market. In its comments, Empower Electronics disagreed with the exemption, stating that 347 V and 480 V electronic ballasts for metal halide lamps are now feasible, and suggested that regulations could help the maturation of these technologies. (Empower Electronics, No. 36 at pp. 3–4) [13] Following additional research for the NOPR, DOE did identify one manufacturer of 480 V electronic ballasts, but determined that these ballasts have a very small market share based on their limited availability from distributors and only being manufactured by one company. Therefore, DOE concluded that there is no potential for significant energy savings and proposes to continue exempting fixtures that use 480 V electronic ballasts until DOE has an opportunity to analyze commercially available products. DOE requests comment on this proposal.

Exempted 150 W Fixtures

In the preliminary analysis, DOE considered eliminating the current exemption for 150 W outdoor fixtures rated for wet and hot locations because these products could be made more efficient and have the potential for significant energy savings. Shipments for these exempted 150 W fixtures increased in response to the EISA 2007 regulations (a shift from 175 W fixtures), further increasing the potential energy savings for regulations targeted at this product type. In addition, DOE found that many fixtures commonly used indoors (high- and low-bay fixtures for high-ceiling buildings) meet the high-temperature requirements and have the option of being rated for wet locations. DOE preliminarily concluded that some fixtures used indoors were using the exemption designed for outdoor fixtures, negating possible energy savings for indoor 150 W fixtures. DOE requested comment on the impact of eliminating the exemption for 150 W outdoor fixtures rated for wet and high-temperature locations.

The National Electrical Manufacturers Association (NEMA), Philips Lighting Electronics (Philips), and Georgia Power commented that the wet-location and high-temperature outdoor 150 W fixture exemption was created in part to move the market from the popular 175 W ballast to the 150 W ballast, and lead to energy savings through a wattage reduction, and therefore does not constitute a loophole. (NEMA, No. 34 at p. 4; Philips, Public Meeting Transcript, No. 33 at pp. 24–25; Georgia Power, No. 28 at p. 1) NEMA stated that this exemption is critical for outdoor lighting ballasts because 150 W magnetic ballasts cannot meet the 88 percent EISA 2007 requirement. NEMA contended that the power savings realized by shifting from 175 W lamps to 150 W lamps, and the risk that the market would migrate back to 175 W without the exemption, far outweigh any additional savings generated by requiring that 150 W ballasts meet a ballast efficiency requirement. (NEMA, No. 34 at p. 4) DOE disagrees with NEMA that the removal of the exemption will result in a shift to 175 W fixtures. DOE is not required to set the standard for 150 W fixtures at or above the 88 percent minimum set by EISA 2007. Because these fixtures were not previously covered, setting a less stringent standard than 88 percent would not constitute backsliding and has the potential to save significant energy. DOE would analyze efficiency levels for 150 W fixtures according to the same criteria it uses for all other wattages. Section V.C.9 describes the efficiency levels under consideration in the NOPR for 150 W fixtures.

Northwest Energy Efficiency Alliance (NEEA) commented that there is no reason to continue the exclusion for fixtures rated for wet locations and ambient temperatures higher than 50 °C. If electronic ballasts with their higher efficiencies cannot be utilized in these fixtures, NEEA suggested placing them in a separate class for standards purposes rather than excluding them from coverage. (NEEA, No. 31 at pp. 1, 3) ASAP and, in a joint comment, Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Gas Company, and Southern California Edison (hereafter the ''California Investor-Owned Utilities'' [CA IOUs]) also supported the coverage of 150 W fixtures because the exemption may have become a loophole. (ASAP, Public Meeting Transcript, No. 33 at p. 23; CA IOUs, No. 32 at p. 1)

DOE agrees that these 150 W ballasts should be covered by this rulemaking and notes that the criteria for the scope of coverage for this rulemaking is defined as technology which is technologically feasible, economically justified, and has the potential for significant energy savings. Because a range of ballast efficiencies exist or are achievable in commercially available ballasts, DOE believes that improving the efficiencies of ballasts in 150 W fixtures in wet locations and high ambient temperatures is technologically feasible. DOE's analysis indicates that removing the wet-location and high-ambient-temperature 150 W fixture exemption has the potential for energy savings and is economically justified. Therefore, in this NOPR, DOE proposes to remove the exemption for fixtures that are rated only for use with 150 W lamps, wet environments, and in ambient temperatures greater than 50 °C and include these fixtures in the scope of coverage. DOE requests comment on this proposal.

2. Additional Rated Lamp Wattages

During the preliminary analysis, DOE considered expanding its coverage of energy conservation standards to include metal halide lamp fixtures that operate lamps rated from 50 W to 150 W and fixtures that operate lamps rated greater than 500 W. DOE's review of ballast manufacturer catalogs (an indication of product availability) showed many types of metal halide ballasts for fixtures operating lamps rated outside the currently regulated wattage range. The catalogs showed that approximately 30 percent (by number of products, not by market share) of available metal halide ballasts are designed for lamps rated less than 150 W and approximately 13 percent of available metal halide ballasts are designed for lamps rated greater than 500 W. Due to the number of ballasts outside of the existing scope of coverage, DOE believed that there was potential for significant energy savings and considered including fixtures designed to operate lamps with rated

public meeting on April 18, 2011; (2) in the transcript of that public meeting, document number 33 in the docket of this rulemaking; and (3) appearing on page 24 of the transcript.

[13] A notation in the form ''Empower Electronics, No. 36 at pp. 3–4'' identifies a written comment that DOE has received and included in the docket of this rulemaking. This particular notation refers to a comment: (1) Submitted by Empower Electronics; (2) in document number 36 of the docket; and (3) on pages 3 to 4 of that document.

wattage ≥50 W in the analysis. DOE received comment on expanding the scope to fixtures that operate lamps rated from 50 W to 150 W and fixtures that operate lamps rated greater than 500 W.

In response to request for comment in the preliminary TSD, NEMA suggested that there is little energy savings to be realized by regulating fixtures for the 50 W to 150 W range due to their low energy usage and the movement of the market to the greater than 150 W power range. (NEMA, Public Meeting Transcript, No. 34 at p. 13) ASAP, NEEA, the CA IOUs, Empower Electronics, and Progress Energy Carolinas supported the expansion of scope to the greater than 50 W and less than 150 W range discussed in the preliminary TSD. (ASAP, Public Meeting Transcript, No. 33 at p. 23; NEEA, No. 31 at p. 1; CA IOUs, No. 32 at p. 1; Empower Electronics, No. 36 at p. 3; Progress Energy Carolinas, No. 24 at p. 2) DOE conducted testing within the 50 W to 150 W range and identified varying efficiencies within a single wattage, which suggests that standards to improve the least-efficient ballasts are technologically feasible. Furthermore, as discussed in section VI.B.3, DOE determined that standards for this wattage range have the potential for significant energy savings. Therefore, DOE proposes to include fixtures designed to operate lamps rated ≥50 W and <150 W.

DOE also received comment on the greater than 500 W equipment class. Georgia Power stated that regulating high wattages (such as 1000 W and 1500 W) would save little energy at significant cost. (Georgia Power, No. 28 at p. 2) ASAP, NEEA, the CA IOUs, Empower Electronics, and Progress Energy Carolinas, however, agreed with DOE's preliminary findings and supported the expansion of scope to the >500 W range discussed in the preliminary TSD. (ASAP, Public Meeting Transcript, No. 33 at p. 23; NEEA, No. 31 at p. 1; CA IOUs, No. 32 at p. 1; Empower Electronics, No. 36 at p. 3; Progress Energy Carolinas, No. 24 at p. 2) In terms of technological feasibility, NEMA stated that the ballasts included in high-wattage fixtures are already up to 92 percent efficient. NEMA took the position that because this efficiency is comparable to the efficiencies of lower-wattage equipment with the highest-grade components, it would be difficult, if not impossible, to define energy efficiency requirements that would result in appreciable savings. Still, NEMA supported DOE's determination that ballasts greater than 500 W were within the scope of DOE's authority for preclusion of ''state-by-state'' rulemaking through preemption (NEMA, No. 34 at p. 3) In terms of potential for significant energy savings, NEMA noted that market estimates for greater-than-500–W ballasts are on the order of 15 percent, while the total energy use for equipment in this power range is estimated to be as high as 40 percent of the total of installed metal halide lamp fixtures. Id.

DOE agrees that the greater-than-500–W ballasts have higher efficiencies than the lower-wattage equipment. However, based on test data, DOE still found a range of efficiencies present in commercially available ballasts, indicating technological feasibility. DOE also verified NEMA's comment that these high-wattage products have fewer shipments than the lower-wattage products included in this rulemaking, but they consume more energy per installation. DOE's analysis indicates that regulation of these higher wattages could be economically justified and has the potential for significant energy savings. Finally, based on review of product catalogs, DOE determined that fixtures rated for use with lamps rated for wattages greater than 2000 W served small-market-share applications like graphic arts, ultraviolet curing, and scanners. Therefore, DOE proposes not to include fixtures rated for wattages greater than 2000 W in this rulemaking. In summary, because DOE finds economic justification and potential energy savings in regulating ballasts greater than 500 W and less than or equal to 2000 W, DOE proposes that these fixtures be included in the scope of this rulemaking. DOE requests comment on this proposal.

3. General Lighting

EISA 2007 defines the scope of this rulemaking as applying to fixtures used in general lighting applications. (42 U.S.C. 6291(64)) In section 2 of 10 CFR Part 430, Subpart A, a general lighting application is defined as lighting that provides an interior or exterior area with overall illumination. DOE is proposing to add this definition to 10 CFR 431.2,[14] the section of the CFR that relates to commercial and industrial equipment. DOE applies this definition to determine which lighting applications DOE has the authority to cover.

[14] The general lighting application definition prescribed by EISA 2007 was previously incorporated into the consumer products section (10 CFR Part 430), but has not yet been added to the commercial and industrial equipment section (10 CFR Part 431).

NEMA and OSRAM SYLVANIA (OSI) recommended capping the greater-than-500 W class at 1000 W because 1000 W is the highest wattage used for general lighting applications, arguing that DOE does not have authority to consider higher wattages. (NEMA, No. 34 at pp. 13–14; OSI, No. 27 at p. 4) OSI also commented that metal halide systems are also used in specialty applications such as stage, theater, television, film, solar simulation, airfield, medical/surgical, microscope, endoscope, video projection, display, treatment of skin disorders, sports, and automotive. OSI recommended that these specialized applications be excluded from this rulemaking. (OSI, No. 27 at p. 7)

DOE's research indicated that there are a number of fixtures available for general lighting applications above 1000 W. The primary application of such fixtures is outdoor sports lighting, which commonly uses metal halide ballasts of 1000 W to 2000 W. Because sports lighting provides overall illumination to an exterior area (playing field and stadium), DOE believes sports lighting does meet the definition of a general lighting application. While DOE agrees that some special applications listed by OSI do not fit under the covered general illumination definition, others, such as sports and airfield lighting, do provide general illumination to an exterior area and are covered by this rulemaking. DOE requests comment on this proposal.

4. Summary

DOE proposes to include metal halide lamp fixtures designed to operate ballasts rated from 50 W to 2000 W and for use in general lighting applications in the scope of coverage. EISA 2007 exempted specific metal halide lamp fixtures from regulation. These included (a) fixtures that include regulated-lag ballasts, (b) fixtures that include 480 V electronic metal halide ballasts, and (c) fixtures that include lamps rated at 150 W with ballasts that (1) are rated for use in wet locations and (2) contain a ballast that is rated to operate at ambient air temperatures greater than 50 °C. In this rulemaking, DOE proposes to continue the exemption for the first two categories (regulated-lag ballasts and 480 V electronic ballasts) but not for the third, certain 150 W fixtures. DOE finds that regulating these 150 W ballasts could provide considerable potential energy savings and would be economically justifiable. As such, DOE proposes that the 150 W ballasts rated for use in wet locations and containing a ballast that is rated to operate at ambient air temperatures greater than 50 °C be covered in this rulemaking.

B. Alternative Approaches to Energy Conservation Standards: System Approaches

EISA 2007 requires DOE to set standards for metal halide lamp fixtures. (42 U.S.C. 6295(hh)(2)) As previously stated, although metal halide lamp fixtures usually comprise a metal halide lamp, a metal halide ballast, and other fixture components, EPCA established MHLF energy conservation standards by setting minimum efficiency requirements for only the ballast. For the preliminary analysis, DOE considered three system approaches as alternatives to regulating only ballast efficiency. The first was a lamp and ballast system approach in which the lamp and ballast would be rated together in terms of lumens per lamp-ballast system watts. The second was a whole fixture system approach in which the ballast, lamp, and optics/enclosure would all be rated together in terms of a fixture-level metric such as Fitted Target Efficacy (FTE) or Target Efficacy Rating (TER). The third was an approach similar to California Title 20, which allowed for multiple compliance pathways utilizing a combination of design standards, ballast efficiency standards, and lamp wattage requirements. DOE received several comments on these three system approaches.

In general, interested parties recognized the potential value for system approaches over a ballast efficiency approach, but also noted several limitations related to each possible approach. NEEA supported systems approaches to rating equipment, but did not find any of the three specific approaches discussed in the preliminary analysis to be practicable to implement. (NEEA, No. 31 at p. 2) Philips stated that, generally, NEMA considers the system approach to be the preferred approach for any rulemaking. (Philips, Public Meeting Transcript, No. 33 at p. 32) Philips noted that a system approach is an extremely complex issue and pointed out that there are other metrics beyond those that DOE listed as under consideration. (Philips, Public Meeting Transcript, No. 33 at pp. 36–37) DOE found that the three system approaches considered in the preliminary TSD have the theoretical potential of saving more energy than the current ballast-only approach, but also have many practical limitations. DOE weighed the benefits and drawbacks of each system approach, but for this rulemaking, DOE proposes a ballast-efficiency approach consistent with the current EISA 2007 regulations. DOE discusses each of the system approaches in the following sections. DOE also discusses the possibility of a coordinated metal halide lamp fixture and high-intensity discharge lamp rulemaking in section III.C as an additional approach to considering all aspects of the metal halide lighting system when considering energy conservation standards.

1. Lamp-Ballast System

In the lamp-ballast system approach, metal halide lamp fixtures would be regulated on the basis of a lumens-per-watt metric that assesses the performance of the lamp and ballast included in the fixture. Fixture manufacturers would be required to report the system lumens per watt (lm/W) of every lamp and ballast pair included in their fixtures. This approach has the potential to save more energy and allow more design flexibility for manufacturers. However, this approach is somewhat at odds with current fixture sales practices. Fixture manufacturers commonly ship fixtures with the ballast installed to ensure that the fixture is compliant with fire safety requirements and meets energy conservation standards. There are currently no requirements for fixtures to be shipped with certain lamps, and in general, fixture manufacturers noted that few fixtures are sold with lamps, giving customers flexibility to choose lamps from a variety of manufacturers. In a lamp-ballast system approach, fixture manufacturers would be required to provide fixtures with installed lamps and ballasts, and customers would be limited to predetermined lamp and ballast combinations.

During preliminary interviews, DOE found that there are several metal halide ballast manufacturers that do not manufacture metal halide lamps. In a lamp-ballast system approach, these manufacturers could have a competitive disadvantage compared with manufacturers that manufacture both lamps and ballasts. Manufacturers said that for fixture manufacturers that are not vertically integrated (*i.e.,* fixture manufacturers that do not also produce lamps and ballasts), sourcing lamp and ballast systems is problematic as only a few manufacturers have the capability to provide them. Non-vertically-integrated manufacturers also said that they would not have the same ability to optimize the fixtures as their lamp and ballast-manufacturer competitors. Based on the concern that some manufacturers would be at a disadvantage to their vertically integrated competitors and that fixtures are typically not shipped with lamps, DOE preliminarily determined that ballast efficiency was a better approach than lamp-ballast systems.

NEMA described the pros and cons of a simple lumens-per-watt standard based on a lamp-ballast system. NEMA stated that this methodology provides more technological flexibility and can yield overall higher performance by including the effect of lamp efficacy. On the other hand, NEMA stated that there are compatibility issues with operation of certain lamp and ballast pairs. While some of these compatibility issues would be resolved through use of a database, that database would require management by the industry, which represents additional cost and a reporting burden if manufacturers are required to report on various lamp and ballast combinations. It also might require manufacturers to transport mercury (if DOE mandates that a fixture be sold with a lamp). (NEMA, No. 34 at p. 5)

Georgia Power and NEEA commented on the practical limitations of a lamp-ballast system approach. Georgia Power pointed out that utilities buy lamps and fixtures separately and strive to minimize the number of lamp types that they must stock to use in new and existing fixtures. Georgia Power said that matching different lamps to different ballasts of the same wattage would be costly and very confusing. Additionally, Georgia Power noted that training the installers and relampers would be costly and impractical for the utilities. (Georgia Power, No. 28 at p. 1) NEEA commented that because there is no way to control which replacement lamps are used after the initial lamp fails, real system energy savings may be smaller than forecasts that assume an equivalent lamp is used as a replacement. (NEEA, No. 31 at p. 2)

With regards to lamp-ballast compatibility concerns with a lamp-ballast approach to setting standards, OSI commented that lamp and electronic ballast manufacturers already maintain lists of compatible products, indicating a lamp-ballast approach would not create additional burden. OSI stated that NEMA's main concern is with high-frequency electronic ballasts operating high-wattage lamps. As noted in section V.C.8, these ballasts can create acoustic resonance problems with lamps. The issue is further complicated by the fact that different lamps have different acoustic resonance points. OSI noted that NEMA has assembled a task force on lamp and electronic ballast compatibility issues, and the task force is close to finalizing compatibility test procedures. Once finalized, each manufacturer will conduct testing based on the procedure to determine compatibility with other products. OSI recommended that all electronic metal halide ballasts be designed to meet existing American National Standards Institute (ANSI) standards based on magnetic operation. This redesign will help assure lamp and ballast compatibility. (OSI, No. 27 at p. 7)

In the preliminary TSD, DOE also considered a 'table of standard lamps' for use in a lamp-ballast system standard approach. The use of a table of standard lamps would allow for fixture performance to be assigned to all fixtures, including those not shipped with lamps. This table of standard lamps would allow for conversion of tested ballast efficiency to lumens per watt for determination of compliance with a lamp-ballast system standard, mitigating the potential for lost competitive advantage for ballast-only manufacturers. NEEA commented that they did not agree that a table of standard lamps (and a lamp-ballast system approach without a table of standard lamps) would adequately control which replacement lamps are used in fixtures. (NEEA, No. 31 at p. 2)

DOE recognizes these positive and negative aspects of the lamp and ballast approach (both with and without the table of standard lamps) and has weighed them carefully and tentatively decided not to propose this approach. DOE found that a lamp and ballast system approach might be burdensome due to unresolved compatibility and compliance issues related to specifying performance of every lamp and ballast combination sold. DOE tentatively agrees with Georgia Power's concern that some users could need to stock multiple lamps for pairing with different manufacturers' ballasts of the same wattage, unless they were willing to place all of their lamp and ballast orders from a single supplier. Additionally, once the original lamp fails, customers may replace it with a lower-efficacy alternative. A lamp-ballast system approach could also complicate defining categories and classes. In regards to a lamp-ballast system approach with a table of standard lamps, DOE agrees with NEEA that such a table would not address customers using less-efficacious replacement lamps and does not provide an adequate improvement over a traditional lamp-ballast system approach or a simple ballast efficiency approach. Though inclusion of the table could be more equitable for ballast-only manufacturers, it is still hindered by compliance and compatibility issues, and would likely result in less energy savings than a pure lamp-ballast system approach.

2. Fixtures Systems—Lamp, Ballast, Optics, and Enclosure

For the preliminary TSD, DOE analyzed fixture-level metrics by conducting independent research and interviewing manufacturers. DOE found that fixture energy use depends on four variables: (1) Lamp efficacy; (2) ballast efficiency; (3) light absorption by the fixture; and (4) usefulness of light emitted by the fixture (direction or light distribution pattern). DOE considered two alternative metrics to quantify these areas of importance, namely FTE and TER. DOE drafted the FTE metric for the solid-state lighting (SSL) ENERGY STAR® program. NEMA, along with its luminaire division, developed TER. FTE and TER metrics treat each fixture-energy-use area of importance more effectively in some ways than others.

The FTE metric measures the fixture performance by fitting a rectangle to a uniform "pool" of light for each fixture, then multiplying the lumens delivered to this pool by the percent coverage of the rectangular target, and dividing the result by input watts to the fixture. Because FTE was developed for roadway and parking lot applications, separate algorithms for each respective application would need to be calculated and verified. As FTE is calculated using a rectangular area, a fixture that is designed to (1) light a non-rectangular area, (2) produce a large amount of unlighted area within the rectangle, or (3) produce specific light patterns that light both a horizontal plane and a vertical plane, or even above the fixture, will be at a disadvantage.

TER involves calculating fixture efficacy by multiplying the light leaving the fixture by the Coefficient of Utilization (CU), which factors in the distribution of light, room geometry, and room surface reflectances. CU represents the percentage of rated lamp lumens reaching the workplane. The calculation of efficacy for TER also takes into account lamp and ballast efficiency. TER has 22 different types of luminaire classifications, each with a different TER calculation method and value,[15] though every classification is not applicable to metal halide lamp fixtures.

For the preliminary TSD, DOE tentatively decided not to implement either FTE or TER. DOE found that FTE only accounts for light hitting the specified test area and does not take into account other surfaces that the fixture is designed to light. This methodology disadvantages fixture types not designed to light a uniform, flat, rectangular space. DOE tentatively decided not to use TER out of concern that certain fixtures could fall within multiple categories of fixture due to their designs. Because of the need for uniformity and more simplicity, DOE preliminarily found TER unsuitable this rulemaking. The following discussion describes the comments DOE received about the use of these metrics.

Georgia Power and Progress Energy Carolinas suggested that TER and FTE were better metrics than the current ballast-efficiency metric because they address the optical performance of the entire fixture, accounting for light directionality and losses. (Georgia Power, No. 28 at p. 1; Progress Energy Carolinas, No. 24 at p. 1) However, NEEA commented that it did not believe that FTE or TER is appropriate as the basis for energy efficiency standards at this time. NEEA stated that either approach could be used as a design optimization framework, but both have sufficient drawbacks and lack of field implementation experience that render them unusable as the basis for a minimum efficiency standard. (NEEA, No. 31 at p. 2) NEMA agreed with the preliminary TSD, stating that because this rulemaking covers all types of products (*e.g.,* downlights, track lighting, industrial highbay/lowbay, streetlighting, roadway lighting, floodlights, parking lots, parking garages), it is challenging to define a metric that effectively covers all applications without flawed assumptions. Specifically, NEMA pointed out that none of the metrics considered covers equipment that is designed to be aimed or tilted. (NEMA, No. 34 at p. 6) Both NEEA and Empower Electronics also supported DOE's determination from the preliminary TSD not to use either FTE or TER. (NEEA, No. 31 at p. 2; Empower Electronics, No. 36 at p. 4)

Though a fixture-level metric has the potential to save the most energy, DOE does not believe an approach currently exists that adequately assesses the types of metal halide lamp fixtures included in this rulemaking. Because FTE is focused on applications that deliver light to a horizontal space and a TER standard would require fixture classifications that have not yet been developed, DOE has determined that ballast efficiency is a better approach at this time. Therefore, DOE does not find fixture-level metrics practicable for setting standards for this equipment at this time, and proposes not to use a system-approach metric in this rulemaking.

[15] There are two main calculation methods—one for indoor and one for outdoor applications. The methods are then customized to each classification.

3. California Title 20 Approach

California's Title 20 [16] includes regulations that aim to reduce energy consumption in appliances, including metal halide lamp fixtures.[17] For metal halide lamp fixtures, Title 20 requires compliance through one of four primary paths: (1) The use of lamps from reduced-wattage bins with a minimum 88 percent efficient ballast; (2) an integrated motion sensor and high-low control with a minimum 88 percent efficient ballast; (3) an integrated daylight sensor and high-low control (for indoor only) with a minimum 88 percent efficient ballast; and (4) high-efficiency ballasts with a minimum efficiency of 90 percent for 150 W to 250 W lamps or 92 percent for 251 W to 500 W lamps. In the preliminary TSD, DOE requested comment on the implementation of a similar approach, with multiple options for compliance, including the integration of controls.

Several commenters gave direct feedback on the Title 20 approach. Energy Solutions supported DOE's consideration of a Title 20 or Title-20-like approach. (Energy Solutions, Public Meeting Transcript, No. 33 at p. 39) NEMA and Acuity Brands Lighting (Acuity) stated that although it also adds complexity to the associated enforcement and reporting, the Title 20 approach provides flexibility for manufacturers and designers. Additionally, NEMA and Acuity noted that the Title 20 requirement for 336 W to 500 W reduced-wattage lamps to produce 80 lm/W is not currently achievable. Acuity requested that DOE not consider these lamp specifications, and stated that they have been working with the California Energy Commission (CEC) to correct that efficacy level. (NEMA, No. 34 at p. 6; Acuity, Public Meeting Transcript, No. 33 at p. 41)

NEMA and Philips then addressed regulations that consider lamps and ballasts simultaneously for analysis, but assign performance metrics to each component individually. NEMA commented that they would support regulation that allows for lower ballast efficiency requirements in conjunction with higher lamp efficacy requirements. However, NEMA noted that a requirement to ship high-efficacy lamps in new fixtures would not prevent future replacement of these lamps with lower-efficacy alternatives. (NEMA, No. 34 at p. 5) Philips noted that it is possible to specify certain lamps for particular fixtures through an Underwriters Laboratories (UL) listing. Philips explained that if a ballast and a fixture are labeled for a particular lamp, then that fixture would only keep its UL listing when that lamp is used. This could mitigate the risk that the type of lamp originally packaged with the fixture would be replaced with a less-efficacious alternative. Additionally, Philips pointed out that for ENERGY STAR and fluorescent lamps, NEMA has maintained a table of corresponding lamp and ballast efficacies so that fixture manufacturers can easily select compliant products. Philips suggested that DOE could create a similar database for this rulemaking. (Philips, Public Meeting Transcript, No. 33 at pp. 33–34)

DOE also received many comments on the controls and dimming compliance pathways of the Title 20 approach. The CA IOUs noted that dimming and occupancy controls can greatly reduce the overall electricity consumption of a lighting system. The CA IOUs stated that many electronic ballasts in the 150 W to 575 W range include dimming circuitry. (CA IOUs, No. 32 at p. 5) OSI agreed that the use of dimming as an energy-saving tool is growing. OSI clarified that it is actually easier to develop an electronic metal halide dimming ballast than a magnetic one; and the electronic ballast will provide more utility for the end user. (OSI, No. 27 at p. 3) The CA IOUs specifically noted that for outdoor fixtures, from a public safety standpoint, dimming can be prohibitively slow in magnetic ballasts. However, there are commercially available electronically ballasted systems with appropriate response times that are much better suited for the transition towards fully controllable and dimmable fixtures. (CA IOUs, No. 32 at p. 5)

Several commenters provided feedback on the relative merits of electronic metal halide lamp dimming, magnetic metal halide lamp dimming, and other lighting technologies like fluorescent lighting. OSI explained that magnetic ballasts (by using a split capacitor) can only provide two light levels (bi-level dimming). An electronic ballast has a microprocessor to provide stepped dimming at programmed levels or continuous dimming using a 0 to 10 V signal. A continuously dimming ballast is compatible with daylight harvesting, scheduling, building management, demand response systems, and other processes where dimming is desirable. OSI stated that dimming can be provided in various applications, including outdoor lighting, by replacing a magnetic ballast with an electronic one with no rewiring needed. (OSI, No. 27 at p. 3) Progress Energy Carolinas stated that bi-level dimming in magnetic ballasts has been around for years and has a proven track record. Although there is an efficacy decrease associated with dimming to 50 percent, Progress Energy Carolinas concluded that bi-level dimming is cost effective. (Progress Energy Carolinas, No. 24. at pp. 1–2) NEMA stated, however, that the incremental cost associated with an integrated bi-level dimming control in a metal halide lamp fixture can almost double the overall fixture cost. By contrast, the cost of integrated controls for a fluorescent lamp fixture designed for the same application requirements are about 30 to 40 percent higher than without controls, and the controls have more functionality due to the instant on and continuous dimming capability of the fluorescent system. For these reasons, NEMA argued that bi-level dimming with metal halide lamp fixtures is more costly and has less functionality than alternative technologies. (NEMA, No. 34 at p. 9)

Next, DOE received several comments relating to the applications that commonly use dimming, and the potential for difficulty in distinguishing some of these categories based on technical features. NEMA pointed out that although dimming metal halide lamp fixtures in certain applications where there is sporadic or limited occupancy (*e.g.,* high-bay and low-bay applications for warehousing) can result in significant energy reduction, many MHLF applications are not well suited for bi-level control capabilities, such as operations and roadway lighting that operates 24 hours per day, 7 days per week. (NEMA, No. 34 at p. 9) Progress Energy Carolinas also noted that apart from dusk-to-dawn photocontrol, occupancy sensors will not work for street lighting. Progress Energy Carolinas stated that street lighting would need to be controlled with a smart-box type of control. (Progress Energy Carolinas, No. 24 at p. 2) Cooper Lighting suggested that DOE analyze dimming in roadway lighting separately from other applications. (Cooper, Public Meeting Transcript, No. 33 at p. 40) Georgia Power recognized that the specifics of which applications can and cannot be dimmed, and how to measure energy reduction in unmetered applications (*e.g.,* roadway lighting provided by a utility), will be complex. (Georgia Power, No. 28 at p. 1) NEMA noted that because DOE cannot distinguish products based on application type, it is unclear how DOE would describe regulatory requirements without specifying the use of controls based on application characteristics.

[16] *www.energy.ca.gov/regs/title20/index.html.*

[17] California's term 'metal halide luminaire' refers to the same item as DOE's 'metal halide lamp fixture.'

(NEMA, No. 34 at p. 9) Specifically, NEMA also observed that the Title 20 approach requires differentiation between indoor and outdoor products, which DOE would have to define based on product attributes. (NEMA, No. 34 at p. 6)

Several commenters reported on the low percentage of fixtures using the controls pathways to compliance for California Title 20. Energy Solutions and the CA IOUs reported that of the chosen compliance pathways recorded in the CEC Appliance Database, most are either the reduced lamp wattage or the ballast efficiency requirement; not many report the controls compliance pathway. (Energy Solutions, Public Meeting Transcript, No. 33 at pp. 39–40; CA IOUs, No. 32 at p. 2) Philips explained that the controls compliance pathway has not been embraced because Title 20 requires all pieces of a control system to be integral to the fixture. Philips urged DOE to consider that a simplified approach to controllable fixtures would encourage more dimming systems and, therefore, more energy savings. (Philips Lighting Electronics, Public Meeting Transcript, No. 33 at p. 40) Similarly, NEMA supported the concept of controllable fixtures and also suggested that controls be separate from the fixture for any regulations. NEMA stated that any incorporation of controls should be technology-neutral, allowing various control technologies without requiring the control to be integral to the fixture. (NEMA, No. 34 at p. 6)

NEEA expressed concern over any forecasted energy savings resulting from the implementation of dimming ballasts, commenting that the presence of controls and the capability of dimming are no guarantee of use, and therefore, no guarantee of the promised energy savings. Consequently, NEEA did not agree with a Title 20 approach as part of a federal minimum efficiency standard. Furthermore, NEEA opposed DOE's adoption of the Title 20 approach because California's regulatory approach depends heavily on the existence of its Title 24 regulations (which have no DOE analog) for compliance and enforcement, including verifying the installation of the qualifying components that would meet the system requirements. For these reasons, NEEA felt that the Title 20 approach is unworkable at the federal level. (NEEA, No. 31 at p. 3)

In response to the various approaches in California Title 20, DOE is concerned that adopting these methods would risk reducing energy savings and complicating compliance and enforcement relative to ballast-efficiency-only regulations. With regards to the controls/dimming approach, DOE tentatively agrees that a standard requiring the presence of controls or dimming does not ensure energy savings. DOE believes that the use of such technologies is much less popular for metal halide systems relative to other lighting technologies. Metal halide lamp fixtures typically take 5 to 10 minutes to re-strike and turn on again after being turned off, so controls that would turn metal halide lamp fixtures on and off more frequently have less utility relative to lighting with instant restarting capability. Additionally, a majority of metal halide lamp fixtures installed today use magnetic ballasts. Magnetic ballasts are typically only capable of bi-level dimming, giving them less functionality compared to other lighting technologies. Regarding the approach to allow less-efficient ballasts when sold in fixtures with more efficacious lamps, DOE is concerned that some energy savings could be lost if the lamp is replaced with a less efficacious lamp after the first failure, similar to its conclusions with lamp and ballast systems. Given the uncertainty of resulting energy savings, DOE has tentatively decided not to propose Title-20-like standards in this rulemaking.

C. Combined Rulemakings

In addition to system approaches, another method for maximizing energy savings and simplifying compliance would be to combine the metal halide lamp fixture and high-intensity discharge (HID) lamp rulemakings (Docket EERE–2010–BT–STD–0043). These rulemakings are related because the MH lamps used in metal halide lamp fixtures are a subset of HID lamps. During the comment period and the public meeting for the metal halide lamp fixture preliminary TSD, and also in subsequent manufacturer interviews, DOE received requests that DOE consider metal halide lamp fixtures and HID lamps in a combined manner. The stated benefits of this approach include maximizing potential energy savings, avoiding conflicting rules for related technologies, avoiding duplicative efforts, improving consistency and ease of review, saving taxpayer dollars, and simplifying compliance. Based on the outcome of this NOPR, DOE will consider how to best combine the rulemakings.

OSI, NEMA, and Philips commented that the metal halide lamp fixture rulemaking should be conducted in conjunction with metal halide lamp rulemakings. (OSI, No. 27 at p. 6; NEMA, Public Meeting Transcript, No. 33 at p. 15; NEMA, No. 34 at p. 5; Philips, Public Meeting Transcript, No. 33 at p. 32) NEMA expressed concern that potential energy savings could be missed by keeping the metal halide lamp fixtures and HID lamps rulemakings separate. (NEMA, Public Meeting Transcript, No. 33 at p. 15) OSI and NEMA recommended that the ballast efficiency and lamp efficacy regulations be completed in conjunction so that overall system efficacy can be recognized in resulting regulations. (OSI, No. 27 at p. 6; NEMA, No. 34 at p. 21) Additionally, Philips stated that keeping the lamp and ballast rulemakings separate will add complexity to maintaining lamp and ballast compatibility. (Philips, Public Meeting Transcript, No. 33 at p. 32) Philips noted that if ballast regulations eliminate certain ballast types, they may also take certain lamps out of the market, losing all energy savings that were meant to be generated by the lamps' standards. (Philips, Public Meeting Transcript, No. 33 at p. 132)

In its work to date on the HID lamp and MHLF energy conservation standards, DOE has identified and is using a number of shared data sources and analytical processes in the two rulemakings. The following is an initial inventory of rulemaking data and processes either fully or partially shared between HID lamps and metal halide lamp fixtures:

- market and technology assessments;
- distribution channels and price markups;
- annual operating hours;
- lamp, fixture, and ballast lifetimes;
- lamp lumen maintenance;
- installation times and costs;
- electricity prices;
- discount rates;
- lamp and fixture shipments;
- life-cycle cost (LCC) subgroup analysis; and
- Regulatory impact analysis.

DOE is currently evaluating the data and analytical processes that are shared between the two rulemakings.

D. Standby Mode and Off Mode Energy Consumption Standards

EPCA requires energy conservation standards adopted for covered equipment after July 1, 2010 to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) The requirement to incorporate standby mode and off mode energy use into the energy conservation standards analysis is therefore applicable in this rulemaking. 10 CFR 431.322 defines the terms ''active mode,'' ''standby mode,'' and ''off mode'' as follows:

- ''Active mode'' is the condition in which an energy-using piece of equipment is connected to a main power source, has been activated, and provides one or more main functions.

• "Off mode" is the condition in which an energy-using piece of equipment is connected to a main power source, and is not providing any standby or active mode function.

• "Standby mode" is the condition in which an energy-using piece of equipment is connected to a main power source and offers one or more of the following user-oriented or protective functions: facilitating the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer; or providing continuous functions, including information or status displays (including clocks) or sensor-based functions.

For the preliminary TSD, DOE analyzed these definitions to determine their applicability to metal halide lamp fixtures. DOE tentatively found that it is possible for metal halide fixtures to operate in active mode and standby mode. The off mode condition does not apply because metal halide lamp fixtures do not operate in off mode. 74 FR 33171, 33175 (July 10, 2009).[18] Therefore, for this energy conservation standard rulemaking, DOE only considered the active mode and standby mode energy use provisions from EISA 2007 applicable to metal halide lamp fixtures that are (or could be) covered by this rulemaking.

DOE recognizes that metal halide lamp fixtures can be designed with auxiliary control devices, which could consume energy in standby mode. One example of this fixture design involves Digitally Addressable Light Interface (DALI) enabled ballasts. These ballasts may draw power in standby mode, as the internal circuitry remains on and active even when the ballast is not driving any lamps. DOE has yet to encounter such a ballast that it could purchase. DOE has continued to search for and consider DALI-enabled fixtures, as well as other types of metal halide lamp fixtures, to evaluate the issue of standby mode energy use in metal halide lamp fixtures. In the preliminary TSD, DOE tentatively concluded that it cannot establish a separate standard that incorporates standby mode energy use and invited comments on the issue of standby mode and ballast designs that incorporate it.

Philips and NEMA both expressed NEMA's view, agreeing that a standard cannot be established for standby mode energy consumption. (Philips, Public Meeting Transcript, No. 33 at p. 29, NEMA, No. 34 at p. 3) Empower Electronics also commented that a standby mode energy standard cannot be established. (Empower Electronics, No. 36 at p. 2) NEEA agreed with DOE's findings and proposals for standby mode and off mode. (NEEA, No. 31 at p. 2)

With no new findings with regard to ballasts drawing power in standby and off modes and comments supporting DOE's preliminary proposal, DOE continues to conclude in this NOPR that it cannot establish a separate standard that incorporates standby mode or off mode energy consumption.

IV. General Discussion

A. Test Procedures

1. Current Test Procedures

The current test procedures for metal halide ballasts and fixtures are outlined in Subpart S of 10 CFR Part 431. The test conditions, setup, and methodology generally follow the guidance of ANSI C82.6–2005. Testing requires the use of a reference lamp, which is to be driven by the ballast under test conditions until the ballast reaches operational stability. Ballast efficiency for the fixture is then calculated as the measured ballast output power divided by the ballast input power. In this NOPR, DOE proposes changes to test input voltage, testing electronic ballasts, and rounding requirements.

2. Test Input Voltage

Metal halide ballasts can be operated at a variety of voltages, with different voltages chosen based on the application and use of the fixture. The most common voltages are 120 V, 208 V, 240 V, 277 V, and 480 V. Ballasts will also commonly be rated for more than one, such as dual-input-voltage ballasts that can be operated on 120 V or 277 V, or quad-input-voltage ballasts that can be operated on 120 V, 208 V, 240 V, or 277 V. DOE received manufacturer feedback that the specific design of a ballast and the voltage of the lamp operated by the ballast can affect the trend between input voltage and efficiency. DOE likewise observed that changes in efficiency (on the level of several percent) were possible in individual ballasts based on its own testing of multiple-input-voltage ballasts.

The existing test procedures do not specify the voltage at which a ballast is to be tested. Therefore, to ensure consistency among testing and reported efficiencies, the input voltage should be specified in the test procedures. To set an energy conservation standard based on test data, DOE needed to determine which input voltage to use for its data. In addition, manufacturers would need to their equipment at the same input voltage that DOE used when developing energy conservation standards for the regulations to have the intended effect. Because the majority of ballasts sold are capable of operating at multiple input voltages, DOE is considering standardizing this aspect of testing. In the preliminary TSD, DOE requested comment on this issue, specifically on the possibility of testing at all input voltages and reporting the average of the efficiencies. DOE discusses several input voltage specification options in the following paragraphs.

a. Average of Tested Efficiency at All Possible Voltages

In the preliminary TSD, DOE asked for comment on the possibility of testing ballasts at each input voltage at which they are able to operate, then having a standard for the average of these efficiencies. NEEA commented that they saw the positive aspects of this method of testing. NEEA said that even though it would increase testing burden, it would also reduce efficiency bias associated with input voltage. (NEEA, No. 31 at p. 2) Philips commented that adapting a magnetic ballast for use with multiple input voltages lowers the efficiencies on one or more of the voltages, but the market has demanded the use of multi-tap ballasts, especially because the manufacturers desire to reduce inventory in an effort to lower cost. (Philips, Public Meeting Transcript, No. 33 at p. 28) NEMA said it disagreed with measuring at multiple voltages and then averaging due to the increased testing burden and associated costs. (NEMA, No. 34 at p. 2) Although DOE found little difference in ballast efficiency at different input voltages, DOE recognizes the possibility for efficiencies associated with rarely used input voltages to skew the overall efficiency of ballasts under this averaged-efficiencies approach. For example, a ballast might have the capability to operate on 120 V and 277 V at approximately 90 percent efficiency, but at 208 V (an uncommon input voltage for metal halide lighting) it operated at only 88 percent efficiency. Averaging these three efficiencies would lead to a reported value of about 89 percent, when the ballast will in all

[18] The definition of "off mode" requires that ballasts be connected to a main power source and not provide any standby mode or active mode function. (42 U.S.C. 6295(gg)(1)(A)(ii)) As discussed in the metal halide ballast test procedures, DOE does not believe that there is any condition in which the ballast is connected to the main power source and is not already accounted for in either active mode or standby mode.

likelihood only operate at 120 V or 277 V (at 90 percent efficiency). In this instance, averaging the efficiencies misrepresents the performance of the ballast in its most common uses. Additionally, DOE recognizes that testing at each input voltage could increase the burden relative to a requirement of testing ballasts at only a single voltage. For these reasons, in this NOPR, DOE is not proposing to test at all available input voltages and average the resulting efficiencies.

b. Posting the Highest and Lowest Efficiencies

Another approach, suggested by Empower Electronics, would require testing at each input voltage and listing the best and worst efficiencies on the product label. (Empower Electronics, No. 36 at p. 2) DOE acknowledges that, as with voltage averaging, this method could help address the concern that a manufacturer could optimize their ballasts on a voltage that could easily increase in efficiency, while most customers would be using a non-optimized voltage. Also similar to voltage averaging, however, DOE finds that this approach would lead to a compliance burden for manufacturers and would increase the required tests compared to a requirement to test ballasts only at a single voltage.

c. Test at Single Manufacturer-Declared Voltage

In response to the preliminary TSD, NEMA suggested that the test procedures should allow testing at a single voltage determined by the manufacturer and declared in the test report. (NEMA, No. 34 at p. 2) In manufacturer interviews, DOE received feedback that manufacturers optimize ballasts at a specific voltage and prefer to test their products at that voltage. DOE is concerned, however, that manufacturers might optimize efficiency at a voltage that is most convenient or least expensive rather than the voltage most used by customers. Were manufacturers to optimize efficiency at a less commonly used voltage, the efficiency claimed at this voltage would not be representative of typical efficiency in the more common uses. Because the efficiency at the manufacturer-declared voltage and the efficiency at the more commonly used voltages may not have direct correlation, such test procedures could potentially reduce the energy savings of this rulemaking.

d. Test at Highest-Rated Voltage

Another input voltage specification could be that the ballast should be tested at the highest voltage possible. OSI commented, and NEEA agreed, that fluorescent ballast test procedures set the precedent for having to test only at the highest rated voltage. They also said that this would reduce costs associated with additional testing for metal halide ballasts. (OSI, Public Meeting Transcript, No. 33 at p. 29; NEEA, No. 31 at p. 2) DOE understands the concern regarding increased burdens and costs associated with being required to test ballasts at multiple input voltages. DOE's research, however, found that a ballast's highest-rated voltage is not always its most common input voltage. For example, DOE found a significant number of 70 W ballasts that were capable of operating on 120 V, 208 V, 240 V, and 277 V. Testing at the highest-rated voltage would mean these ballasts are tested at 277 V, but manufacturer feedback indicated that 70 W ballasts are much more likely to be actually used in 120 V applications. One possible reaction to energy conservation standards based on this test procedure specification could be for manufacturers to optimize 70 W ballasts at 277 V (the tested voltage) as opposed to 120 V (the more commonly used voltage). Because of this possibility, DOE finds that testing and enforcing standards at the highest voltage could reduce the potential energy savings of this rulemaking.

e. Test on Input Voltage Based on Wattage and Available Voltages

In this NOPR, DOE is proposing that the most common input voltages for each wattage range be used in testing. Progress Energy Carolinas commented that an amendment to the current test procedures that would specify the required input voltage for testing would not provide enough energy savings for the additional expense. (Progress Energy Carolinas, No. 24 at p. 2) DOE disagrees with Progress Energy Carolinas' assertion that an added expense is inherent in specification of the input voltage for testing. DOE's proposal only requires testing at one input voltage, the minimum number of tests possible. By proposing testing at a single voltage, DOE reduces testing burden relative to a requirement for testing at multiple input voltages. In addition, because the input voltage specification matches the most commonly used voltage, the requirement encourages optimization of efficiency around an input voltage commonly used in practice. Finally, analysis of the impact of energy savings for this rulemaking is made more accurate by assessing ballast efficiency at the most commonly used input voltages.

In manufacturer interviews, DOE received feedback on usage of different input voltages. DOE learned that 208 V is the least used and least optimized voltage. DOE also received feedback that efficiencies at 277 V and 240 V are similar to each other. In general, DOE determined that fixtures with wattages less than 150 W were most often used at 120 V. Wattages of 150 W and above were most commonly used at 277 V. Thus, this NOPR proposes that testing of metal halide ballasts use the following input voltages:

- For ballasts less than 150 W that have 120 V as an available input voltage, ballasts are to be tested at 120 V.
- For ballasts less than 150 W that lack 120 V as an available voltage, ballasts should be tested at the highest available input voltage.
- For ballasts operated at greater than or equal to 150 W and less than or equal to 2000 W that also have 277 V as an available input voltage, ballasts are to be tested at 277 V.
- For ballasts greater than or equal to 150 W and less than or equal to 2000 W that lack 277 V as an available input voltage, ballasts should be tested at the highest available input voltage.

3. Testing Electronic Ballasts

With regards to testing electronic metal halide ballasts, DOE received feedback on several issues in response to the preliminary TSD. Some interested parties commented that the test procedures do not apply to any electronic ballasts and others commented that high-frequency electronic ballast testing is not specified and is more prone to measurement variation than low-frequency electronic ballast testing is. DOE discusses these comments below.

In the preliminary TSD, DOE noted that it would continue to use the 2005 version of ANSI C82.6 for testing both electronic and magnetic ballasts. Philips and Venture both commented that there are currently no test procedures for electronic ballasts. (Philips, Public Meeting Transcript, No. 33 at p. 130; Venture, Public Meeting Transcript, No. 33 at p. 130) Both Cooper and NEMA noted that an update to ANSI C82.6 that was to be released by the end of 2011 would include test procedures for low-frequency electronic (LFE) ballasts, but not high-frequency electronic (HFE) ballasts.[19] (Cooper, Public Meeting Transcript, No. 33 at pp. 27–28; NEMA, No. 34 at p. 2) NEEA commented that

[19] At the time of development of this NOPR in mid-2012, an update to ANSI C82.6–2005 was not yet available.

this delay should preclude DOE from altering the test procedures for electronic metal halide ballasts at this time. (NEEA, No. 31 at p. 2) In DOE's reading of ANSI C82.6, the scope dictates testing HID lamp ballasts without specifying applicability only to magnetic ballasts. In interviews with manufacturers, DOE received feedback confirming that ANSI C82.6–2005 does provide a method for testing low-frequency ballasts. Additionally, section 4.4.3 of ANSI C82.6–2005 discusses low-frequency electronic ballasts in the context of alternative stabilization methods.

DOE also received comments that HFE ballasts should be excluded from the rulemaking because there are no test procedures for them. Philips, OSI, and NEMA noted that the available equipment cannot test HFE ballast frequencies above 125 kHz as accurately as other ballasts, and Philips noted that HFE ballast testing accuracy can range from plus or minus two to five percent. (Philips, Public Meeting Transcript, No. 33 at p. 130; NEMA, No. 34 at p. 14; OSI, No. 27 at p. 4) NEEA commented that manufacturers stated that there are no ANSI or NEMA HFE standards, and that no test procedures could accurately assess the efficiency of these ballasts to within plus or minus one percent. Based on this information, NEEA recommended that DOE should not consider these products in this rulemaking. (NEEA, No. 31 at p. 9) Empower Electronics commented that the test procedures should be amended to include HFE ballast testing. (Empower Electronics, No. 36 at p. 2) DOE agrees that the instrumentation in ANSI C82.6–2005 is specified only up to 800 Hz for ammeters and voltmeters and to 1 kHz for wattmeters, and also that these would be insufficient for measurements of HFE ballasts.

DOE is proposing to amend the metal halide ballast and fixtures test procedures to specify the instrumentation required to test HFE ballasts. DOE found that the instrumentation commonly used for high-frequency electronic metal halide ballast testing is the same instrumentation used for fluorescent lamp ballast testing. DOE proposes that instrumentation at least as accurate as required by ANSI C82.6–2005 be used to assess the output frequency of the ballast. Once the output frequency is determined to be greater than or equal to 1000 Hz, (the frequency at which DOE proposes to define high-frequency electronic ballasts), the test procedure instrumentation would be required to include a power analyzer that conforms to ANSI C82.6–2005 with a maximum of 100 picofarads (pF) capacitance to ground and frequency response between 40 Hz and 1 MHz. The test procedures would also require a current probe compliant with ANSI C82.6–2005 that is galvanically isolated and has a frequency response between 40 Hz and 20 MHz, and lamp current measurement where the full transducer ratio is set in the power analyzer to match the current to the analyzer. The full transducer ratio would be required to satisfy:

$$\frac{I_{in}}{V_{out}} \times \frac{R_{in}}{R_{in} + R_s}$$

Where:

I_{in} is current through the current transducer;
V_{out} is the voltage out of the transducer;
R_{in} is the power analyzer impedance; and
R_s is the current probe output impedance.

4. Rounding Requirements

DOE also proposes to amend the metal halide ballast test procedure requirements for measuring and recording input wattage and output wattage to require rounding to the nearest tenth of a watt, and the resulting calculation of efficiency to the nearest tenth of a percent. Through testing, DOE found that testing multiple samples of the same ballast yielded a range of ballast efficiencies typically differing by less than one percent. Because this data introduces both test measurement and sample to sample variation, the test measurement itself should be at least this accurate. Therefore, DOE believes its test procedures can resolve differences of less than one percent and rounding to the tenths decimal place would be reasonable.

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis based on information it has gathered on current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in this analysis, DOE develops a list of design options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of these options for improving efficiency is technologically feasible. DOE considers technologies incorporated in commercially available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i)

Once DOE has determined that particular design options are technologically feasible, it evaluates each of these design options according to the following three 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. Section V.B of this notice discusses the results of the screening analysis for metal halide lamp fixtures. In particular, it lists the designs DOE considered, those it screened out, and those that are the basis for the TSLs in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the NOPR TSD.

2. Maximum Technologically Feasible Levels

Section 325(o) of EPCA requires that when DOE amends standards for a type or class of covered equipment, 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(o)) Accordingly, DOE determined the maximum technologically feasible (''max tech'') ballast efficiency in this NOPR's engineering analysis, using the design options identified in the screening analysis (see chapter 4 of the NOPR TSD).

To determine the max tech level, DOE conducted a survey of the MHLF market and the research fields that support the market. DOE's view based on test data is that within a given equipment class, no working prototypes exist that have a distinguishably higher ballast efficiency than currently available equipment. Therefore, the highest efficiency level presented, which represents the most efficient tier of commercially available equipment, is the max tech level for this rulemaking. This highest efficiency level requires electronic ballasts using the best components and circuit topologies commercially available for fixtures rated ≥50 W to ≤500 W. The max tech efficiency level requires the highest grades of core steel and copper windings for the fixtures rated >500 W and ≤2000 W.

DOE did not screen out any technology options in the preliminary analysis. DOE received several comments regarding its determination of max tech ballast efficiency in the preliminary TSD. These comments are discussed in section V.C.8. For this NOPR, DOE conducted additional analysis to determine the appropriate max tech levels for metal halide ballasts. As discussed in section V.C.3, DOE added 150 W as a representative wattage, and tested ballasts to establish an appropriate max tech level for this wattage. DOE also conducted additional testing of the 70 W, 250 W, 400 W, and 1000 W ballasts on the market, and determined the highest efficiency levels that are technologically feasible within each equipment class. As discussed in section V.C.9, data for each equipment class has been fit with a wattage-efficiency equation to determine the minimum efficiency levels. Table IV.1 presents the max tech efficiencies for each wattage range analyzed in the NOPR.

TABLE IV.1—MAX TECH LEVELS

Equipment class wattage range	Efficiency level*	Efficiency level equation %
≥50 and ≤100	EL4	100/(1+0.36*P∧(−0.3))†.
>100 and <150*	EL4	100/(1+0.36*P∧(−0.3)).
≥150** and ≤250	EL4	100/(1+0.36*P∧(−0.3)).
>250 and ≤500	EL4	100/(1+0.36*P∧(−0.3)).
>500 and ≤2000	EL2	For >500 W to <1000 W: 3.2*10∧(−3)*P + 89.9 For ≥1000 W to ≤2000 W: 93.1.

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

† P is defined as the rated wattage of the lamp that the fixture is designed to operate.

DOE requests comment on its selection of the max tech levels and whether it is technologically feasible to attain these high efficiencies. Specifically, DOE seeks data on the potential change in efficiency, the design options employed, and the associated change in cost. Any design option that DOE considers to improve efficiency must meet the four criteria outlined in the screening analysis: technological feasibility; practicability to manufacture, install, and service; adverse impacts on product or equipment utility to customers or availability; and adverse impacts on health or safety. DOE also requests comment on any technological barriers to an improvement in efficiency above the max tech efficiency levels for all or certain types of ballasts.

C. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the equipment that are the subject of this rulemaking purchased in the 30-year period that begins in the year of compliance with new or amended standards (2016–2045). The savings are measured over the entire lifetime of products purchased in the 30-year period.[20] DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. The base case represents a projection of energy consumption in the absence of amended mandatory efficiency standards, and considers market forces and policies that affect demand for more efficient equipment. For example, in the base case, DOE models a migration from covered metal halide lamp fixtures to higher-efficiency technologies such as high-intensity fluorescent (HIF), induction lights, and light-emitting diodes (LEDs). DOE also models a move to other HID fixtures such as high-pressure sodium, based on data given by manufacturers during the 2010 framework public meeting. (Philips, Public Meeting Transcript, No.8 at p. 91)

DOE used its NIA spreadsheet to estimate energy savings from new or amended-standards for the metal halide lamp fixtures that are the subject of this rulemaking. The NIA spreadsheet model (described in section V.G of this notice and in chapter 11 of the NOPR TSD) calculates energy savings in site energy, which is the energy directly consumed by products at the locations where they are used. DOE reports national energy savings on an annual basis in terms of the source (primary) energy savings, which is the savings in the energy that is used to generate and transmit the site energy. To convert site energy to source energy, DOE derived annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) *Annual Energy Outlook 2013* (*AEO2013*).

DOE has begun to also estimate energy savings using full-fuel-cycle metrics. The full-fuel-cycle (FFC) metric includes the energy consumed in extracting, processing, and transporting primary fuels, and, thus, presents a more complete picture of the impacts of efficiency standards. DOE's approach is based on application of FFC multipliers for each fuel type used by covered products and equipment, as discussed in DOE's statement of policy published in the **Federal Register** on August 18, 2011 (76 FR 51281), and in the notice of policy amendment. 77 FR 49701 (August 17, 2012).

2. Significance of Savings

As noted above, 42 U.S.C. 6295(o)(3)(B) prevents DOE from adopting a standard for a covered product unless such standard would result in ''significant'' energy savings. Although 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 (D.C. Cir. 1985), indicated that Congress intended ''significant'' energy savings in this context to be savings that were not ''genuinely trivial.'' The energy savings for all of the TSLs considered in this rulemaking (presented in section VI.B.3) 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)) The following sections discuss how DOE addresses each of those seven factors in this rulemaking.

[20] In the past DOE presented energy savings results for only the 30-year period that begins in the year of compliance. In the calculation of economic impacts, however, DOE considered operating cost savings measured over the entire lifetime of equipment purchased in the 30-year period. DOE has chosen to modify its presentation of national energy savings to be consistent with the approach used for its national economic analysis.

a. Economic Impact on Manufacturers and Customers

In determining the impacts of a new or amended standard on manufacturers, DOE first determines quantitative impacts using an annual-cash-flow approach. This approach 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 comes into effect—and a long-term (30-year) assessment. The quantitative impacts analyzed include INPV (which values the industry based on expected future cash flows), annual cash flows, and changes in revenue and income. 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 overall and technology-specific domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment for technology-specific manufacturers. DOE also takes into account cumulative impacts of different DOE regulations and other regulatory requirements on manufacturers.

For individual customers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. LCC 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)), and is discussed in the following section. For customers viewed from a national perspective, DOE calculates the net present value of the economic impacts on them over the 30-year equipment shipments period used in this rulemaking.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a fixture (including its installation) and its operating expenses (including energy, maintenance, and repair expenditures) discounted over the lifetime of the fixture. 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 required a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetimes, and customer discount rates. DOE assumed in its analysis that customers purchase the equipment in 2016.

To account for uncertainty and variability in specific inputs, such as equipment lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value. DOE identifies the percentage of customers estimated to receive LCC savings or experience an LCC increase, in addition to the average LCC savings associated with a particular standard level. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of customers that may be affected disproportionately by a national standard.

c. Energy Savings

Although 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)) As discussed in section V.G, DOE uses the NIA spreadsheet to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing classes of equipment and 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 equipment under consideration. The efficiency levels considered in today's NOPR will not affect features valued by customers, such as input voltage and light output. Therefore, DOE believes that none of the TSLs presented in section VI.A would reduce the utility or performance of the ballasts considered in the rulemaking. (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 a proposed standard 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 such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) DOE has transmitted a copy of today's proposed rule to the Attorney General and has requested that the Department of Justice (DOJ) provide its determination on this issue. DOE will address the Attorney General's determination in any final rule.

f. Need for National Energy Conservation

The energy savings from the proposed standards are likely to provide improvements to the security and reliability of the nation's energy system. Reductions in the demand for electricity also may 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.

The proposed standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production. DOE reports the emissions impacts from today's proposed standards, and from each TSL it considered, in section VI.B.6 of this notice. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs.

g. Other Factors

EPCA allows the Secretary to consider any other relevant factors in determining whether a standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) Under this provision, DOE considered subgroups of customers that may experience disproportionately adverse effects under the standards proposed in this rule. DOE specifically assessed the effect of standards on utilities, transportation facility owners, and warehouse owners. In considering these subgroups, DOE analyzed differences in electricity prices, operating hours, discount rates, and baseline ballasts. See section V.H for further detail.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the customer of equipment that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for customers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to customers, manufacturers, the nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of 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 VI.B.1 of this NOPR.

V. Methodology and Discussion

DOE used two spreadsheet tools to estimate the impact of today's proposed standards. The first spreadsheet tool calculates LCCs and PBPs of potential new energy conservation standards. The second spreadsheet tool provides shipment projections and then calculates national energy savings and net present value impacts of potential new energy conservation standards. The Department also assessed manufacturer impacts, largely through use of the Government Regulatory Impact Model (GRIM).

Additionally, DOE estimated the impacts of energy efficiency standards on utilities and the environment. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its *Annual Energy Outlook,* a widely known reference energy forecast for the United States. The NEMS-based model used for appliance standards analysis is called NEMS–BT (BT stands for DOE's Building Technologies Program), and is based on the current AEO (*AEO2013)* NEMS with minor modifications.[21] The NEMS–BT accounts for the interactions between the various energy supply and demand sectors and the economy as a whole. 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*.

A. Market and Technology Assessment

1. General

When beginning an energy conservation standards rulemaking, DOE develops information that provides an overall picture of the market for the equipment concerned, including the purpose of the products, the industry structure, and the market characteristics. This activity includes both quantitative and qualitative assessments based on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include: Equipment classes and manufacturers; historical shipments; market trends; regulatory and non-regulatory programs; and technologies or design options that could improve the energy efficiency of the product(s) under examination. See chapter 3 of the NOPR TSD for further discussion of the market and technology assessment.

2. Equipment Classes

In establishing energy conservation standards, DOE divides covered equipment into classes by: (a) The type of energy used, (b) the capacity of the equipment, or (c) any other performance-related feature that justifies different standard levels, such as features affecting consumer utility. (42 U.S.C. 6295(q)) DOE then considers establishing separate standard levels for each equipment class based on the criteria set forth in 42 U.S.C. 6295(o).

In the preliminary analysis, DOE considered several potential class-setting factors for fixtures, including rated lamp wattage, input voltage, number of lamps operated, starting method, electronic configuration, circuit type, and fixture application. DOE preliminarily determined that rated lamp wattage was the only factor affecting both consumer utility and efficiency. DOE, therefore, analyzed four equipment classes for fixtures with rated lamp wattages: (1) Greater than or equal to 50 W and less than 150 W; (2) greater than or equal to 150 W and less than or equal to 250 W; (3) greater than 250 W and less than or equal to 500 W; and (4) greater than 500 W. As discussed in the following sections, several interested parties commented on the preliminary equipment classes and the other class-setting factors that DOE considered.

a. Input Voltage

Metal halide lamp fixtures are available in a variety of input voltages (such as 120 V, 208 V, 240 V, 277 V, and 480 V), and the majority of fixtures are equipped with ballasts that are capable of operating at multiple input voltages (for example quad-input-voltage ballasts are able to operate at 120 V, 208 V, 240 V, and 277 V). DOE determined that input voltage represents a feature affecting consumer utility as certain applications demand specific input voltages. Although input voltage can affect ballast resistive losses and thus, efficiency, for the preliminary analysis, DOE's ballast testing did not indicate a prevailing relationship (*e.g.,* higher voltages are not always more efficient) between discrete input voltages and ballast efficiencies. Therefore, in the preliminary analysis, DOE did not establish separate equipment classes for metal halide lamp fixtures based on input voltage. In the preliminary analysis, DOE suggested that efficiency be represented by the average of tested efficiencies at each of the input voltages at which the ballast is rated for operation.

In response to the preliminary analysis, DOE received several comments supporting and opposing input voltage as a class-setting criterion. NEMA noted that multiple-input-voltage ballasts are often optimized for the most popular voltage application. For example, a quint-input-voltage ballast (able to operate at five different input voltages) will often have a lower efficiency at 480 V than at 277 V because the ballast is optimized for 277 V operation. NEMA suggested that 480 V-capable ballasts be given an efficiency allowance, or that all ballasts be allowed to be tested at the optimal operating voltage as specified by the manufacturer. (NEMA, No. 34 at p. 10) Georgia Power also commented that due to their increased costs relative to non-480 V ballasts, dedicated 480 V and quint-input-voltage ballasts should be in a separate equipment class. (Georgia Power, No. 28 at p. 1) Progress Energy Carolinas agreed that separate equipment classes should be established for ballasts above 300 V. (Progress Energy Carolinas, No. 24 at p. 2) NEEA found that voltage does not appear to be a significant factor in energy efficiency performance or system utility. However, NEEA had no objection to treating 480 V systems as a separate class, should DOE choose to do so. (NEEA, No. 31 at p. 3) Empower Electronics commented that a separate classification based on input voltage is not needed. (Empower Electronics, No. 36 at p. 5)

As discussed in section IV.A of this NOPR, DOE is proposing that metal halide ballasts be tested at a single input voltage, based on the lamp wattage operated by the ballast. Ballasts that operate lamps 150 W or less would be tested at 120 V, and all others would be tested at 277 V, unless the ballast is incapable of operating at the specified input voltage; in that case, the ballast would be tested at the highest input voltage possible. DOE's view is that this proposal would reduce the testing burden and better characterize the

[21] The EIA does not approve use of the name ''NEMS'' unless it describes 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.

energy consumption of metal halide lamp fixtures for the majority of applications in which they are installed. Based on the proposed test procedures, DOE evaluated efficiency differences between dedicated 480 V, quint-input-voltage, and quad-input-voltage ballasts (which represent the vast majority of ballasts on the market). DOE found that the quint-input-voltage ballasts had similar efficiencies as the quad-input-voltage ballasts when both were tested at 120 V or 277 V. In contrast, DOE found that the dedicated 480 V ballasts (tested at 480 V) were, on average, 1.4 percent less efficient than quad-input-voltage ballasts (tested at 120 V or 277 V).

Because dedicated 480 V ballasts have a distinct utility and a difference in efficiency relative to ballasts tested at 120 V and 277 V, DOE proposes separate equipment classes for ballasts tested at 480 V (in accordance with the test procedures). These would include dedicated 480 V ballasts and any ballasts that are capable of being operated at 480 V, but incapable of being operated at the input voltage specified by the test procedures (either 120 V or 277 V, depending on lamp wattage). DOE requests comment on this proposal.

Fixture Application

Metal halide lamp fixtures are used in a variety of applications such as parking lots, roadways, warehouses, big-box retail, and flood lighting. Although the fixture size, shape, and optics are often tailored to the application, generally the same types of ballasts are currently utilized for most of the applications. DOE did not expect fixture-application-related attributes to affect ballast efficiency for a given lamp wattage, and in the preliminary analysis DOE did not analyze separate equipment classes based on such attributes.

In response to the preliminary analysis, DOE received several comments regarding the problems of utilizing electronic ballasts in outdoor applications and recommending that DOE establish separate equipment classes for outdoor fixtures and indoor fixtures. Energy Solutions noted that there are significant fixture design considerations necessitated by outdoor use. (Energy Solutions, Public Meeting Transcript, No. 33 at pp. 46–47) Progress Energy Carolinas clarified that ballasts used in outdoor fixtures need to be able to withstand high temperatures, voltage variations, and lightning and other voltage surges. Progress Energy Carolinas also indicated that the same concerns existed with LED fixtures (utilizing electronic drivers) and that they were successfully addressed by adding heat sinks to dissipate excess heat; building regulation into the drivers to deal with voltage variations; and adding metal oxide varistor (MOV) protection (typically 10 kilo volt [kV] ANSI C62.41.1–2002 [22] Class C protection) to protect against lightning and other voltage surges. LED fixtures also underwent field testing through all four seasons to prove overall reliability. Progress Energy Carolinas explained that until some of these issues are similarly addressed and their solutions proven, end users will be reluctant to use electronic metal halide ballasts in outdoor fixtures. (Progress Energy Carolinas, No. 24 at p. 1) Georgia Power and Progress Energy Carolinas stated that outdoor electronic metal halide ballasts have not been widely adopted by utilities, largely due to these reliability concerns. NEMA urged DOE to establish MHLF standards for outdoor applications (which have higher transient requirements and wider operating temperature ranges) such that magnetic ballasts would be compliant. (NEMA, No. 34 at p. 9) If electronic ballasts are mandated for outdoor fixtures, Progress Energy Carolinas recommended that utilities be exempt until reliability concerns decrease. (Georgia Power, No. 28 at p. 2; Progress Energy Carolinas, No. 24 at p. 2)

The CA IOUs, however, stated that electronic ballasts have been successfully applied in outdoor applications and are readily available on the market today, citing examples of commercially available electronic metal halide products rated for outdoor use and municipalities that have adopted electronically ballasted metal halide streetlights. The CA IOUs expressed their belief that the application environment does not affect the utility or the achievable efficiency of a ballast. The CA IOUs also stated that should DOE decide that the use of electronic ballasts in outdoor environments requires additional fixture modifications, DOE would need to conduct separate cost and savings analyses for indoor versus outdoor applications. If DOE decides to set different equipment classes for indoor and outdoor metal halide lamp fixtures, the CA IOUs suggested that DOE adopt California's approach for differentiation of these types by specifying fixtures that are ''UL 1598 Wet Location Listed and labeled 'Suitable for Wet Locations' as specified by the National Electrical Code [NEC] 2005, Section 410.4(A).'' (CA IOUs, No. 32 at pp. 2–3)

Although electronic ballasts are being successfully used in certain outdoor applications, DOE acknowledges that there is currently a market reluctance to use electronic metal halide ballasts in outdoor applications, particularly due to concerns with the electronic ballast's ability to withstand voltage transients. However, DOE disagrees with NEMA that an efficiency level that requires electronic ballasts should not be analyzed or proposed on the basis of the features of transient suppression and operating temperature ranges. DOE's view is that addressing these concerns with either (1) an external surge protection device or (2) internal transient protection of the ballast using MOVs in conjunction with other inductors and capacitors is technologically feasible, as shown by the CA IOUs' list of examples. DOE understands that this added protection also adds an incremental cost to the ballast or fixture (further discussed in section V.C.12). As these incremental costs could affect the cost effectiveness of fixtures for outdoor applications, DOE proposes separate equipment classes for indoor and outdoor fixtures. DOE proposes that outdoor fixtures be defined as those that (1) are rated for use in wet locations and (2) have 10 kV of voltage transient protection. Conversely, fixtures that do not meet these requirements will be defined as indoor fixtures.

DOE proposes to define the wet location rating as specified by the National Electrical Code 2011,[23] section 410.10(A) or Underwriters Laboratories (UL) 1598 Wet Location Listed.[24] DOE believes that providing two possible definitions will reduce the compliance burden as many manufacturers are already familiar with one or both of these ratings (the NEC definition was included in EISA 2007 and both are used in California energy efficiency regulations). For 10 kV voltage transient protection, DOE proposes to use the 10

[22] ''Institute of Electrical and Electronics Engineers Guide on the Surge Environment in Low-Voltage (V and Less) AC Power Circuits,'' Approved April 4, 2003.

[23] The NEC 2011 states that fixtures installed in wet or damp locations shall be installed such that water cannot enter or accumulate in wiring components, lampholders, or other electrical parts. All fixtures installed in wet locations shall be marked, ''Suitable for Wet Locations.'' All fixtures installed in damp locations shall be marked ''Suitable for Wet locations'' or ''Suitable for Damp Locations.''

[24] UL Standard Publication 1598 defines a wet location is one in which water or other liquid can drip, splash, or flow on or against electrical equipment. A wet location fixture shall be constructed to prevent the accumulation of water on live parts, electrical components, or conductors not identified for use in contact with water. A fixture that permits water to enter the fixture shall be provided with a drain hole.

kV voltage pulse withstand requirement from ANSI C136.2–2004 as a characteristic unique to outdoor fixtures. As discussed in section VI.C, based on weighing the benefits and drawbacks of different requirements, DOE is proposing efficiency standards that are the same for indoor and outdoor equipment classes. If a different requirement is ultimately adopted by DOE in the final rule, the definitions of indoor and outdoor will be added to the Code of Federal Regulations for metal halide lamp fixtures.

c. Electronic Configuration and Circuit Type

Of the two metal halide ballast types (electronic and magnetic), magnetic ballasts are currently more common. Magnetic ballasts typically use transformer-like copper or aluminum windings on a steel or iron core. The newer electronic ballasts, which are more efficient but less common, rely on integrated circuits, switches, and capacitors/inductors to control current and voltage to the lamp. Both electronic and magnetic ballasts are capable of producing the same light output and, with certain modifications (*e.g.,* thermal management, transient protection, 120 V auxiliary power functionality), can be used interchangeably in all applications.

Magnetic metal halide ballasts are available in the market in several types of circuit configurations including high-reactance autotransformer, constant-wattage isolated transformer, constant-wattage autotransformer (CWA), linear reactor (reactor), and magnetically regulated-lag (reg-lag or mag-reg) ballasts. Each magnetic circuit type listed has different characteristics that may be preferred in certain applications. These characteristics (discussed further in chapter 3 of the NOPR TSD) include size, efficiency, and power regulation. For example, magnetically regulated-lag ballasts are typically the largest and heaviest circuit type, but provide the greatest degree of resistance to input voltage variation (which sustains light output). In the preliminary analysis, DOE determined that although magnetic ballasts are usually less efficient and have a lower initial cost than electronic ballasts, neither configuration provides a distinct consumer utility over the other. Because electronic ballasts can provide the same utility as any magnetic circuit type, can be used as substitutes in all applications, and are generally more efficient than magnetic ballasts, DOE determined in the preliminary analysis that setting separate equipment classes based on electronic configuration (magnetic vs. electronic) or on circuit type was unnecessary.

At wattages greater than 500 W, few electronic ballasts are available due to their higher cost and lower expected efficiency improvement over magnetic ballasts. Electronic ballasts have two primary circuit types that operate the lamp at either ''high'' or ''low'' frequency. DOE proposes to define a high-frequency ballast to be a ballast with output frequency greater than or equal to 1000 Hz. For low-frequency electronic ballasts, a square current waveform is used to diminish acoustic resonance and maintain lamp life. All lamps operate well on low-frequency square waves, so these low-frequency ballasts have few compatibility issues with lamps. At higher frequencies, however, acoustic resonance issues and electromagnetic interference (EMI) effects cause compatibility issues with lamps. At these high frequencies, ballasts have to be designed to have the right frequency for a desired lamp, but the selected frequency may be incompatible with other lamps designed for different frequencies. Therefore, high-frequency electronic ballasts are less widely compatible with lamps relative to low-frequency electronic ballasts. High-frequency ballasts may also have difficulty complying with Federal Communications Commission (FCC) standards.[25]

In response to DOE's preliminary determination not to use electronic configuration or circuit type as a class-setting factor, DOE received several comments relating to replacement of magnetic ballasts with electronic ballasts, possible reliability issues with electronic ballasts, and non-efficiency-related benefits to using electronic ballasts. Cooper Lighting stated that electronic ballasts are not direct replacements for magnetic ballasts in fixtures. (Cooper Lighting, Public Meeting Transcript, No. 33 at p. 64) With regard to reliability, Georgia Power said that (1) electronic ballasts are unproven in outdoor applications and (2) electronic ballasts are vulnerable to failures due to high temperature, moisture, and voltage variations and surges caused by lightning and other outdoor events. Progress Energy Carolinas did not disagree with including electronic and magnetically ballasted fixtures in the same equipment class, but commented that the expected energy savings are small. They stated that other operating characteristics drive the use of electronic ballasts in indoor applications (*i.e.,* correlated color temperature variation, lamp lumen depreciation, and dimming). (Progress Energy Carolinas, No. 24 at p. 2) The CA IOUs agreed with Georgia Power that electronic ballasts, especially in conjunction with pulse-start ceramic metal halide lamps that offer higher efficacy and improved color rendering index (CRI), have other advantages that can offset their added cost. The CA IOUs also stated that electronic ballasts do save energy relative to magnetically ballasted systems. (CA IOUs, No. 32 at p. 4) Finally, Empower Electronics supported DOE's preliminary determination, stating that equipment classes need not be set according to electronic configuration and circuit type. (Empower Electronics, No. 36 at p. 6)

As discussed in section V.C.12, DOE recognizes the technological differences between magnetic and electronic ballasts and has incorporated the cost of additional devices or modifications necessary for certain applications into its analysis. In section V.I.2, DOE addresses impacts on manufacturers of a transition to electronic ballasts, but does not consider these impacts in development of equipment classes. While acknowledging that customers make purchasing decisions on electronic versus magnetic ballasts after consideration of other parameters in addition to efficiency, DOE has determined that significant energy savings can be realized through a transition from magnetic to electronic ballasts (see section VI.B.3). For this NOPR, DOE maintains that electronic configuration does not affect consumer utility because with the necessary design adders, electronic ballasts can provide the same utility as magnetic ballasts. Because of this, DOE is not proposing to define equipment classes based on electronic configuration and requests comment on this matter.

d. Lamp Wattage

As lamp wattage increases, lamp and ballast systems generally (but not always) produce increasing amounts of light (lumens). The goal of efficiency standards is to decrease the wattage needed for the same lumens—resulting in an increase in energy efficiency. Because certain applications require more light than others, wattage often varies by application. For example, low-wattage (less than 150 W) lamps are

[25] FCC regulations at 47 CFR part 18, subpart C set forth technical standards for industrial, scientific, and medical equipment that specify frequency bands and tolerance ranges as well as electromagnetic field strength limits. Some metal halide ballasts may be covered under these ''industrial, scientific, and medical (ISM) equipment'' standards, which list the general operating conditions for ISM equipment. Ballasts designed to exceed 9 kHz ballast frequency have to be designed so that interference with transmitted radio frequencies is eliminated. 47 CFR 18.111, 18.301–11

used today in commercial applications for general lighting. Medium-wattage (150–500 W) lamps are the most widely used today and include warehouse, street, and general commercial lighting. High-wattage (greater than 500 W) lamps are used today in searchlights, stadiums, and other applications that require powerful white light. In the preliminary analysis, based on its impact on light output, DOE determined that lamp wattage affects consumer utility. DOE also determined that the wattage of a lamp operated by a ballast is correlated with the ballast efficiency, which generally increases for higher-wattage loads. For electronic ballasts, this efficiency gain can be attributed to the decreasing proportion of fixed losses (*e.g.,* switches) to total losses. For low-wattage electronic ballasts, certain fixed losses contribute a larger proportion of total losses than they do for high-wattage ballasts. Magnetic ballasts—essentially transformers (sometimes with capacitors for power correction and igniters for pulse-starting)—have proportionally lower overall losses with increased wattage. Transformer losses (resistive losses in windings, eddy currents, and hysteresis) do not scale linearly with wattage, meaning that overall efficiency increases with wattage. Because wattage affects consumer utility (lumen output) and has a strong correlation to efficiency, DOE determined that separate equipment classes based on wattage were warranted. As a result in the preliminary analysis, DOE analyzed four lamp wattage class bins: ≥50 W and <150 W, ≥150 W and ≤250 W, >250 W and ≤500 W, and >500 W.

NEEA, Empower Electronics, and Progress Energy Carolinas supported DOE's determination in the preliminary analysis that wattage should be a class-setting factor. (NEEA, No. 31 at p. 3; Empower Electronics, No. 36 at p. 7; Progress Energy Carolinas, No. 24 at p. 3) Because no adverse comments were received on DOE's determination, DOE proposes to continue using lamp wattage as a class-setting factor for this NOPR.

For the NOPR, DOE found that even within a designated wattage range (such as between 100 W and 150 W), the potential efficiencies manufacturers can reach is not constant, but rather varies with wattage. Instead of setting a constant efficiency standard within a wattage bin, DOE is proposing the use of an equation-based energy conservation standard for certain equipment classes (see section V.C). DOE is also continuing to use wattage bins (instead of a single equation spanning the entire covered wattage range) to define equipment classes, for two reasons. First, the range of ballast efficiencies considered can differ significantly by lamp wattage, thus making it difficult to construct a single continuous equation for ballast efficiency from 50 W to 2000 W. This efficiency difference can be attributed to the varying cost of increasing ballast efficiency for different wattages and the impact of legislated (EISA 2007) standards that affect only some wattage ranges. Second, different wattages often serve different applications and have unique cost-efficiency relationships. Analyzing each wattage range as a separate equipment class allows DOE to establish the energy conservation standards that are cost-effective for each wattage bin.

DOE also received comment that certain wattage ranges used in the preliminary analysis should be further divided. Progress Energy Carolinas commented that further division of the 50 W to 250 W equipment class was warranted on the basis of different levels of efficiency being possible for different wattages. (Progress Energy Carolinas, No. 24 at p. 1) For this NOPR, DOE determined that the ≥50 W and <150 W range should be further subdivided. DOE's test data indicates that efficiency varies more significantly for ballasts that operate 50 W to 150 W lamps than for any other wattage range considered in the preliminary TSD. Based on catalog information and manufacturer interviews, DOE determined that 50 W and 100 W fixtures typically serve the same applications, while 150 W products begin to serve applications with increased light demand such as area lighting or parking lots. DOE used this natural division in wattage based on application to further divide the lowest-wattage range from the preliminary analysis.

With regards to the specification of the boundary between fixtures rated to operate at wattages above and below 150 W, Georgia Power commented that 150 W fixtures should be included with fixtures less than 150 W, not those greater than 150 W. (Georgia Power, No. 2 at p. 2) DOE agrees that some 150 W fixtures (those exempted by EISA 2007) should be included in the >100 to <150 W equipment classes. As discussed previously in section III.A.1, there is an existing EISA 2007 exemption for ballasts rated for only 150 W lamps, used in wet locations, and that operate in ambient air temperatures higher than 50 °C. This exemption has led to a difference in the commercially available efficiencies for ballasts that are exempted or not exempted from EISA 2007. The exempted ballasts have a range of efficiencies similar to wattages less than 150 W. Ballasts not exempted by EISA 2007 have efficiencies similar to ballasts greater than 150 W. As a result, DOE is proposing that 150 W fixtures previously exempted from EISA 2007 be included in a >100 W and <150 W range, while 150 W fixtures subject to EISA 2007 standards would be included in a ≥150 W to ≤250 W range.

In the preliminary analysis, DOE included all fixtures rated to operate at wattages greater than 500 W in the same equipment class. OSI suggested that DOE include 500 W ballasts in the highest-wattage range. OSI stated that electronic ballasts that operate lamps greater than or equal to 500 W have not been developed yet. (OSI, No. 27 at p. 4) In response to the lack of electronic ballasts operating lamps greater than or equal to 500 W, DOE agrees that there are not commercially available electronic ballasts at these wattages today, but also notes that magnetic ballasts are also unavailable at this wattage. Because leaving the boundary between these two wattage ranges at 500 W does not affect any commercially available products, DOE proposes to maintain the >250 W and ≤500 W range for consistency with the EISA 2007 covered wattage range.

In summary, DOE is proposing to define metal halide lamp fixture equipment classes by rated lamp wattage ranges ≥50 W to ≤100 W, >100 W to <150 W, ≥150 W to ≤250 W, >250 W to ≤500 W, and >500 W to ≤2000 W. DOE proposes that 150 W fixtures previously exempted by EISA 2007 be included in the >100 W to <150 W range, while 150 W fixtures subject to EISA 2007 standards continue to be included in the ≥150 W to ≤250 W range. DOE requests comment on these wattage ranges.

e. Number of Lamps

Metal halide lamp fixtures are commonly designed to operate with a single lamp because of lamp characteristics related to re-striking (turning the lamp on again after being turned off, because metal halide lamps require time to cool down before being lighted again) and voltage regulation. DOE's review of manufacturer catalogs revealed that while a majority of available ballasts operate only one lamp, a small fraction are designed for two lamps. Based on this review, DOE determined that there is little to no change in efficiency between one-lamp and two-lamp metal halide ballast fixtures. In the preliminary analysis, DOE determined it unnecessary to consider multiple-lamp ballasts in equipment classes separate from single-lamp ballasts.

NEMA agreed with DOE on the limited number of two-lamp metal halide lamp fixtures. Because two-lamp ballasts represent such a small part of the market, NEMA suggested they be excluded from the rulemaking. Given the optical size of a metal halide lamp, NEMA found it unlikely that a manufacturer would use this exemption as a loophole. Fixtures using multiple-lamp ballasts would have to be larger, more expensive, and less optically efficient than those with single-lamp ballasts. (NEMA, No. 34 at p. 10) Because catalog data shows no difference in efficiency, in this NOPR, DOE continues to propose including ballasts with differing numbers of lamps in the same equipment class. DOE is not proposing to exclude 2-lamp ballasts from the scope of coverage.

f. Starting Method

Metal halide lamp fixtures currently available in the market are designed to operate with either probe-start or pulse-start lamps, but not a mixture of both types at the same time.[26] The main differences between these starting methods are: (1) The inclusion of a third probe in probe-start lamps, (2) the need for an igniter circuit for pulse-start lamps, and (3) the different wiring specification for ballasts of each starting method. Most new applications in the market are pulse-start due to its higher efficacy (pulse-start lamps provide more lumens per watt than probe-start lamps). In the preliminary analysis, DOE did not consider probe versus pulse-starting to be a class-setting factor. While pulse-start lamps are more efficacious than probe-start lamps, probe and pulse-start ballasts can achieve the same levels of ballast efficiency and are used in similar applications. DOE did not receive any adverse comment relating to this preliminary determination, so in this NOPR, DOE proposes that both probe and pulse-start ballasts be included in the same equipment class.

EISA 2007 distinguishes nonpulse-start electronic equipment classes by separating them into two rated lamp wattage ranges (≥150 W and ≤250 W, and >250 W and ≤500 W) and applying a more stringent standard to them than to other ballast types. According to DOE's review of manufacturer catalogs and information provided by manufacturers during interviews, nonpulse-start electronic metal halide lamp fixtures are not available in the market. While EISA 2007 contemplated the creation of additional classes for alternative technologies that could become available in the future, DOE has no information that indicates differences in efficiency or consumer utility based on pulse-start versus nonpulse-start ballast fixtures. Based on this information, in the preliminary analysis, DOE determined that a separate equipment class for nonpulse-start ballasts was unnecessary. DOE did not receive adverse comments relating to this preliminary determination, so in this NOPR, DOE is proposing that nonpulse-start electronic ballasts be included in the same equipment class as all other starting methods. The term nonpulse-start electronic ballast is currently undefined in the CFR. To avoid confusion, DOE is proposing to define 'nonpulse-start electronic ballast' in 10 CFR 431.322 as an electronic ballast with a starting method other than pulse-start.

Due to their apparent interchangeability and lack of unique or separate utility that would affect efficiency, DOE proposes not to use ballast-starting method as a class-setting feature.

g. Conclusions

Based on interested party input and additional research, in this NOPR, DOE has decided to propose the equipment classes in the following table. DOE has revised the wattage bins considered in the preliminary analysis to account for a varying number of efficiency levels, different cost-efficiency relationships in the lower wattages, and the lack of general lighting applications for wattages higher than 2000 W. Additionally, each of these wattage bins is further divided into indoor and outdoor applications to account for the difference in consumer utility and the cost-efficiency relationships for these application types (see section V.C.12 for further details about the cost adders that effect these relationships). Finally, each of these classes is subdivided by input voltage, with one class for ballasts tested at 480 V (in accordance with the 2009 test procedures, supplemented with the testing guidance included in this document), and the non-480 V ballasts in a separate class. Ballasts tested at 480 V include dedicated 480 V ballasts and any ballast capable of being operated at 480 V, but incapable of being operated at the input voltage specified by the amendments to the test procedures proposed in this NOPR (either 120 V or 277 V, depending on lamp wattage). DOE invites comments on these proposed equipment classes.

TABLE V.1—METAL HALIDE LAMP FIXTURE NOPR EQUIPMENT CLASSES

Equipment classes	Rated lamp wattage	Indoor/outdoor †	Input voltage type ‡
1	≥50 W and ≤100 W	Indoor	Tested at 480 V.
2	≥50 W and ≤100 W	Indoor	All others.
3	≥50 W and ≤100 W	Outdoor	Tested at 480 V.
4	≥50 W and ≤100 W	Outdoor	All others.
5	>100 W and <150 W *	Indoor	Tested at 480 V.
6	>100 W and <150 W *	Indoor	All others.
7	>100 W and <150 W *	Outdoor	Tested at 480 V.
8	>100 W and <150 W *	Outdoor	All others.
9	≥150 W ** and ≤250 W	Indoor	Tested at 480 V.
10	≥150 W ** and ≤250 W	Indoor	All others.
11	≥150 W ** and ≤250 W	Outdoor	Tested at 480 V.
12	≥150 W ** and ≤250 W	Outdoor	All others.
13	>250 W and ≤500 W	Indoor	Tested at 480 V.
14	>250 W and ≤500 W	Indoor	All others.
15	>250 W and ≤500 W	Outdoor	Tested at 480 V.
16	>250 W and ≤500 W	Outdoor	All others.
17	>500 W and ≤2000 W	Indoor	Tested at 480 V.
18	>500 W and ≤2000 W	Indoor	All others.

[26] DOE is aware of some metal halide lamps that can be operated by a pulse-start or a probe-start ballast. These lamps are much less common than lamps designed to be operated by ballasts of only one starting method.

TABLE V.1—METAL HALIDE LAMP FIXTURE NOPR EQUIPMENT CLASSES—Continued

Equipment classes	Rated lamp wattage	Indoor/outdoor †	Input voltage type ‡
19	>500 W and ≤2000 W	Outdoor	Tested at 480 V.
20	>500 W and ≤2000 W	Outdoor	All others.

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

† DOE's proposed definitions for ''indoor'' and ''outdoor'' metal halide lamp fixtures are described in section V.A.2.

‡ Input voltage for testing would be specified by the test procedures. Ballasts rated to operate lamps less than 150 W would be tested at 120 V, and ballasts rated to operate lamps ≥150 W would be tested at 277 V. Ballasts not designed to operate at either of these voltages would be tested at the highest voltage the ballast is designed to operate. See section IV.A for further detail.

DOE requests comment on the proposed equipment classes.

B. Screening Analysis

For the screening analysis, DOE consults with industry, technical experts, and other interested parties to develop a list of technology options for consideration and to determine which technology options to consider further and which to screen out.

Section 325(o)(2) of EPCA requires that any new or revised standard achieve the maximum improvement in energy efficiency determined to be technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)) Appendix A to subpart C of 10 CFR part 430, ''Procedures, Interpretations, and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products'' (the Process Rule), sets forth procedures to guide DOE in its consideration and promulgation of new or revised energy conservation standards. These procedures elaborate on the statutory criteria provided in 42 U.S.C. 6295(o) and, in part, eliminate problematic technologies early in the process of prescribing or amending an energy conservation standard. In particular, sections 4(b)(4) and 5(b) of the Process Rule provide guidance to DOE for determining which design options are unsuitable for further consideration:

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

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

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

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

For the preliminary analysis, DOE identified the design options listed in Table V.2 as technologies that could improve MHLF ballast efficiency and pass the screening criteria discussed above. For further details on these design options, see chapter 3 of the NOPR TSD. DOE received several comments, discussed below, in response to the design options presented in the preliminary analysis, particularly on ''improved core steel'' for magnetic ballasts and ''improved components'' for electronic ballasts.

TABLE V.2—METAL HALIDE LAMP FIXTURE PRELIMINARY ANALYSIS DESIGN OPTIONS

Ballast type	Design option		Description
Magnetic	Improved Core Steel		Use a higher grade of electrical steel, including grain-oriented silicon or amorphous steel, to lower core losses.
	Copper Wiring		Use copper wiring in place of aluminum wiring to lower resistive losses.
	Increased Stack Height		Add steel laminations to lower core losses.
	Increased Conductor Cross-Section		Increase conductor cross section to lower winding losses.
	Electronic Ballast		Replace magnetic ballasts with electronic ballasts.
Electronic	Improved Components	Magnetics	Use grain-oriented or amorphous electrical steel to reduce core losses.
			Use optimized-gauge copper or litz wire to reduce winding losses.
			Add steel laminations to lower core losses.
			Increase conductor cross section to lower winding losses.
		Diodes	Use diodes with lower losses.
		Capacitors	Use capacitors with a lower effective series resistance and output capacitance.
		Transistors	Use transistors with lower drain-to-source resistance.

TABLE V.2—METAL HALIDE LAMP FIXTURE PRELIMINARY ANALYSIS DESIGN OPTIONS—Continued

	Improved Circuit Design	Integrated Circuits	Substitute discrete components with an integrated circuit.

DOE received comment on whether improved core steel was a design option or if the highest-grade steels are already used in commercially available ballasts. NEEA was generally in support of the 13 selected design options and DOE's decision to not screen any of them further. However, NEEA did comment that if higher-grade electrical steels are already being utilized in the baseline efficiency ballasts, this may limit DOE's ability to apply ''improved core steel'' as a design option for improving efficiency. (NEEA, No. 31 at p. 4) DOE agrees that some ballasts available on the market today already use some of the highest grades of grain-oriented core steel available. For example, DOE has received feedback that 175 W magnetic ballasts typically require M6 steel, a high-grade, grain-oriented steel, to reach 88 percent, the minimum EISA 2007 requirement. (Philips, Public Meeting Transcript, No. 33 at p. 69–70) However, through manufacturer interviews, DOE has learned that there exists significant opportunity for improvement in the steels used for other wattage ballasts. Therefore, DOE continues to consider higher-grade, grain-oriented silicon steel as a design option to improve magnetic ballast efficiency.

ASAP commented that DOE should evaluate the efficiency potential of using amorphous steel in cores for the highest efficiency levels analyzed. (ASAP, Public Meeting Transcript, No. 33 at pp. 68–69) Conversely, NEMA stated that amorphous steel is neither technologically feasible nor practicable to manufacture for any HID ballast, including metal halide ballasts. NEMA commented that distribution transformers are linear devices that have relatively simpler core configurations. In contrast, metal halide ballasts are non-linear devices that require specific flux leakages and wave shaping. These unique characteristics are achieved through reconfiguring flux pathways within the metal halide ballast by using flux choke points and leakage paths between the primary and secondary circuits. NEMA explained that these manipulations of the core are extremely difficult with relatively brittle amorphous steel without causing fractures. (NEMA, No. 34 at p. 12) Based on this feedback and the lack of any commercially available metal halide ballast or prototype that utilizes amorphous steel cores, DOE proposes to screen out amorphous steels within the ''improved core steel'' design option due to the impracticability to manufacture at the scale necessary to serve the relevant market.

NEMA also commented that commercially available electronic ballasts already utilize the high-quality components. (NEMA, No. 34 at p. 12) Based on its teardown analysis and assessment of the components in commercially available metal halide electronic ballasts, DOE concurs with NEMA that these ballasts generally use low-loss components. However, as discussed in section V.C, DOE found a range of efficiencies commercially available for electronic ballasts. As these efficiency differences were, at least in part, due to variations in components used, DOE believes that ''improved components'' is a valid design option and continues to consider it in the engineering analysis.

C. Engineering Analysis

1. Approach

The engineering analysis develops cost-efficiency relationships depicting the fixture manufacturing costs of achieving increased ballast efficiency. DOE applies two methodologies to estimate manufacturing costs for the engineering analysis: (1) The design-option approach, which provides the incremental costs of adding the design options (*e.g.,* improved core steels) discussed in section V.B to improve the efficiency of a baseline model; and (2) the efficiency-level approach, which estimates the costs of achieving increases in energy efficiency levels, through ballast efficiency testing and teardowns, without regard to the design options used to achieve such increases. Details of the engineering analysis are in chapter 5 of the NOPR TSD. The following discussion summarizes the general steps of the engineering analysis:

Determine Representative Equipment Classes. When multiple equipment classes exist, to streamline testing and analysis, DOE selects certain classes as ''representative'' primarily because of their high market volumes. DOE then adapts the efficiency levels (ELs) from representative equipment classes to those equipment classes it does not analyze directly.

Determine Representative Wattages. Within each representative equipment class, DOE also selects a particular wattage fixture as ''representative'' of the wattage range, primarily because of their high market volumes. In this NOPR, DOE assigns only one representative wattage per representative equipment class.

Representative Fixture Types. To calculate the typical cost of a fixture at each representative wattage, DOE selects certain types of fixtures to analyze as representative.

Select Baseline Units. DOE establishes a baseline unit for each representative wattage. The baseline unit has attributes (circuit type, input voltage capability, electronic configuration) typical of ballasts used in fixtures of that wattage. The baseline unit also has the lowest (base) efficiency for each equipment class. DOE measures changes resulting from potential amended energy conservation standards compared with this baseline. For fixtures subject to existing Federal energy conservation standards, a baseline unit is a metal halide lamp fixture with a commercially available ballast that just meets existing standards. If no standard exists for a fixture, the baseline unit is the metal halide lamp fixture with a ballast within that equipment class with the lowest tested ballast efficiency that is sold. To determine energy savings and changes in price, DOE compares each higher energy-efficiency level with the baseline unit.

To determine the ballast efficiency, DOE tested a range of metal halide ballasts from multiple ballast manufacturers. Appendix 5A of the NOPR TSD presents the test results. In some cases, DOE selects more than one baseline for a representative wattage to ensure consideration of different fixture and ballast types and their associated customer economics.

Select More Efficient Units. DOE selects commercially available metal halide lamp fixtures with higher-than-baseline-efficiency ballasts as replacements for each baseline model in each representative equipment class. In general, DOE can identify the design options associated with each more-efficient ballast model by considering the 12 design options identified in the technology assessment (chapter 3 of the NOPR TSD) and screening analysis (chapter 4 of the NOPR TSD). Where design options cannot be identified for that class by the product number or catalog description, DOE uses a database of commercially available ballasts. DOE then tests these ballasts to determine their efficiency. Appendix 5A of the NOPR TSD presents these test results. All ballast efficiencies were calculated according to the metal halide ballast test procedures (10 CFR 431.324) unless otherwise specified. DOE estimates the design options likely to be used in the ballast to achieve a higher efficiency based on information gathered during manufacturer interview and information presented in ballast catalogs.

Determine Efficiency Levels. DOE develops ELs based on: (1) The design options associated with the equipment class studied and (2) the maximum technologically feasible (max tech) efficiency level for that class. As just noted and as discussed in section IV.B.2, DOE's efficiency levels are based on catalog data, test data collected from commercially available equipment, and manufacturer input.

Conduct Price Analysis. DOE generated a bill of material (BOM) by disassembling multiple manufacturers' ballasts from a range of efficiency levels and fixtures that span a range of applications for each equipment class. The BOMs describe the equipment in detail, including all manufacturing steps required to make and/or assemble each part. DOE then developed a cost model to convert the BOMs for each representative unit into manufacturer production costs (MPCs). By applying derived manufacturer markups to the MPCs, DOE calculated the manufacturer selling prices [27] and constructed industry cost-efficiency curves. In cases where DOE was not able to generate a BOM for a given ballast, DOE estimated an MSP based on the relationship between teardown data and retail data. DOE also estimated ballast and fixture cost adders necessary to allow replacement of more efficient substitutes for baseline models.

2. Representative Equipment Classes

As described above, DOE selects certain equipment classes as ''representative'' to focus its analysis. The 20 equipment classes proposed in this NOPR (based on rated lamp wattage, test voltage, and indoor or outdoor designation) and the criteria used for development are presented in section V.A.2. Due to their low shipment volume (as indicated through manufacturer interviews), DOE does not directly analyze the equipment classes containing only fixtures with ballasts tested at 480 V. DOE selected all other equipment classes as representative, resulting in a total of ten representative classes covering the full range of lamp wattages, as well as indoor and outdoor designations.

3. Representative Wattages

In the preliminary analysis, DOE selected four representative rated wattages of fixtures (70 W, 250 W, 400 W, and 1000 W) to analyze in the engineering analysis. Each representative wattage was typically the most commonly sold wattage within each equipment class, based on analysis of fixture availability from catalogs and manufacturer input. DOE received several comments relating to the criteria for representative wattage selection, as well as recommendations to change specific wattages analyzed in the preliminary analysis. Also, because of the addition of the 101 W to 150 W equipment classes (discussed in section V.A.2), DOE proposes to add an additional representative wattage at 150 W. These comments and proposed changes are discussed further below.

In general, NEMA recommended that DOE use the lowest-rated-wattage ballast to propose energy efficiency levels and the most prevalent model within a class to determine the volume of shipments. NEMA explained that the highest attainable efficiency for a rated wattage range is determined by the lowest-rated-wattage ballast, while in many cases that equipment may not represent the highest volume. OSI explained that the ballast losses (power dissipated within the ballast) in a lower-rated-wattage ballast represent a higher percentage of the total system wattage, thus resulting in lower efficiencies at lower rated powers. In particular, NEMA, OSI, and NEEA disagreed with the choice of the 250 W fixture as the representative wattage for the 150 W to 250 W equipment class, recommending instead 175 W as a more appropriate wattage due to its high market share. (OSI, Public Meeting Transcript, No. 33 at p. 54; NEEA, No. 31 at p. 4; OSI, No. 27 at p. 3; NEMA, No. 34 at p. 13)

DOE recognizes that lower-rated-wattage ballasts will have lower efficiencies than higher-rated-wattage ballasts. To account for this effect in the NOPR, as discussed in section V.C.9, DOE is proposing to use equations for each wattage range to define minimum efficiency requirements as a function of rated lamp wattage. This equation-based approach allows DOE to, in general, base its selection of representative wattages, and thus the resulting economic analysis, on the high-market-share products, while still ensuring technological feasibility of the entire equipment class. DOE has continued to use 250 W as the representative wattage primarily because it is the only wattage in the 150 W to 250 W equipment class with a range of commercially available magnetic ballast efficiencies above the EISA 2007 minimum requirements. By conducting a cost-efficiency analysis on 250 W fixtures, DOE is able to characterize the potential energy savings of equipment within this class at efficiency levels below those characterized by electronic ballasts.

Although 175 W fixtures may currently have high market share, DOE understands that EISA 2007 has caused, and may continue to cause, a significant shift from 175 W probe-start metal halide fixtures to the 150 W pulse-start fixtures exempted from EISA 2007 standards. DOE believes that this may result in 250 W fixtures gaining market share (relative to 175 W fixtures) in the future. Thus, DOE believes that 250 W is an appropriate representative wattage for analysis.

Because of the current and projected high market share of 150 W fixtures exempted from EISA standards, and to match the newly proposed equipment class for fixtures rated from 100 W to 150 W (discussed in section V.A.2), DOE has decided to add a 150 W representative unit. Based on an assessment of commercially available fixtures and manufacturer interviews, DOE has come to the conclusion that 150 W fixtures represent the vast majority of the equipment class and, therefore, believes it to be an appropriate representative wattage.

In summary, after considering the comments received and changes to the proposed equipment class structure, DOE has selected five representative wattages for analysis: 70 W, 150 W, 250 W, 400 W, and 1000 W.

4. Representative Fixture Types

After selecting representative wattages for analysis, DOE identified the applications commonly served by each equipment class's wattage range in order to select representative Fixture Types. Although DOE is evaluating ballast efficiency only as a metric for reducing MHLF energy consumption, DOE recognizes that technological changes in the ballast, specifically moving from magnetic ballasts to electronic ballasts, can necessitate alterations to the fixture. These changes, discussed in further detail in section V.C.12, often incur additional costs dependent on the Fixture Type that is redesigned. In the engineering analysis, DOE estimates a baseline fixture cost as well as

[27] The MSP is the price at which the manufacturer can recover all production and non-production costs and earn a profit. Non-production costs include selling, general, and administration (SG&A) costs, the cost of research and development, and interest.

incremental costs to the fixture (with increasing ballast efficiency) based on the representative Fixture Types selected.

For the preliminary analysis, DOE selected one to three representative Fixture Types for each rated wattage range. For wattages less than 150 W, DOE selected canopy fixtures as the representative Fixture Types. For wattages from 150 W to 250 W, DOE identified three representative fixture types: canopy, low-bay, and wallpack. For wattages greater than 250 W, DOE chose canopy, flood, and high-bay fixtures as representative fixture types.[28] Georgia Power commented that DOE should consider post tops as a representative fixture for 150 W fixtures. (Georgia Power, No. 28.1 at p. 2) During metal halide lamp fixture manufacturer interviews, DOE requested market data on the most common Fixture Types sold for each wattage range analyzed. For the equipment class represented by the 150 W fixture, DOE did not receive feedback that post-tops were a large portion of that market. Instead, manufacturers responded that area lighting and wallpacks comprised the majority of the 150 W market. Thus, for this NOPR, and similar to the representative fixtures for the 150 W to 250 W equipment, DOE selected canopy, low-bay, and wallpack fixtures as representative fixture types for the 100 W to 150 W equipment class.

5. Ballast Efficiency Testing

After selecting representative wattages and fixture types, DOE purchased and tested a multitude of metal halide ballasts, ranging from low-efficiency magnetic to high-efficiency electronic, in order to evaluate the range of commercially available ballast efficiencies. In selecting units for testing and analysis, DOE focused its effort on representative wattage ballasts with operating characteristics similar to ballasts prevalent in the market. For example, through interviews and an assessment of commercially available products, DOE learned that the majority of metal halide ballasts sold are quad-input voltage ballasts. Thus, DOE primarily tested metal halide ballasts capable of quad-input or multiple-input voltage operation.

Regarding magnetic circuit types, Progress Energy Carolinas commented that there is wide variation between magnetic operating characteristics of the different magnetic ballast types, such as regulated, magnetic regulated, CWA, reactor, and high-power-factor reactor. They suggested that DOE study this issue further to ensure proper selection of representative units for analysis. (Progress Energy Carolinas, No. 24 at p. 2) In response, DOE has investigated the technical differences between magnetic circuit types and provides its assessment in Chapter 3 of the NOPR TSD. In addition, through an assessment of commercially available products and manufacturer interviews, DOE has learned that at low wattages (less than or equal to 150 W), high reactance autotransformer (HX–HPF) ballasts and CWA ballasts are most prevalent. At higher wattages, CWA ballasts compose the vast majority of the market. In consideration of these findings, DOE focused its testing and analysis on HX–HPF and CWA ballasts for the 70 W and 150 W representative units and CWA ballasts for all other wattage units.

Average ballast efficiencies (across four samples) were determined in accordance with metal halide ballast test procedures (10 CFR 431.324) by dividing measured output power by measured input power. As discussed in sections V.C.7 and V.C.8, DOE selects baseline and higher-efficiency representative units for analysis based on these average efficiencies. Also, as discussed in the following section, DOE determines representative ballast input power for each efficiency level based on these tested ballast efficiencies. To determine the efficiency levels under consideration, as discussed in section V.C.9, DOE uses a reported efficiency value based on the four tested samples, pursuant to the metal halide ballast certification procedures in 10 CFR 429.54.

6. Input Power Representations

In the preliminary analysis, ballast input powers for use in the downstream analyses (such as the LCC and NIA analyses) were normalized such that the ballast outputted the rated lamp input power by dividing rated lamp wattage by measured ballast efficiency. In response, NEMA commented that ballast efficiency should not be calculated based on rated lamp power and input power. They remarked that not all ballasts operate lamps at their rated wattages and, thus, these ballasts could appear to have higher efficiencies than technologically feasible if this method is used. (NEMA, No. 34 at p. 13)

To clarify, DOE is not calculating ballast efficiencies based on rated lamp powers. Rather, DOE is using measured ballast efficiencies and rated lamp output to calculate normalized input powers for the downstream energy-use analyses. Although DOE's test results indicate slight variations in ballast output power relative to rated lamp power from unit to unit, based on the marketing of these ballasts, DOE concludes that the metal halide ballasts tested are generally designed to operate lamps at their rated wattages. DOE believes these variations (on the order of three percent of the rated lamp power) are unlikely to significantly affect average ballast efficiency. In this NOPR, DOE continues to utilize normalized input powers in order to best characterize the energy use of all products that meet a particular efficiency level and to eliminate any artifacts due to the particular model chosen.

Additionally, OSI noted that the system wattage of magnetic ballasts increases up to 11 percent over lamp life. In contrast, electronic ballasts do not exhibit this behavior and, thus, have lower energy use relative to a magnetic system of the same efficiency when considering operation over the lifetime of the lamp. (OSI, No. 27 at p. 7) DOE's research indicates that as metal halide lamps age, they require higher voltages. Electronic ballasts have the capability to sense that the lamp voltage has increased and, in response, decrease their output current to maintain constant wattage throughout the life of the ballast. The CA IOUs also noted that electronic ballasts can improve lamp efficacy and lumen maintenance, resulting in higher mean rated lumens over the lifetime of the lamp. The CA IOUs urged DOE to consider scenarios where either reduced-wattage lamps or fewer (but more luminous) total fixtures can be used with electronic ballasts to capture even greater energy savings while maintaining the same mean system light output as the baseline system. (CA IOUs, No. 32 at p. 4)

DOE accounted for the increase in wattage for magnetic ballasts by using a multiplier when calculating magnetic efficiencies. DOE assumed that magnetic ballasts' wattage increase occurs in a linear fashion over the life of the ballast. With this assumption, the ballast would average a 5.5 percent increase in output wattage over its lifetime. Therefore, DOE multiplied the rated lamp wattage by 1.055 when calculating the input power normalized to rated lamp power for all magnetic ballasts, but not for electronic ballasts. To investigate electronic ballast lumen maintenance, DOE reviewed lamp and ballast manufacturer product information, but did not find a consistent description of the impact of an electronic ballast on lumen maintenance. Based on the limited information and uncertainty of the potential impacts, DOE is not proposing an adjustment to electronic ballast input power to account for improved lumen

[28] Descriptions of each of these fixture types can be found in chapter 3 of the NOPR TSD.

maintenance relative to magnetic ballast operation. DOE requests comment on using a 5.5 percent increase when calculating the representative input power of magnetic ballasts.

7. Baseline Ballast Models

DOE selected baseline models as reference points for each representative equipment class, against which DOE measured changes in energy use and price resulting from potential amended energy conservation standards. For metal halide lamp fixtures and ballasts subject to existing Federal energy conservation standards, a baseline model is a commercially available ballast that just meets existing standards and provides basic consumer utility. If no standard exists for a specific fixture type (*e.g.,* less than 150 W or greater than 500 W fixtures), DOE chooses baselines that represent lowest efficiency products (based on average test ballast efficiencies) or highest-volume products within the representative parameters defined (*e.g.,* representative wattage, magnetic circuit type, input voltage). For the preliminary analysis, DOE analyzed a CWA, quad-input voltage, pulse-start baseline ballast for each of the 70 W, 250 W, 400 W, and 1000 W representative wattages. As DOE received no adverse comment to the selection of the 70 W, 250 W, and 400 W baselines, DOE continues to use the same baseline ballasts for the NOPR. The following paragraphs discuss changes to the 1000 W baseline and the additions of a second 70 W baseline and a new 150 W baseline.

a. 70 W Baseline Ballast

In the preliminary analysis, DOE analyzed a single 70 W magnetic ballast with an efficiency of 72.0 percent as the baseline unit. However, through manufacturer interviews, DOE has learned that electronic ballasts compose a significant portion (estimated as more than 25 percent) of the ≥50 W and ≤100 W ballasts shipped with indoor fixtures. Therefore, for this NOPR, DOE has added an electronic baseline ballast for analysis. This ballast utilizes an LFE circuit, operates at quad-voltage, and has an efficiency of 88.0 percent. DOE requests comment on the addition of this electronic 70 W baseline ballast.

150 W Baseline Ballast

As discussed earlier, to analyze the new equipment classes with a rated wattage range of 100 W to 150 W, DOE has added a 150 W representative unit to its analysis. Through market research and ballast efficiency testing, DOE has determined that both CWA and HX–HPF ballasts are common at the 150 W level. Based on test results, DOE found the lowest efficiency ballast that could be incorporated into a fixture exempt from EISA 2007 standards was a magnetic pulse-start, quad-voltage CWA ballast with an efficiency of 81.2 percent, and, thus, analyzed this ballast as a baseline.

1000 W Baseline Ballast

In the preliminary analysis, DOE selected a 1000 W CWA, quad-input voltage, magnetic, pulse-start ballast with an efficiency of 91.8 percent as a baseline for the >500 W equipment class. Since publication of the preliminary analysis, DOE has learned that although pulse-start ballasts are available at the 1000 W level, probe-start, CWA, quad-voltage units predominate in this wattage category, and are, therefore, more appropriate baselines. Because DOE's analysis indicates that ballast efficiency is not affected by starting method, DOE created a probe-start baseline by utilizing the same baseline ballast efficiency (91.8 percent) and applying a manufacturer production cost representative of a probe-start ballast. DOE further discusses the derivation of manufacturing production costs in section V.C.12 of this NOPR and in chapter 5 of the NOPR TSD.

8. Selection of More Efficient Units

After selection of baseline models, DOE used a combination of two methods to determine more efficient units for analysis within each representative equipment class. The first method was by examining DOE's own test data (discussed in section V.C.5) to select commercially available ballasts to represent higher efficiency levels. The second method involved filling in large gaps of efficiency present in the test data (often between commercially available magnetic and electronic ballasts) through estimating efficiency increases due to the implementation of several of the design options described in section V.B. DOE derived those estimates based on manufacturer interviews and by validating or supplementing that input with independent modeling of potential reductions in losses. Specifically, DOE used the watts loss/pound characteristics for various steel types and the resistive losses for various winding materials to determine the levels of efficiency modeled ballasts could achieve. In modeling more efficient magnetic ballasts, DOE maintained the physical size of the higher-efficiency models relative to commercially available products within the representative wattages. DOE seeks comment on whether features or consumer utility of the ballasts such as the physical size, including footprint, stack height, and weight can be maintained or if they would be adversely affected for the magnetic ballast efficiencies associated with the modeled ballasts.

In summary, for the NOPR, DOE developed a maximum technologically feasible magnetic ballast based on either commercially available equipment (for the 1000 W level) or a modeled ballast (for other representative wattages) that utilizes the highest grade steels practicable for manufacturing metal halide ballasts. DOE also developed a maximum technologically feasible electronic ballast (which also serves to represent the maximum technologically feasible level overall) for the 70 W, 150 W, 250 W, and 400 W representative wattages. To determine this level, DOE conducted a survey of the MHLF market and the research fields that support the market. DOE concluded that, within a given equipment class, no working prototypes exist that have a distinguishably higher ballast efficiency than currently available electronic ballasts. As such, the highest-efficiency units analyzed in the engineering analysis represent the most efficient tier of commercially available equipment. For further details on the higher-efficiency units analyzed in the NOPR, see chapter 5 of the NOPR TSD.

DOE received several comments, discussed below, on the higher-efficiency magnetic and electronic units analyzed in the preliminary analysis.

a. Higher-Efficiency Magnetic Ballasts

NEMA noted that magnetic ballasts are already as efficient as possible while still being cost-effective, and further changes to their designs could make them cost-prohibitive and not physically feasible for use in current products. In particular, NEMA stated that 150 W magnetic ballasts only exist on the market due to their current exemption from standards, and to make them any more efficient would involve a size increase and redesign. (NEMA, No. 34 at p. 7, 13–14) Similarly, Philips stated that 88 percent efficiency is the highest possible efficiency for 175 W magnetic ballasts, but it is not achievable for lower-wattage magnetic ballasts. (Philips, Public Meeting Transcript, No. 33 at pp. 69–70)

On the other hand, the CA IOUs recommended that DOE re-examine the maximum technologically feasible efficiency for magnetic ballasts. They noted that according to the CEC database, 12 fixtures (at the representative 400 W level) listed by manufacturers in 2010 used magnetic ballasts that claimed 93 percent or higher ballast efficiency, which significantly more efficient than DOE's highest magnetic ballast analyzed. (CA IOUs, No. 32 at p. 5–6)

As discussed in the screening analysis (section V.B), DOE recognizes that several commercially available magnetic ballasts (such as the 175 W 88-percent efficient ballast) may already utilize the highest efficiency design options and have reached their efficiency limits. However, based on feedback from manufacturer interviews, DOE has learned that for each of the representative wattages analyzed, there exist design options to improve efficiency. Therefore, DOE utilizes these design options to estimate the maximum technologically feasible efficiency for magnetic ballasts for each representative wattage. DOE does account for efficiency limits of non-representative wattages by creating efficiency-level equations (dependent on rated wattage) for each equipment class. In response to the CA IOUs comment, DOE reviewed the CEC database, but was unable find any of the more-efficient 400 W ballasts available for purchase. As DOE was unable to test these ballasts and confirm their higher efficiencies, DOE could not include them in this analysis.

b. Electronic Ballasts

In the preliminary analysis and in this NOPR, DOE analyzed electronic ballasts as higher-efficiency replacements to magnetic ballasts and based max tech efficiencies on commercially available electronic ballasts independently tested by DOE. In response to those efficiencies, DOE received several comments, discussed below, regarding the appropriate electronic max tech efficiencies, use of high-frequency electronic ballasts as representative units of analysis, and whether electronic ballasts should be considered the maximum technologically feasible level for 1000 W ballasts.

Maximum Technologically Feasible Efficiencies

Regarding the maximum technologically feasible efficiency of electronic ballasts, OSI stated that their commercially available ballasts represent the current max tech. Any further increases in efficiency would be theoretical and not proven through actual performance. (OSI, No. 27 at p. 5) In contrast, the CA IOUs noted that the CEC database contains several electronic ballasts from manufacturers such as Metrolight and Advance with efficiencies significantly higher than those identified as max tech. The CA IOUs encouraged DOE to revisit maximum achievable efficiencies for each equipment class and technology option. (CA IOUs, No. 32 at p. 5–6)

As DOE does not have any indication electronic ballast efficiency can exceed that which is currently commercially available, DOE agrees with OSI's assessment that any efficiency improvement above commercially available electronic ballasts would be widely speculative. Therefore, all of the max tech levels proposed by DOE reflect existing commercially available ballasts. DOE has attempted to purchase and test the highest-efficiency ballasts, as determined through catalog rated efficiencies and the CEC metal halide lamp fixture database. Thus, DOE believes that its max tech electronic ballast efficiencies represent the highest efficiencies that are commercially available and validated by independent testing in accordance with DOE's metal halide ballast test procedures.

High-Frequency Electronic Ballasts

In the preliminary analysis, the maximum technologically feasible level for 400 W fixtures was based on a high-frequency electronic ballast. DOE requested comment on the appropriateness of using high-frequency electronic ballasts as representative units, particularly with respect to lamp and ballast compatibility concerns.

In response, OSI, Philips, and NEMA opposed regulatory requirements obtainable only with high-frequency electronic ballasts. While they recognized that high-frequency electronic ballasts can have higher efficiencies, they noted that their test measurements also have a significantly higher degree of error (as high as five percent) than those obtained with low-frequency ballasts. OSI and NEMA argued that if DOE establishes standards based on high-frequency technology, this increased variation should be accounted for. In addition, all three stakeholders remarked that high-frequency electronic ballast technology is often not compatible with the most efficacious systems, specifically noting their incompatibility with ceramic metal halide lamps, which represent the highest efficacy, best lumen maintenance, and longest life of metal halide lamps. (Philips, Public Meeting Transcript, No. 33 at p. 34, 62–63; OSI, No. 27 at p. 4; NEMA, No. 34 at p. 14) While acknowledging that there are some lamp and ballast compatibility concerns, Empower Electronics stated that high-frequency ballasts can be more efficient and should be used as a representative unit. (Empower Electronics, No. 36 at p. 8)

In response, DOE has researched product application notes in catalogs and technical literature regarding lamp compatibility with high-frequency ballasts. Based on this research, DOE agrees that due to acoustic resonance issues, high-frequency ballasts may have significant compatibility problems with some high-efficacy metal halide lamps, thus, reducing potential energy savings at those levels. Although DOE maintains high-frequency electronic ballasts as a valid design option to improve ballast efficiency, DOE will take the impact of lamp and ballast compatibility into account when adopting any amended standards.

Acuity also commented that high-frequency ballasts are less reliable in outdoor applications because ambient temperature and power quality effects. (Acuity, Public Meeting Transcript, No. 33 at p. 63) DOE is considering in this NOPR (discussed in section V.C.12) fixture redesigns (accounting for increased thermal management and voltage transient suppression) and corresponding incremental costs incurred as a result of implementing electronic ballasts in outdoor applications. DOE has not found evidence of any difference between high-frequency and low-frequency electronic ballasts in this regard. DOE requests clarification on whether high-frequency electronic ballasts require additional thermal and transient protection relative to low-frequency electronic ballasts. If so, DOE requests comment on technical reasons for this difference and whether ballast or fixture redesigns can overcome these barriers.

1000 W Electronic Ballasts

In the preliminary analysis, DOE analyzed only magnetic ballasts as higher efficiency replacements for the 1000 W baseline unit and requested comment on whether 1000 W electronic metal halide ballasts are technologically feasible. Philips and OSI stated that 1000 W electronic ballasts only exist in niche applications, with no ballasts in general lighting or area lighting. Even though 1000 W electronic ballasts are commercially available, Philips pointed out that these ballasts do not have a significant efficiency improvement over the magnetic ballasts at that wattage, but may be preferred for technological reasons (*e.g.,* in high definition TVs). (Philips, Public Meeting Transcript, No. 33 at pp. 63–64; OSI, No. 27 at p. 5) NEEA also recommended that DOE analyze only magnetic ballasts at 1000 W. (NEEA, No. 31 at p. 4) DOE's research has confirmed that the 1000 W electronic ballasts on the market today appear to be for specialized functions, such as hydroponics and aquariums, rather than general illumination applications. Because these fixtures may have unique thermal characteristics, DOE cannot be certain that incorporating 1000 W electronic ballasts into general lighting fixtures is technologically feasible. Thus, DOE does not consider electronic ballasts as higher efficiency replacements for 1000 W magnetic ballasts.

9. Efficiency Levels

Based on the higher-efficiency ballasts selected for analysis, discussed in section V.C.8, DOE developed four efficiency levels for the 70 W, 150 W, 250 W, and 400 W representative wattages. Due to the fact that DOE did not analyze electronic ballasts for the 1000 W representative wattages, DOE analyzes only two efficiency levels for this wattage. The baseline of each representative equipment class represents the lowest-efficiency commercially available magnetic ballast covered by these standards. EL1 represents a moderately higher efficiency magnetic ballast, and EL2 represents the maximum technologically feasible magnetic ballast. EL1 and EL2 are characterized by a combination of commercially available and modeled magnetic ballasts. EL3 represents the lowest-efficiency commercially available electronic ballast, and EL4 represents the maximum technologically feasible level for all ballasts incorporated into metal halide lamp fixtures.

In the preliminary analysis, DOE considered both binned and equation-based approaches to defining efficiency levels within wattage ranges. In a binned approach, DOE would set the same standard for all wattages within an equipment class. In an equation-based approach, DOE would define equations that relate rated lamp wattage to ballast efficiency such that different wattages within an equipment class would be subject to different efficiency requirements. For the preliminary analysis, DOE analyzed setting standards based on a binned approach and received several comments in response to this decision.

Philips noted that there is significant change in ballast efficiency throughout the 150 W to 250 W range, with a definite trend for higher efficiency as the wattage increases up to 500 W. (Philips, Public Meeting Transcript, No. 33 at pp. 55, 66) Philips suggested that efficiencies in the 150 W to 250 W range could benefit from further delineation, perhaps in the form of a formula approach. (Philips, Public Meeting Transcript, No. 33 at p. 47) Based on manufacturer comments at the preliminary analysis public meeting, NEEA supported the proposal to either divide the 150 W to 250 W range into two classes, or develop efficiency levels in the form of wattage-based equations. (NEEA, No. 31 at pp. 3–4)

In contrast, OSI did not recommend using an equation-based approach for efficiency levels. They commented that having a known, fixed efficiency requirement allows manufacturers to more easily redesign their ballasts to incorporate additional features (such as dimming or 120 V tap). (OSI, No. 27 at p. 4)

After considering all of the comments, DOE agrees with Philips and NEEA that an equation-based approach for efficiency levels would be most appropriate, as it allows DOE to account for changes in efficiency across a rated wattage range. In addition, this approach ensures that efficiency levels for all wattages, even those not analyzed as representative, are technologically feasible. To develop the equation forms and efficiency trends for each wattage range, DOE utilized its own efficiency test data as well as catalog efficiency data. The discussion below describes the equations used in each wattage bin. For further details, see chapter 5 of the NOPR TSD.

For the two lowest wattage bins, which consist of 50 W to 150 W ballasts, DOE used its own test data as well as efficiency trends according to catalog data to generate separate power-law best fits for magnetic (EL1 and EL2) and electronic ballasts (EL3 and EL4).

The next wattage bin consists of 150 W ballasts, excluding the currently exempted 150 W, up through and including 250 W ballasts. Because EISA 2007 covered equipment in this wattage bin, DOE can only evaluate efficiencies equal to or above the existing standards to avoid backsliding. Manufacturers stated during interviews that 150 W magnetic ballasts could not be designed to meet 88 percent and that 175 W ballasts only reached 88 percent by using the high-grade-score steel and increasing the ballast's footprint. DOE's test data also indicated that there are no 150 or 175 W magnetic ballasts available that exceed 88 percent efficiency. Though DOE did not test any 200 W ballasts, a review of catalog data indicates that 200 W ballasts are only available at 88 percent efficiency. Because DOE has no specific information indicating that these ballasts can be designed to be more efficient, DOE assumed that 88 percent is also the max tech magnetic ballast efficiency for wattages up through 200 W. Thus, DOE maintained the EISA 2007 efficiency requirement of 88 percent for ELs designed to represent levels met by magnetic ballasts. DOE did not have any information about the achievable efficiencies for ballasts >200 W and <250 W, as products in this range are not commercially available. Therefore, DOE gradually increased the magnetic efficiency levels (EL1 and EL2) between 200 W and 250 W ballasts using a linear trend from 88 percent to the efficiency of the EL1 and EL2 250 W representative units. For the electronic ballast efficiency levels (EL3 and EL4), DOE continued the power-law function fit from the 50 to 150 W range up to 250 W.

The next wattage bin consists of ballasts higher than 250 W up through and including 500 W. Because the 250 W and 400 W magnetic representative units at EL1 and EL2 have the same efficiency and utilize similar design options, DOE created a flat efficiency requirement for magnetic ballasts within this wattage bin. For the electronic ballast efficiency levels (EL3 and EL4), DOE continued the power-law function fit from the 250 to 500 W range up through 500 W.

The highest wattage bin consists of ballasts higher than 500 W up through and including 2000 W. DOE examined catalog data for market availability and found no electronic ballasts for general lighting applications in this wattage range. Manufacturer feedback confirmed that there are no electronic ballasts for general lighting applications commercially available above 500 W. Thus, there are two only efficiency levels at the highest wattage range rather than four. DOE used a linear fit for ballasts above 500 W through 1000 W after examining the efficiency trends within manufacturers' product lines in this wattage bin. DOE fit the linear trend from the previous wattage bin's 500 W efficiencies at efficiency levels 1 and 2 through the representative units at 1000 W. However, due to the lack of test data and limited wattage offerings for ballasts over 1000 W, DOE could not develop a conclusive trend between wattage and efficiency. Thus DOE created a flat efficiency requirement extending from the tested efficiency of the 1000 W representative unit to 2000 W.

Table V.3 summarizes all of the functions and efficiencies describing each equipment class. DOE requests comment on the described efficiency levels.

TABLE V.3—NOPR EFFICIENCY LEVEL DESCRIPTIONS FOR THE REPRESENTATIVE EQUIPMENT CLASS

Representative equipment class	Rep. wattage	EL	Minimum efficiency equation %
≥50 W and ≤100 W	70 W	EL1	100/(1+3.90*P∧(−0.60)) †
		EL2	100/(1+2.50*P∧(−0.55))
		EL3	100/(1+0.60*P∧(−0.34))
		EL4	100/(1+0.36*P∧(−0.30))
>100 W and <150 W*	150 W	EL1	100/(1+3.90*P∧(−0.60))
		EL2	100/(1+2.50*P∧(−0.55))
		EL3	100/(1+0.60*P∧(−0.34))
		EL4	100/(1+0.36*P∧(−0.30))
≥150 W** and ≤250 W	250 W	EL1	≥150 W and ≤200 W: 88.0; >200 W and ≤250 W: 4.0*10∧(−2)*P + 80.0
		EL2	≥150 W and ≤200 W: 88.0; >200 W and ≤250 W: 7.0*10∧(−2)*P + 74.0
		EL3	100/(1+0.60*P∧(−0.34))
		EL4	100/(1+0.36*P∧(−0.30))
>250 W and ≤500 W	400 W	EL1	90.0
		EL2	91.5
		EL3	100/(1+0.60*P∧(−0.34))
		EL4	100/(1+0.36*P∧(−0.30))
>500 W and ≤2000 W	1000 W	EL1	>500 W and ≤1000 W: 5.0*10∧(−3)*P + 87.5.; >1000 W and ≤2000 W: 92.5
		EL2	>500 W and ≤1000 W: 3.2*10∧(−3)*P + 89.9.; >1000 W and ≤2000 W: 93.1

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50° C, as specified by UL 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50° C, as specified by UL 1029–2001.

† P is defined as the rated wattage of the lamp the fixture is designed to operate.

As discussed in section V.C.5, DOE used a reported efficiency value based on the four tested samples, pursuant to the metal halide ballast certification procedures in 10 CFR 429.54, to describe its representative units and to develop the ELs. DOE invites comment on whether any adjustments to the ELs are necessary to account for sources of variation not captured by the reporting requirements of 10 CFR 429.54.

10. Design Standard

In the preliminary TSD, DOE considered a design standard that would prohibit the sale of probe-start ballasts in newly sold fixtures. DOE notes that under 42 U.S.C. 6295(hh)(4), DOE is permitted to set an energy efficiency standard based on both design and performance requirements. EISA prescribed probe-start ballasts to be 94 percent efficient, effectively banning probe-start ballasts between 150 and 500 W (except those 150 W ballasts exempt by EISA) based on their inability to meet this performance requirement. (42 U.S.C. 6295(hh)(1)(A)(ii) Manufacturers responded to the EISA 2007 standards by shifting their inventory to pulse-start ballasts, which are subject to less stringent standards. The following paragraphs describe comments received and DOE's analysis of a design standard prohibiting probe-start ballasts to be sold in new fixtures in these wattages.

With regards to probe-start ballast availability, OSI, NEMA, Hubbell Lighting Incorporated, Venture Lighting, and NEEA also commented that there are no 70 W probe-start ballasts on the market. (OSI, Public Meeting Transcript, No. 33 at pp. 58–60; NEMA, No. 34 at p. 14; Hubbell, Public Meeting Transcript, No. 33 at pp. 42, 57, 59–60; Venture Lighting, Public Meeting Transcript, No. 33 at pp. 59–60; NEEA, No. 31 at p. 4) Hubbell also clarified that probe-start ballasts are available at wattages of 150 W and above. Hubbell stated that there are a few probe-start ballasts at 150 W and there are no probe-start ballasts at smaller wattages because the seals for the arc tubes in the lamps become too small to contain the third electrode needed to start probe-start ballasts. OSI added that when medium screw-base, low-wattage metal halide lamps were first introduced to the market, they were all pulse-start. The manufacturers never made low-wattage probe-start metal halide lamps. (Hubbell, Public Meeting Transcript, No. 33 at pp. 58–59; OSI, Public Meeting Transcript, No. 33 at p. 59) Even though probe-start has become technically possible at 150 W, OSI and NEMA pointed out that because of EISA 2007, there are no new fixtures using probe-start ballasts less than 500 W, and, therefore, no probe-start ballasts at less than 500 W on the market. (OSI, No. 27 at p. 5; NEMA, No. 34 at p. 15) Hubbell noted that pulse-start ballasts only provide 8 to 15 percent energy savings over probe-start ballasts for 250 W and 400 W products, and anywhere from 0 to 8 percent energy savings over probe-start ballasts in the 1000 W class. (Hubbell, Public Meeting Transcript, No. 33 at p. 42–43) GE put forward one cause for the mistaken impression that there are probe-start ballasts at lower wattages: In the manufacturers' fixture catalogues, the lamp designation given for lower wattages is ''M,'' for metal halide. Even though the starting method of these lower wattage lamps is not explicitly labeled, they are all pulse-start. (GE, Public Meeting Transcript, No. 33 at p. 60) Finally, NEMA and Hubbell commented further that only 1000 W ballasts have a probe-start baseline. (NEMA, No. 34 at p. 14; Hubbell, Public Meeting Transcript, No. 33 at pp. 57–58)

DOE reexamined ballast availability in manufacturer catalogs and, in response to GE, was careful not to consider ''M'' designated lamps as probe-start. DOE determined that probe-start ballasts are only available at wattages above 150 W and also confirmed that there are no 70 W probe-start ballasts currently on the market. EISA 2007 allowed probe-start ballasts in the 150 W to 500 W range, but set a minimum efficiency standard of 94 percent. None of the probe-start ballasts DOE found could meet this minimum efficiency level, so the standards from EISA 2007 essentially prohibit probe-start ballasts less than or equal to 500 W for use in new fixtures. However, because certain fixtures designed for use with lamps rated at 150 W are exempted from EISA 2007 standards, probe-start ballasts can be used at 150 W in new fixtures. However, DOE's review of manufacturer catalogs indicates that probe-start ballasts are not sold at 150 W. Therefore, the only wattage range in which probe-start ballasts are available for use in new fixtures is the greater than 500 W to 2000 W range. In this NOPR, DOE is analyzing the impact of a design standard that would prohibit probe-start ballasts from being sold in new fixtures in the greater than 500 to 2000 W range.

NEMA and Hubbell also commented that at that high wattage, there is very little to be gained from a switch to pulse-start, stating that 1000 W probe-start ballasts are already 92 percent efficient and these lamp-ballast systems produce only slightly fewer mean lumens than pulse-start lamp-ballast systems. (NEMA, No. 34 at p. 14; Hubbell, Public Meeting Transcript, No. 33 at pp. 57–58) Given the absence of probe-start ballasts at the lower wattages, and the insignificant discrepancy between probe-start and pulse-start ballasts at the higher wattages, NEEA did not see much utility in a design standard that prohibits probe-start systems. (NEEA, No. 31 at p. 3) DOE notes that the major motivation for prohibiting probe-start ballasts is not the efficiency difference between the ballasts, but the decreased mean efficacy of probe-start lamps when compared to pulse-start lamps. Even a small percentage gain in mean lamp efficacy could yield energy savings on the order of the ballast efficiency savings calculated in other equipment classes.

Progress Energy Carolinas, however, supported requiring pulse-start ballasts in all wattages. Yet, Progress Energy Carolinas also urged DOE to consider other technologies to realize significant efficiency gains over pulse-start. Specifically, Progress Energy Carolinas cited the examples of ceramic arc tube metal halide lamps and the super metal halide technology as seen in the Elite and Cosmopolis models from Philips. Progress Energy Carolinas argued that both of these measures improve not only efficiency, but also other operating characteristics. While Progress Energy Carolinas noted that the super technology may be sole-source, proprietary technology only available in low- to mid-range wattages, Progress Energy Carolinas commented that Philips may be willing to share the technology with others like they have offered to do with their fluorescent low-mercury lamp technology. (Progress Energy Carolinas, No. 24 at p. 2) DOE will not consider efficiency levels that require proprietary technology like that used in the Philips Elite and Cosmopolis systems. Though a company like Philips may be willing to share technology, DOE is unable to analyze the impacts of the agreement because the terms of the agreement cannot be known in advance. In this MHLF rulemaking, DOE has decided to only consider performance and design requirements that affect the ballast included in a metal halide lamp fixture. Therefore, DOE is not planning to consider a design requirement that mandates the use of ceramic metal halide lamps in new metal halide lamp fixtures.

Empower Electronics disagreed with the use of a design standard, instead recommending that a minimum ballast-and-lamp efficiency standard be established regardless of design to effectively prohibit the use of inefficient probe-start systems. Empower Electronics suggested that this standard be set at 94 percent for fixtures designed to operate lamps rated for 250 W and above, effectively requiring electronic ballast technology. (Empower Electronics, No. 36 at p. 8) DOE notes that it is planning to consider efficiency levels that require electronic ballasts when determining a proposed standard. In addition to this consideration, DOE is also continuing to analyze a design standard as a possibility for a proposed standard.

Georgia Power stated that the concept of using fewer fixtures when replacing existing probe-start systems with pulse-start systems may be practical for indoor applications, but not for outdoor uses. Currently, parking lots have lighting system designs that use probe-start fixtures at an acceptable photometric level. DOE assumes that the poles, bases and conductors are all in place and the investment has been made. Georgia Power said that using fewer pulse-start fixtures on the same poles at the same places will not result in the same photometric design. (Georgia Power, No. 28 at p. 2) In regards to setting a design standard requiring reduced wattage versions of lamps and the expected change in lumen output, Progress Energy Carolinas said that in general, the percent light reduction is half the percent wattage reduction. Progress Energy Carolinas also noted that reduced wattage pulse-start lamps are not currently available; instead, a reduced wattage probe-start lamp is used as a replacement. (Progress Energy Carolinas, No. 24 at p. 3) DOE agrees with Georgia Power that in some applications, changing the spacing of fixtures is not feasible. Instead, users of these applications may use the same number of pulse-start ballasts in their systems, but at reduced wattage to maintain light output. This customer response to a design standard is discussed in more detail in section V.C.10. DOE disagrees with Progress Energy Carolinas that reduced-wattage lamps are only available in the probe-start variety. DOE has found several pulse-start lamps available at reduced wattages such as 320 W and 875 W.

To quantify the difference in mean lumen output of probe-start lamps relative to pulse-start lamps of the same wattage, DOE compared several major manufacturers' 1000 W lamp catalog data for these two lamp start types. DOE paired these lamps from the same manufacturer and of the same characteristics (open vs. enclosed, CRI, percentage of rated life at which the mean lumen value is recorded) and calculated the ratio of probe-start mean lumens divided by pulse-start mean lumens. Then, DOE averaged the ratio of each pairing from every manufacturer and determined that, on average, probe-start metal halide lamps are 5.6 percent less efficacious than comparable pulse-start lamps. Thus, pulse-start metal halide lamp and ballast fixtures can output 5.6 percent more lm/W than probe-start fixtures. Energy savings could be achieved in two ways. Because each pulse-start metal halide lamp fixture outputs 5.6 percent more lumens (for a given wattage) than comparable probe-start lamp fixtures, customers could:

1. Illuminate an area to the same level with 5.6 percent fewer fixtures if they switch from probe-start to pulse-start; or
2. Switch from full-wattage probe-start lamp fixtures to the same number of reduced-wattage pulse-start lamp fixtures, maintaining light output, but reducing energy consumption.

Using fewer fixtures (option 1) would lead to reduced energy consumption and could save administrative and maintenance costs associated with purchasing and maintaining fewer fixtures. However, this response to the design standard is only feasible in applications that have flexibility in fixture spacing. In some applications, such as small parking lots, changing spacing means moving poles and conductors, which would be expensive and could change the targeting of light in certain areas. For applications in which the height of the fixture is limited, the additional light output of a full-wattage pulse-start system might not be adequately distributed over a larger floor space (because the number of fixtures has been reduced) without fixture redesign.

For customers using reduced-wattage pulse-start fixtures (option 2), a customer could, for example, change a 1000 W probe-start fixture for an 875 W pulse-start fixture, maintaining light output to near the original level. DOE's view is that replacing probe-start lamp fixtures with reduced-wattage pulse-start lamp fixtures is generally more realistic and practical than replacing them with fewer pulse-start lamp fixtures because fixture spacing does not need to be changed. For this reason, DOE assumed reduced-wattage replacements in its analysis of a proposed design standard to prohibit metal halide lamp fixtures that use probe-start as their starting method.

When analyzing the energy-savings impact of a design standard efficiency level, DOE multiplied the normalized input power of the 1000 W ballast tested by 0.944. Because DOE determined that using the same number of reduced-wattage fixtures is the most likely market response to a design standard, DOE did not also scale the cost of a design standard efficiency level by 0.944. Instead, DOE assumed that reduced-wattage systems would cost approximately the same amount as full-wattage systems, with the exception of the addition of an igniter (device that provides a voltage pulse to start the lamp). In the non-design-standard scenario, DOE assumed that the representative cost of a 1000 W ballast would equal the cost of a probe-start ballast as this starting method is the most common in the greater than 500 W but less than or equal to 2000 W equipment classes. However, in the design-standard scenario, an igniter would need to be added, as only pulse-start ballasts could be included in new fixtures.

DOE requests comment on the decision to include a design standard that would prohibit the sale of probe-start ballasts in newly sold fixtures, the proposed methods of analyzing these levels, and the potential for lessening of the utility or the performance through the prohibition of the sale of probe-start ballasts in newly sold fixtures.

11. Scaling to Equipment Classes Not Analyzed

In the preliminary analysis, DOE analyzed all equipment classes as representative and, therefore, did not scale. As discussed in section V.C.2, DOE has added additional equipment classes for the NOPR. Although DOE set efficiency levels for quad-voltage ballasts directly, DOE did not analyze 480 V input voltage ballasts directly. Thus, it was necessary to develop a scaling relationship for this input voltage. To do so, DOE compared quad-voltage ballasts to their 480 V ballast counterparts using catalog data over all representative wattages at various efficiencies. DOE found the average reduction to ballast efficiency to be 0.6 percent. Thus, DOE proposes to apply this scaling factor to the efficiency levels for the quad-volt ballasts to determine the appropriate values for the 480 V ballasts. For the ≥150 W to ≤250 W equipment classes, DOE made adjustments to resulting scaled equations to ensure all efficiency levels were more stringent than the existing standards (see chapter 5 of the NOPR TSD for additional detail). DOE requests comment on this proposal.

12. Manufacturer Selling Prices

For the preliminary analysis, DOE developed the manufacturer selling prices for metal halide lamp fixtures and ballasts by determining a manufacturer production cost (MPC), either through a teardown or retail pricing analysis, and then applying a markups analysis to arrive at the manufacturer selling price (MSP). For further details on this analysis, see chapter 5 of the NOPR TSD.

Based on stakeholder comments and manufacturer interviews, DOE adjusted a number of parameters in its pricing analysis for this NOPR. In calculating prices, DOE adjusted material prices to better reflect current trends based on manufacturer input and commodity prices research. Additionally, for this NOPR, DOE applied incremental costs to fixtures utilizing electronic ballasts based on application characteristics (indoor vs. outdoor). Finally, DOE modified its approach to applying manufacturer markups to align better with existing fixture component manufacturing channels. The following sections describe these changes and approaches.

a. Manufacturer Production Costs

For the NOPR analyses, DOE conducted teardown analyses on a total of 32 commercially available metal halide ballasts (including four 150 W ballasts not presented in the preliminary analysis) and eight metal halide lamp fixtures. Using the information from these teardowns, DOE summed the direct materials, labor, and overhead costs used to manufacture a product to calculate the MPC.[29] In the case of electronic ballasts, direct material costs represent the direct purchase price of components (resistors, connecting wires, etc.). In the case of magnetic ballasts, direct material costs represent the purchase prices of steel laminations, copper wires, and other components. The direct labor costs include fabrication and assembly labor.

When determining material costs, DOE used material prices based on a five-year average to account for the fluctuations in the prices of certain raw materials, such as steel and copper. Several manufacturers of ballasts and fixtures noted the high prices and scarcity of copper and high-grade steels, such as M6 steel. Philips also commented that M6 steel is mostly manufactured in China, resulting in potential import difficulties. Acuity stated that volatility of material markets, especially in the availability and pricing of steel and copper, has greatly increased since the preliminary analysis. Acuity and NEMA suggested that DOE consider availability and price volatility of an improved steel core or copper wiring in their cost analysis. NEMA suggested that DOE factor in expected inflation and price volatility for materials. (Philips, Public Meeting Transcript, No. 33 at p. 71; Hubbell, Public Meeting Transcript, No. 33 at p. 70; NEMA, No. 34 at p. 7, 12, 16; Acuity, Public Meeting Transcript, No. 33 at p. 132–133)

DOE agrees that high-grade steel laminations and copper are materials that have seen high price fluctuations in recent years. Due to the uncertainty of how these prices will continue to change, DOE continues to use five-year average materials prices, rather than projected inflations, to characterize the expected cost impacts in years following the compliance date of the amended standards considered in this rule. For this NOPR, DOE updated these averages to include 2010 price data.

For the preliminary analysis, DOE used financial data to estimate the

[29] When viewed from the company-wide perspective, the sum of all material, labor, and overhead costs equals the company's sales cost, also referred to as the cost of goods sold (COGS).

overhead cost (including indirect material and labor costs, maintenance, depreciation, taxes, and insurance related to assets) by calculating it as a percentage of the MPC. NEEA noted that manufacturers have previously recommended that DOE apply overhead only to labor costs. NEEA urged DOE to ensure that this part of the analysis accurately reflects reality in the manufacturing world relevant to each rulemaking. (NEEA, No. 31 at p. 5) NEMA and OSI noted that manufacturing and overhead costs can vary greatly by manufacturer, production volume, and complexity of the product (*e.g.,* magnetic versus electronic technology). NEMA stated that design and overhead costs for electronic ballasts are inherently higher than those for magnetic ballasts and require different engineering specializations. (NEMA, No. 34 at p. 16; OSI, No. 27 at p. 5)

DOE recognizes that manufacturing and overhead costs can vary and, therefore, developed separate estimates for material, labor, and overhead for each representative unit in the analysis. In response to NEEA's comment, DOE notes that because it calculates overhead from available financial data, it can either calculate overhead as a percentage of the material and labor costs, or labor costs alone. In either case, overhead as a percentage of net sales remains the same. Thus, DOE maintained its approach from the preliminary TSD by utilizing information available in the recent standards rulemaking for fluorescent lamp ballasts.[30] In that rulemaking, DOE used financial data to estimate the overhead cost by calculating it as a percentage of the MPC. DOE estimated the depreciation cost from a representative electronics fabrication company's U.S. Securities and Exchange Commission (SEC) 10–K, and determined that it is approximately 2.6 percent of the cost of goods sold or the MPC. To determine the material and labor percentage, DOE marked down aggregated confidential MSPs to an MPC using the manufacturer markup. Then, DOE computed the ratio of aggregated teardown-sourced material and labor costs to the manufacturer-markdown-sourced MPC. DOE found the material and labor costs to be approximately 93.8 percent of the MPC. DOE then subtracted the materials and labor and depreciation percentages from 100 percent to back out the remainder of overhead as a percentage of MPC. Overhead was estimated to be 3.6 percent of the MPC. DOE found overhead and depreciation to be 6.2 percent of the MPC or 6.6 percent of the material and labor costs. The 6.6 percent factor was then used to mark up the material and labor costs contained in the teardown results to the MPC.

Incremental Costs for Electronically Ballasted Fixtures

After determining metal halide ballast MPCs and baseline fixture MPCs, DOE considered whether transitioning from magnetic to electronic ballast technology would require any further ballast or fixture design changes to accommodate the electronic ballast or maintain similar utility to the baseline magnetic ballast. In the preliminary analysis, DOE identified three potential sources of additional costs of switching from magnetic to electronic ballasts: Increasing the size of the fixture to accommodate the new footprint of the electronic ballast; increasing the heat sinking of the fixture to reduce thermal build up; and including voltage transient suppression for outdoor applications.

Based on its initial evaluation, DOE did not include any of these incremental costs in the preliminary analysis. In response, Philips and Georgia Power emphasized that electronic ballasts are not direct replacements for magnetic ballasts due to form factor. (Philips Lighting Electronics, Public Meeting Transcript, No. 33 at p. 64; Georgia Power, No. 28 at p. 1) Georgia Power noted that redesign of magnetic ballast fixture housing and optics may be required to accommodate electronic ballasts. (Georgia Power, No. 28 at p. 1) NEEA did not agree that there are no fixture incremental costs associated with a switch to electronic ballasts. NEEA recommended that DOE derive some incremental cost values for the analysis, and to the extent possible, use a distribution of costs for the analysis, perhaps with zero at the bottom end. (NEEA, No. 31 at p. 5)

While DOE agrees that fixtures may require redesign to accommodate a new form factor of ballast, based on its analysis of selected commercially available fixtures, DOE tentatively concludes that this redesign does not necessarily incur additional material or labor costs. Instead, DOE accounts for the capital conversion costs of redesigning fixtures in the MIA, as discussed in section V.I.2. However, for this NOPR, DOE further investigated three sources of potential incremental costs: (1) Outdoor transient protection, (2) thermal management, and (3) 120 V auxiliary power functionality.

Outdoor Transient Protection

In response to the preliminary TSD, DOE received a number of comments indicating that electronic ballasts were unfit to be used outside because of their inability to withstand high voltage surges. Cooper commented that the ANSI standard for area and roadway lighting in the utility division, ANSI C62.41.1–2002, requires that outdoor lighting be able to withstand a voltage transient of 10 kV. (Cooper, Public Meeting Transcript, No. 33 at p. 78) Progress Energy Carolinas specified that an inline MOV (a surge-protection device external to the ballast) is required for electronic ballasts in outdoor fixture. (Progress Energy Carolinas, No. 24 at p. 3) In response, OSI and Empower Electronics commented that some electronic ballasts incorporate integral transient protection and do not require additional technology. (OSI, Public Meeting Transcript, No. 33 at p. 74; Empower Electronics, No. 36 at p. 5) Similarly, NEEA agreed that because many electronic ballasts have voltage transient protection built-in already, transient protection will not be an incremental cost in all cases. (NEEA, No. 31 at p. 5)

DOE recognizes the necessity for outdoor fixtures to be able to withstand large voltage transients, primarily due to lightning strikes. While metal halide fixtures with magnetic ballasts are robust and do not require any additional devices or enhancements to withstand these transients, based on its evaluation of commercially available products, DOE finds that fixtures with electronic ballasts usually require additional design features in order to have adequate protection. Some manufacturers indicated that a portion of their electronic ballasts already have 10 kV surge protection built in, but most electronic ballasts are only rated for 2.5–6 kV voltage spikes. Though magnetic ballasts are known to provide protection in excess of the 10 kV ANSI C62.41.1–2002 Class C rating, for this NOPR, DOE only considers the cost of meeting the 10 kV requirement. Through interviews and an assessment of commercially available voltage-transient suppressors, DOE developed an incremental fixture cost of $19 for 10 kV inline (external to the ballast) surge protection for electronically ballasted outdoor fixtures.

Thermal Management

Commenters also indicated that electronic ballasts are more vulnerable than magnetic ballasts to high ambient temperatures, which, if not managed well, can cause premature ballast failure. In order to correct for this

[30] *http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/62.*

difference, fixtures housing electronic ballasts would need to be redesigned to account for thermal management in both indoor and outdoor applications.

NEMA expressed concern about electronic ballasts' ability to operate at high ambient temperatures. (NEMA, Public Meeting Transcript, No. 33 at p. 16) NEMA noted that while magnetic ballasts can operate at temperatures as high as 150 °C, electronic ballasts generally cannot operate at temperatures exceeding 90 °C. This temperature limit makes it impossible to place electronic ballasts in a fixture in the traditional location near the lamp. (NEMA, No. 34 at pp. 8–9) NEMA and Progress Energy Carolinas indicated that the sensitivity of electronics to thermal conditions requires redesign of the fixture or ballast, such as larger ballast housing, thermal shields, or fixture venting to sink the heat outside of the fixture. (NEMA, No. 34. at pp. 8–9; Progress Energy Carolinas, No. 24 at p. 3) NEMA noted that these requirements add additional materials, redesigning, engineering, UL testing, and warranty burden costs. (NEMA, No. 34. at pp. 8–9)

In contrast, OSI explained that electronic ballasts are more efficient than magnetic ballasts, and, therefore, generate less heat and run at cooler temperatures. OSI commented that they manufacture an electronic metal halide ballast with a maximum allowable case temperature of 90 °C, and a maximum ambient temperature of 55 °C. These ballasts also use a power foldback feature to manage the temperature of the ballast and prevent damage to the ballast in extreme high-heat conditions. OSI has successfully retrofitted magnetically ballasted fixtures with these electronic ballasts and achieved thermal performance that met the requirements of their five-year warranty. (OSI, No. 27 at p. 2) Empower Electronics noted that several companies have made strides in managing thermal issues surrounding electronic ballasts with a maximum tolerable case temperature of 85 °C. (Empower Electronics, No. 36 at p. 5)

DOE agrees that because of temperature sensitivity concerns, manufacturers cannot directly replace a magnetic ballast with an electronic ballast in fixtures. Instead, the fixtures must be redesigned to tolerate the higher sensitivity to temperature of an electronic ballast. Manufacturers must design new and often larger brackets, and apply additional potting material to create an adequate thermal contact between the ballast and fixture. During interviews, manufacturers gave DOE information about the cost to add thermal management to fixtures with electronic ballasts. In aggregate, manufacturers indicated a 20-percent increase in fixture MPCs associated with thermal management. Additionally, DOE conducted teardown analyses of empty metal halide fixtures. Through analysis of pairs of fixtures designed for electronic ballasts and fixtures designed for comparable magnetic ballasts, DOE also found an approximately 20-percent increase in fixture MPCs to include thermal management for electronic ballasts. Accordingly, in the cost analysis for this rulemaking, all electronically ballasted metal halide lamp fixtures incur a 20-percent incremental cost to the empty fixture MPCs.

120 V Auxiliary Tap

In manufacturer interviews, DOE learned that for indoor applications, a number of magnetic ballasts include a 120 V auxiliary tap. This output is used to operate an emergency incandescent lamp after a temporary loss of power and while the metal halide lamp is still too hot to restart. These taps, primarily used in indoor applications, are generally required for only one out of every ten indoor lamp fixtures. A 120 V tap is easily incorporated into a magnetic ballast due to its traditional core and coil design, and incurs a negligible incremental cost. Electronic ballasts, though, require additional design to add this 120 V auxiliary power functionality. Using a combination of manufacturer information and market research, DOE concluded that a representative value for electronic ballasts to incorporate this auxiliary tap is $7.50. Because this functionality is only needed for 10 percent of ballasts in indoor fixtures, that number is multiplied by 0.10 to get an incremental ballast cost of $0.75 per indoor ballast.

Manufacturer Markups

The last step in determining manufacturer selling prices is development and application of manufacturer markups to scale the MPCs to MSPs. DOE developed initial manufacturer markup estimates by examining the annual SEC 10–K reports filed by publicly traded manufacturers of metal halide ballasts and metal halide lamp fixtures, among other products. DOE recognized that the financial information summarized in the 10–K reports is not usually exclusive to the metal halide portion of their businesses. To account for this, DOE asked manufacturers during interviews to comment on the calculated average MSP, and to provide both the manufacturer markup and manufacturer selling price of metal halide ballasts or metal halide lamp fixtures. Using this information, DOE determined in the preliminary TSD that a manufacturer markup of 1.47 was appropriate for both the metal halide ballast and fixture industries across all distribution channels.

In the preliminary TSD, DOE assumed that fixture manufacturers would not apply an additional markup to the ballasts they either purchase or manufacture in-house. Philips commented that a manufacturer would not carry the overhead of manufacturing their own ballasts if they could realize the same overall margin by purchasing one from a third party. Therefore, Philips found it unreasonable to use a single markup on the ballast. (Philips, Public Meeting Transcript, No. 33 at p. 74) NEEA suggested that DOE use separate markups for ballast manufacturers and fixture manufacturers, with the ballast manufacturer markup split into one value for the Original Equipment Manufacturer (OEM) channel and one value for the distributor channel. (NEEA, No. 31 at p. 4) NEEA also indicated that DOE should take into account the unique distribution channel for outdoor fixtures in its analysis when estimating markups and pricing for fixtures. (NEEA, No. 31 at p. 5)

DOE has revised its markup structure for today's NOPR. Based on feedback from manufacturers, DOE now uses separate markups for ballast manufacturers (1.47) and fixture manufacturers (1.58). DOE also assumes that fixture manufacturers apply the 1.58 markup to the ballasts used in their fixtures rather than to only the empty fixtures as assumed in the preliminary TSD. This assumption is consistent with feedback from both fixture manufacturers that purchase their ballasts and those that produce their ballasts in-house. In aggregate, the markup also accounts for the different markets served by fixture manufacturers. The 1.47 markup for ballast manufacturers now applies only to ballasts sold to fixture OEMs directly impacted by this rulemaking. For the purpose of the LCC analysis, DOE assumes a higher markup of 1.60 for ballasts that are sold to distributors for the replacement market.

D. Markups To Determine Equipment Price

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

1. Distribution Channels

Before it could develop markups, DOE needed to identify distribution channels (*i.e.,* how the equipment is distributed from the manufacturer to the end-user) for the metal halide lamp fixture designs addressed in this rulemaking. In an electrical wholesaler distribution channel, DOE assumed the fixture manufacturer sells the fixture to an electrical wholesaler (*i.e.,* distributor), who in turn sells it to a contractor, who sells it to the end-user. In a contractor distribution channel, DOE assumed the fixture manufacturer sells the fixture directly to a contractor, who sells it to the end-user. In a utility distribution channel, DOE assumed the fixture manufacturer sells the fixture directly to the end-user (*i.e.,* electrical utility).

2. Estimation of Markups

To estimate wholesaler and utility markups, DOE used financial data from 10–K reports from publicly owned electrical wholesalers and utilities. DOE's markup analysis developed both baseline and incremental markups to transform the fixture MSP into an end-user equipment 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 wholesaler and utility sales prices. These markups refer to higher-efficiency designs sold under market conditions with new and amended energy conservation standards.

In the preliminary analysis, DOE assumed a wholesaler baseline markup of 1.23 and a contractor baseline markup of 1.13, for a total wholesaler distribution channel baseline markup of 1.39 (excluding sales tax). In the public meeting, Philips inquired about documentation for these values. (Philips, Public Meeting Transcript, No. 33 at p. 89) DOE responded that these values were consistent with values used in other lighting-related rules (*e.g.,* for fluorescent lamp ballasts), and that DOE would review the values. In its manufacturer interviews and background research, DOE confirmed that although the individual values for wholesaler and contractor markups varied, the total value was consistent with actual markups. For this proposed rule, DOE retained its wholesaler and contractor markups, and also assumed utility baseline markups of 1.00 and 1.13 for the utility distribution channel in which the manufacturer sells a fixture directly to the end-user, and the channel in which a manufacturer sells a fixture to a contractor who in turn sells it to the end-user, respectively.

The sales tax represents state and local sales taxes applied to the end-user equipment price. For the preliminary analysis, DOE obtained state and local tax data from the Sales Tax Clearinghouse.[31] These data represent weighted averages that include state, county, and city rates. DOE then calculated population-weighted average tax values for each census 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 7.13 percent. DOE received no comments related to sales tax, and retained its approach for this proposed rule.

3. Summary of Markups

Table V.4 summarizes the markups at each stage in the distribution channels and the overall baseline and incremental markups, and sales taxes, for each of the three identified channels.

TABLE V.4—SUMMARY OF FIXTURE DISTRIBUTION CHANNEL MARKUPS

	Wholesaler distribution		Utility distribution			
			Via wholesaler & contractor		Direct to end-user	
	Baseline	Incremental	Baseline	Incremental	Baseline	Incremental
Electrical Wholesaler (Distributor)	1.23	1.05	N/A	N/A	N/A	N/A
Utility	N/A	N/A	1.00	1.00	1.00	1.00
Contractor or Installer	1.13	1.13	1.13	1.13	N/A	N/A
Sales Tax	1.07		1.07		1.07	
Overall	1.49	1.27	1.21	1.21	1.07	1.07

Using these markups, DOE generated fixture end-user prices for each efficiency level it considered, assuming that each level represents a new minimum efficiency standard. Chapter 6 of the NOPR TSD provides additional detail on the markups analysis.

E. Energy Use Analysis

For the energy use analysis, DOE estimated the energy use of metal halide lamp fixtures in actual field conditions. The energy use analysis provided the basis for other DOE analyses, particularly assessments of the energy savings and the savings in operating costs that could result from DOE's adoption of new and amended standard levels.

To develop annual energy use estimates for the preliminary analysis, 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 input power ratings. To characterize the country's average use of fixtures for a typical year, DOE developed annual operating hour distributions by sector, using data published in the 2010 U.S. Lighting Market Characterization: (LMC),[32] the Commercial Building Energy Consumption Survey (CBECS),[33] and the Manufacturer Energy

[31] The Sales Tax Clearinghouse. Available at *https://thestc.com/STRates.stm.* (Last accessed June 24, 2013.)

[32] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. 2010 *U.S. Lighting Market Characterization.* 2010. Available at *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf.*

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

Consumption Survey (MECS).[34] NEMA agreed with this approach. (NEMA, No. 34 at p. 17)

In the preliminary analysis, DOE assumed the different operating hours for commercial and industrial (typically indoor) fixtures and for outdoor fixtures. NEMA stated that outdoor equipment operates largely at night. (NEMA, No. 34 at p. 21) NEEA did its own analysis of fixture operating hours and generally supported the estimates DOE used in the preliminary analysis. (NEEA, No. 31 at p.6) For this proposed rule, DOE revised its assumed fixture operating hours to better distinguish indoor and outdoor applications.

DOE's preliminary energy use analysis assumed full operating power and no dimmed operation. NEMA suggested that HID dimming is possible, but significantly increases ballast and fixture cost, whereas fluorescent or other lighting technologies can be more easily and affordably dimmed. (NEMA, No. 34 at p. 8) OSI confirmed that they are developing dimming electronic ballasts for metal halide lamp fixtures. (OSI, No. 27 at p.3) DOE maintains that dimming is still a small portion of the MH market, however, and did not assume dimmed operation in the energy use analysis for this proposed rule. Chapter 7 of the NOPR TSD provides a more detailed description of DOE's energy use analysis. DOE is seeking data and information on the energy use analysis.

F. Life-Cycle Cost and Payback Period Analysis

DOE conducted the LCC and PBP analysis to evaluate the economic effects of potential energy conservation standards for metal halide lamp fixtures on individual customers. For any given efficiency level, DOE measured the PBP and the change in LCC relative to an estimated baseline equipment efficiency level. The LCC is the total customer expense over the life of the equipment, 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 equipment. The PBP is the estimated amount of time (in years) it takes customers to recover the increased purchase cost (including installation) of more efficient equipment through lower operating costs. DOE calculates the PBP by dividing the 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 cost include the cost of the equipment—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, equipment lifetimes, discount rates, and the year that compliance with new and amended standards is required. To account for uncertainty and variability, DOE created value distributions for selected inputs, including operating hours, electricity prices, discount rates, and sales tax rates. 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 variations across building types, lighting applications, and metal halide systems for three sectors (commercial, industrial, and outdoor stationary). In contrast, fixture MSPs were specific to the representative designs evaluated in DOE's engineering analysis, and price markups were based on limited publicly available financial data. Consequently, 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 the probability distributions and fixture user samples. NOPR TSD chapter 8 and its appendices provide details on the spreadsheet model and all the inputs to the LCC and PBP analysis.

Table V.5 summarizes the approach and data DOE used to develop inputs to the LCC and PBP calculations for the April 2011 preliminary TSD as well as the changes made for today's NOPR. The subsections that follow discuss the initial inputs and DOE's changes to them.

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

Inputs	Preliminary TSD	Changes for the proposed rule
Equipment Cost.	Derived by multiplying MHLF MSPs by distribution channel markups and sales tax.	No change.
Installation Cost.	Calculated costs using estimated labor times and applicable labor rates from *RS Means Electrical Cost Data* (2009) and U.S. Bureau of Labor Statistics.	No change.
Annual Energy Use.	Determined operating hours by associating building-type-specific operating hours with distributions of various building types using lighting market and building energy consumption survey data: LMC (2002), CBECS (2003), and MECS (2006).	Determined operating hours separately for indoor and outdoor fixtures. Used lighting market data: LMC (2012).
Energy Prices.	Electricity: Based on EIA's Form 861 data for 2010	Electricity: Based on EIA's Form 826 data for 2012.
		Variability: Energy prices determined at state level; incorporated off-peak electricity prices in the Monte Carlo analysis.
Energy Price Projections.	Projected using *AEO2010*	Projected using *AEO2013*.
Replacement Costs.	Included labor and material costs for lamp and ballast replacement at the end of their lifetimes.	No change.
Equipment Lifetime.	Ballasts: Assumed 50,000 hours for magnetic ballasts and 30,000 hours for electronic ballasts.	Ballasts: Assumed 50,000 hours for magnetic ballasts and 40,000 hours for electronic ballasts.

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

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

Inputs	Preliminary TSD	Changes for the proposed rule
Discount Rates.	Fixtures: Assumed 20 years for indoor fixtures and 25 years for outdoor fixtures.	Fixtures: No change.
	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.	Commercial/Industrial: Developed a distribution of discount rates for each end-use sector.
	Outdoor Stationary: Assumed to be the same as commercial sector.	Outdoor Stationary: Developed a distribution of discount rates for each end-use sector.

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

1. Equipment Cost

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

For the April 2011 preliminary TSD, DOE assumed that the MSPs and retail prices of products meeting various efficiency levels remain fixed, in real terms, after 2010 (the year for which the engineering analysis estimated costs) and throughout the analysis period. Subsequently, examination of historical price data for various appliances and equipment indicates that the assumption of constant real prices and costs may, in many cases, overestimate long-term appliance and equipment price trends. Economic literature and historical data suggest that the real costs of these products may in fact trend downward over time, partially because of ''learning'' or ''experience.'' [35]

On February 22, 2011, DOE published a notice of data availability (February 2011 NODA; 76 FR 9696) stating that DOE may consider improving regulatory analysis by addressing 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.

For this proposed rule and consistent with the February 2011 NODA, DOE examined two methods for estimating price trends for metal halide lamp fixtures: Using historical producer price indices (PPIs), and using projected price indices (called deflators). With PPI data, DOE found both positive and negative real price trends, depending on the specific time period examined, and did not use this method to adjust fixture prices. DOE instead adjusted fixture prices using deflators used by EIA to develop the *AEO.* When adjusted for inflation, the deflator-based price indices decline from 100 in 2010 to approximately 76 in 2045.

DOE invites comment on methods to improve its fixture price projections beyond the assumption of constant real prices, as well as any data supporting alternate methods. A more detailed discussion of price trend modeling and calculations is provided in appendix 8B of the NOPR TSD.

2. Installation Cost

Installation costs for metal halide lamp fixtures include the costs to install the fixture, maintain the ballast, and replace the lamp. For the April 2011 preliminary TSD, DOE used data collected for its July 2010 HID lamps determination,[36] labor rates for electricians from *RS Means,*[37] and other research to estimate the installation costs. DOE annualized maintenance costs in its preliminary analysis, and NEEA questioned why DOE annualized costs that do not occur annually, but rather occur periodically during the equipment lifetime. (NEEA, Public Meeting Transcript, No. 33 at p. 102) For this NOPR, DOE developed a methodology that allows the use of annualized maintenance costs while maintaining the integrity of the NPV calculations in the NIA. For further detail, see chapter 8 of the NOPR TSD.

3. Annual Energy Use

As discussed in section V.E, DOE estimated the annual energy use of representative metal halide systems using system input power ratings and sector operating hours. The annual energy use inputs to the LCC and PBP analysis 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 April 2011 preliminary TSD, DOE developed weighted average energy prices for 13 U.S. geographic areas consisting of the 9 census divisions, with 4 large states (1. California, 2. Florida, 3. New York, and 4. Texas) treated separately. For census divisions containing one of these large states, DOE calculated the regional average excluding the data for the large state. Prices were based on data from EIA Form 826, ''Monthly Electric Utility Sales and Revenue Data, 2011.'' GE commented that metal halide lighting is commonly used outdoors during off-peak hours, and recommended that DOE account for off-peak electricity prices in the analysis. (GE, Public Meeting Transcript, No. 33 at p. 135) For this proposed rule, DOE incorporated off-peak electricity pricing by using a distribution of percentages of average electricity prices in its Monte Carlo analysis, from which a lower average electricity price for the outdoor sector was calculated and used in the main LCC analysis. For more information, see chapter 8 of the NOPR TSD.

5. Energy Price Projections

To estimate the trends in energy prices, DOE used the price projections

[35] A draft paper, *Using the Experience Curve Approach for Appliance Price Forecasting,* posted on the DOE Web site at *www.eere.energy.gov/buildings/appliance_standards,* provides a summary of the data and literature currently available to DOE that is relevant to price forecasts for selected appliances and equipment.

[36] U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy. Energy Conservation Program for Consumer Equipment: Preliminary Technical Support Document: High-Intensity Discharge Lamps. 2010. Washington, DC <*www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/60*>

[37] R.S. Means Company, Inc. *2010 RS Means Electrical Cost Data.* 2010. Kingston, MA.

in *AEO2013*. To arrive at prices in future years, DOE multiplied current average prices by the projected of annual average price changes in *AEO2013*. Because *AEO2013* projects prices to 2040, DOE used the average rate of change from 2010 to 2040 to estimate the price trend for electricity after 2040. In addition, the spreadsheet tools that DOE used to conduct the LCC and PBP analysis allow users to select price forecasts from the *AEO* 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 comments on the April 2011 preliminary TSD concerning its energy price projecting method for the LCC analysis, and retained this approach for this proposed rule.

6. Replacement Costs

In the April 2011 preliminary TSD, DOE addressed ballast and lamp replacements that occur within the LCC analysis period. Replacement costs include the labor and materials costs associated with replacing a ballast or lamp at the end of their lifetimes and are annualized across the years preceding and including the actual year in which equipment is replaced. For the LCC and PBP analysis, the analysis period corresponds with the fixture lifetime that is assumed to be longer than that of either the lamp or the ballast. For this reason, ballast and lamp prices and labor costs are included in the calculation of total installed costs. DOE received comments regarding its annualizing approach concerning replacement costs for the LCC analysis in its April 2011 preliminary TSD and developed a new annualizing methodology for this proposed rule. (NEEA, Public Meeting Transcript, No. 33 at p. 103)

7. Equipment Lifetime

For the April 2011 preliminary TSD, DOE defined equipment lifetime as the age (in hours in operation) when a fixture, ballast, or lamp is retired from service. For fixtures in all equipment classes, DOE assumed lifetimes for indoor and outdoor fixtures of 20 and 25 years, respectively.

Metal halide lamp fixtures are operated by either magnetic or electronic ballasts. In the April 2011 preliminary analysis, DOE assumed that magnetic ballasts last for 50,000 hours and electronic ballasts last for 30,000 hours. NEMA and Empower Electronics agreed with DOE's general estimates about magnetic and electronic ballast lifetimes, but NEMA cautioned that fixtures are often removed before end of service life, especially as new energy-efficient alternatives appear on the market. (NEMA, No. 34 at p. 18; Empower Electronics, No. 36 at p. 11) Similarly, Philips noted that ballasts may be replaced prior to physical failure. (Philips, Public Meeting Transcript, No. 33 at p. 107) OSI suggested an average rated life of 50,000 hours for electronic ballasts, and agreed with NEMA and Philips that fixtures may be replaced before end of service life. (OSI, No. 27 at p. 6) The California IOUs believed that DOE underestimated electronic ballast lifetime by as much as twofold based on their experience with electronic ballast manufacturers. (California IOUs, No. 32 at p. 3) Finally, NEEA suggested that DOE use a distribution of ballast lifetimes for LCC and other analyses. (NEEA, No. 31 at p. 7)

DOE notes that actual ballast lifetime data are limited. However, based on comments and additional research, DOE revised its average electronic ballast lifetime to 40,000 hours and maintained its average lifetime of 50,000 hours for magnetic ballasts for this proposed rule. DOE agrees that ballast lifetimes can vary due to both physical failure and economic factors (*e.g.,* early replacements due to retrofits). Consequently, DOE accounted for variability in lifetime in LCC and PBP via the Monte Carlo simulation, and in the shipments and NIA analyses by assuming a Weibull distribution for lifetimes to accommodate failures and replacements.[38]

Metal halide lamp lifetimes vary by fixture equipment class. For the April 2011 preliminary TSD, DOE assumed that lamps in the 70 W, 250 W, 400 W, and 1000 W equipment classes operate for 12,000, 15,000, 20,000, and 12,000 hours, respectively. Commenters noted that lamp lifetime can vary with operating position (*e.g.,* vertical, horizontal, or tilted), and recommended that DOE consider this variation in developing weighted-average lamp lifetimes. (GE, Public Meeting Transcript, No. 33 at p. 97; Hubbell, Public Meeting Transcript, No. 33 at p. 98) DOE agrees with the comments, and surveyed published MH lamp life ratings in developing weighted-average lamp lifetimes for this proposed rule.

Some public meeting participants asked about the effects of ballast type (*i.e.,* magnetic vs. electronic) on lamp life. (ASAP, Public Meeting Transcript, No. 33 at p. 98; Energy Solutions Public Meeting Transcript, No. 33 at p. 104) Hubbell and Philips acknowledged the lack of industry consensus on this subject and the variability of related lifetime data between manufacturers. (Hubbell, Public Meeting Transcript, No. 33 at p. 98; Philips, Public Meeting Transcript, No. 33 at p. 104) Based on its review of industry data and literature, DOE could not substantiate the effect of ballast type on MH lamp lifetimes, and used published lamp life ratings only in developing weighted-average lamp lifetimes for this proposed rule.

8. Discount Rates

The discount rate is the rate at which future expenditures are discounted to estimate their present value. In this NOPR, DOE estimated separate discount rates for commercial, industrial and outdoor stationary customers. For all such customers, DOE estimated the cost of capital for commercial and industrial companies by examining both debt and equity capital, and developed an appropriately weighted average of the cost to the company of equity and debt financing. For the proposed rule, DOE also developed a distribution of discount rates for each end-use sector from which the Monte Carlo simulation samples.

For each sector, DOE assembled data on debt interest rates and the cost of equity capital for representative firms that use metal halide lamp fixtures. 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.[39] The average discount rates, weighted by the shares of each rate value in the sectoral distributions, are 4.5 percent for commercial end-users, 4.3 percent for industrial end-users, and 3.4 percent for outdoor stationary end-users.

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

9. Analysis Period

DOE calculated the LCC for all end-users as if each one would purchase a new fixture in the year 2016.

10. Fixture Purchasing Events

DOE designed the LCC and PBP analysis for this rulemaking around scenarios where customers need to purchase a metal halide lamp fixture. The ''event'' that prompts the purchase

[38] Weibull distribution is a probability density function; for more information, see *www.itl.nist.gov/div898/handbook/eda/section3/eda3668.htm.*

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

of a new fixture (either a ballast failure or new construction/renovation) was assumed to influence the cost-effectiveness of the customer purchase decision. DOE assumed that a customer will replace a failed fixture with an identical fixture in the base case, or a new standards-compliant fixture with comparable light output in the standards case. DOE analyzed five representative equipment classes for fixtures and presented the results for each of these representative equipment classes by fixture purchasing event, which influenced the LCC and PBP results.

DOE received no comments on the April 2011 preliminary TSD concerning its assumed fixture purchasing events for the LCC analysis and retained this approach for this proposed rule.

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

DOE's NIA assessed the national energy savings (NES) and the national net present value (NPV) of total customer costs and savings that would be expected to result from new or amended standards at specific efficiency levels. (''Customer'' in this context refers to users of the regulated equipment.)

DOE used a Microsoft Excel spreadsheet model to calculate the energy savings and the national customer costs and savings from each TSL. The TSD and other documentation for the rulemaking help 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 use and total installed cost data from the energy use and LCC analyses. DOE projected the energy savings, energy cost savings, equipment costs, and NPV of customer benefits for each equipment class for equipment sold from 2016 through 2045. The projections provided annual and cumulative values for all four output parameters.

DOE evaluated the impacts of new and amended standards for metal halide lamp fixtures by comparing base-case projections with standards-case projections. The base-case projections characterize energy use and customer costs for each equipment class in the absence of new or amended energy conservation standards. DOE compared these projections with projections characterizing the market for each equipment 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 the NOPR 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 preliminary TSD, as well as the changes to the analyses for the proposed rule. A discussion of selected inputs and changes follows. See chapter 11 of the NOPR TSD for further details.

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

Inputs	Preliminary TSD	Changes for the proposed rule
Shipments	Developed annual shipments from shipments model	See Table V.7.
Annual Energy Consumption per Unit	Established in the energy use characterization (preliminary TSD chapter 7).	See section V.E.
Rebound Effect	0%	No change.
Electricity Price Forecast	*AEO2010*	*AEO2013*.
Energy Site-to-Source Conversion Factor	Assumed to be constant across time: 1 site kWh = 10,239 source Btu.	Used annually variable site kWh to source Btu conversion factor.
Discount Rate	3% and 7% real	No change.
Present Year	2011	2013.

1. Shipments

Equipment shipments are an important component of any estimate of the future impact of a standard. Using a three-step process, DOE developed the shipments portion of the NIA spreadsheet, a model that uses historical data as a basis for projecting future fixture shipments. First, DOE used a combination of historical fixture shipment data from the U.S. Census Bureau for HID fixtures from 1993 to 2001. DOE correlated the HID fixture data with HID lamp data from 1990 to 2010 from the HID lamps rulemaking (EERE–2010–BT–STD–0043). Fixture shipments correlated to roughly a third of lamp shipments. DOE applied this fixture-to-lamp correlation to the larger and more detailed data set of HID lamp data to estimate the total historical shipments of each fixture type analyzed. Second, DOE estimated an installed stock for each fixture in 2016 based on the average service lifetime of each fixture type. Third, DOE developed annual shipment projections for 2016–2045 by modeling fixture purchasing events, such as replacement and new construction, and applying growth rate, replacement rate, and alternative technologies penetration rate assumptions. For details on the shipments analysis, see chapter 10 of the NOPR TSD. DOE is seeking comment on whether the assumptions and methods used to project MHLF shipments are reasonable and likely to occur. DOE is also seeking data and information that could be used to refine DOE's estimates. DOE also requests comment on the impediments that prevent users of metal halide lamp fixtures from switching to LED lighting to garner further energy savings.

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

Inputs	Preliminary TSD	Changes for the proposed rule
Historical Shipments	Used historical shipments for 1990–2008 to develop shipments and stock projections for the analysis period.	Used historical MH lamp shipments for 1990–2010 to develop shipments and stock projections for MH fixtures.

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

Inputs	Preliminary TSD	Changes for the proposed rule
Fixture Stock	Based projections on the shipments that survive up to a given date; assumed Weibull lifetime distribution.	No change.
Growth	Adjusted based on fixture market	No change.
Base Case Scenarios	Analyzed one scenario incorporating alternative technologies encroaching on fixture shipments.	Developed "low" and "high" shipments scenarios.
Standards Case Scenarios	Analyzed Roll-up and Shift scenarios	Analyzed Roll-up only.

a. Historical Shipments

For the April 2011 preliminary TSD, DOE reviewed U.S. Census Bureau data from 1993 to 2001 for metal halide lamp fixtures.[40] DOE compared the MHLF census data to NEMA data for historical metal halide lamp shipments from 1990 to 2008 taken from DOE's final determination for HID lamps published on July 1, 2010. 75 FR 37975. DOE found a correlation between metal halide lamp fixture and metal halide lamp shipments. From 1993 to 2001, the number of MHLF shipments on average represented 37 percent of the amount of lamp shipments, with a standard deviation of 3 percent. Using this relationship, DOE multiplied all of the metal halide lamp shipments from 1990 to 2010 by 37 percent to estimate the historical shipments of metal halide lamp fixtures. DOE received no comments on the April 2011 preliminary TSD regarding historical fixture shipments data and estimates and retains this approach for this proposed rule.

b. Fixture Stock Projections

In its preliminary shipments analysis, DOE calculated the installed fixture stock using historical fixture shipments estimated from U.S. Census Bureau Current Industrial Reports data (1993–2001), data from the HID lamps rule, and its projected shipments for future years. DOE estimated the installed stock during the analysis period by using fixture shipments and calculating how many will survive up to a given year based on a Weibull lifetime distribution for each fixture type. DOE received no comments on the April 2011 preliminary TSD regarding its fixture stock projection method and retained this approach for this proposed rule.

c. Base Case Shipment Scenarios

For the April 2011 preliminary TSD, DOE's projection showed fixture shipments increasing until 2020 and then declining. Several manufacturers stated that DOE's projection overestimated fixtures shipments in the near term. (Acuity, Cooper, GE, Philips, Public Meeting Transcript, No. 33 at pp. 112–120) Philips noted that T5 and T8 fluorescent systems are already displacing metal halide systems, with solid-state lighting also starting to penetrate the metal halide lamp fixture market. (Philips, Public Meeting Transcript, No. 33 at p. 113) DOE revisited its preliminary fixture shipment estimates and manufacturer interview data, and revised its projections downward for this proposed rule. DOE assumed that shipments for metal halide lamp fixtures would peak somewhere between 2010 and 2015. From the manufacturer interviews, DOE was able to approximate the shipments in 2010. Through separate data, additional assumptions, and research, DOE was able to approximate the same shipments in 2010 in the DOE model. In the "low" shipment scenario, DOE reviewed trends in replacement technologies and projected a decline such that the 2040 shipment projection fell back to the level of the 2000 shipments. In the "high" scenario, the decline in metal halide lamp fixture shipments is not as large as in the "low" scenario. The shipments in the "high" scenario in 2040 roughly equal the shipments in 2006.

d. Standards Case 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 equipment efficiency. For the April 2011 preliminary TSD, DOE used two shipment efficiency scenarios: "Roll-up" and "Shift." DOE received no comments on its efficiency scenarios, but eliminated the Shift scenario and retained the Roll-up scenario for this proposed rule. The Roll-up scenario is a standards case in which all equipment efficiencies in the base case that do not meet the standard would 'roll up' to the lowest level that can meet the new standard level. Equipment efficiencies in the base case above the standard level are unaffected in the Roll-up scenario, as these customers are assumed to continue to purchase the same base-case fixtures. The Roll-up scenario characterizes customers primarily driven by the first cost of the analyzed equipment, which DOE believes more accurately characterizes the metal halide lamp fixture marketplace.

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 into primary or source energy consumption (the energy required to convert and deliver the site energy). These conversion factors account for the energy used at power plants to generate electricity and losses in transmission and distribution, as well as for natural gas losses from pipeline leakage and energy used for pumping. For electricity, the conversion factors vary over time due to projected changes in generation sources (*i.e.,* the types of power plants 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 preliminary TSD, DOE used the average of all annual site-to-source conversion factors based on the version of NEMS that corresponds to *AEO2010,* which provides energy forecasts through 2035. For 2036–2044, DOE used conversion factors that remain constant at the 2035 values.

DOE has historically presented NES in terms of primary energy savings. In response to the recommendations of a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" appointed by the National Academy of Science, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011) While DOE stated in that notice that it intended to use the Greenhouse Gases, Regulated Emissions,

[40] U.S. Census Bureau. *Manufacturing, Mining, and Construction Statistics.* Current Industrial Reports, Fluorescent Lamp Ballasts, MQ335C. 2008. (Last accessed September 1, 2010). <*www.census.gov/mcd/*>.

and Energy Use in Transportation (GREET) model to conduct the analysis, it also said it would review alternative methods, including the use of NEMS. After evaluating both models and the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in the **Federal Register** in which DOE explained its determination that NEMS is a more appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). DOE received one comment, which was supportive of the use of NEMS for DOE's FFC analysis.[41]

The approach used for today's NOPR, and the FFC multipliers that were applied, are described in appendix 11B of the NOPR TSD. NES results are presented in both primary and FFC savings in section VI.B.

H. Customer Subgroup Analysis

The life-cycle cost subgroup analysis evaluates impacts of standards on identifiable groups, such as different customer populations or business types that may be disproportionately affected by any national energy conservation standard level. DOE will estimate LCC savings and PBPs for customers in the commercial, industrial, and outdoor stationary sectors. DOE will also analyze the LCC effects on customers living in or operating different buildings in the commercial and industrial sectors. In addition, DOE will analyze effects on customers in different regions of the country.

I. Manufacturer Impact Analysis

1. Overview

DOE performed a manufacturer impact analysis (MIA) to estimate the financial impact of proposed new and amended energy conservation standards on manufacturers of metal halide lamp fixtures and ballasts, and to estimate 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, equipment costs, shipments, and assumptions about markups and conversion expenditures. The key output is the industry net present value (INPV). Different sets of shipment and markup assumptions (scenarios) will produce different results. The qualitative part of the MIA addresses factors such as equipment attributes; characteristics of, and impacts on, particular sub-groups of firms; and market and product trends. Chapter 13 of the NOPR TSD outlines the complete MIA.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1, Industry Profile, DOE prepared an industry characterization based on the market and technology assessment, preliminary manufacturer interviews, and publicly available information. In Phase 2, Industry Cash Flow Analysis, DOE estimated industry cash flows in the GRIM using industry financial parameters derived in Phase 1 and the shipment scenarios used in the NIA. In Phase 3, Sub-Group Impact Analysis, DOE conducted structured, detailed interviews with a representative cross-section of manufacturers that represent more than 65 percent of domestic fixture sales and 90 percent of domestic ballast sales. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics specific to each company, and obtained each manufacturer's view of the MHLF industry as a whole. The interviews provided valuable information that DOE used to evaluate the impacts of new and amended standards on manufacturers' cash flows, manufacturing capacities, and employment levels. See section V.I.4 for a description of the key issues manufacturers raised during the interviews.

During Phase 3, DOE also used the results of the industry characterization analysis in Phase 1 and feedback from manufacturer interviews to group manufacturers that exhibit similar production and cost structure characteristics. DOE identified one sub-group for a separate impact analysis—small manufacturers—using the small business size standards published by the Small Business Administration (SBA).[42] These thresholds include all employees in a business' parent company and any other subsidiaries. Based upon this classification, DOE identified 54 small metal halide lamp fixture manufacturers and five small metal halide ballast manufacturers that qualify as small businesses.

2. GRIM Analysis and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow that result in a higher or lower industry value. The GRIM analysis uses a standard annual cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs and models changes in costs, investments, and manufacturer margins that would result from new and amended energy conservation standards. The GRIM spreadsheet uses the inputs to calculate a series of annual cash flows beginning with the base year of the analysis, 2013, and continuing to 2045. DOE computes INPVs by summing the stream of annual discounted cash flows during this period. DOE uses a real discount rate of 9.5 percent and 8.9 percent for fixtures and ballasts, respectively. The discount rate estimates were derived from industry corporate annual reports to the Securities and Exchange Commission (SEC 10-Ks) and then modified according to feedback during manufacturer interviews.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between a base case and various TSLs (the standards cases). The difference in INPV between the base case and a standards case represents the financial impact of the new and amended standard on manufacturers. The GRIM results are shown in section VI.B.2. Additional details about the GRIM can be found in chapter 13 of the NOPR TSD.

DOE typically presents its estimates of manufacturer impacts by groups of the major equipment types served by the same manufacturers. Although the covered equipment in today's proposed rulemaking is metal halide lamp fixtures, by requiring a particular ballast efficiency in this regulation, metal halide ballast manufacturers will also be affected by new and amended standards. Because fixture and ballast markets are served by separate groups of manufacturers, DOE presents impacts on metal halide lamp fixture manufacturers and metal halide ballast manufacturers separately.

a. Manufacturer Production Costs

Manufacturing a higher-efficiency product is typically more expensive than manufacturing a baseline product due to the use of components that are more costly than baseline components. The changes in the MPCs of the analyzed equipment can affect the revenues, gross margins, and cash flows of the manufacturer, making these equipment cost data key GRIM inputs for DOE's analysis. DOE employed one of two methods to derive these per-unit production costs. DOE was able to establish a BOM for those ballasts it tore

[41] Docket ID: EERE–2010–BT–NOA–0028, comment by Kirk Lundblade.

[42] DOE determined whether a company is a small business (65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121). To be categorized as a small business, a metal halide lamp fixture manufacturer may have up to 500 employees; a metal halide ballast manufacturer may have up to 750 employees.

down. DOE then converted the BOMs at each efficiency level into corresponding MPCs composed of labor, materials, and overhead expenses using its engineering cost model. When DOE was not able to generate a BOM for a given ballast, DOE estimated the per-unit production costs based on the relationship between teardown data and manufacturer-supplied MSPs. DOE included a cost adder for indoor electronic ballasts to account for the additional cost of including a 120 V auxiliary tap in some models. DOE also developed fixture MPCs for several different fixture types using either a teardown analysis or retail price scaling. With these costs for several common fixture types, DOE created a single ''hybrid'' fixture for each of the five representative wattages, reflecting the weighted average of the common fixture types. DOE included a cost adder for all fixtures that use electronic ballasts to account for thermal management and a cost adder for outdoor fixtures that use electronic ballasts to account for voltage transient protection. For a complete description these cost adders, see section V.C.12 of this NOPR. In addition, DOE used teardown cost data to disaggregate the ballast and fixture MPCs into material, labor, and overhead costs.

b. Base Case Shipment Projections

Changes in sales volumes and efficiencies over time can significantly affect manufacturer finances. The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of shipments by efficiency level. For this analysis, the GRIM uses the NIA's annual shipment projections from 2013 to 2045, the end of the analysis period. The shipments analysis also estimated the distribution of fixture efficiencies in the base case for all equipment classes.

DOE employed two scenarios that affect base case shipments over the analysis period (2016 through 2045): a low-shipment scenario and a high-shipment scenario. In the low-shipment scenario, DOE reviewed trends in fixture replacement technologies and projected a decline in shipments over the analysis period. In the high-shipment scenario, the decline in metal halide lamp fixture shipments is not as large as in the low-shipment scenario. Manufacturers earn greater revenue under the high-shipment scenario compared to the low-shipment scenario. See chapter 10 of the NOPR TSD for additional details on shipments.

c. Standards Case Shipment Projections

In addition to the two shipment scenarios affecting base case shipments, DOE modeled a roll-up scenario to estimate the standards case efficiency distributions. See chapter 10 of the NOPR TSD for more information on the standards case shipment scenarios.

d. Markup Scenarios

As discussed above, MSPs include direct manufacturing production costs (*i.e.,* labor, material, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* selling, general and administrative expenses (SG&A), R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied markups to the MPCs estimated in the engineering analysis for each equipment class and efficiency level. Modifying these markups in the standards cases yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards case markup scenarios to represent the uncertainty regarding impacts on prices and profitability: (1) A flat markup scenario, and (2) a 'preservation of operating profit' markup scenario. These scenarios lead to different markups values, which, when multiplied by the MPCs, result in varying revenue and cash flow impacts.

The flat markup scenario assumes that the cost of goods sold for each product is marked up by a flat percentage to cover SG&A expenses, R&D expenses, and profit. The flat markup scenario uses the baseline manufacturer markup (1.47 for ballasts and 1.58 for fixtures, as discussed in chapter 5 of the NOPR TSD) for all fixture equipment classes in both the base case and the standards case. This scenario represents the upper bound of industry profitability in the standards case because it is designed so that manufacturers can fully pass through additional costs due to standards to their customers. To derive the flat markup percentage, DOE evaluated publicly available financial information for manufacturers of metal halide ballasts or fixtures. DOE also requested feedback on this value during manufacturer interviews.

During interviews, manufacturers expressed skepticism that they would be able to mark up higher equipment costs in the standards case to the same degree as in the base case. In recognition of this concern, DOE also modeled a scenario called the 'preservation of operating profit' markup scenario. In this scenario, markups in the standards case are lowered such that manufacturers are only able to maintain their total base case operating profit in absolute dollars, despite higher product costs and investments. This scenario represents the lower bound of industry profitability following new and amended energy conservation standards because the resulting higher production costs and investments do not yield any additional operating profits. DOE implemented this scenario in the GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case in 2017, as in the base case.

e. 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. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with the new and amended energy conservation standards. 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.

NEMA expressed concern about the costs (in time and dollars) that manufacturers may incur due to this rulemaking, specifically with respect to product redesigns and product testing. NEMA disagreed with DOE's assumption in the preliminary analysis that ballast redesigns would not cause fixture redesigns. NEMA argued that DOE should account for fixture redesign costs for both magnetic and electronic ballast efficiency levels and provided estimates of these costs. (NEMA, No. 34 at p. 7, 21) Acuity and OSI agreed that fixture manufacturers would face increased costs due to additional engineering, testing, and material costs. (Acuity, Public Meeting Transcript, No. 33 at p. 79; OSI, No. 27 at p. 6)

For today's NOPR, DOE has revised its assumption about additional fixture costs and believes that empty fixture costs are likely to increase for standards requiring electronic ballasts, as described in section V.C.12, because of the need to incorporate thermal protection and voltage transient protection. Because the use of electronic ballasts could necessitate fixture redesigns, DOE includes the costs of these fixture redesigns in its product and capital conversion costs. DOE has taken into account the feedback and estimates provided by NEMA in its analysis, as well as the input from individual manufacturers during confidential manufacturer interviews. DOE's methodology for developing product and capital conversion cost estimates is described below and in chapter 13 of the NOPR TSD. DOE requests comment on the methodology applied to determine the product and capital conversion costs.

Several stakeholders commented that the costs to develop and test electronic ballasts are higher than for magnetic ballasts. (NEMA, No 34 at p. 8; OSI, No. 27 at p. 6) Cooper noted that the cost of UL certification when switching from magnetic to electronic ballasts falls into this category. (Cooper, Public Meeting Transcript, No. 33 at p. 76) Acuity added that long lead times accentuate the cost of UL certification and make it more difficult for manufacturers to quickly bring new products to market. (Acuity, Public Meeting Transcript, No. 33 at p. 79) DOE agrees that the engineering, testing, and certification costs for electronic ballasts may be significant and has included these costs in today's analysis, as described in what follows.

Ballast Industry Conversion Costs

DOE's interviews with ballast manufacturers revealed that they expect the need to develop new and improved circuit designs—as opposed to the purchase of new capital equipment—will account for most of the conversion costs at each TSL. Due to the flexible nature of most ballast production equipment and DOE's assumption that the stack height of magnetic ballasts will not increase, manufacturers do not expect new and amended standards to strand (make obsolete in advance of complete depreciation) a significant share of their production assets. As opposed to other more capital-intensive appliance manufacturers, much of the expenses required to achieve higher efficiency levels would occur through research and development, engineering, and testing efforts.

DOE based its estimates of the product conversion costs that would be required to meet each TSL on information obtained from manufacturer interviews and catalog data on the number and efficiency of models that each major manufacturer supports. DOE estimated the product development costs manufacturers would incur for each model that would need to be converted based on the necessary engineering and testing resources required to redesign each model. DOE assumed higher R&D and testing costs for levels requiring electronic ballasts compared to magnetic ballasts. Testing costs include internal testing, UL testing, additional certifications, pilot runs, and product training. DOE then multiplied these per-model cost estimates for each interviewed manufacturer by the total number of ballast models that would need to be converted at each efficiency level in each wattage bin, based on information from manufacturer catalogs and interviews, to estimate the total product conversion costs.

To separate total product conversion costs into indoor and outdoor equipment classes, DOE assigned costs based on the percentage of indoor or outdoor shipments in the NIA. Finally, DOE scaled these costs to account for the market share of the companies not interviewed. DOE's estimates of the product conversion costs for metal halide ballasts affected by this rulemaking can be found in section VI.B.2, as follows and in chapter 13 of the NOPR TSD.

As discussed above, DOE also estimated the capital conversion costs ballast manufacturers would incur to comply with the potential new and amended energy conservation standards represented by each TSL. During interviews, DOE asked manufacturers to estimate the capital expenditures required to expand the production of higher-efficiency products. These estimates included the required tooling and plant changes that would be necessary if product lines meeting the proposed standard did not currently exist.

DOE estimated capital conversion costs, like product conversion costs, based on interviews with manufacturers. Some manufacturers anticipated minimal to no conversion costs because of the flexibility of their existing equipment or because they source certain ballast types rather than produce them in-house. Other manufacturers expected greater capital conversion costs because they would need to acquire new stamping dies for higher-efficiency magnetic ballasts and/or wave solder machines for electronic ballasts. In general, DOE's view is that significant changes to existing production lines and equipment would not be necessary in response to new or amended standards. It is therefore unlikely that most manufacturers would require high levels of capital expenditures compared to ordinary capital additions or replacements.

DOE scaled its estimated conversion costs based on interviews to account for the market share of the companies not interviewed. DOE's estimates of the capital conversion costs for metal halide ballasts can be found in section VI.B.2, as follows and in chapter 13 of the NOPR TSD.

Fixture Industry Conversion Costs

To estimate conversion costs for fixture manufacturers, DOE again based its estimates on manufacturer interviews and industry research. DOE doubts that the stack height of magnetic ballasts will increase in response to new and amended standards. As such, DOE assumed that fixture manufacturers would be able to use higher-efficiency magnetic ballasts without incurring redesign or capital costs. Even if higher-efficiency levels can be met with magnetic ballasts, DOE expects manufacturers will incur one-time non-capital expenses at these levels associated with testing, literature changes, and marketing costs. These costs are included in DOE's product conversion cost estimates.

At efficiency levels requiring electronic ballasts, DOE expects that fixture manufacturers may face more significant conversion costs. Manufacturers will have to consider thermal protection in their product designs because more-efficient electronic ballasts have lower tolerances for high temperatures than magnetic ballasts do. DOE estimated product conversion costs for fixture manufacturers by multiplying the number of product families in each wattage bin by the expected cost of fixture redesign and testing. DOE then multiplied these totals by the percentage of fixtures that would need to be redesigned at each efficiency level.

DOE employed a similar methodology to estimate fixture capital conversion costs at efficiency levels associated with electronic ballasts. Based on manufacturer interviews, DOE estimated platform tooling and equipment costs, such as costs for die castings, bracketing, and extrusions, and multiplied these costs by the number of fixtures affected by the standard.

To separate total product and capital conversion costs for fixture manufacturers into indoor and outdoor equipment classes, DOE assigned costs based on the percentage of indoor and outdoor fixtures each interviewed manufacturer offers. DOE's estimates of the product and capital conversion costs for metal halide lamp fixtures addressed in this rulemaking can be found in section VI.B.2, as follows and in chapter 13 of the NOPR TSD.

3. Discussion of Comments

During the April 2011 public meeting, interested parties commented on the assumptions and results of the preliminary TSD. DOE addresses those comments below relating to the compliance period, the opportunity cost of investments, and impacts on competition.

a. Compliance Period

NEMA stated that fixture manufacturers may be unable to meet the compliance date of standards for all products. NEMA believes that it could take one year to redesign the ballasts, one year to test and certify the ballasts, and one year to handle marketing of fixture phase-outs. NEMA said that this entire process may be difficult and burdensome given the scope of the rulemaking. (NEMA, No. 34 at p. 15) OSI also noted its concern about the compliance period, stating that any change in the standard must provide adequate time for the ballast OEMs to develop, test, and begin producing the additional ballast types needed to provide a complete line of electronic metal halide ballasts. Fixture OEMs would, in turn, need adequate time to redesign their products. (OSI, No. 27 at p. 6)

At the same time, OSI stated that ballast OEMs could provide bench-top temperature-rise data to help reduce the UL testing requirements and costs for the fixture OEMs. OSI also stated that several ballast manufacturers are already manufacturing electronic metal halide ballasts and are developing additional products to broaden their product offerings. OSI has plans to expand production capacity to supply market needs. On the fixture side, several manufacturers are already developing fixtures using electronic metal halide ballasts, and these manufacturers will be able to expand their fixture offering as more ballast types become available. (OSI, No. 27 at p. 6, 7)

DOE acknowledges that fixture manufacturers and ballast manufacturers may need to coordinate production to comply with a MHLF energy conservation standard. However, EISA 2007 specifies a compliance date of January 1, 2015, and DOE proposes to adopt this date in today's NOPR. (42 U.S.C. 6295(hh)(2)(B)) DOE requests comment on the impact and feasibility of the compliance date for manufacturers.

b. Opportunity Cost of Investments

Several manufacturers argued that developing products to meet new and amended energy conservation standards has an opportunity cost due to the limited resources at their disposal. Manufacturers are currently focusing on new technologies such as solid-state lighting and controls with greater potential energy savings than mature technologies such as HID. New and amended standards for metal halide lamp fixtures could divert finite resources away from new product development, at a significant cost to the manufacturers. (NEMA, No. 34 at p. 7–8; Philips, Public Meeting Transcript, No. 33 at p. 81; Georgia Power, No. 28 at p.1) Manufacturers may also choose not to convert their products and abandon the market because of the high opportunity cost. This could effectively eliminate the metal halide market and negate any potential energy savings from MHLF and HID lamp standards as well. (Philips, Public Meeting Transcript, No. 33 at p. 132; NEMA, No 34 at p. 16)

DOE recognizes the opportunity cost associated with any investment, and agrees that manufacturers would need to spend capital to meet today's standards 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 metal halide market with investment in emerging technologies. The companies will have to weigh tradeoffs between deferring investments and deploying additional capital. DOE includes the costs of meeting today's proposed standard in its analysis.

c. Impact on Competition

NEMA stated that manufacturers who produce only magnetic ballasts would be at a disadvantage should DOE set a standard that requires the use of electronic ballasts. NEMA believed that magnetic ballast manufacturers would not be able to move to electronic ballast production because of the increased cost and complexity of electronic ballast designs and because of the different engineering specializations required. (NEMA, No. 34 at p. 16) OSI stated, however, that no manufacturers produce magnetic ballasts as their only product type, and many of those that offer magnetic ballasts also manufacture LED power supplies and drivers, which require the same or greater technology knowledge to develop and manufacture as electronic ballasts do. (OSI, No. 27 at p. 5)

DOE agrees with NEMA that manufacturers with no experience producing electronic ballasts would face a steeper learning curve than those with experience. DOE doubts that competition will be significantly affected, however. Electronic ballasts are widely used throughout the industry, particularly at lower wattages. Additionally, as suggested by OSI, DOE has not identified any manufacturers that produce only magnetic metal halide ballasts.

4. Manufacturer Interviews

DOE interviewed manufacturers representing more than 65 percent of metal halide lamp fixture sales and 90 percent of metal halide ballast sales. These NOPR interviews were in addition to the preliminary interviews DOE conducted as part of the engineering analysis. The information gathered during these interviews enabled DOE to tailor the GRIM to reflect the unique financial characteristics of the ballast and fixture industries. All interviews provided information that DOE used to evaluate the impacts of potential new and amended energy conservation standards on manufacturer cash flows, manufacturing capacities, and employment levels. Appendix 13A of the NOPR TSD contains the interview guides DOE used to conduct the MIA interviews.

During the manufacturer interviews, DOE asked manufacturers to describe their major concerns about this rulemaking. The following sections describe the most significant issues identified by manufacturers. DOE also included additional concerns in chapter 13 of the NOPR TSD.

a. Ability To Recoup Investments

Several manufacturers worried that new and amended energy conservation standards would force them to invest while their market was shrinking. The increasing market penetration of emerging technologies could strand these investments, particularly as metal halide lamp fixture standards hasten the switch to emerging technologies by narrowing the difference between MHLF and emerging technology purchase prices. If the standard threatens to accelerate the ongoing migration to new technology, manufacturers would be more likely to abandon their metal halide product lines.

To address the emerging technologies issues discussed by manufacturers, DOE included several shipment scenarios in both the NIA and the GRIM. See chapter 10 and chapter 13 of the NOPR TSD for a discussion of the shipment scenarios used in the respective analyses. DOE is seeking comment on whether manufacturers' ability to recoup investment, combined with the opportunity cost of investment would encourage manufacturers to exit the metal halide lamp fixture market.

b. Efficiency Metric Used

Some manufacturers disagreed over which metric should be used to regulate efficiency for metal halide lamp fixtures. Manufacturers agreed that ballast efficiency is the most straightforward metric to use and the simplest for compliance purposes, but they noted that it ignores opportunities for energy savings from lamps and the fixtures themselves. At the same time, some manufacturers did not favor a lamp and ballast metric because a lamp and ballast metric could confer a competitive advantage to those manufacturers who produce both metal halide lamps and ballasts. Lastly, several manufacturers opposed the use of a fixture efficiency metric.

In today's notice, DOE proposes a ballast efficiency metric for the reasons described in section III.B. DOE notes that it is concurrently conducting a rulemaking for HID lamps, including metal halide lamps, which will examine the lamp efficiency component of the metal halide system.

c. Maintenance of 150 W Exemption

Nearly all manufacturers said that DOE should maintain its exemption for 150 W only fixtures rated for wet (e.g., outdoor) locations and containing ballasts rated to operate in air temperatures higher than 50 °C. Manufacturers stated that it is cost-prohibitive to meet EISA 2007 standard levels with magnetic ballasts, and electronic ballasts are currently less reliable for outdoor applications. Furthermore, manufacturers acknowledged that this exemption created energy savings by pushing customers of the more-expensive 175 W ballasts to the less-expensive 150 W magnetic ballasts. Manufacturers contended that customers would revert back to the 175 W equipment if the exemption were not maintained because of the significant price increase caused by bringing the 150 W ballast into compliance. This cost increase would cause customers to revert to 175 W, they said, thereby negating any potential energy savings that could have been achieved by regulating 150 W products.

DOE, however, is proposing not to maintain the 150 W exemption in today's notice for the reasons detailed in section III.A.1.

J. 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—which are not considered here—are any changes in the number of employees working for manufacturers of the equipment that is the subject of this rulemaking, their suppliers, and related service firms. Indirect employment impacts—the subject of this section—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 equipment. The MIA addresses the direct employment impacts that concern metal halide lamp fixture manufacturers in section VI.B.2.

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, because of: (1) Reduced spending on energy by end-users; (2) reduced spending on new energy supplies by the utility industry; (3) increased spending on new equipment 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, as explained as follows.

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 *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 the 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.[43]

Energy conservation standards reduce customer utility bills. Because reduced customer 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, the Department believes that net national employment will increase due to shifts in economic activity resulting from new and amended standards for metal halide lamp fixtures.

In developing today's proposed standards, DOE estimated indirect national employment impacts using an input/output 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.[44] ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (I–O) model, designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 187 sectors. ImSET's national economic I–O structure is based on a 2002 U.S. benchmark table,[45] 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 potential new efficiency standards for metal halide ballasts. For more details on the employment impact analysis, see chapter 14 of the NOPR TSD.

DOE notes that ImSET is not a general equilibrium projection model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis.[46] 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

[43] *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.

[44] 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 *www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf.*

[45] Stewart, R.L., J.B. Stone, and M.L. Streitwieser, ''U.S. Benchmark Input-Output Accounts, 2002,'' *Survey of Current Business* (Oct. 2007).

[46] Scott, M., J.M. Roop, R.W. Schultz, D.M. Anderson, K.A. Cort, ''The Impact of DOE Building Technology Energy Efficiency Programs on U.S. Employment, Income, and Investment.'' *Energy Economics* (Sep. 2008).

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 NOPR TSD chapter 13 using the GRIM. The methodologies used and the sectors analyzed in the ImSET and GRIM models are different.

K. Utility Impact Analysis

The utility impact analysis estimates several important effects on the utility industry of the adoption of new or amended standards. For this analysis, DOE used the NEMS–BT model to generate forecasts of electricity consumption, electricity generation by plant type, and electric generating capacity by plant type, that would result from each considered TSL. DOE obtained the energy savings inputs associated with efficiency improvements to considered products from the NIA. DOE conducts the utility impact analysis as a scenario that departs from the latest *AEO* Reference Case. In the analysis for today's rule, the estimated impacts of standards are the differences between values forecasted by NEMS–BT and the values in the *AEO2013* Reference Case. Chapter 15 of the NOPR TSD describes the utility impact analysis.

L. Emissions Analysis

In the emissions analysis, DOE estimated the reduction in power sector emissions of CO_2, NO_X, SO_2, and Hg from potential energy conservation standards for metal halide lamp fixtures. In addition to estimating impacts of standards on power sector emissions, DOE estimated emissions impacts in production activities that provide the energy inputs to power plants. These are referred to as ''upstream'' emissions. In accordance with the FFC Statement of Policy (76 FR 51281 (August 18, 2011)), this FFC analysis includes impacts on emissions of methane (CH_4) and nitrous oxide (N_2O), both of which are recognized as greenhouse gases.

To estimate impacts on the environment, DOE conducted the emissions analysis using emissions factors that were derived from data in *AEO2013,* supplemented by data from other sources. DOE developed separate emissions factors for power sector emissions and upstream emissions. The method that DOE used to derive emissions factors is described in chapter 16 of the NOPR TSD.

EIA prepares the *Annual Energy Outlook* using NEMS. Each annual version of NEMS incorporates the projected impacts of existing air quality regulations on emissions. *AEO2013* generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2012.

SO_2 emissions from affected electricity-generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. 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 were also limited under the Clean Air Interstate Rule (CAIR; 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program. CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia Circuit but it remained in effect. See *North Carolina* v. *EPA,* 550 F.3d 1176 (D.C. Cir. 2008); *North Carolina* v. *EPA,* 531 F.3d 896 (D.C. Cir. 2008). On July 6, 2011 EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR. See *EME Homer City Generation, LP* v. *EPA,* 696 F.3d 7, 38 (D.C. Cir. 2012). The court ordered EPA to continue administering CAIR. The *AEO2013* emissions factors used for today's NOPR assume that CAIR remains a binding regulation through 2040.

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. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning in 2015, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants, which were announced by EPA on December 21, 2011. 77 FR 9304 (Feb. 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *AEO2013* assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2015. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, NEMS shows a reduction in SO_2 emissions when electricity demand decreases (*e.g.,* as a result of energy efficiency standards). Emissions will be far below the cap that would be established by CSAPR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU. Therefore, DOE believes that efficiency standards will reduce SO_2 emissions in 2015 and beyond.

CSAPR established a cap on NO_X emissions in 28 eastern States and the District of Columbia. Energy conservation standards are expected to have little effect on NO_X emissions in those States covered by CSAPR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions. However, standards would be expected to reduce NO_X emissions in the States not affected by the caps, so DOE estimated NO_X emissions reductions from the standards considered in today's NOPR for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would likely reduce Hg emissions. DOE estimated mercury emissions reduction using NEMS–BT based on *AEO2013,* which incorporates the MATS.

M. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this proposed 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 customer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the projection 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 NOPR, DOE is relying on a set of values for the social cost of carbon (SCC) that was developed by an interagency process. A summary of the basis for these values is provided below, and a more detailed description of the methodologies used is provided as an appendix to chapter 17 of the NOPR TSD.

1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of carbon dioxide. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b) of E.O. 12866, agencies must, to the extent permitted by law, ''assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.'' The purpose of the SCC estimates presented here is to allow agencies to incorporate the 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

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 [47] points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) future emissions of GHGs, (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. 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 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, however.

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. 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

Past economic analyses for Federal regulations used a wide range of values to estimate the benefits associated with reducing CO_2 emissions. The model year 2011 Corporate Average Fuel Economy final rule used both a ''domestic'' SCC value of $2 per metric ton of CO_2 and a ''global'' SCC value of $33 per metric ton of CO_2 for 2007 emission reductions (in 2007$), increasing both values at 2.4 percent per year. It also included a sensitivity analysis at $80 per metric ton of CO_2.[48] The proposed rule for Model Years 2011–2015 assumed a domestic SCC value of $7 per metric ton of CO_2 (in 2006$) for 2011 emission reductions (with a range of $0–$14 for sensitivity analysis), also increasing at 2.4 percent per year.[49] A regulation for packaged terminal air conditioners and packaged terminal heat pumps finalized by DOE in 2008 used a domestic SCC range of $0 to $20 per metric ton CO_2 for 2007 emission reductions (in 2007$). 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 $40 per metric ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006$ 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

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

[48] 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: *www.nhtsa.gov/fuel-economy*).

[49] 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: *www.nhtsa.gov/fuel-economy*).

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.

c. Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. 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. 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. The SCC values used for today's notice were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.[50]

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 sets of SCC values for use in regulatory analyses.[51] 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. The values estimated for 2010 grow in real terms over time, as depicted in Table V.8. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although preference is given to consideration of the global benefits of reducing CO_2 emissions.

TABLE V.8—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050

[In 2007 dollars per metric ton CO_2]

	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

Table V.9 shows the updated sets of SCC estimates in five year increments from 2010 to 2050. Appendix 17B of the NOPR TSD provides the full set of values, as well as the 2013 draft report from the interagency group. The central value that emerges is the average SCC across models at the 3 percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

TABLE V.9—ANNUAL SCC VALUES FROM 2013 INTERAGENCY UPDATE, 2010–2050

[In 2007 dollars per metric ton CO_2]

Year	Discount rate %			
	5	3	2.5	3
	Average	Average	Average	95th Percentile
2010	11	33	52	90
2015	12	38	58	109
2020	12	43	65	129

[50] *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, Technical Model Update for the Social Cost of Carbon (SCC).* Interagency Working Group on Social Cost of Carbon, United States Government, May 2013.

[51] *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* Interagency Working Group on Social Cost of Carbon, United States Government, 2010.

TABLE V.9—ANNUAL SCC VALUES FROM 2013 INTERAGENCY UPDATE, 2010–2050—Continued

[In 2007 dollars per metric ton CO_2]

Year	Discount rate %			
	5	3	2.5	3
	Average	Average	Average	95th Percentile
2025	14	48	70	144
2030	16	52	76	159
2035	19	57	81	176
2040	21	62	87	192
2045	24	66	92	206
2050	27	71	98	221

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 recognized that the existing models are imperfect and incomplete. The National Research Council report mentioned above points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of CO_2 emissions 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. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report, adjusted to 2012$ using the Gross Domestic Product price deflator. For each of the four cases specified, the values used for emissions in 2015 were $12.9, $40.8, $62.2, and $117 per metric ton avoided (values expressed in 2012$).[52] DOE derived values after 2050 using the growth rate for the 2040–2050 period in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

2. Valuation of Other Emissions Reductions

DOE investigated the potential monetary benefit of reduced NO_X emissions from the TSLs it considered. As noted above, 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 CSAPR. DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's NOPR based on estimates found in the relevant scientific literature. Available estimates suggest a very wide range of monetary values per ton of NO_X from stationary sources, ranging from $468 to $4,809 per ton in 2012$).[53] In accordance with OMB guidance,[54] DOE calculated the monetary benefits using each of the economic values for NO_X and real discount rates of 3 percent and 7 percent.

DOE did not monetize Hg emission reductions because it is currently evaluating estimates of the value of Hg emissions.

VI. Analytical Results

A. Trial Standard Levels

DOE analyzed the benefits and burdens of a number of TSLs for the metal halide lamp fixtures that are the subject of today's proposed rule. Table VI.1 presents the trial standard levels and the corresponding equipment class ELs for representative equipment classes.[55] See the engineering analysis in section V.C.9 of this NOPR for a more detailed discussion of the efficiency levels.

In the following section, DOE presents the analytical results for the TSLs of the equipment classes that DOE analyzed directly. DOE scaled the ELs for these representative equipment classes to create ELs for other equipment classes that were not directly analyzed as set forth in chapter 5 of the NOPR TSD. For more details on the representative equipment classes, please see section V.C.2.

TABLE VI.1—TRIAL STANDARD LEVELS

Rep. wattage	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
70 W Indoor	EL1	EL2	EL2	EL2	EL4
70 W Outdoor	EL1	EL2	EL2	EL3	EL4
150 W Indoor	EL1	EL2	EL4	EL4	EL4
150 W Outdoor	EL1	EL2	EL4	EL4	EL4
250 W Indoor	EL1	EL2	EL2	EL2	EL4
250 W Outdoor	EL1	EL2	EL2	EL2	EL4
400 W Indoor	EL1	EL2	EL2	EL2	EL4

[52] The interagency report presents SCC values through 2050. DOE derived values after 2050 using the 3-percent per year escalation rate used by the interagency group.

[53] 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.

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

[55] See section V.C.3 for more information on the chosen representative wattages.

TABLE VI.1—TRIAL STANDARD LEVELS—Continued

Rep. wattage	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
400 W Outdoor	EL1	EL2	EL2	EL2	EL4
1000 W Indoor	EL1+DS *	EL2+DS	EL2+DS	EL2+DS	EL2+DS
1000 W Outdoor	EL1+DS	EL2+DS	EL2+DS	EL2+DS	EL2+DS

* DS is a design standard that bans the use of probe-start ballasts in new metal halide lamp fixtures.

TSL1 represents EL1 for each equipment class with a positive NPV at EL1. TSL 1 would set energy conservation standards at EL1 for the indoor and outdoor fixtures at 70 W,[56] 150 W, 250 W, 400 W, and 1000 W. Standards included in TSL 1 typically can be satisfied by magnetic ballasts with mid-grade steel and copper windings. These ballasts are commercially available for the ballasts in indoor and outdoor 70 W, 250 W, and 1000 W fixtures, with the rest being modeled. TSL 1 includes a design standard for indoor and outdoor 1000 W fixtures that prohibits the sale of probe-start ballasts in new fixtures.

TSL 2 represents the max tech magnetic ballast EL for each equipment class. TSL 2 would set energy conservation standards at EL2 for the indoor and outdoor fixtures at 70 W, 150 W, 250 W, 400 W, and 1000 W. EL2 is the max tech EL for the indoor and outdoor 1000 W fixtures. Standards included in TSL 2 typically can be satisfied by fixtures that contain magnetic ballasts with high-grade core steel and copper windings. These ballasts are modeled, except for the 1000 W ballasts, which are commercially available. TSL 2 includes a design standard for the indoor and outdoor 1000 W fixtures that prohibits the sale of probe-start ballasts in new fixtures. TSL 2 sets the same standards for indoor and outdoor representative equipment classes at the same wattage.

TSL 3 represents the maximum energy savings achievable with maximum positive NPV with the requirement that the same efficiency levels for fixtures operating indoors and outdoors be analyzed. TSL 3 would set energy conservation standards at EL2 for indoor and outdoor fixtures at 70 W, 250 W, 400 W, and 1000 W, and EL4 for indoor and outdoor fixtures at 150 W. EL4 is the max tech EL for indoor and outdoor fixtures at 150 W, and EL2 is the max tech EL for indoor and outdoor fixtures at 1000 W. Standards included in TSL 3 typically can be satisfied by fixtures that contain magnetic ballasts with high-grade core steel and copper windings, except for the 150 W fixtures, which require max tech electronic ballasts with high-grade electronic components. The 150 W and 1000 W ballasts are commercially available, while the rest are modeled. TSL 3 includes a design standard for indoor and outdoor 1000 W fixtures that prohibits the sale of probe-start ballasts in new fixtures. TSL 3 sets the same standards for indoor and outdoor representative equipment classes at the same wattage.

TSL 4 represents the maximum energy savings achievable with a positive NPV for each equipment class, considering indoor and outdoor fixtures separately. TSL4 would set energy conservation standards at EL2 for indoor and outdoor 250 W, 400 W, and 1000 W fixtures and indoor 70 W fixtures, EL3 for outdoor 70 W fixtures, and EL4 for indoor and outdoor 150 W fixtures. EL4 is the max tech EL for indoor and outdoor fixtures at 150 W, and EL2 is the max tech EL for indoor and outdoor fixtures at 1000 W. Standards included in TSL 4 typically can be satisfied by fixtures that contain magnetic ballasts with high-grade core steel and copper windings, except for 70 W outdoor fixtures, which require standard-grade electronic ballasts, and 150 W fixtures, which require max tech electronic ballasts with high-grade electronic components. The ballasts for indoor and outdoor 150 W and 1000 W fixtures and outdoor 70 W fixtures are commercially available, and the rest are modeled. TSL 4 includes a design standard for indoor and outdoor 1000 W fixtures that prohibits the sale of probe-start ballasts in new fixtures.

TSL 5 represents all of the max tech efficiency levels, which would set energy conservation standards at EL4 for indoor and outdoor 70, 150, 250, and 400 W fixtures, and EL2 for indoor and outdoor 1000 W fixtures. Standards included in TSL 5 require fixtures to contain the max tech electronic ballasts with high-grade electronic components for indoor and outdoor 70, 150, 250, and 400 W fixtures. High-grade core steel and copper windings are typically used in the ballasts included in 1000 W fixtures. Commercially available ballasts meet TSL 5 for all equipment classes. TSL 5 would require high-frequency electronic ballasts for 400 W indoor and outdoor fixtures, which have limited compatibility with CMH technology. See section V.C.8 for additional detail.TSL 5 includes a design standard for indoor and outdoor 1000 W fixtures that prohibits the sale of probe-start ballasts in new fixtures. TSL 5 sets the same standards for indoor and outdoor representative equipment classes at the same wattage.

DOE requests comment on these proposed trial standard levels.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Customers

a. Life-Cycle Cost and Payback Period

Customers affected by new or amended standards usually experience higher purchase prices and lower operating costs. Generally, these effects on individual customers are best summarized by changes in LCCs and PBP. 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 equipment class in Table VI.2 through Table VI.13. Each table includes the average total LCC and the average LCC savings, as well as the fraction of equipment customers for which the LCC will either decrease (net benefit) or increase (net cost) relative to the baseline case. The last column in each table contains the median PBPs for the customer purchasing a design compliant with the TSL.

The results for each TSL are presented relative to the energy use in the baseline case (no new or amended standards), based on energy consumption under conditions of actual equipment use. As discussed in section IV.D.2, the presumption PBP is based on test values under conditions prescribed by the DOE test procedures, as required by EPCA. (42 U.S.C. 6295(o)(2)(B)(iii))

[56] The nomenclature 70 W indoor fixture refers to the ≥50 W and ≤100 W indoor equipment class. 70 W is the representative wattage for the equipment class as discussed in section V.C.3. A similar shorthand naming convention is used for other equipment classes.

TABLE VI.2—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (INDOOR, MAGNETIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	537.80	1,379.32	1,917.12				
1	1	539.03	1,345.26	1,884.28	32.84	0.0	100.0	0.5
2, 3, 4	2	552.28	1,326.43	1,878.71	38.41	0.0	100.0	4.2
	3	555.25	1,379.56	1,934.80	−17.68	24	76	3.3
5	4	568.68	1,374.61	1,943.29	−26.16	28	72	5.4

TABLE VI.3 EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (INDOOR, ELECTRONIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
1, 2, 3, 4	Baseline/3	555.25	1,379.56	1,934.80				
5	4	568.68	1,374.61	1,943.29	−8.48	96	4	32.3

TABLE VI.4—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR, MAGNETIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	527.98	1,844.61	2,372.59				
1	1	529.16	1,803.94	2,333.09	39.50	0.0	100.0	0.6
2, 3	2	541.86	1,784.29	2,326.15	46.44	0.0	100.0	4.4
4	3	580.46	1,722.54	2,303.00	69.59	42	58	12.8
5	4	593.33	1,715.50	2,308.82	63.77	43	57	14.6

TABLE VI.5—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR, ELECTRONIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
1, 2, 3, 4	Baseline/3	580.46	1,722.54	2,303.00				
5	4	593.33	1,715.50	2,308.82	−5.82	84	16	44.7

TABLE VI.6—EQUIPMENT CLASS 2—150 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	657.04	2,110.32	2,767.36				
1	1	673.27	2,075.60	2,748.87	18.50	1	99	7.2
2	2	681.07	2,046.61	2,727.68	39.68	0	100	5.8
	3	676.72	2,063.23	2,739.95	27.41	15	85	2.4
3,4,5	4	696.00	2,061.22	2,757.23	10.14	23	77	4.7

TABLE VI.7—EQUIPMENT CLASS 2—150 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	641.19	2,681.81	3,322.99				
1	1	656.74	2,645.59	3,302.33	20.66	0	100	8.3
2	2	664.20	2,614.09	3,278.30	44.70	0	100	6.6
	3	695.81	2,499.35	3,195.16	127.84	16	84	7.9
3, 4, 5	4	714.28	2,496.20	3,210.48	112.51	26	74	10.5

TABLE VI.8—EQUIPMENT CLASS 3—250 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	710.86	2,485.37	3,196.24				
1	1	734.37	2,455.32	3,189.69	6.55	36	64	12.4
2, 3, 4	2	749.99	2,433.12	3,183.11	13.12	31	69	11.8
	3	790.69	2,485.61	3,276.30	−80.07	52	48	14.4
5	4	783.45	2,472.23	3,255.68	−59.44	44	56	11.5

TABLE VI.9—EQUIPMENT CLASS 3—250 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	690.34	3,132.65	3,822.99				
1	1	712.86	3,103.40	3,816.26	6.73	20	80	14.8
2, 3, 4	2	727.82	3,081.42	3,809.24	13.75	15	85	14.0
	3	802.58	2,996.28	3,798.86	24.13	65	35	28.0
5	4	795.64	2,981.26	3,776.91	46.08	54	46	21.4

TABLE VI.10—EQUIPMENT CLASS 4—400 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	784.44	3,453.98	4,238.41				
1	1	823.04	3,406.28	4,229.31	9.10	40	60	12.8
2, 3, 4	2	841.82	3,368.36	4,210.18	28.23	18	82	10.5
	3	921.01	3,389.35	4,310.36	−71.95	49	51	13.8
5	4	962.37	3,375.11	4,337.48	−99.07	61	39	16.2

TABLE VI.11—EQUIPMENT CLASS 4—400 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
	Baseline	760.80	4,173.10	4,933.90				
1	1	797.78	4,126.96	4,924.74	9.16	22	78	15.4
2, 3, 4	2	815.77	4,087.66	4,903.43	30.47	7	93	12.3
	3	927.40	3,958.53	4,885.93	47.97	56	44	21.3
5	4	967.02	3,940.38	4,907.40	26.49	63	37	24.4

TABLE VI.12—EQUIPMENT CLASS 5—1000 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience: Net cost	Percent of customers that experience: Net benefit	
	Baseline ...	1,143.88	11,657.30	12,801.18	....	....	....	....
	1	1,185.86	11,619.06	12,804.91	−3.73	62	38	16.3
1	1 + DS* ...	1,207.74	11,122.24	12,329.98	471.20	0.0	100.0	1.8
	2	1,199.97	11,570.62	12,770.60	30.58	12	88	9.7
2, 3, 4, 5	2 + DS*	1,221.85	11,077.12	12,298.97	502.21	0.0	100.0	2.0

* DS = Design standard requiring that all fixtures sold shall not contain a probe-start ballast.

TABLE VI.13—EQUIPMENT CLASS 5—1000 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience: Net cost	Percent of customers that experience: Net benefit	
	Baseline ...	1,101.52	9,854.56	10,956.08	....	....	....	....
	1	1,141.74	9,823.86	10,965.59	−9.52	67	33	24.9
1	1 + DS* ...	1,162.70	9,408.20	10,570.89	385.18	0.0	100.0	2.7
	2	1,155.26	9,783.72	10,938.98	17.10	18	82	14.5
2, 3, 4, 5	2 + DS* ...	1,176.22	9,370.84	10,547.05	409.02	0.0	100.0	3.0

* DS = Design standard requiring that all fixtures sold shall not contain a probe-start ballast.

b. Customer Subgroup Analysis

Using the LCC spreadsheet model, DOE determined the effect of the trial standard levels on the following customer sub-groups: utilities, owners of transportation facilities, and warehouse owners. DOE adjusted particular inputs to the LCC model to reflect conditions faced by the identified subgroups. For utilities, DOE assumed that maintenance costs would be higher than average maintenance costs because utilities have to maintain more equipment than the other subgroups do. DOE assumed that owners of transportation facilities face higher annual operating hours than the average used in the main LCC analysis. For warehouse owners, DOE assumed lower annual operating hours than average used in the main LCC analysis.

Table VI.14 through Table VI.25 show the LCC effects and PBPs for identified sub-groups that purchase metal halide lamp fixtures. In general, the average LCC savings for the identified subgroups at the considered efficiency levels are not significantly different from the average for all customers.

TABLE VI.14—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (INDOOR, MAGNETIC BASELINE): LCC SUBGROUP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience: Net cost	Percent of customers that experience: Net benefit	
Subgroup: Utilities								
	Baseline ...	650.30	1,632.71	2,283.01	....	....	....	....
1	1	651.53	1,598.65	2,250.17	32.84	0.0	100.0	0.5
2, 3, 4	2	664.78	1,579.82	2,244.60	38.41	0.0	100.0	4.2
	3	667.75	1,663.46	2,331.20	−48.19	35	65	3.5
5	4	681.18	1,658.51	2,339.68	−56.67	36	64	5.8
Subgroup: Transportation Facility Owners								
	Baseline ...	537.80	1,428.88	1,966.68	....	....	....	....
1	1	539.03	1,392.23	1,931.26	35.41	0.0	100.0	0.5
2, 3, 4	2	552.28	1,371.90	1,924.18	42.49	0.0	100.0	3.9
	3	555.25	1,413.15	1,968.39	−1.72	26	74	3.0
5	4	568.68	1,407.13	1,975.80	−9.13	29	71	5.0
Subgroup: Warehouse Owners								
	Baseline ...	537.80	1,372.08	1,909.88	....	....	....	....
1	1	539.03	1,338.45	1,877.47	32.40	0.0	100.0	0.4

TABLE VI.14—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (INDOOR, MAGNETIC BASELINE): LCC SUBGROUP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
2, 3, 4	2	552.28	1,319.92	1,872.20	37.68	0.0	100.0	3.4
	3	555.25	1,373.94	1,929.19	−19.31	14	86	1.9
5	4	568.68	1,369.17	1,937.85	−27.97	15	85	3.2

TABLE VI.15—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (INDOOR, ELECTRONIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
1, 2, 3, 4	Baseline/3	667.75	1,663.46	2,331.20				
5	4	681.18	1,658.51	2,339.68	−8.48	96	4	32.4
Subgroup: Transportation Facility Owners								
1, 2, 3, 4	Baseline/3	555.25	1,413.15	1,968.39				
5	4	568.68	1,407.13	1,975.80	−7.41	95	5	31.3
Subgroup: Warehouse Owners								
1, 2, 3, 4	Baseline/3	555.25	1,373.94	1,929.19				
5	4	568.68	1,369.17	1,937.85	−8.66	98	2	21.9

TABLE VI.16—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR, MAGNETIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	640.48	2,205.61	2,846.10				
1	1	641.66	2,164.94	2,806.60	39.50	0.0	100.0	0.6
2, 3	2	654.36	2,145.30	2,799.66	46.44	0.0	100.0	4.4
4	3	692.96	2,090.08	2,783.04	63.06	46	54	16.9
5	4	705.83	2,083.03	2,788.86	57.23	48	52	18.7
Sugroup: Transportation Facility Owners								
	Baseline	527.98	1,844.61	2,372.59				
1	1	529.16	1,803.94	2,333.09	39.50	0.0	100.0	0.6
2, 3	2	541.86	1,784.29	2,326.15	46.44	0.0	100.0	4.4
4	3	580.46	1,722.54	2,303.00	69.59	46	54	16.9
5	4	593.33	1,715.50	2,308.82	63.77	48	52	18.7
Subgroup: Warehouse Owners								
	Baseline	527.98	1,844.61	2,372.59				
1	1	529.16	1,803.94	2,333.09	39.50	0.0	100.0	0.6
2, 3	2	541.86	1,784.29	2,326.15	46.44	0.0	100.0	4.4
4	3	580.46	1,722.54	2,303.00	69.59	38	62	12.4
5	4	593.33	1,715.50	2,308.82	63.77	41	59	14.2

TABLE VI.17—EQUIPMENT CLASS 1—70 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR, ELECTRONIC BASELINE): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
1, 2, 3, 4	Baseline/3	692.96	2,090.08	2,783.04	....	....	....	....
5	4	705.83	2,083.03	2,788.86	−5.82	85	15	44.3
Subgroup: Transportation Facility Owners								
1, 2, 3, 4	Baseline/3	580.46	1,722.54	2,303.00	....	....	....	....
5	4	593.33	1,715.50	2,308.82	−5.82	95	5	31.0
Subgroup: Warehouse Owners								
1, 2, 3, 4	Baseline/3	580.46	1,722.54	2,303.00	....	....	....	....
5	4	593.33	1,715.50	2,308.82	−5.82	85	15	44.3

TABLE VI.18—EQUIPMENT CLASS 2—150 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	792.04	2,416.48	3,208.52	....	....	....	....
1	1	808.27	2,381.76	3,190.03	18.50	1	99	7.2
2	2	816.07	2,352.77	3,168.84	39.68	0	100	5.8
	3	811.72	2,404.29	3,216.01	−7.48	29	71	2.7
3, 4, 5	4	831.00	2,402.28	3,233.28	−24.76	34	66	5.2
Subgroup: Transportation Facility Owners								
	Baseline	657.04	2,225.70	2,882.74	....	....	....	....
1	1	673.27	2,187.50	2,860.77	21.97	1	99	6.8
2	2	681.07	2,155.69	2,836.76	45.98	0	100	5.4
	3	676.72	2,173.66	2,850.38	32.36	12	88	2.2
3, 4, 5	4	696.00	2,171.29	2,867.29	15.45	20	80	4.4
Subgroup: Warehouse Owners								
	Baseline	657.04	2,098.07	2,755.11	....	....	....	....
1	1	673.27	2,063.78	2,737.05	18.06	0	100	5.8
2	2	681.07	2,035.14	2,716.20	38.91	0	100	4.7
	3	676.72	2,053.01	2,729.73	25.37	8	92	1.3
3, 4, 5	4	696.00	2,051.17	2,747.17	7.93	12	88	2.6

TABLE VI.19—EQUIPMENT CLASS 2—150 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	776.19	3,115.02	3,891.20	....	....	....	....
1	1	791.74	3,078.80	3,870.54	20.66	0	100	8.3
2	2	799.20	3,047.30	3,846.51	44.70	0	100	6.5
	3	830.81	2,940.40	3,771.21	120.00	33	67	9.2
3, 4, 5	4	849.28	2,937.25	3,786.53	104.67	38	62	12.2

TABLE VI.19—EQUIPMENT CLASS 2—150 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Transportation Facility Owners								
	Baseline	641.19	2,681.81	3,322.99				
1	1	656.74	2,645.59	3,302.33	20.66	0	100	8.3
2	2	664.20	2,614.09	3,278.30	44.70	0	100	6.5
	3	695.81	2,499.35	3,195.16	127.84	33	67	9.2
3, 4, 5	4	714.28	2,496.20	3,210.48	112.51	38	62	12.2
Subgroup: Warehouse Owners								
	Baseline	641.19	2,681.81	3,322.99				
1	1	656.74	2,645.59	3,302.33	20.66	0	100	8.3
2	2	664.20	2,614.09	3,278.30	44.70	0	100	6.5
	3	695.81	2,499.35	3,195.16	127.84	16	84	7.7
3, 4, 5	4	714.28	2,496.20	3,210.48	112.51	25	75	10.3

TABLE VI.20—EQUIPMENT CLASS 3—250 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period ears
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	845.86	2,706.30	3,552.16				
1	1	869.37	2,676.24	3,545.61	6.55	36	64	12.4
2, 3, 4	2	884.99	2,654.05	3,539.04	13.12	30	70	11.9
	3	925.69	2,741.43	3,667.13	−114.96	57	43	16.9
5	4	918.45	2,728.05	3,646.50	−94.34	49	51	13.0
Subgroup: Transportation Facility Owners								
	Baseline	710.86	2,918.78	3,629.64				
1	1	734.37	2,885.59	3,619.96	9.69	29	71	11.8
2, 3, 4	2	749.99	2,861.10	3,611.09	18.56	24	76	11.2
	3	790.69	2,918.08	3,708.78	−79.13	50	50	14.3
5	4	783.45	2,903.52	3,686.97	−57.32	43	57	11.1
Subgroup: Warehouse Owners								
	Baseline	710.86	2,466.57	3,177.44				
1	1	734.37	2,436.94	3,171.31	6.13	17	83	10.1
2, 3, 4	2	749.99	2,415.04	3,165.03	12.40	15	85	9.6
	3	790.69	2,468.82	3,259.52	−82.08	26	74	6.7
5	4	783.45	2,455.53	3,238.98	−61.54	22	78	5.6

TABLE VI.21—EQUIPMENT CLASS 3—250 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	825.34	3,472.93	4,298.27				
1	1	847.86	3,443.68	4,291.54	6.73	20	80	14.8
2, 3, 4	2	862.82	3,421.70	4,284.52	13.75	16	84	14.1
	3	937.58	3,344.40	4,281.98	16.29	72	28	39.8
5	4	930.64	3,329.38	4,260.03	38.25	61	39	28.2

TABLE VI.21—EQUIPMENT CLASS 3—250 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Transportation Facility Owners								
	Baseline	690.34	3,132.65	3,822.99				
1	1	712.86	3,103.40	3,816.26	6.73	20	80	14.8
2, 3, 4	2	727.82	3,081.42	3,809.24	13.75	16	84	14.1
	3	802.58	2,996.28	3,798.86	24.13	72	28	39.8
5	4	795.64	2,981.26	3,776.91	46.08	61	39	28.2
Subgroup: Warehouse Owners								
	Baseline	690.34	3,132.65	3,822.99				
1	1	712.86	3,103.40	3,816.26	6.73	20	80	14.8
2, 3, 4	2	727.82	3,081.42	3,809.24	13.75	16	84	14.1
	3	802.58	2,996.28	3,798.86	24.13	64	36	27.1
5	4	795.64	2,981.26	3,776.91	46.08	54	46	20.7

TABLE VI.22—EQUIPMENT CLASS 4—400 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	934.44	3,649.31	4,583.74				
1	1	973.04	3,601.60	4,574.64	9.10	40	60	12.9
2, 3, 4	2	991.82	3,563.69	4,555.51	28.23	18	82	10.5
	3	1,071.01	3,623.45	4,694.47	−110.72	56	44	15.5
5	4	1,112.37	3,609.21	4,721.58	−137.84	66	34	18.2
Subgroup: Transportation Facility Owners								
	Baseline	784.44	3,880.58	4,665.01				
1	1	823.04	3,827.87	4,650.91	14.10	34	66	12.2
2, 3, 4	2	841.82	3,786.15	4,627.97	37.04	14	86	10.0
	3	921.01	3,808.34	4,729.36	−64.34	48	52	13.4
5	4	962.37	3,792.38	4,754.75	−89.74	58	42	15.9
Subgroup: Warehouse Owners								
	Baseline	784.44	3,423.90	4,208.33				
1	1	823.04	3,376.86	4,199.90	8.43	20	80	10.4
2, 3, 4	2	841.82	3,339.44	4,181.25	27.08	9	91	8.5
	3	921.01	3,362.34	4,283.36	−75.02	25	75	7.5
5	4	962.37	3,348.56	4,310.93	−102.59	30	70	8.9

TABLE VI.23—EQUIPMENT CLASS 4—400 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	910.80	4,462.71	5,373.51				
1	1	947.78	4,416.57	5,364.35	9.16	23	77	15.4
2, 3, 4	2	965.77	4,377.27	5,343.04	30.47	7	93	12.4
	3	1,077.40	4,256.85	5,334.25	39.26	61	39	24.5
5	4	1,117.02	4,238.70	5,355.73	17.79	68	32	27.7

TABLE VI.23—EQUIPMENT CLASS 4—400 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS—Continued

Trial standard level	Efficiency level	Life-cycle cost 2012$			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Transportation Facility Owners								
	Baseline	760.80	4,173.10	4,933.90				
1	1	797.78	4,126.96	4,924.74	9.16	23	77	15.4
2, 3, 4	2	815.77	4,087.66	4,903.43	30.47	7	93	12.4
	3	927.40	3,958.53	4,885.93	47.97	61	39	24.5
5	4	967.02	3,940.38	4,907.40	26.49	68	32	27.7
Subgroup: Warehouse Owners								
	Baseline	760.80	4,173.10	4,933.90				
1	1	797.78	4,126.96	4,924.74	9.16	23	77	15.4
2, 3, 4	2	815.77	4,087.66	4,903.43	30.47	7	93	12.4
	3	927.40	3,958.53	4,885.93	47.97	55	45	21.0
5	4	967.02	3,940.38	4,907.40	26.49	62	38	24.1

TABLE VI.24—EQUIPMENT CLASS 5—1000 WATT METAL HALIDE LAMP FIXTURES (INDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-Cycle Cost *2012$*			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	1,353.88	12,420.47	13,774.35				
1	1 + DS*	1,417.74	11,885.42	13,303.15	471.20	0.0	100.0	1.8
2, 3, 4, 5	2 + DS*	1,431.85	11,840.29	13,272.15	502.21	0.0	100.0	2.0
Subgroup: Transportation Facility Owners								
	Baseline	1,143.88	13,479.99	14,623.87				
1	1 + DS*	1,207.74	12,835.48	14,043.22	580.65	0.0	100.0	1.5
2, 3, 4, 5	2 + DS*	1,221.85	12,780.37	14,002.23	621.64	0.0	100.0	1.7
Subgroup: Warehouse Owners								
	Baseline	1,143.88	11,657.30	12,801.18				
1	1 + DS*	1,207.74	11,122.24	12,329.98	471.20	0.0	100.0	1.4
2, 3, 4, 5	2 + DS*	1,221.85	11,077.12	12,298.97	502.21	0.0	100.0	1.6

* DS = Design standard requiring all fixtures sold shall not contain a probe-start ballast.

TABLE VI.25—EQUIPMENT CLASS 5—1000 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS

Trial standard level	Efficiency level	Life-Cycle Cost *2012$*			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Utilities								
	Baseline	1,311.52	10,528.44	11,839.96				
1	1 + DS*	1,372.70	10,082.08	11,454.77	385.18	0.0	100.0	2.6
2, 3, 4, 5	2 + DS*	1,386.22	10,044.72	11,430.93	409.02	0.0	100.0	3.0
Subgroup: Transportation Facility Owners								
	Baseline	1,101.52	9,854.56	10,956.08				
1	1 + DS*	1,162.70	9,408.20	10,570.89	385.18	0.0	100.0	2.6
2, 3, 4, 5	2 + DS*	1,176.22	9,370.84	10,547.05	409.02	0.0	100.0	3.0

TABLE VI.25—EQUIPMENT CLASS 5—1000 WATT METAL HALIDE LAMP FIXTURES (OUTDOOR): LCC AND PBP RESULTS—Continued

Trial standard level	Efficiency level	Life-Cycle Cost *2012$*			Life-cycle cost savings			Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2012$	Percent of customers that experience		
						Net cost	Net benefit	
Subgroup: Warehouse Owners								
	Baseline ...	1,101.52	9,854.56	10,956.08	....	....	....	....
1	1 + DS*	1,162.70	9,408.20	10,570.89	385.18	0.0	100.0	2.6
2, 3, 4, 5	2 + DS*	1,176.22	9,370.84	10,547.05	409.02	0.0	100.0	3.0

* DS = Design standard requiring that all fixtures sold shall not contain a probe-start ballast.

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 equipment 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 analysis generates values for calculating the PBP for customers affected by potential energy conservation standards. This includes the 3-year PBP 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 proposed rule, DOE calculated a rebuttable presumption PBP for each TSL. DOE used discrete values rather than distributions for inputs and, as required by EPCA, based the calculations on using the applicable DOE test procedures for metal halide lamp fixtures. DOE then calculated a single rebuttable presumption payback value, rather than a distribution of PBPs, for each TSL. Table VI.26 shows the rebuttable presumption PBPs that are less than 3 years.

While DOE examined the rebuttable-presumption criterion, it also conducted a more detailed analysis of the economic impacts of these levels to determine whether the proposed standard levels 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 VI.26—FIXTURE EFFICIENCY LEVELS WITH A REBUTTABLE PAYBACK PERIOD OF LESS THAN THREE YEARS

Equipment class	Efficiency level	Median payback period *years*
70 W (indoor, magnetic baseline)	1	0.5
70 W (outdoor, magnetic baseline)	1	0.5
1000 W (indoor)	1 + DS*	1.7
	2 + DS*	1.9
1000 W (outdoor)	1 + DS*	2.4
	2 + DS*	2.7

* DS = Design standard requiring that all fixtures shall not contain a probe-start ballast.

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of new and amended energy conservation standards on manufacturers of metal halide lamp fixtures and metal halide ballasts. The section below describes the expected impacts on manufacturers at each TSL. Chapter 13 of the NOPR TSD explains the analysis in further detail.

a. Industry Cash-Flow Analysis Results

The tables below depict the financial impacts (represented by changes in INPV) of new and amended energy standards on manufacturers as well as the conversion costs that DOE estimates manufacturers would incur at each TSL. DOE breaks out the impacts on manufacturers of ballasts and fixtures separately. Within each industry, DOE presents the results for all equipment classes in one group because most equipment classes are generally made by the same manufacturers. To evaluate the range of cash flow impacts on the ballast and fixture industries, DOE modeled four different scenarios using different assumptions for markups and shipments that correspond to the range of anticipated market responses to new and amended standards. Each scenario results in a unique set of cash flows and corresponding industry values at each TSL.

Two of these market response scenarios are presented below, corresponding to the outer bounds of a range of market responses that DOE anticipates could occur in the standards case. In the following discussion, the INPV results refer to the difference in industry value between the base case and the standards case that result from the sum of discounted cash flows from the base year (2013) through the end of the analysis period. The results also discuss the difference in cash flow between the base case and the standards case in 2015. This figure represents the size of the required conversion costs relative to the cash flow generated by the industry in the absence of new and amended energy conservation standards.

Cash-Flow Analysis Results by TSL for Metal Halide Ballasts

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

DOE also used the high-shipment scenario to assess the upper bound of impacts. Under the high-shipment scenario, base case shipments of metal halide lamp fixtures decrease at a slower rate over the analysis period compared to the low-shipment scenario. Of all the scenario combinations analyzed in the MIA, the flat markup and high-shipment scenario provides the best conditions for cash flow generation—the annual shipment volume and the ability to preserve gross margins are greatest. Thus, this scenario set yields the greatest modeled industry profitability.

To assess the lower (more severe) end of the range of potential impacts on the metal halide ballast industry, DOE modeled the 'preservation of operating profit' markup scenario. The scenario represents the lower end of the range of potential impacts on manufacturers because no additional operating profit is earned on the higher production costs, eroding profit margins as a percentage of total revenue.

DOE also used the low-shipment scenario to assess the lower bound of impacts. Under the low-shipment scenario, metal halide lamp fixture shipments decrease at a faster rate over the analysis period compared to the high-shipment scenario. Of all the scenarios analyzed in the MIA, this combination of scenarios ('preservation of operating profit' markup and low-shipment) most restricts manufacturers' ability to pass on costs to customers and assumes the lowest level of shipments. Thus, this scenario set estimates the largest manufacturer impacts.

TABLE VI.27—MANUFACTURER IMPACT ANALYSIS FOR METAL HALIDE BALLASTS—FLAT MARKUP AND HIGH-SHIPMENT SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2012$ millions)	123	123	126	127	127	159
Change in INPV	(2012$ millions)		0.8	3.3	4.5	4.7	36.5
	(%)		0.7%	2.7	3.7	3.8	29.8
Product Conversion Costs	(2012$ millions)		9	12	13	14	20
Capital Conversion Costs	(2012$ millions)		10	17	16	14	7
Total Conversion Costs	(2012$ millions)		19	30	29	28	26

TABLE VI.28—MANUFACTURER IMPACT ANALYSIS FOR METAL HALIDE BALLASTS—PRESERVATION OF OPERATING PROFIT MARKUP AND LOW-SHIPMENT SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2012$ millions)	103	86	77	77	79	79
Change in INPV	(2012$ millions)		(17.1)	(26.8)	(25.9)	(24.8)	(24.1)
	(%)		−16.6%	−25.9	−25.0	−24.0	−23.3
Product Conversion Costs	(2012$ millions)		9	12	13	14	20
Capital Conversion Costs	(2012$ millions)		10	17	16	14	7
Total Conversion Costs	(2012$ millions)		19	30	29	28	26

TSL 1 is EL1 for all ten equipment classes (the 70 W indoor and outdoor, 150 W indoor and outdoor, 250 W indoor and outdoor, 400 W indoor and outdoor, and 1000 W indoor and outdoor fixtures). At TSL 1, DOE estimates impacts on INPV range from $0.8 million to −$17.1 million, or a change in INPV of 0.7 percent to −16.6 percent. At TSL 1, industry free cash flow (operating cash flow minus capital expenditures) under the low-shipment scenario is estimated to decrease by approximately 68 percent to $3.4 million, compared to the base case value of $10.7 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 69 percent to $3.3 million, compared to the base case value of $10.6 million in 2015.

Impacts on INPV are slightly positive to moderately negative at TSL 1. TSL 1 requires the use of more efficient magnetic ballasts for the 70 W indoor and outdoor, 150 W indoor and outdoor, 250 W indoor and outdoor, 400 W indoor and outdoor, and 1000 W indoor and outdoor equipment classes. DOE projects that in 2016 100 percent of 70 W indoor shipments, 5 percent of 150 W indoor shipments, 14 percent of 250 W indoor shipments, 23 percent of 400 W indoor shipments, 10 percent of 1000 W indoor shipments, 30 percent of 70 W outdoor shipments, zero percent of 150 W outdoor shipments, 10 percent of 250 W outdoor shipments, 10 percent of 400 W outdoor, and 6 percent of 1000 W outdoor shipments would meet TSL 1 or higher in the base case.

Conversion costs are expected to be moderate at TSL 1. DOE expects ballast manufacturers to incur $9 million in product conversion costs for model redesigns and testing and $10 million in capital conversion costs for equipment such as stamping dies to process more efficient steel cores.

At TSL 1, under the flat markup scenario the shipment-weighted average MPC increases by 25 percent relative to the base case MPC. Manufacturers are able to fully pass on this cost increase to customers under this scenario. Additionally, under the high-shipment scenario, shipments are 191 percent higher than shipments under the low-shipment scenario in the last year of the analysis period. Thus, manufacturers generate the most revenue under this combination (flat markup and high-shipment) of scenarios. The moderate price increase applied to a large quantity of shipments mitigates the impact of the $19 million in conversion costs estimated at TSL 1, resulting in slightly positive impacts at TSL 1 under the flat markup and high-shipment scenarios.

Under the 'preservation of operating profit' markup scenario, manufacturers earn the same operating profit as would be earned in the base case in 2017, but manufacturers do not earn additional profit from their investments. The 22 percent MPC increase is outweighed by a lower average markup of 1.44 in the 'preservation of operating profit' markup scenario (compared to the flat markup scenario markup of 1.47) and $19 million in conversion costs, resulting in greater negative impacts at TSL 1 under this scenario. On a percentage basis, the low-shipment scenario exacerbates these impacts relative to the high-shipment scenario because the base case INPV against which the absolute change in INPV is compared is 16 percent lower in the low shipment scenario compared to the high shipment scenario.

TSL 2 is EL2 for all ten equipment classes (the 70 W indoor and outdoor, 150 W indoor and outdoor, 250 W indoor and outdoor, 400 W indoor and outdoor, and 1000 W indoor and outdoor fixtures). At TSL 2, DOE estimates impacts on INPV to range from $3.3 million to −$26.8 million, or a change in INPV of 2.7 percent to −25.9 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 106 percent to −$0.7 million, compared to the base case value of $10.7 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 108 percent to −$0.8 million, compared to the base case value of $10.6 million in 2015.

TSL 2 is the highest efficiency level the engineering analysis assumes manufacturers can meet with magnetic ballasts for all equipment classes. DOE projects that in 2016, 100 percent of 70 W indoor shipments, 5 percent of 150 W indoor shipments, 10 percent of 250 W indoor, 15 percent of 400 W indoor, 5 percent of 1000 W indoor shipments, and 3 percent of 1000 W outdoor shipments would meet TSL 2 or higher in the base case. No shipments from the 70 W outdoor, 150 W outdoor, 250 W outdoor, and 400 W outdoor equipment classes would meet TSL 2 or higher in the base case. At TSL 2, product conversion costs rise to $12 million and capital conversion costs rise to $17 million as manufacturers need to purchase additional equipment and tooling to upgrade magnetic production lines.

At TSL 2, under the flat markup scenario the shipment-weighted average MPC increases 40 percent over the base case MPC. In this scenario INPV impacts are slightly positive because manufacturers' ability to pass on the higher equipment costs to customers outweighs the $30 million in conversion costs. Under the 'preservation of operating profit' markup scenario, the 35 percent MPC increase is outweighed by a lower average markup of 1.42 and $30 million in conversion costs, resulting in moderately negative INPV impacts at TSL 2.

TSL 3 includes, for the first time, EL4 for two equipment classes (the 150 W indoor and outdoor fixtures) and EL2 for the other eight equipment classes (the 70 W indoor and outdoor, 250 W indoor and outdoor, 400 W indoor and outdoor, and 1000 W indoor and outdoor fixtures). At TSL 3, DOE estimates impacts on INPV to range from $4.5 million to −$25.9 million, or a change in INPV of 3.7 percent to −25.0 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 102 percent to −$0.2 million, compared to the base case value of $10.7 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 104 percent to −$0.4 million, compared to the base case value of $10.6 million in 2015.

The technology changes from TSL 2 to TSL 3 are that manufacturers must use max tech level electronic ballasts for the 150 W indoor and outdoor equipment classes at TSL 3. This has a negligible effect on total conversion costs, which slightly decreases to $29 million. DOE projects that no 150 W indoor or outdoor shipments would meet TSL 3 or higher in 2016 in the base case. DOE expects product conversion costs to increase slightly to $13 million and capital conversion costs to decrease slightly to $16 million.

At TSL 3, under the flat markup scenario the shipment-weighted average MPC increases 40 percent over the base case MPC. In this scenario the additional revenues earned from passing on these higher MPC costs outweigh the $29 million in conversion costs and higher working capital requirements, resulting in slightly positive INPV impacts. Under the 'preservation of operating profit' markup scenario, the 35 percent MPC increase is outweighed by a lower average markup of 1.42 and $29 million in conversion costs, resulting in INPV results remaining moderately negative at TSL 3.

TSL 4 is EL4 for two equipment classes (the 150 W indoor and outdoor fixtures), EL3 for one equipment class (the 70 W outdoor fixtures), and EL2 for the remaining seven equipment classes (the 70 W indoor fixtures, 250 W indoor and outdoor fixtures, 400 W indoor and outdoor fixtures, and 1000 W indoor and outdoor fixtures). At TSL 4, DOE estimates impacts on INPV to range from $4.7 million to −$24.8 million, or a change in INPV of 3.8 percent to −24.0 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 97 percent to $0.3 million, compared to the base case value of $10.7 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 98 percent to $0.2 million, compared to the base case value of $10.6 million in 2015.

The technology changes from TSL 3 to TSL 4 are that manufacturers must use electronic ballasts for the 70 W outdoor equipment class at TSL 4. DOE projects that no 70 W outdoor shipments would meet TSL 4 or higher in 2016 in the base case. Total conversion costs decrease from $29 million at TSL 3 to $28 million at TSL 4, because of the flexibility of electronic ballast production within the lighting manufacturing industry.

At TSL 4, under the flat markup scenario the shipment-weighted average MPC increases 39 percent over the base case MPC. In this scenario the additional revenues earned from passing on these higher MPC costs outweigh the $28 million in conversion costs, resulting in slightly positive impacts on INPV. Under the 'preservation of operating profit' markup scenario, the 34 percent MPC increase is outweighed by a lower average markup of 1.42 and $28 million in conversion costs, resulting in INPV results remaining moderately negative at TSL 4.

TSL 5 is EL4 for eight equipment classes (the 70 W indoor and outdoor fixtures, 150 W indoor and outdoor fixtures, 250 W indoor and outdoor fixtures, and 400 W indoor and outdoor fixtures) and EL2 for two equipment classes (the 1000 W indoor and outdoor fixtures). At TSL 5, DOE estimates impacts on INPV to range from $36.5 million to −$24.1 million, or a change in INPV of 29.8 percent to −23.3 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 83 percent to $1.8 million, compared to the base case value of $10.7 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 84 percent to $1.7 million, compared to the base case value of $10.6 million in 2015.

At TSL 5, the stringency of standards increases to max tech ballasts for the 70 W indoor and outdoor, 250 W indoor and outdoor, and 400 W outdoor equipment classes compared to TSL 4. DOE projects that 1 percent of 70 W indoor shipments would meet TSL 5 or higher in 2016 in the base case. No shipments from the 70 W outdoor, 250 W indoor or outdoor, and 400 W indoor or outdoor equipment classes would meet TSL 5 or higher in the base case. As a result, product conversion costs increase to $20 million because of the need to redesign and test additional models, and capital conversion costs decrease to $7 million due to the flexibility of electronic ballast production.

At TSL 5, under the flat markup scenario the shipment-weighted average MPC increases 76 percent over the base case MPC. In this scenario the additional revenues earned from passing on these higher MPC costs outweigh the decreased conversion costs of $26 million, resulting in a significantly positive impact on INPV. Under the 'preservation of operating profit' markup scenario, the 67 percent MPC increase is outweighed by a lower average markup of 1.39 and $26 million in conversion costs, resulting in INPV results remaining moderately negative at TSL 5.

Cash Flow Analysis Results by TSL for Metal Halide Lamp Fixtures

DOE incorporated the same scenarios to represent the upper and lower bounds of industry impacts for metal halide lamp fixtures as for metal halide ballasts: The flat markup scenario with the high-shipment scenario and the 'preservation of operating profit' markup scenario with the low-shipment scenario. Note that the TSLs below represent the same sets of efficiency levels as discussed above in the description of impacts on ballast manufacturers.

TABLE VI.29—MANUFACTURER IMPACT ANALYSIS FOR METAL HALIDE LAMP FIXTURES—FLAT MARKUP AND HIGH-SHIPMENT SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2012$ millions)	630	667	694	695	703	741
Change in INPV	(2012$ millions)		37.0	63.9	64.8	73.6	111.3
(%)		5.9%	10.2	10.3	11.7	17.7	
Product Conversion Costs	(2012$ millions)		3	3	9	13	62
Capital Conversion Costs	(2012$ millions)		0	0	6	10	75
Total Conversion Costs	(2012$ millions)		3	3	15	23	137

TABLE VI.30—MANUFACTURER IMPACT ANALYSIS FOR METAL HALIDE LAMP FIXTURES—PRESERVATION OF OPERATING PROFIT MARKUP AND LOW-SHIPMENT SCENARIO

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2012$ millions)	540	534	532	523	516	423
Change in INPV	(2012$ millions)		(6.1)	(8.1)	(17.3)	(23.8)	(116.9)
(%)		−1.1%	−1.5	−3.2	−4.4	−21.6	
Product Conversion Costs	(2012$ millions)		3	3	9	13	62
Capital Conversion Costs	(2012$ millions)		0	0	6	10	75
Total Conversion Costs	(2012$ millions)		3	3	15	23	137

At TSL 1, DOE estimates impacts on INPV to range from $37.0 million to −$6.1 million, or a change in INPV of 5.9 percent to -1.1 percent. At TSL 1, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 2 percent to $58.7 million, compared to the base case value of $59.8 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 2 percent to $58.0 million, compared to the base case value of $59.1 million in 2015.

DOE expects minimal conversion costs for fixture manufacturers at TSL 1. Fixture manufacturers would incur $3 million in product conversion costs for the testing of redesigned ballasts. Because the stack height of magnetic ballasts is not expected to change in response to the standards, fixture manufacturers would not incur any capital conversion costs at magnetic ballast levels such as TSL 1.

At TSL 1, under the flat markup scenario the shipment-weighted average MPC increases by 12 percent from the base case MPC. In this scenario manufacturers maximize revenue since they are able to fully pass on this cost increase to customers. The moderate price increase applied to a large quantity of shipments outweighs the impact of the $3 million in conversion costs for TSL 1, resulting in positive impacts at TSL 1 under the flat markup and high-shipment scenarios.

Under the 'preservation of operating profit' markup scenario, the 10 percent MPC increase is outweighed by a lower average markup of 1.56 (compared to the flat manufacturer markup of 1.58) and $3 million in conversion costs, resulting in slightly negative impacts at TSL 1. These impacts increase on a percentage basis under the low-shipment scenario relative to the high-shipment scenario because the base case INPV against which changes are compared is 14 percent lower.

At TSL 2, DOE estimates impacts on INPV to range from $63.9 million to −$8.1 million, or a change in INPV of 10.2 percent to −1.5 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 2 percent to $58.7 million, compared to the base case value of $59.8 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 2 percent to $58.0 million, compared to the base case value of $59.1 million in 2015.

At TSL 2, DOE expects conversion costs to remain low at $3 million for the testing of redesigned ballasts and catalog updates. Under the flat markup scenario the shipment-weighted average MPC increases 19 percent over the base case MPC. In this scenario the INPV impacts are positive because the ability to pass on the higher equipment costs to customers outweighs the $3 million in estimated conversion costs. Under the ‘preservation of operating profit’ markup scenario, the 15 percent MPC increase is outweighed by a lower average markup of 1.53 and $3 million in conversion costs, resulting in slightly negative INPV impacts at TSL 2.

At TSL 3, DOE estimates impacts on INPV to range from $64.8 million to −$17.3 million, or a change in INPV of 10.3 percent to −3.2 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 9 percent to $54.2 million, compared to the base case value of $59.8 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 9 percent to $53.5 million, compared to the base case value of $59.1 million in 2015. DOE expects product conversion costs to increase to $9 million because of the additional cost of redesigning fixtures for thermal protection to accommodate 150 W indoor and outdoor electronic ballasts. Manufacturers would also incur an estimated $6 million in capital costs for 150 W indoor fixture changes.

At TSL 3, the electronic fixture cost increases for the 150 W indoor and outdoor equipment classes because of fixture adders for thermal protection and voltage transient protection. Under the flat markup scenario, the shipment-weighted average MPC increases 21 percent over the base case MPC. This increase in revenue outweighs the increase of $15 million in conversion costs, resulting in positive impacts at TSL 3. Under the ‘preservation of operating profit’ markup scenario, the 17 percent MPC increase is outweighed by a lower average markup of 1.53 and $15 million in conversion costs, resulting in slightly negative INPV impacts at TSL 3.

At TSL 4, DOE estimates impacts on INPV to range from $73.6 million to −$23.8 million, or a change in INPV of 11.7 percent to −4.4 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 14 percent to $51.4 million, compared to the base case value of $59.8 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 14 percent to $50.7 million, compared to the base case value of $59.1 million in 2015.

The technology changes from TSL 3 to TSL 4 are that manufacturers must use electronic ballasts to meet the required efficiencies for the 70 W outdoor fixture class at TSL 4. This increases the product conversion costs from $9 million at TSL 3 to $13 million at TSL 4 and increases the capital conversion costs from $6 million at TSL 3 to $10 million at TSL 4.

At TSL 4, under the flat markup scenario the shipment-weighted average MPC increases 26 percent over the base case MPC. In this scenario the additional revenue results in slightly more positive impacts on INPV at TSL 4 compared to TSL 3. Under the ‘preservation of operating profit’ markup scenario the 21 percent MPC increase is outweighed by a lower average markup of 1.52 and $23 million in conversion costs, resulting in slightly more negative INPV impacts at TSL 4 compared to TSL 3.

At TSL 5, DOE estimates impacts on INPV to range from $111.3 million to -$116.9 million, or a change in INPV of 17.7 percent to -21.6 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 89 percent to $6.5 million, compared to the base case value of $59.8 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 90 percent to $5.8 million, compared to the base case value of $59.1 million in 2015.

At TSL 5, product conversion costs significantly increase to $62 million as manufacturers must redesign all equipment classes to accommodate the most efficient electronic ballasts. Capital conversion costs also significantly increase to $75 million because of the need for additional equipment and tooling, such as new castings, to incorporate thermal protection in all equipment classes.

At TSL 5, DOE estimates impacts on INPV to range from $111.3 million to -$116.9 million, or a change in INPV of 17.7 percent to -21.6 percent. At this proposed level, industry free cash flow under the low-shipment scenario is estimated to decrease by approximately 89 percent to $6.5 million, compared to the base case value of $59.8 million in 2015. Under the high-shipment scenario, industry free cash flow is estimated to decrease by approximately 90 percent to $5.8 million, compared to the base case value of $59.1 million in 2015.

At TSL 5, product conversion costs significantly increase to $62 million as manufacturers must redesign all equipment classes to accommodate the most efficient electronic ballasts. Capital conversion costs also significantly increase to $75 million because of the need for additional equipment and tooling, such as new castings, to incorporate thermal protection in all equipment classes.

At TSL 5, under the flat markup scenario the shipment-weighted average MPC increases 57 percent over the base case MPC. In this scenario the revenue increase from TSL 4 to TSL 5 outweighs the increase in conversion costs of $137 million, resulting in greater positive impacts on INPV at TSL 5 compared to TSL 4. Under the ‘preservation of operating profit’ markup scenario, the 46 percent MPC increase is outweighed by a lower average markup of 1.47 and $137 million in conversion costs, resulting in significantly more negative INPV impacts at TSL 5 compared to TSL 4.

b. Impacts on Employment

DOE quantitatively assessed the impacts of potential new and amended energy conservation standards on direct employment. DOE used the GRIM to estimate the domestic labor expenditures and number of domestic production workers in the base case and at each TSL from 2013 to 2045. DOE used statistical data from the U.S. Census Bureau’s 2009 Annual Survey of Manufacturers (ASM), the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures involved with the manufacture of the product are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time.

In the GRIM, DOE used the labor content of each product and the manufacturing production costs to estimate the annual labor expenditures in the industry. DOE used Census data and interviews with manufacturers to estimate the portion of the total labor expenditures that is attributable to domestic labor.

The production worker estimates in this section cover only workers up to the line-supervisor level who are directly involved in fabricating and assembling a product within an OEM facility. Workers performing services that are closely associated with production operations, such as material handing with a forklift, are also included as production labor. DOE's estimates account for only production workers who manufacture the specific products covered by this rulemaking. For example, a worker on a fluorescent lamp ballast line would not be included with the estimate of the number of metal halide ballast or fixture workers.

The employment impacts shown in the tables below represent the potential production employment that could result following new and amended energy conservation standards. The upper bound of the results estimates the maximum change in the number of production workers that could occur after compliance with new and amended energy conservation standards when assuming that manufacturers continue to produce the same scope of covered equipment in the same production facilities. It also assumes that domestic production does not shift to lower-labor-cost countries. Because there is a real risk of manufacturers evaluating sourcing decisions in response to new and amended energy conservation standards, the lower bound of the employment results includes the estimated total number of U.S. production workers in the industry who could lose their jobs if all existing production were moved outside of the U.S. While the results present a range of employment impacts following 2016, the sections below also include qualitative discussions of the likelihood of negative employment impacts at the various TSLs. Finally, the employment impacts shown are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 14 of the NOPR TSD.

Employment Impacts for Metal Halide Ballasts

Based on 2009 ASM data and interviews with manufacturers, DOE estimates that less than 40 domestic production workers would be involved in manufacturing metal halide ballasts in 2016, as the vast majority of metal halide ballasts are manufactured abroad. DOE's view is that manufacturers could face moderate positive impacts on domestic employment levels because increasing equipment costs at each TSL would result in higher labor expenditures per unit, causing manufacturers to hire more workers to meet demand for metal halide ballasts, assuming that production remains in domestic facilities. Many manufacturers, however, do not expect a significant change in total employment at their facilities. Although manufacturers are concerned that higher prices for metal halide ballasts will drive customers to alternate technologies, most manufacturers offer these alternate technologies and can shift their employees from metal halide ballast production to production of other technologies in their facilities. Most manufacturers believe that domestic employment will only be significantly adversely affected if customers shift to foreign imports, causing the total lighting market share of the major domestic manufacturers to decrease.

Employment Impacts for Metal Halide Lamp Fixtures

Using 2009 ASM data and interviews with manufacturers, DOE estimates that approximately 60 percent of the metal halide lamp fixtures sold in the United States are manufactured domestically. With this assumption, DOE estimates that in the absence of new and amended energy conservation standards, there would be between 519 and 525 domestic production workers involved in manufacturing metal halide lamp fixtures in 2016. The tables below show the range of the impacts of potential new and amended energy conservation standards on U.S. production workers in the metal halide lamp fixture industry.

TABLE VI.31—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC METAL HALIDE LAMP FIXTURE PRODUCTION WORKERS IN 2016

[Flat markup and high-shipment scenario]

Base case		Trial standard level				
		1	2	3	4	5
Total Number of Domestic Production Workers in 2016 (without changes in production locations)	525	588	626	625	630	684
Potential Changes in Domestic Production Workers in 2016 *		63–(525)	101–(525)	100–(525)	105–(525)	159–(525)

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

TABLE VI.32—POTENTIAL CHANGES IN THE TOTAL NUMBER OF DOMESTIC METAL HALIDE LAMP FIXTURE PRODUCTION WORKERS IN 2016

[Preservation of operating profit markup and low-shipment scenario]

Base case		Trial standard level				
		1	2	3	4	5
Total Number of Domestic Production Workers in 2016 (without changes in production locations)	519	581	619	618	623	676
Potential Changes in Domestic Production Workers in 2016 *		62–(519)	100–(519)	99–(519)	104–(519)	157–(519)

At the upper end of the range, all examined TSLs show slight to moderate positive impacts on domestic employment levels. The increasing equipment cost at each higher TSL would result in higher labor expenditures per unit, causing manufacturers to hire more workers to meet demand levels of metal halide fixtures, assuming that production remains in domestic facilities. Many manufacturers, however, do not expect a significant change in total employment at their facilities. Although manufacturers are concerned that higher prices for metal halide lamp fixtures will drive customers to alternate technologies, most manufacturers offer these alternate technologies and can shift their employees from metal halide lamp fixture production to production of other technologies in their facilities. As with ballast manufacturers, most fixture manufacturers believe that domestic employment will only be significantly adversely affected if customers shift to foreign imports, causing the total lighting market share of the major domestic manufacturers to decrease. Because of the potentially high cost of shipping fixtures from overseas, many manufacturers believe that this shift is unlikely to occur. This is particularly true for the significant portion of the market served by small manufacturers, for whom the per-unit shipping costs of sourcing products would be even greater because of the lower volumes that they sell.

Based on the above, DOE does not expect the proposed energy conservation standards for metal halide lamp fixtures, at TSL 3, to have a significant negative impact on direct domestic employment levels. DOE notes that domestic employment levels could be negatively affected in the event that small fixture businesses choose to exit the market due to standards. However, discussions with small manufacturers indicated that most small businesses will be able to adapt to new and amended regulations. The impacts on small businesses are discussed in section VII.B.

c. Impacts on Manufacturing Capacity

Both ballast and fixture manufacturers stated that they do not anticipate any capacity constraints at efficiency levels that can be met with magnetic ballasts, which are the efficiency levels being proposed for eight of the 10 equipment classes in today's NOPR, the two exceptions are the 150W indoor and outdoor equipment classes. If the production of higher-efficiency magnetic ballasts decreases the throughput on production lines, manufacturers stated that they would be able to add shifts on existing lines and maintain capacity.

At efficiency levels that require electronic ballasts, however, manufacturers are concerned about the current worldwide shortage of electrical components. The components most affected by this shortage are high-efficiency parts, for which demand would increase even further following new and amended energy conservation standards. The increased demand could exacerbate the component shortage, thereby impacting manufacturing capacity in the near term, according to manufacturers. The only equipment classes requiring electronic ballasts that are being proposed in today's NOPR are the 150W indoor and outdoor equipment classes. DOE does not anticipate a significant increase in demand for electric components due to today's proposed energy conservation standards. While DOE recognizes that the premium component shortage is currently a significant issue for manufacturers, DOE views it as a relatively short-term phenomenon to which component suppliers will ultimately adjust. According to several manufacturers, suppliers have the ability to ramp up production to meet ballast component demand by the compliance date of potential new 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 2016 will likely affect the duration of the premium component shortage. Potential mandatory standards, however, could create more certainty for suppliers about the eventual demand for these components. Additionally, the premium components at issue are not new technologies; rather, they have simply not historically been demanded in large quantities by ballast manufacturers.

d. Impacts on Subgroups of Manufacturers

Using average cost assumptions to develop an industry cash-flow estimate may not be adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting cost structures substantially different from the industry average could be affected disproportionately. DOE analyzed the impacts to small businesses in section VII.B and did not identify any other adversely impacted subgroups for metal halide ballasts or fixtures for this rulemaking based on the results of the industry characterization.

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 metal halide lamp fixtures, that manufacturers will face for products and equipment they manufacture approximately 3 years prior to and 3 years after the compliance date of the new and amended standards. The following section briefly addresses comments DOE received with respect to cumulative regulatory burden and summarizes other key related concerns that manufacturers raised during interviews.

Several manufacturers expressed concern about the overall volume of DOE energy conservation standards with which they must comply. Most metal halide lamp fixture manufacturers also make a full range of lighting products and share engineering and other resources with these other internal manufacturing divisions for different products (including certification testing for regulatory compliance). Manufacturers worried that today's proposed standards could punish compliant manufacturers while potentially driving others to noncompliance, creating an unfair playing field. NEMA referenced general service fluorescent lamps, incandescent reflector lamps, fluorescent lamp ballasts, and high-intensity discharge lamps as other products subject to DOE regulation. (NEMA, No. 34 at p. 17) NEMA and Philips also raised concerns about other regulatory actions, including ENERGY STAR standards utilizing separate metrics from DOE's standards and potential outdoor lighting legislation. (NEMA, Public Meeting Transcript, No. 33 at p. 16; Philips, Public Meeting Transcript, No. 33 at p. 132; NEMA, No. 34 at p. 17) Other regulations noted by manufacturers during interviews include California Title 20 and Title 24.

DOE discusses these and other requirements in chapter 13 of the NOPR TSD. DOE takes into account the cost of compliance with other published Federal energy conservation standards in weighing the benefits and burdens of today's proposed rulemaking. DOE does not describe the quantitative impacts of standards that have not yet been finalized because any impacts would be speculative. DOE also notes that certain standards, such as ENERGY STAR, are optional for manufacturers.

3. National Impact Analysis

a. Significance of Energy Savings

For each TSL, DOE projected energy savings for metal halide lamp fixtures purchased in the 30-year period that begins in the year 2016, ending in the year 2045. The savings are measured over the entire lifetime of equipment purchased in the 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. Table VI.33 presents the estimated primary energy savings for each TSL for the low- and high-shipment scenarios, which represent the minimum and maximum energy savings resulting from all the scenarios analyzed. Table VI.34 presents the estimated FFC energy savings for each considered TSL. Chapter 11 of the NOPR TSD describes these estimates in more detail.

TABLE VI.33—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2045

Trial standard level	Equipment class	National Primary Energy Savings quads	
		Low-shipments scenario	High-shipments scenario
1	70 W	0.01	0.01
	150 W	0.03	0.05
	250 W	0.02	0.03
	400 W	0.10	0.13
	1000 W	0.27	0.37
Total		0.44	0.58
2	70 W	0.05	0.06
	150 W	0.06	0.09
	250 W	0.04	0.06
	400 W	0.20	0.27
	1000 W	0.31	0.42
Total		0.66	0.89
3	70 W	0.05	0.06
	150 W	0.19	0.26
	250 W	0.04	0.06
	400 W	0.20	0.27
	1000 W	0.31	0.42
Total		0.79	1.06
4	70 W	0.15	0.19
	150 W	0.19	0.26
	250 W	0.04	0.06
	400 W	0.20	0.27
	1000 W	0.31	0.42
Total		0.89	1.20
5	70 W	0.18	0.24
	150 W	0.19	0.26
	250 W	0.35	0.49
	400 W	0.77	1.08

TABLE VI.33—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2045—Continued

Trial standard level	Equipment class	National Primary Energy Savings quads	
		Low-shipments scenario	High-shipments scenario
	1000 W	0.31	0.42
Total		1.80	2.49

TABLE VI.34—CUMULATIVE NATIONAL FULL-FUEL-CYCLE ENERGY SAVINGS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2045

Trial standard level	Equipment class	National FFC energy savings quads	
		Low-shipments scenario	High-shipments scenario
1	70 W	0.01	0.01
	150 W	0.03	0.05
	250 W	0.02	0.03
	400 W	0.10	0.13
	1000 W	0.28	0.38
Total		0.45	0.59
2	70 W	0.05	0.06
	150 W	0.06	0.09
	250 W	0.04	0.06
	400 W	0.21	0.28
	1000 W	0.31	0.42
Total		0.67	0.90
3	70 W	0.05	0.06
	150 W	0.19	0.27
	250 W	0.04	0.06
	400 W	0.21	0.28
	1000 W	0.31	0.42
Total		0.80	1.08
4	70 W	0.16	0.20
	150 W	0.19	0.27
	250 W	0.04	0.06
	400 W	0.21	0.28
	1000 W	0.31	0.42
Total		0.91	1.22
5	70 W	0.19	0.24
	150 W	0.19	0.27
	250 W	0.36	0.50
	400 W	0.78	1.10
	1000 W	0.31	0.42
Total		1.83	2.53

Circular A–4 requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using nine rather than 30 years of fixture shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[57] We would note that the review timeframe established in EPCA generally does not overlap with the equipment lifetime, equipment manufacturing cycles or other factors specific to metal halide lamp fixtures. Thus, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology. The NES results based on a 9-year analytical period are presented in Table VI.35. The impacts are counted over the lifetime of fixtures purchased in 2016–2024.

[57] EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3 year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6 year period and that the 3-year compliance date may yield to the 6-year backstop.

TABLE VI.35—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2024

Trial standard level	Equipment class	National primary energy savings quads	
		Low-shipments scenario	High-shipments scenario
1	70 W	0.01	0.01
	150 W	0.02	0.02
	250 W	0.01	0.01
	400 W	0.06	0.07
	1000 W	0.15	0.16
Total		0.25	0.28
2	70 W	0.03	0.03
	150 W	0.03	0.03
	250 W	0.02	0.03
	400 W	0.11	0.12
	1000 W	0.16	0.18
Total		0.36	0.40
3	70 W	0.03	0.03
	150 W	0.09	0.10
	250 W	0.02	0.03
	400 W	0.11	0.12
	1000 W	0.16	0.18
Total		0.42	0.46
4	70 W	0.09	0.10
	150 W	0.09	0.10
	250 W	0.02	0.03
	400 W	0.11	0.12
	1000 W	0.16	0.18
Total		0.48	0.53
5	70 W	0.11	0.12
	150 W	0.09	0.10
	250 W	0.17	0.19
	400 W	0.36	0.40
	1000 W	0.16	0.18
Total		0.89	0.99

b. Net Present Value of Customer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for customers that would result from the TSLs considered for metal halide lamp fixtures. In accordance with OMB's guidelines on regulatory analysis,[58] DOE calculated the NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return on private capital in the U.S. economy, and reflects the returns on real estate and small business capital as well as corporate capital. This discount rate approximates the opportunity cost of capital in the private sector (OMB analysis has found the average rate of return on capital to be near this rate). The 3-percent rate reflects the potential effects of standards on private consumption (*e.g.,* through higher prices for products and reduced purchases of energy). This rate represents the rate at which society discounts future consumption flows to their present value. It can be approximated by the real rate of return on long-term government debt (*i.e.,* yield on United States Treasury notes), which has averaged about 3 percent for the past 30 years.

Table VI.36 shows the customer NPV results for each TSL DOE considered for metal halide lamp fixtures, using both 7-percent and 3-percent discount rates. In each case, the impacts cover the lifetime of equipment purchased in 2016–2045. See chapter 11 of the NOPR TSD for more detailed NPV results.

[58] OMB Circular A–4, section E (Sept. 17, 2003). Available at: *www.whitehouse.gov/omb/circulars_a004_a-4.*

TABLE VI.36—NET PRESENT VALUE OF CUSTOMER BENEFITS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2045

Trial standard level	Equipment class	Net present value billion 2012$			
		Low-shipments scenario		High-shipments scenario	
		7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	70 W	0.039	0.068	0.042	0.073
	150 W	0.036	0.094	0.044	0.124
	250 W	0.009	0.065	0.012	0.084
	400 W	0.009	0.109	0.014	0.140
	1000 W	0.596	1.292	0.728	1.680
Total		0.688	1.629	0.840	2.100
2	70 W	0.054	0.124	0.060	0.144
	150 W	0.083	0.205	0.104	0.274
	250 W	0.028	0.146	0.038	0.194
	400 W	0.108	0.383	0.140	0.507
	1000 W	0.636	1.393	0.779	1.815
Total		0.909	2.251	1.121	2.933
3	70 W	0.054	0.124	0.060	0.144
	150 W	0.125	0.408	0.162	0.558
	250 W	0.028	0.146	0.038	0.194
	400 W	0.108	0.383	0.140	0.507
	1000 W	0.636	1.393	0.779	1.815
Total		0.951	2.454	1.179	3.217
4	70 W	0.029	0.330	0.034	0.406
	150 W	0.125	0.408	0.162	0.558
	250 W	0.028	0.146	0.038	0.194
	400 W	0.108	0.383	0.140	0.507
	1000 W	0.636	1.393	0.779	1.815
Total		0.927	2.660	1.153	3.479
5	70 W	−0.015	0.278	−0.018	0.344
	150 W	0.125	0.408	0.162	0.558
	250 W	−0.055	0.287	−0.050	0.430
	400 W	−0.344	0.134	−0.394	0.256
	1000 W	0.636	1.393	0.779	1.815
Total		0.347	2.500	0.478	3.401

The NPV results based on the aforementioned 9-year analytical period are presented in Table VI.37. The impacts are counted over the lifetime of fixtures purchased in 2016–2024. As mentioned previously, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE VI.37—NET PRESENT VALUE OF CUSTOMER BENEFITS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2024

Trial standard level	Equipment class	Net present value billion 2012$			
		Low-shipments scenario		High-shipments scenario	
		7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	70 W	0.039	0.068	0.042	0.073
	150 W	0.023	0.053	0.025	0.058
	250 W	0.004	0.037	0.004	0.041
	400 W	0.001	0.062	0.001	0.069
	1000 W	0.419	0.779	0.457	0.856
Total		0.485	0.999	0.530	1.097
2	70 W	0.047	0.099	0.051	0.107
	150 W	0.053	0.113	0.059	0.124
	250 W	0.013	0.078	0.015	0.086
	400 W	0.061	0.206	0.068	0.227

TABLE VI.37—NET PRESENT VALUE OF CUSTOMER BENEFITS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2024—Continued

Trial standard level	Equipment class	Net present value billion 2012$			
		Low-shipments scenario		High-shipments scenario	
		7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
	1000 W	0.445	0.834	0.486	0.916
Total		0.620	1.329	0.678	1.461
3	70 W	0.047	0.099	0.051	0.107
	150 W	0.075	0.209	0.082	0.231
	250 W	0.013	0.078	0.015	0.086
	400 W	0.061	0.206	0.068	0.227
	1000 W	0.445	0.834	0.486	0.916
Total		0.642	1.426	0.702	1.567
4	70 W	0.024	0.216	0.025	0.236
	150 W	0.075	0.209	0.082	0.231
	250 W	0.013	0.078	0.015	0.086
	400 W	0.061	0.206	0.068	0.227
	1000 W	0.445	0.834	0.486	0.916
Total		0.618	1.542	0.676	1.696
5	70 W	−0.010	0.178	−0.012	0.194
	150 W	0.075	0.209	0.082	0.231
	250 W	−0.063	0.099	−0.068	0.110
	400 W	−0.280	−0.027	−0.305	−0.027
	1000 W	0.445	0.834	0.486	0.916
Total		0.166	1.292	0.183	1.424

Finally, DOE evaluated the NPV results for both indoor and outdoor fixtures for each equipment class. Table VI.38 gives the NPV associated with each equipment class broken down into indoor and outdoor fixture environments.

TABLE VI.38—NET PRESENT VALUE OF CUSTOMER BENEFITS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2045

[Low shipments, by fixture environment]

Trial standard level	Equipment class	Net present value billion 2012$			
		Indoor fixtures		Outdoor fixtures	
		7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	70 W	0.000	0.000	0.039	0.068
	150 W	0.011	0.028	0.025	0.066
	250 W	0.005	0.024	0.004	0.041
	400 W	0.007	0.037	0.002	0.072
	1000 W	0.183	0.378	0.413	0.914
Total		0.205	0.468	0.483	1.161
2	70 W	0.000	0.000	0.054	0.124
	150 W	0.025	0.059	0.058	0.146
	250 W	0.012	0.048	0.017	0.098
	400 W	0.036	0.115	0.072	0.268
	1000 W	0.197	0.411	0.439	0.981
Total		0.269	0.633	0.640	1.618
3	70 W	0.000	0.000	0.054	0.124
	150 W	0.019	0.012	0.106	0.396
	250 W	0.012	0.048	0.017	0.098
	400 W	0.036	0.115	0.072	0.268
	1000 W	0.197	0.411	0.439	0.981
Total		0.263	0.586	0.688	1.868
4	70 W	0.000	0.000	0.029	0.330
	150 W	0.019	0.012	0.106	0.396

TABLE VI.38—NET PRESENT VALUE OF CUSTOMER BENEFITS FOR METAL HALIDE LAMP FIXTURE TRIAL STANDARD LEVELS FOR UNITS SOLD IN 2016–2045—Continued

[Low shipments, by fixture environment]

Trial standard level	Equipment class	Net present value billion 2012$			
		Indoor fixtures		Outdoor fixtures	
		7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
	250 W	0.012	0.048	0.017	0.098
	400 W	0.036	0.115	0.072	0.268
	1000 W	0.197	0.411	0.439	0.981
Total		0.263	0.586	0.664	2.074
5	70 W	−0.012	−0.018	−0.003	0.296
	150 W	0.019	0.012	0.106	0.396
	250 W	−0.042	−0.120	−0.012	0.407
	400 W	−0.148	−0.284	−0.196	0.418
	1000 W	0.197	0.411	0.439	0.981
Total		0.013	0.002	0.334	2.499

c. Impacts on Employment

DOE estimated the indirect employment impacts of potential standards on the economy in general, assuming that energy conservation standards for metal halide lamp fixtures will reduce energy bills for fixture users and the resulting net savings will be redirected to other forms of economic activity. DOE used an input/output model of the U.S. economy to estimate these effects, including the demand for labor as described in section V.H.

The input/output model results suggest that today's proposed 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 shown in Table VI.39, DOE estimates that net indirect employment impacts from proposed fixture standards are small relative to the national economy.

TABLE VI.39—NET CHANGE IN JOBS FROM INDIRECT EMPLOYMENT EFFECTS UNDER FIXTURE TSLS

Analysis period year	Trial standard level	Net national change in jobs	
		Low shipments scenario, roll-up	High shipments scenario, roll-up
2017	1	10	8
	2	−30	−36
	3	76	73
	4	170	168
	5	352	346
2020	1	376	392
	2	511	530
	3	791	827
	4	1,091	1,142
	5	2,336	2,445

4. Impact on Utility or Performance of Equipment

As presented in section V.B of this notice, DOE concluded that none of the TSLs that were analyzed 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 proposed standards. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

5. Impact of Any Lessening of Competition

DOE also considered any lessening of competition that is likely to result from new and amended energy conservation standards. The Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination to the Secretary, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii))

To assist the Attorney General in making such determination, DOE has provided DOJ with copies of this notice and the TSD for review. DOE will consider DOJ's comments on the proposed rule in preparing the final rule, and DOE will publish and respond to DOJ's comments in that document.

6. Need of the Nation To Conserve Energy

An improvement in the energy efficiency of the products subject to today's rule is likely to improve the security of the nation's energy system by reducing overall demand for energy. Reduced electricity demand may also improve the reliability of the electricity system. Reductions in national electric generating capacity estimated for each considered TSL are reported in chapter 14 of the NOPR TSD.

Energy savings from new and amended energy conservation standards for fixtures could produce environmental benefits in the form of reduced emissions of air pollutants and GHGs associated with electricity production. Table VI.40 and Table VI.41 provide DOE's estimate of cumulative emissions reductions projected to result from the TSLs considered in this rulemaking, for the low and high shipment scenarios, respectively. The tables include both power sector emissions and upstream emissions. The upstream emissions were calculated using the multipliers discussed in section V.L. DOE reports annual emissions reductions for each TSL in the emissions analysis in chapter 16 the NOPR TSD.

TABLE VI.40—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES

[Low Shipments Scenario]

	Trial standard level				
	1	2	3	4	5
Power Sector Emissions*					
CO_2 *(million metric tons)*	25.90	38.85	46.04	52.32	104.72
NO_X *(thousand tons)*	17.39	26.22	31.20	35.41	71.71
Hg *(tons)*	0.06	0.09	0.11	0.12	0.24
N_2O *(thousand tons)*	0.48	0.72	0.86	0.98	2.00
CH_4 *(thousand tons)*	2.90	4.37	5.18	5.89	11.86
SO_2 *(thousand tons)*	36.23	54.37	64.42	73.25	146.53
Upstream Emissions					
CO_2 *(million metric tons)*	1.40	2.11	2.50	2.84	5.70
NO_X *(thousand tons)*	19.27	28.98	34.37	39.08	78.45
Hg *(tons)*	0.001	0.001	0.001	0.002	0.003
N_2O *(thousand tons)*	0.01	0.02	0.03	0.03	0.06
CH_4 *(thousand tons)*	116.89	175.81	208.58	237.15	476.16
SO_2 *(thousand tons)*	0.30	0.45	0.54	0.61	1.22
Total Emissions					
CO_2 *(million metric tons)*	27.30	40.96	48.53	55.16	110.43
NO_X *(thousand tons)*	36.66	55.20	65.57	74.48	150.16
Hg *(tons)*	0.06	0.09	0.11	0.12	0.24
N_2O *(thousand tons)*	0.49	0.74	0.89	1.01	2.06
CH_4 *(thousand tons)*	119.79	180.18	213.76	243.04	488.01
SO_2 *(thousand tons)*	36.53	54.82	64.95	73.85	147.75

TABLE VI.41—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES

[High shipments scenario]

	Trial standard level				
	1	2	3	4	5
Power Sector Emissions*					
CO_2 *(million metric tons)*	33.93	51.48	61.61	69.58	143.59
NO_X *(thousand tons)*	23.50	35.86	43.14	48.58	101.88
Hg *(tons)*	0.08	0.12	0.14	0.16	0.34
N_2O *(thousand tons)*	0.66	1.01	1.22	1.37	2.90
CH_4 *(thousand tons)*	3.85	5.87	7.04	7.95	16.50
SO_2 *(thousand tons)*	47.41	71.94	86.07	97.26	200.46
Upstream Emissions					
CO_2 *(million metric tons)*	1.85	2.81	3.37	3.81	7.88
NO_X *(thousand tons)*	25.44	38.69	46.36	52.37	108.39
Hg *(tons)*	0.001	0.002	0.002	0.002	0.004
N_2O *(thousand tons)*	0.02	0.03	0.03	0.04	0.08
CH_4 *(thousand tons)*	154.45	234.93	281.50	317.98	658.29
SO_2 *(thousand tons)*	0.40	0.60	0.72	0.82	1.69
Total Emissions					
CO_2 *(million metric tons)*	35.78	54.29	64.98	73.39	151.47
NO_X *(thousand tons)*	48.94	74.55	89.50	100.95	210.26
Hg *(tons)*	0.08	0.12	0.15	0.16	0.34
N_2O *(thousand tons)*	0.68	1.04	1.25	1.41	2.98
CH_4 *(thousand tons)*	158.30	240.80	288.54	325.92	674.79
SO_2 *(thousand tons)*	47.80	72.54	86.79	98.08	202.14

As discussed in section V.L, 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 new emissions standards for power plants under the MATS rule. DOE also did not include NO_X emissions reductions from power plants in states subject to CAIRR because an energy conservation standard would not affect the overall level of NO_X emissions in those states due to the emissions caps.

As part the analysis for this proposed rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the TSLs considered. As discussed in section V.M.1, DOE used values for the SCC developed by an interagency process. The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, 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. The four SCC values for CO_2 emissions reductions in 2015, expressed in 2012$, are $12.9/ton, $40.8/ton, $62.2/ton, and $117.0/ton. These values for later years are higher due to increasing emissions-related costs as the magnitude of projected climate change increases.

Table VI.42 and Table VI.43 present the global value of CO_2 emissions reductions at each TSL for the low and high shipment scenarios, respectively. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in chapter 17 of the NOPR TSD.

TABLE VI.42—GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES

[Low Shipments Scenario]

TSL	SCC Scenario*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
	Million 2012$			
Power Sector Emissions				
1	180.6	824.4	1,309.4	2,521.8
2	268.6	1,230.7	1,956.1	3,766.3
3	316.6	1,453.6	2,311.6	4,449.4
4	360.3	1,653.5	2,629.2	5,061.5
5	709.1	3,276.7	5,218.2	10,037.1
Upstream Emissions				
1	9.6	44.2	70.3	135.5
2	14.3	66.2	105.3	202.8
3	16.9	78.3	124.6	239.9
4	19.3	89.1	141.8	273.0
5	38.0	177.1	282.3	543.0
Total Emissions				
1	190.2	868.7	1,379.7	2,657.2
2	283.0	1,296.9	2,061.5	3,969.1
3	333.5	1,531.9	2,436.2	4,689.3
4	379.5	1,742.6	2,771.0	5,334.5
5	747.2	3,453.8	5,500.6	10,580.1

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.9, $40.8, $62.2 and $117.0 per metric ton (2012$).

TABLE VI.43—GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES

[High shipments scenario]

TSL	SCC Scenario*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
	Million 2012$			
Power Sector Emissions				
1	226.5	1,052.4	1,678.3	3,225.1
2	340.4	1,587.8	2,534.4	4,868.3
3	404.3	1,891.8	3,021.8	5,802.1

TABLE VI.43—GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES—Continued

[High shipments scenario]

TSL	SCC Scenario*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
4	458.2	2,141.2	3,418.9	6,566.6
5	924.3	4,359.1	6,975.4	13,379.6
Upstream Emissions				
1	12.2	56.9	90.9	174.7
2	18.3	86.1	137.6	264.4
3	21.8	102.8	164.3	315.5
4	24.7	116.3	185.9	357.1
5	50.1	237.6	380.6	730.0
Total Emissions				
1	238.7	1,109.3	1,769.2	3,399.8
2	358.7	1,674.0	2,672.0	5,132.7
3	426.2	1,994.6	3,186.1	6,117.6
4	482.9	2,257.5	3,604.9	6,923.7
5	974.3	4,596.7	7,356.0	14,109.6

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.9, $40.8, $62.2 and $117.0 per metric ton (2012$).

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

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

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the customer savings calculated for each TSL considered in this proposed rulemaking. The dollar-per-ton values that DOE used are discussed in section V.M. Table VI.44 presents the present value of cumulative NO_X emissions reductions for each TSL calculated using the average dollar-per-ton values and 7-percent and 3-percent discount rates.

TABLE VI.44—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES

TSL	Low shipments scenario		High shipments scenario	
	3% discount rate	7% discount rate	3% discount rate	7% discount rate
	million 2012$			
Power Sector Emissions				
1	24.4	12.3	30.9	14.7
2	36.3	18.1	46.5	21.8
3	42.8	21.2	55.4	25.7
4	48.7	24.1	62.7	29.1
5	96.3	46.6	127.3	57.2
Upstream Emissions				
1	27.2	13.6	34.1	16.2
2	40.5	20.0	51.3	24.0
3	47.7	23.4	60.9	28.3
4	54.3	26.6	69.0	32.1

TABLE VI.44—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR METAL HALIDE LAMP FIXTURES—Continued

TSL	Low shipments scenario		High shipments scenario	
	3% discount rate	7% discount rate	3% discount rate	7% discount rate
5	106.9	51.4	139.1	63.0
Total Emissions				
1	51.6	25.9	65.0	30.9
2	76.8	38.1	97.8	45.8
3	90.6	44.6	116.3	53.9
4	103.0	50.8	131.7	61.2
5	203.2	98.1	266.4	120.3

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the customer savings calculated for each TSL considered in this rulemaking. Table VI.45 and Table VI.46 present the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of customer savings calculated for each TSL considered in this rulemaking, at both a 7-percent and a 3-percent discount rate, and for the low and high shipment scenarios, respectively. The CO_2 values used in the columns of each table correspond to the four scenarios for the valuation of CO_2 emission reductions discussed above.

TABLE VI.45—METAL HALIDE LAMP FIXTURE TSLS: NET PRESENT VALUE OF CUSTOMER SAVINGS COMBINED WITH NET PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS

[Low shipments scenario]

TSL	Customer NPV at 3% discount rate added with:			
	SCC Value of $12.9/metric ton CO_2* and low value for NO_X**	SCC Value of $40.8/metric ton CO_2* and medium value for NO_X**	SCC Value of $62.2/metric ton CO_2* and medium value for NO_X**	SCC Value of $117.0/metric ton CO_2* and high value for NO_X**
	billion 2012$			
1	*1.828*	*2.549*	*3.060*	*4.380*
2	*2.547*	*3.624*	*4.389*	*6.360*
3	*2.803*	*4.076*	*4.981*	*7.308*
4	*3.058*	*4.506*	*5.534*	*8.182*
5	*3.284*	*6.157*	*8.204*	*13.451*
	Customer NPV at 7% Discount Rate added with:			
	billion 2012$			
1	*0.883*	*1.583*	*2.094*	*3.393*
2	*1.199*	*2.244*	*3.008*	*4.947*
3	*1.293*	*2.528*	*3.432*	*5.722*
4	*1.315*	*2.720*	*3.749*	*6.354*
5	*1.112*	*3.899*	*5.946*	*11.106*

* These label values represent the global SCC in 2015, in 2012$. The present values have been calculated with scenario-consistent discount rates.

** Low Value corresponds to $468 per ton of NO_X emissions. Medium Value corresponds to $2,639 per ton of NO_X emissions. High Value corresponds to $4,809 per ton of NO_X emissions.

TABLE VI.46—METAL HALIDE LAMP FIXTURE TSLS: NET PRESENT VALUE OF CUSTOMER SAVINGS COMBINED WITH NET PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS

[High shipments scenario]

TSL	Customer NPV at 3% discount rate added with:			
	SCC Value of \$12.9/metric ton CO_2* and low value for NO_X**	SCC Value of \$40.8/metric ton CO_2* and medium value for NO_X**	SCC Value of \$62.2/metric ton CO_2* and medium value for NO_X**	SCC Value of \$117.0/metric ton CO_2* and high value for NO_X**
	billion 2012$			
1	*2.351*	*3.275*	*3.935*	*5.619*
2	*3.309*	*4.705*	*5.703*	*8.244*
3	*3.664*	*5.328*	*6.520*	*9.547*
4	*3.985*	*5.868*	*7.215*	*10.642*
5	*4.423*	*8.264*	*11.023*	*17.996*
	Customer NPV at 7% Discount Rate added with:			
	billion 2012$			
1	*1.085*	*1.981*	*2.641*	*4.297*
2	*1.488*	*2.841*	*3.839*	*6.337*
3	*1.614*	*3.227*	*4.419*	*7.395*
4	*1.647*	*3.472*	*4.819*	*8.188*
5	*1.474*	*5.195*	*7.955*	*14.807*

* These label values represent the global SCC in 2015, in 2012$. The present values have been calculated with scenario-consistent discount rates.

** Low Value corresponds to \$468 per ton of NO_X emissions. Medium Value corresponds to \$2,639 per ton of NO_X emissions. High Value corresponds to \$4,809 per ton of NO_X emissions.

Although adding the value of customer savings to the values of emission reductions provides a valuable perspective, the following should be considered: (1) The national customer savings are domestic U.S. customer 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 customer savings and emissions-related benefits are performed with different computer models, leading to different time frames for analysis. For fixtures, the present value of national customer savings is measured for the period in which units shipped in 2016–2045 continue to operate. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of CO_2 in each year. These impacts continue well beyond 2100.

C. Proposed Standards

DOE is subject to the EPCA requirement that any new or amended energy conservation standard for any type (or class) of covered equipment be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens to the greatest extent practicable, in light of the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

DOE considered the impacts of MHLF standards at each trial standard level, beginning with the max tech 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 based on the quantitative analytical results for each trial standard level (presented in section VI.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 customers' 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 (Table VI.47 and Table VI.48) that summarize DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. Section VI.B.1 presents the estimated impacts of each TSL for the LCC subgroup analysis.

TABLE VI.47—SUMMARY OF RESULTS FOR METAL HALIDE LAMP FIXTURES

[Low-shipments scenario]

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National Energy Savings (quads).	0.45	0.67	0.80	0.91	1.83
NPV of Customer Benefits (2012 billion)					
3% discount rate	1.63	2.25	2.45	2.66	2.50
7% discount rate	0.69	0.91	0.95	0.93	0.35
Industry Impacts*					
Ballast + Fixture Industry NPV (2012 $ million).	620	609	600	595	502
(Base Case Industry NPV of $643 million).					
Ballast + Fixture Industry NPV (change in 2012$ million).	(23.2)	(34.9)	(43.2)	(48.6)	(141.0)
Ballast + Fixture Industry NPV (% change).	−3.6%	−5.4%	−6.7%	−7.6%	−21.9%
Cumulative Emissions Reduction					
CO_2 (Mt)	27.30	40.96	48.53	55.16	110.43
SO_2 (kt)	36.53	54.82	64.95	73.85	147.75
NO_X (kt)	36.66	55.20	65.57	74.48	150.16
Hg (t)	0.06	0.09	0.11	0.12	0.24
CH_4 (kt)	119.79	180.18	213.76	243.04	488.01
N_2O (kt)	0.49	0.74	0.89	1.01	2.06
Value of Cumulative Emissions Reduction					
CO_2 (2012$ billion) **	0.2 to 2.7	0.3 to 4.0	0.3 to 4.7	0.4 to 5.3	0.7 to 10.6
NO_X—3% discount rate (2012$ million) **.	51.6	76.8	90.6	103.0	203.2
NO_X—7% discount rate (2012$ million) **.	25.9	38.1	44.6	50.8	98.1
Mean LCC Savings (and Percent Customers Experiencing Net Benefit) * (2012$)**					
50to100W_Ind_OtherV ****† (magnetic baseline).	32.84 (100)	38.41 (100)	38.41 (100)	38.41 (100)	−26.16 (72)
50to100W_Outd_OtherV (magnetic baseline).	39.50 (100)	46.44 (100)	46.44 (100)	69.59 (58)	63.77 (57)
50to100W_Ind_OtherV (electronic baseline)					−8.48 (4)
50to100W_Outd_OtherV (electronic baseline).					−5.82 (16)
100to150W_Ind_OtherV‡	18.50 (99)	39.68 (100)	10.14 (77)	10.14 (77)	10.14 (77)
100to150W_Outd_OtherV	20.66 (100)	44.70 (100)	112.51 (74)	112.51 (74)	112.51 (74)
150to250W_Ind_OtherV‡	6.55 (64)	13.12 (69)	13.12 (69)	13.12 (69)	−59.44 (56)
150to250W_Outd_OtherV	6.73 (80)	13.75 (85)	13.75 (85)	13.75 (85)	46.08 (46)
250to500W_Ind_OtherV	9.10 (60)	28.23 (82)	28.23 (82)	28.23 (82)	−99.07 (39)
250to500W_Outd_OtherV	9.16 (78)	30.47 (93)	30.47 (93)	30.47 (93)	26.49 (37)
500to2000W_Ind_OtherV	471.20 (100)	502.21 (100)	502.21 (100)	502.21 (100)	502.21 (100)
500to2000W_Outd_OtherV	385.18 (100)	409.02 (100)	409.02 (100)	409.02 (100)	409.02 (100)
Median PBP (years)					
50to100W_Ind_OtherV (magnetic baseline).	0.5	4.2	4.2	4.2	5.4
50to100W_Outd_OtherV (magnetic baseline).	0.6	4.4	4.4	12.8	14.6
50to100W_Ind_OtherV (electronic baseline).					32.3
50to100W_Outd_OtherV (electronic baseline).					44.7
100to150W_Ind_OtherV‡	7.2	5.8	4.7	4.7	4.7
100to150W_Outd_OtherV	8.3	6.6	10.5	10.5	10.5
150to250W_Ind_OtherV‡	12.4	11.8	11.8	11.8	11.5
150to250W_Outd_OtherV	14.8	14.0	14.0	14.0	21.4
250to500W_Ind_OtherV	12.8	10.5	10.5	10.5	16.2

TABLE VI.47—SUMMARY OF RESULTS FOR METAL HALIDE LAMP FIXTURES—Continued

[Low-shipments scenario]

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
250to500W_Outd_OtherV	15.4	12.3	12.3	12.3	24.4
500to2000W_Ind_OtherV	1.8	2.0	2.0	2.0	2.0
500to2000W_Outd_OtherV	2.7	3.0	3.0	3.0	3.0
Employment Impacts					
Direct Employment Impacts	41–(502)	97–(502)	96–(502)	101–(502)	152–(502)
Indirect Domestic Jobs‖	376	511	791	1,091	2,336

* INPV results are shown under the preservation of operating profit markup scenario.

** Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions. Economic value of NO_X reductions is based on estimates at $2,636/ton.

*** For LCCs, a negative value means an increase in LCC by the amount indicated.

**** "Indoor" and "outdoor" as defined in section V.A.2.

† Equipment class abbreviations in the form of 50to100W_Ind_OtherV refers to the equipment class of fixtures with (1) a rated lamp wattage of 50 W to 100 W, (2) an indoor operating location, and (3) a tested input voltage other than 480 V. See section V.A.2 for more detail on equipment class distinctions.

‡ The >100 W and ≤150 W equipment classes include 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps that are also rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A) and contain a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001. The ≥150 W and ≤250 W equipment classes contain all other covered fixtures that are rated only for 150 watt lamps.

‖ Changes in 2020.

TABLE VI.48—SUMMARY OF RESULTS FOR METAL HALIDE LAMP FIXTURES

[High-shipments scenario]

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
National Energy Savings (quads).	0.59	0.90	1.08	1.22	2.53
NPV of Customer Benefits (2012$ billion)					
3% discount rate	2.10	2.93	3.22	3.48	3.40
7% discount rate	0.84	1.12	1.18	1.15	0.48
Industry Impacts					
Ballast + Fixture Industry NPV (2012$ million) (Base Case Industry NPV of $752 million).	790	820	822	831	900
Ballast + Fixture Industry NPV (change in 2012$ million).	37.8	67.3	69.2	78.3	147.9
Ballast + Fixture Industry NPV (% change).	5.0%	8.9%	9.2%	10.4%	19.7%
Cumulative Emissions Reduction					
CO_2 (Mt)	35.78	54.29	64.98	73.39	151.47
SO_2 (kt)	47.80	72.54	86.79	98.08	202.14
NO_X (kt)	48.94	74.55	89.50	100.95	210.26
Hg (t)	0.08	0.12	0.15	0.16	0.34
CH_4 (kt)	158.30	240.80	288.54	325.92	674.79
N_2O (kt)	0.68	1.04	1.25	1.41	2.98
Value of Cumulative Emissions Reduction					
CO_2 (2012$ billion) **	0.2 to 3.4	0.4 to 5.1	0.4 to 6.1	0.5 to 6.9	1.0 to 14.1
NO_X—3% discount rate (2012$ million) **.	65.0	97.8	116.3	131.7	266.4
NO_X—7% discount rate (2012$ million) **.	30.9	45.8	53.9	61.2	120.3
*Mean LCC Savings (and Percent Customers Experiencing Net Benefit) ** (2012$)*					
50to100W_Ind_OtherV **** † (magnetic baseline).	32.84 (100)	38.41 (100)	38.41 (100)	38.41 (100)	−26.16 (72)
50to100W_Outd_OtherV (magnetic baseline).	39.50 (100)	46.44 (100)	46.44 (100)	69.59 (58)	63.77 (57)

TABLE VI.48—SUMMARY OF RESULTS FOR METAL HALIDE LAMP FIXTURES—Continued

[High-shipments scenario]

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
50to100W_Ind_OtherV (electronic baseline).					−8.48 (4)
50to100W_Outd_OtherV (electronic baseline).					−5.82 (16)
100to150W_Ind_OtherV‡	18.50 (99)	39.68 (100)	10.14 (77)	10.14 (77)	10.14 (77)
100to150W_Outd_OtherV	20.66 (100)	44.70 (100)	112.51 (74)	112.51 (74)	112.51 (74)
150to250W_Ind_OtherV‡	6.55 (64)	13.12 (69)	13.12 (69)	13.12 (69)	−59.44 (56)
150to250W_Outd_OtherV	6.73 (80)	13.75 (85)	13.75 (85)	13.75 (85)	46.08 (46)
250to500W_Ind_OtherV	9.10 (60)	28.23 (82)	28.23 (82)	28.23 (82)	−99.07 (39)
250to500W_Outd_OtherV	9.16 (78)	30.47 (93)	30.47 (93)	30.47 (93)	26.49 (37)
500to2000W_Ind_OtherV	471.20 (100)	502.21 (100)	502.21 (100)	502.21 (100)	502.21 (100)
500to2000W_Outd_OtherV	385.18 (100)	409.02 (100)	409.02 (100)	409.02 (100)	409.02 (100)
Median PBP (years)					
50to100W_Ind_OtherV (magnetic baseline).	0.5	4.2	4.2	4.2	5.4
50to100W_Outd_OtherV (magnetic baseline).	0.6	4.4	4.4	12.8	14.6
50to100W_Ind_OtherV (electronic baseline).					32.3
50to100W_Outd_OtherV (electronic baseline).					44.7
100to150W_Ind_OtherV‡	7.2	5.8	4.7	4.7	4.7
100to150W_Outd_OtherV	8.3	6.6	10.5	10.5	10.5
150to250W_Ind_OtherV‡	12.4	11.8	11.8	11.8	11.5
150to250W_Outd_OtherV	14.8	14.0	14.0	14.0	21.4
250to500W_Ind_OtherV	12.8	10.5	10.5	10.5	16.2
250to500W_Outd_OtherV	15.4	12.3	12.3	12.3	24.4
500to2000W_Ind_OtherV	1.8	2.0	2.0	2.0	2.0
500to2000W_Outd_OtherV	2.7	3.0	3.0	3.0	3.0
Employment Impacts					
Direct Employment Impacts	41–(508)	98–(508)	97–(508)	102–(508)	154–(508)
Indirect Domestic Jobs √√	392	530	827	1,142	2,445

* INPV results are shown under the -flat markup scenario.

** Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions. Economic value of NO_X reductions is based on estimates at $2,636/ton.

*** For LCCs, a negative value means an increase in LCC by the amount indicated.

**** ''Indoor'' and ''outdoor'' as defined in section V.A.2.

† Equipment class abbreviations in the form of 50to100W_Ind_OtherV refers to the equipment class of fixtures with (1) a rated lamp wattage of 50 W to 100 W, (2) an indoor operating location, and (3) a tested input voltage other than 480 V. See section V.A.2 for more detail on equipment class distinctions.

‡ The >100 W and ≤150 W equipment classes include 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps that are also rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A) and contain a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001. The ≥150 W and ≤250 W equipment classes contain all other covered fixtures that are rated only for 150 watt lamps.

‖ Changes in 2020.

As discussed in previous DOE standards rulemakings and the February 2011 NODA (76 FR 9696, (Feb. 22, 2011)), DOE also notes that the economics literature provides a wide-ranging discussion of how customers trade off upfront costs and energy savings in the absence of government intervention. Much of this economics literature attempts to explain why customers appear to undervalue energy efficiency improvements.

This undervaluation suggests that regulation promoting energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution). There is evidence that customers undervalue future energy savings as a result of (1) a lack of information, (2) a lack of sufficient savings to warrant accelerating or altering purchases (*e.g.,* an inefficient ventilation fan in a new building or the delayed replacement of a water pump), (3) inconsistent weighting of future energy cost savings relative to available returns on other investments, (4) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (5) a divergence in incentives (*e.g.,* renter versus owner; builder vs. purchaser). Other literature indicates that with less-than-perfect foresight and a high degree of uncertainty about the future, it may be rational for customers to trade off these types of investments at a higher-than-expected rate between current consumption and uncertain future energy cost savings. Some studies suggest that this seeming undervaluation may be explained in certain circumstances by differences between tested and actual energy savings, or by uncertainty and irreversibility of energy investments. There may also be ''hidden'' welfare losses to customers if newer energy efficient products are imperfect substitutes for the less efficient products they replace, in terms of performance or other attributes that customers value. In the abstract, it may be difficult to say how a welfare gain from correcting potential under-investment in energy conservation compares in magnitude to the potential welfare losses associated with no longer purchasing a machine or switching to an imperfect substitute, both of which still exist in this framework.

The mix of evidence in the empirical economics literature suggests that if feasible, analysis of regulations mandating energy-efficiency improvements should explore the potential for both welfare gains and losses and move toward a fuller economic framework where all relevant changes can be quantified.[59] While DOE is not prepared at present to provide a fuller quantifiable framework for this discussion, DOE seeks comments on how to assess these possibilities.[60] In particular, DOE requests comment on whether there are features or attributes of the more energy efficient ballasts that manufacturers would produce to meet the standards in this proposed rule that might affect the welfare, positively or negatively, of consumers who purchase MHLFs. One example of such an effect might result from the use of electronic ballasts in outdoor applications, which DOE's analysis models for compliance with TSL3 for 150 watt fixtures. In TSL4, electronic ballasts are also modeled for outdoor applications for 70 watt fixtures. As discussed above, currently magnetic ballasts are generally favored over electronic ballasts for outdoor applications, but there are some commercially available fixtures using electronic ballasts that are designed for outdoor applications. DOE requests comment specifically on whether the more widespread use of electronic ballasts would involve any performance or reliability effects for either 70-watt or 150-watt fixtures, and how any such effects should be weighed in the choice of standards for these two wattage categories for the final rule.

1. Trial Standard Level 5

DOE first considered the most efficient level, TSL 5, which would save an estimated total of 1.8 to 2.5 quads of energy for fixtures shipped in 2016–2045—a significant amount of energy. For the nation as a whole, TSL 5 would have a net savings of $0.35 billion–$0.48 billion at a 7-percent discount rate, and $2.5 billion–$3.4 billion at a 3-percent discount rate. The emissions reductions at TSL 5 are estimated to be 110–151 million metric tons (Mt) of CO_2, 148–202 kt of SO_2, 150–210 kt of NO_X, and 0.24–0.34 tons of Hg. As seen in section VI.B.1, for over half of the representative equipment classes, customers have available designs that result in positive mean LCC savings, ranging from $10.14–$502.21, at TSL 5. The equipment classes with positive mean LCC savings at TSL 5 are outdoor 70 W fixtures[56] (for the magnetic ballast baseline), indoor and outdoor 150 W fixtures, outdoor 250 W fixtures, outdoor 400 W fixtures, and indoor and outdoor 1000 W fixtures. However, DOE's NPV analysis indicates (see Table VI.38) that most equipment classes experience a negative NPV at TSL 5. The equipment classes that have negative NPV at TSL 5 are indoor and outdoor 70 W, 250 W, and 400 W fixtures. The equipment classes with positive NPV at TSL 5 are indoor and outdoor 150 W and 1000 W fixtures. The projected change in industry value for metal halide ballast manufacturers would range from an increase of $36.5 million to a decrease of $24.1 million, or a net gain of 29.8 percent to a net loss of 23.3 percent in INPV. The projected change in industry value for metal halide lamp fixture manufacturers would range from an increase of $111.3 million to a decrease of $116.9 million, or a net gain of 17.7 percent to a net loss of 21.6 percent in INPV.

DOE based TSL 5 on the most efficient commercially available equipment for each representative equipment class analyzed. This TSL corresponds to a commercially available low-frequency electronic ballast for indoor and outdoor 70 W, 150 W, 250 W fixtures, a commercially available high-frequency electronic ballast for indoor and outdoor 400 W fixtures, and a commercially available magnetic ballast in 1000 W fixtures. DOE notes that there is limited compatibility between the high-frequency electronic ballasts required for indoor and outdoor 400W fixtures and high efficiency CMH lamps. This could potentially limit energy savings opportunities through the use of CMH lamps. See section V.C.8 for additional detail. TSL 5 also prohibits the use of probe-start ballasts in new 1000 W fixtures.

After considering the analysis, the comments that DOE received on the preliminary analysis, and the benefits and burdens of TSL 5, the Secretary has reached the following tentative conclusion: The benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and positive net economic savings to the nation are outweighed by negative NPV experienced in some equipment classes at both a 3-percent and 7-percent discount rate, the negative mean LCC savings experienced in some equipment classes, and the potential decrease in INPV for manufacturers. Consequently, the Secretary has tentatively concluded that trial standard level 5 is not economically justified.

2. Trial Standard Level 4

DOE then considered TSL 4, which would save an estimated total of 0.91 to 1.2 quads of energy for fixtures shipped in 2016–2045—a significant amount of energy. For the nation as a whole, TSL 4 would have a net savings of $0.93 billion–$1.2 billion at a 7-percent discount rate, and $2.7 billion–$3.5 billion at a 3-percent discount rate. The emissions reductions at TSL 4 are estimated to be 55–73 Mt of CO_2, 74–98 kt of SO_2, 74–101 kt of NO_X, and 0.12–0.16 tons of Hg. As seen in section VI.B.1, for all representative equipment classes, customers have available designs that result in positive mean LCC savings, ranging from $10.14–$502.21, at TSL 4. DOE's NPV analysis indicates (see Table VI.38) that each equipment class has a positive NPV at TSL 4. The projected change in industry value for metal halide ballast manufacturers would range from an increase of $4.7 million to a decrease of $24.8 million, or a net gain of 3.8 percent to a net loss of 24.0 percent in INPV. The projected change in industry value for metal halide lamp fixture manufacturers would range from an increase of $73.6 million to a decrease of $23.8 million, or a net gain of 11.7 percent to a net loss of 4.4 percent in INPV.

TSL 4 represents the maximum energy savings achievable with positive NPV for each representative equipment class, considering indoor and outdoor fixtures separately. This TSL corresponds to a modeled magnetic ballast in indoor 70 W fixtures, indoor and outdoor 250 W fixtures and indoor and outdoor 400 W fixtures; a commercially available low-frequency electronic ballast in outdoor 70 W fixtures and indoor and outdoor 150 W fixtures; and a commercially available magnetic ballast in indoor and outdoor 1000 W fixtures. TSL 4 sets different standards for 70 W fixtures for the indoor versus outdoor equipment classes. TSL 4 also prohibits the use of probe-start ballasts in new 1000 W fixtures.

[59] A good review of the literature related to this issue can be found in Gillingham, K., R. Newell, K. Palmer. (2009). ''Energy Efficiency Economics and Policy,'' *Annual Review of Resource Economics,* 1: 597–619; and Tietenberg, T. (2009). ''Energy Efficiency Policy: Pipe Dream or Pipeline to the Future?'' *Review of Environmental Economics and Policy.* Vol. 3, No. 2: 304–320.

[60] A draft paper, ''Notes on the Economics of Household Energy Consumption and Technology Choice,'' proposes a broad theoretical framework on which an empirical model might be based and is posted on the DOE Web site along with this notice at *www.eere.energy.gov/buildings/appliance_standards.*

Setting different standards for the indoor versus outdoor fixtures of the same wattage has the potential for certification issues and lost energy savings. Indoor 70 W fixtures require EL2 magnetic ballasts while outdoor 70 W fixtures require electronic ballasts. Because the indoor magnetic ballast can provide the features necessary for outdoor operation, there is potential for indoor fixtures to be used outdoors in applications where moisture is a smaller concern. For example, a parking garage or other semi-covered structure is less likely to sustain direct water contact. Additionally, the indoor EL2 magnetically ballasted fixtures are less expensive than the outdoor EL3 electronically ballasted fixtures. This creates an economic incentive for outdoor customers to use the indoor EL2 fixtures. This substitution could decrease the expected energy savings, and could reduce the reliability and lifetime of the misapplied indoor fixtures. Furthermore, setting different standards for indoor versus outdoor equipment classes increases compliance, certification, and enforcement costs for manufacturers. Fixture manufacturers would use different ballasts for indoor and outdoor fixtures of the same wattage, complicating fixture-ballast matching and increasing the number of basic models.

After considering the analysis, the comments that DOE received on the preliminary analysis, and the benefits and burdens of TSL 4, the Secretary has reached the following tentative conclusion: At TSL 4, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and positive net economic savings to the nation would be outweighed by the potential for certification issues and lost energy savings resulting from setting different standards for the indoor versus outdoor fixtures of the same wattage, and the potential decrease in INPV for manufacturers. Consequently, the Secretary has tentatively concluded that trial standard level 4 is not economically justified.

3. Trial Standard Level 3

DOE then considered TSL 3, which would save an estimated total of 0.80 to 1.1 quads of energy for fixtures shipped in 2016–2045—a significant amount of energy. For the nation as a whole, TSL 3 would have a net savings of $0.95 billion–$1.2 billion at a 7-percent discount rate, and $2.5 billion–$3.2 billion at a 3-percent discount rate. The emissions reductions at TSL 3 are estimated to be 49–65 Mt of CO_2, approximately 65–87 kt of SO_2, 66–90 kt of NO_X, and 0.11–0.15 tons of Hg. As seen in section VI.B.1, for all representative equipment classes, customers have available designs that result in positive mean LCC savings, ranging from $10.14–$502.21, at TSL 3. DOE's NPV analysis indicates (see Table VI.38) that each equipment class has a positive NPV at TSL 3. The projected change in industry value for metal halide ballast manufacturers would range from an increase of $4.5 million to a decrease of $25.9 million, or a net gain of 3.7 percent to a net loss of 25.0 percent in INPV. The projected change in industry value for metal halide lamp fixture manufacturers would range from an increase of $64.8 million to a decrease of $17.3 million, or a net gain of 10.3 percent to a net loss of 3.2 percent in INPV.

TSL 3 represents the maximum positive NPV (when comparing the total NPV associated with TSL 3 to all other TSLs) and sets the same efficiency levels for fixtures operating indoors and outdoors be analyzed. This TSL corresponds to a modeled magnetic ballast in 70 W, 250 W, and 400 W fixtures; a commercially available low-frequency electronic ballast in 150 W fixtures; and a commercially available magnetic ballast in 1000 W fixtures. TSL 3 also prohibits the use of probe-start ballasts in new 1000 W fixtures. Because the 150 W fixtures are subject to a more stringent standard (EL4, max tech) than other equipment classes (EL2), there is potential for customers to switch to the higher wattage fixtures to avoid the more stringent standards. This customer behavior could reduce the energy savings associated with TSL 3.

After considering the analysis, the comments that DOE received on the preliminary analysis, and the benefits and burdens of TSL 3, the Secretary has reached the following tentative conclusion: TSL 3 offers the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. The benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), positive net economic savings (NPV) at discount rates of 3-percent and 7-percent at each representative equipment class would outweigh the potential reduction in INPV for manufacturers. Therefore, DOE today proposes to adopt energy conservation standards for metal halide lamp fixtures at TSL 3. DOE seeks comment on its proposal of adopting energy conservation standards for metal halide lamp fixtures at TSL 3. DOE will consider the comments and information received in determining the final energy conservation standards.

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)) DOE is evaluating amended standards in terms of ballast efficiency, which is the same metric that is currently used in energy conservation standards. Therefore, DOE compared the existing standards to the proposed amendments to confirm that none of the proposals constituted backsliding.

The existing standards for ballast efficiency for metal halide lamp fixtures, set by EISA 2007, mandated that ballasts rated at wattages ≥150 W and ≤500 W operate at a minimum of 88 percent efficiency if pulse-start, 94 percent if probe-start magnetic, 90 percent if nonpulse-start electronic ≥150 W and ≤250 W, and 92 percent if nonpulse-start electronic >250 W and ≤500 W. These standards excluded fixtures with regulated-lag ballasts, fixtures that use 480 V electronic ballasts, and fixtures that (1) are only rated for use with 150 W lamps; (2) are rated for use in wet locations; and (3) contain a ballast that is rated to operate above 50 °C. This rulemaking is proposing to cover fixtures with ballasts rated at ≥50 W and ≤2000 W, retain the exemptions for fixtures with regulated lag ballasts or 480 V electronic ballasts, and remove the exemption for 150 W fixtures used in wet locations with ballasts rated that operate above 50 °C.

As presented in the following table, DOE is not proposing any efficiency standards that would qualify as backsliding. In the ≥50 W and <150 W [61] range, there are no existing federal efficiency standards. Thus, any standard set by DOE in this rulemaking would not be backsliding, as it would be prescribing a standard where there previously was not one. The 150 W ballasts currently exempt by EISA (those only rated for use with 150 W lamps, rated for wet locations, and rated to operate at temperatures greater than 50 °C) are not covered by any existing

[61] This wattage range contains those fixtures that are rated only for 150 watt lamps that are also rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and contain a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

federal energy conservation standards, so amended standards set for such ballasts would likewise not be subject to backsliding. Similarly, in the >500 W and ≤2000 W range, there are no existing federal energy conservation standards, so standards proposed in this rulemaking would not backslide. Finally for the ≥150 W[62] and ≤500 W range (not including the exempt 150 W fixtures), EISA currently prescribes standards. DOE is also proposing standards for fixtures in this wattage range. The proposed standard changes with wattage, but always requires ballasts in new fixtures to be at least 88 percent efficient (88 percent efficiency for pulse-start ballasts is the least stringent of the various EISA 2007 requirements). If the efficiency standard proposed by DOE is lower than the standard prescribed by EISA for any ballast types or wattages (e.g., 94 percent efficiency requirement for probe-start ballasts), then the EISA standard will take precedence and prevent any potential backsliding.

On the basis of this section, the standards proposed in this NOPR are either higher than the existing standards, primarily because they set standards for previously unregulated fixtures, or if the EISA standards are higher than those proposed in this NOPR then the EISA standard is given precedence. As such, the proposed standards do not decrease the minimum required energy efficiency of the covered equipment and, therefore, do not violate the anti-backsliding provision in EPCA.

TABLE VI.49—EXISTING FEDERAL EFFICIENCY STANDARDS AND PROPOSED EFFICIENCY STANDARDS

Rated lamp wattage	Indoor/ outdoor ***	Test input voltage ‡	Existing standards (efficiency)	Proposed efficiency standards/equations %
≥50 W and ≤100 W	Indoor	480 V	N/A	99.4/(1+2.5*P∧(−0.55)) †.
≥50 W and ≤100 W	Indoor	All others	N/A	100/(1+2.5*P∧(−0.55)).
≥50 W and ≤100 W	Outdoor	480 V	N/A	99.4/(1+2.5*P∧(−0.55)).
≥50 W and ≤100 W	Outdoor	All others	N/A	100/(1+2.5*P∧(−0.55)).
>100 W and <150 W *	Indoor	480 V	N/A	99.4/(1+0.36*P∧(−0.30)).
>100 W and <150 W *	Indoor	All others	N/A	100/(1+0.36*P∧(−0.30)).
>100 W and <150 W *	Outdoor	480 V	N/A	99.4/(1+0.36*P∧(−0.30)).
>100 W and <150 W *	Outdoor	All others	N/A	100/(1+0.36*P∧(−0.30)).
≥150 W ** and ≤250 W	Indoor	480 V	Varies from 88% to 94% depending on ballast type.	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0*10∧(−2)*P + 76.0.
≥150 W ** and ≤250 W	Indoor	All others	Varies from 88% to 94% depending on ballast type.	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0*10∧(−2)*P + 74.0.
≥150 W ** and ≤250 W	Outdoor	480 V	Varies from 88% to 94% depending on ballast type.	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0*10∧(−2)*P + 76.0.
≥150 W ** and ≤250 W	Outdoor	All others	Varies from 88% to 94% depending on ballast type.	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0*10∧(−2)*P + 74.0.
>250 W and ≤500 W	Indoor	480 V	Varies from 88% to 94% depending on ballast type.	91.0.
>250 W and ≤500 W	Indoor	All others	Varies from 88% to 94% depending on ballast type.	91.5.
>250 W and ≤500 W	Outdoor	480 V	Varies from 88% to 94% depending on ballast type.	91.0.
>250 W and ≤500 W	Outdoor	All others	Varies from 88% to 94% depending on ballast type.	91.5.
>500 W and ≤2000 W	Indoor	480 V	N/A	For >500 W to <1000 W: 0.994*(3.2*10∧(−3)*P + 89.9). For ≥1000 W to ≤2000 W: 92.5.
>500 W and ≤2000 W	Indoor	All others	N/A	For >500 W to <1000 W: 3.2*10∧(−3)*P + 89.9. For ≥1000 W to ≤2000 W: 93.1.
>500 W and ≤2000 W	Outdoor	480 V	N/A	For >500 W to <1000 W: 0.994*(3.2*10∧(−3)*P + 89.9). For ≥1000 W to ≤2000 W: 92.5.
>500 W and ≤2000 W	Outdoor	All others	N/A	For >500 W to <1000 W: 3.2*10∧(−3)*P + 89.9. For ≥1000 W to ≤2000 W: 93.1.

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

*** DOE's proposed definitions for ''indoor'' and ''outdoor'' metal halide lamp fixtures are described in section V.A.2.

† P is defined as the rated wattage of the lamp the fixture is designed to operate.

[62] This wattage range contains all covered fixtures that are rated only for 150 watt lamps that are not also rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and do not also contain a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

‡ Input voltage for testing would be specified by the test procedures. Ballasts rated to operate lamps less than 150 W would be tested at 120 V, and ballasts rated to operate lamps ≥150 W would be tested at 277 V. Ballasts not designed to operate at either of these voltages would be tested at the highest voltage the ballast is designed to operate.

VII. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of E.O. 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 addressed by today's standards are as follows:

(1) There is a lack of customer information and/or information-processing capability about energy-efficiency opportunities in the commercial equipment market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transaction costs (costs of gathering information and affecting exchanges of goods and services).

(3) There are external benefits resulting from improved energy efficiency of metal halide lamp fixtures 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 E.O. 12866. Accordingly, section 6(a)(3) of the E.O. requires that DOE prepare a regulatory impact analysis (RIA) on today's proposed rule and that the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) review this proposed 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 E.O. 12866 can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to E.O. 13563, issued on January 18, 2011 (76 FR 3281 (Jan. 21, 2011)). E.O. 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in E.O. 12866. To the extent permitted by law, agencies are required by E.O. 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 E.O. 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, OIRA has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, DOE believes that today's NOPR is consistent with these principles, including the requirements that, to the extent permitted by law, benefits justify costs and net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that, by law, must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E. O. 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' (67 FR 53461 (Aug. 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://energy.gov/gc/office-general-counsel*). DOE reviewed the potential standard levels considered in today's NOPR under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003.

As a result of this review, DOE has prepared an IRFA for metal halide ballasts and metal halide lamp fixtures, a copy of which DOE will transmit to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C 605(b). As presented and discussed below, the IRFA describes potential impacts on small metal halide ballast and metal halide lamp fixture manufacturers and discusses alternatives that could minimize these impacts.

A statement of the reasons for the proposed rule, and the objectives of and legal basis for the proposed rule, are set forth elsewhere in the preamble and not repeated here.

1. Description and Estimated Number of Small Entities Regulated

a. Methodology for Estimating the Number of Small Entities

For manufacturers of metal halide ballasts and metal halide lamp fixtures, the SBA has set a size threshold which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. (65 FR 30836, 30850 (May 15, 2000), as amended at 65 FR 53533, 53545 (Sept. 5, 2000) and codified at 13 CFR part 121). The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at *http://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.* Metal halide 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. Metal halide lamp fixture manufacturing is classified under NAICS 335122, ''Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing.'' The SBA sets a threshold of 500 employees or less for an entity to be considered as a small business for this category.

To estimate the number of companies that could be small business manufacturers of equipment covered by this rulemaking, DOE conducted a market survey using all available public information to identify potential small manufacturers. DOE's research involved industry trade association membership directories (including NEMA), individual company Web sites, and market research tools (*e.g.,* Dun and Bradstreet reports and Hoovers reports) to create a list of every company that manufactures or sells metal halide ballasts or metal halide lamp fixtures covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and at previous DOE public meetings. DOE contacted companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered equipment. DOE screened out companies that did not offer equipment covered by this rulemaking, did not meet the definition of a ''small business,'' or were foreign owned and operated.

DOE initially identified at least 25 potential manufacturers of metal halide ballasts sold in the U.S. DOE reviewed publicly available information on these 25 potential manufacturers and determined that 13 were either large manufacturers, manufacturers that were foreign owned and operated, or did not manufacture ballasts covered by this rulemaking. DOE then attempted to contact the remaining 12 companies that were potential small business manufacturers. DOE was able to determine that five companies meet the SBA's definition of a small business and likely manufacture ballasts covered by this rulemaking.

For metal halide lamp fixtures sold in the U.S., DOE initially identified at least 134 potential manufacturers. DOE reviewed publicly available information on these 134 potential manufacturers and determined that 66 were large manufacturers, manufacturers that were foreign owned and operated, or did not sell fixtures covered by this rulemaking. DOE then attempted to contact the remaining 68 companies that were potential small business manufacturers. Though many companies were unresponsive, DOE was able to determine that approximately 54 meet the SBA's definition of a small business and likely manufacture fixtures covered by this rulemaking.

NEMA stated that small manufacturers may be significantly burdened by energy conservation standards because they have limited resources at their disposal to redesign products. (NEMA, No. 34 at p. 16) DOE agrees that there is potential for small manufacturers to be disproportionately burdened by regulations and outlines its conclusions on the potential impacts of standards on small businesses in the sections that follow.

b. Manufacturer Participation

Before issuing this NOPR, DOE attempted to contact the small business manufacturers of metal halide ballasts and metal halide lamp fixtures it had identified. One small ballast manufacturer and two small fixture manufacturers consented to being interviewed. DOE also obtained information about small business impacts while interviewing large manufacturers.

c. Metal Halide Ballast and Fixture Industry Structure

Ballasts. Five major ballast manufacturers with limited domestic production supply the vast majority of the metal halide ballast market. None of the five major manufacturers is a small business. The remaining market share is held by a few smaller domestic companies, only one of which has significant market share. Nearly all metal halide ballast production occurs abroad.

Fixtures. The majority of the metal halide lamp fixture market is supplied by six major manufacturers with sizeable domestic production. None of these major manufacturers is a small business. The remaining market share is held by several smaller domestic and foreign manufacturers. Most of the small domestic manufacturers produce fixtures in the U.S. Although none of the small businesses holds a significant market share individually, collectively these small businesses account for a third of the market. See chapter 3 of the NOPR TSD for further details on the metal halide ballast and metal halide lamp fixture markets.

d. Comparison Between Large and Small Entities

Ballasts. The five large ballast manufacturers typically offer a much wider range of designs of metal halide ballasts than small manufacturers do. Ballasts can vary by start method, input voltage, wattage, and design. Often large ballast manufacturers will offer several different ballast options for each lamp wattage. Small manufacturers generally specialize in manufacturing only a handful of different ballast types and do not have the volume to support as wide a range of products as large manufacturers do. Three of the five small ballast manufacturers specialize in high-efficiency electronic ballasts and do not offer any magnetic ballasts. Some small ballast manufacturers offer a wide variety of lighting products, but others focus exclusively on metal halide ballasts.

Fixtures. The six large fixture manufacturers typically serve large-scale commercial lighting markets, while small fixture manufacturers tend to operate in niche lighting markets such as architectural and designer lighting. Small fixture manufacturers also frequently fill custom orders that are much smaller in volume than large fixture manufacturers' typical orders are. Because small manufacturers typically offer specialized products and cater to individual customers' needs, they can command higher markups than most large manufacturers. Like large ballast manufacturers, large fixture manufacturers offer a wider range of metal halide lamp fixtures than small fixture manufacturers. A small fixture manufacturer may offer fewer than 50 models, while a large manufacturer may typically offer several hundred models. Almost all small fixture manufacturers offer a variety of lighting products in addition to those covered by this rulemaking, such as fluorescent, incandescent, and LED fixtures.

2. Description and Estimate of Compliance Requirements

Ballasts. Because three of the five small metal halide ballast manufacturers offer only electronic ballasts that already meet the standards at TSL 3, the level proposed in today's notice, DOE does not expect any product or capital conversion costs for these small ballast manufacturers. The fourth small ballast manufacturer offers a wide range of magnetic and electronic ballasts, so DOE does not expect this manufacturer's conversion costs to differ significantly from those of the large manufacturers. The fifth small ballast manufacturer currently offers a large variety of lighting products, but only two models of metal halide ballasts. Because it would likely invest in other parts of its business, this manufacturer stated to DOE that this rulemaking is unlikely to significantly affect it.

Fixtures. As stated above, DOE identified approximately 54 small metal halide lamp fixture businesses affected by this rulemaking. Based on interviews with two of these manufacturers and examinations of product offerings on company Web sites, DOE believes that approximately one-fourth of these small businesses will not face any conversion costs because they offer very few metal halide lamp fixture models and would, therefore, focus on more substantial areas of their business. Of the remaining small businesses DOE identified, nearly two-thirds primarily serve the architectural or specialty lighting markets. Because these products command higher prices and margins compared to the typical products offered by a large manufacturer, DOE believes that these small fixture manufacturers will be able to pass on any necessary conversion costs to their customers without significantly impacting their businesses.

The remaining small fixture manufacturers (roughly 14 in number) could be differentially impacted by today's proposed standards. These manufacturers operate partially in industrial and commoditized markets in which it may be more difficult to pass on any disproportionate costs to their customers. The impacts could be relatively greater for a typical small manufacturer because of the far lower production volumes and the relatively fixed nature of the R&D and capital resources required per fixture family.

Based on interviews, however, DOE anticipates that small manufacturers would take steps to mitigate the costs required to meet new and amended energy conservation standards. At TSL 3, DOE believes that under the proposed standards, small fixture 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 not upgrading all product lines prior to the compliance date.

Additionally, DOE does not expect that small fixture manufacturers would be burdened by compliance requirements. As discussed in section IV.A, the standards proposed in this NOPR provide simplifying amendments to the current testing and reporting procedures. One of DOE's goals in this rulemaking was to have minimal, if any, increase in testing and reporting burden on manufacturers. DOE is only mandating testing at a single input voltage for metal halide lamp fixtures. Other options considered would have increased testing to either two or four input voltages per fixture. Because DOE selected the least burdensome input voltage option, DOE concludes that regulations in this NOPR would not have an adverse impact on the testing burden of small manufacturers.

The existing test procedures already dictate that testing for certification requires a sample of at least four fixtures for compliance. DOE is not proposing to change this minimum sample size, and as such, does not find an increased testing burden on small manufacturers.

As discussed in section IV.A, DOE is amending the test procedures to mandate the equipment with which high-frequency electronic ballasts are to be tested, since existing test procedures prescribe test instrumentation only for magnetic and low-frequency electronic ballasts. DOE proposes that equipment be permitted for testing the output frequency of the ballast. Once it is determined that a fixture's output frequency is greater than or equal to 1000 Hz, the frequency at which DOE proposes to define high-frequency electronic ballasts, the test procedures would require equipment to consist of (1) a power analyzer that conforms to ANSI C82.6–2005 with a maximum of 100 pF capacitance to ground and frequency response between 40 Hz and 1 MHz, (2) a current probe compliant with ANSI C82.6–2005 that is galvanically isolated and has a frequency response between 40 Hz and 20 MHz, and (3) a lamp current measurement device where its full transducer ratio is set in the power analyzer to match the current probe to the analyzer. DOE finds that these test requirements do not affect small manufacturers, noting that the equipment described above is the same equipment that is already required for the testing of fluorescent lamp ballasts. Because many lighting companies that manufacture or sell metal halide ballasts also manufacture or sell fluorescent lamp ballasts, this proposed change to the test procedures should not affect manufacturers' testing burden or costs. In addition, DOE believes that the equipment specified for high-frequency electronic ballast testing is representative of typical high-quality equipment currently used by manufacturers in the business of designing and selling these ballasts.

DOE seeks comment on the potential impacts of new and amended standards on the small metal halide ballast and metal halide lamp fixture manufacturers.

3. Duplication, Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being considered today.

4. Significant Alternatives to the Proposed Rule

The discussion above analyzes impacts on small businesses that would result from the other TSLs DOE considered. Though TSLs lower than the proposed TSLs 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 significant conservation of energy. Thus, DOE rejected the lower TSLs.

In addition to the other TSLs being considered, the NOPR TSD includes a regulatory impact analysis in chapter 18. For metal halide lamp fixtures, this report discusses the following policy alternatives: (1) No standard, (2) customer rebates, (3) customer 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.

DOE continues to seek input from businesses that would be affected by this rulemaking and will consider comments received in the development of any final rule.

C. Review Under the Paperwork Reduction Act

Manufacturers of metal halide lamp fixtures must certify to DOE that their equipment complies with any applicable energy conservation standard. In certifying compliance, manufacturers must test their equipment according to the DOE test procedures for metal halide lamp fixtures, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered customer products and commercial equipment, including metal halide lamp fixtures. 76 FR 12422 (March 7, 2011). The collection-of-information requirement for 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

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that the proposed rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR part 1021, appendix. B, B5.1(b); 1021.410(b) and appendix B, B(1)–(5). The proposed rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this proposed rule. CX determination for this proposed rule is available at *http://cxnepa.energy.gov.*

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 E.O. 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 E.O. also requires agencies to have an accountable process to ensure meaningful and timely input by state and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. EPCA governs and prescribes Federal preemption of state regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by E.O. 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 E.O. 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 E.O.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 E.O. 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of E.O. 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

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

Although today's proposed rule does not contain a Federal intergovernmental mandate, it may require expenditures of $100 million or more on the private sector. Specifically, the proposed rule will likely result in a final rule that could require expenditures of $100 million or more. Such expenditures may include: (1) Investment in research and development and capital expenditures by metal halide lamp fixture manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by customers to purchase higher-efficiency metal halide lamp fixtures, 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 proposed rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private-sector mandate substantially overlap with the economic analysis requirements that apply under section 325(o) of EPCA and E.O. 12866. The **SUPPLEMENTARY INFORMATION** section of this NOPR and the ''Regulatory Impact Analysis'' section of the NOPR TSD for this proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least-burdensome alternative that achieves the objectives of the proposed rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(d), (f), and (o), 6313(e), and 6316(a), today's proposed rule would establish energy conservation standards for metal halide lamp fixtures 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 NOPR TSD for today's proposed rule.

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

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

I. Review Under Executive Order 12630

DOE has determined, under E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights'' 53 FR 8859 (Mar. 18, 1988), that this regulation would not result in any takings 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 NOPR under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

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

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are ''influential scientific information,'' which the Bulletin defines as ''scientific information the agency reasonably can determine will have or does have a clear and substantial impact on important public policies or private sector decisions.'' 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: *www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.*

VIII. Public Participation

A. Attendance at the Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this notice. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586–2945 or *Brenda.Edwards@ee.doe.gov*. As explained in the **ADDRESSES** section, foreign nationals visiting DOE Headquarters are subject to advance security screening procedures.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's Web site at: *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49.* Participants are responsible for ensuring that their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements For Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this notice. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this notice. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this notice.

Submitting comments via regulations.gov. The regulations.gov Web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to regulations.gov information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (CBI)). Comments submitted through regulations.gov cannot be claimed as CBI. Comments received through the Web site will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section below.

DOE processes submissions made through regulations.gov before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that regulations.gov provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or mail. Comments and documents submitted via email, hand delivery, or mail also will be posted to regulations.gov. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments

Include contact information each time you submit comments, data, documents, and other information to DOE. Email submissions are preferred. If you submit via mail or hand delivery/courier, please provide all items on a CD, if feasible. It is not necessary to submit printed copies. No facsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, that are written in English, and that are free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery/courier two well-marked copies: One copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. The appropriateness of continuing the exemption of regulated-lag ballasts;

2. The exclusion of dedicated 480 V electronic ballasts in the scope of this rulemaking;

3. The inclusion of ballasts that are rated only for used with 150 W lamps, use in wet locations, and operation in ambient air temperature higher than 50 °C in the scope of this rulemaking;

4. The expansion of coverage of this rulemaking to include metal halide lamp fixtures that operate lamps rated greater than or equal to 50 W and less than or equal to 150 W, and fixtures that operate lamps rated greater than 500 W and less than or equal to 2000 W;

5. The decision that fixtures above 1000 W are available for general lighting applications and are thus covered by this rulemaking;

6. The appropriateness of setting efficiency standards for metal halide lamp fixtures based on ballast efficiency;

7. The appropriateness of the proposed amendments to the testing procedure, especially the specification of input voltage, high-frequency test instrumentation, and rounding requirements;

8. The appropriateness of DOE testing metal halide lamp fixtures at a single input voltage, based on the lamp wattage operated by the ballast;

9. The appropriateness of placing indoor and outdoor fixtures into separate equipment classes;

10. How to best combine the HID lamp and MHLF energy conservation standards;

11. The technological feasibility of the max tech levels selected, specifically data on the potential change in efficiency, the design options employed, and the associated change in cost;

12. Any technological barriers to an improvement in efficiency above the max tech efficiency levels for all or certain types of ballasts;

13. The appropriateness of separate equipment classes for ballasts tested at 480 V (in accordance with the test procedures);

14. The appropriateness of not dividing equipment classes by electronic configuration or circuit type;

15. The suitability of defining equipment class by the rated lamp wattage ranges ≥50 W to ≤100 W, >100 W to ≤150 W, ≥150 W to ≤250 W, >250 W to ≤500 W, and >500 W to ≤2000 W, specially the inclusion of 150 W fixtures previously exempted by EISA 2007 in the >100 W and ≤150 W range, and 150 W fixtures subject to EISA 2007 standards in the ≥150 W to ≤250 W range;

16. The appropriateness of the equipment classes proposed in this NOPR;

17. The assumption that there will be no lessening of utility or performance such that the physical size, including footprint, stack height, and weight, would be adversely affected for the magnetic ballast efficiencies associated with efficiency levels based on modeled ballasts;

18. The appropriateness of the design options selected by the screening analysis presented in this NOPR;

19. The possibility of setting a standard that requires a high-frequency ballast;

20. The issue of operating a lamp at wattages greater or less than its rating and its effect on ballast efficiency or lamp efficacy;

21. The analysis method of applying a 5.5 percent increase when calculating the representative input power of magnetic ballasts to account for the increase in wattage over a ballast's lifetime;

22. The addition of the electronic 70 W baseline ballast;

23. The possibility of high-frequency electronic ballasts requiring additional thermal and transient protection relative to low-frequency electronic ballasts and, if so, the technical reasons for this difference and whether ballast or fixture redesigns can overcome these barriers;

24. The appropriateness of the efficiency levels proposed in this NOPR and whether or not an adjustment is needed for sources of variation not currently captured by the methodology;

25. The proposal to apply a scaling factor of 0.6 percent to the efficiency levels for quad-volt ballasts to determine the appropriate values for 480 V ballasts;

26. The determination to include a design standard that would prohibit the sale of probe-start ballasts in newly sold fixtures, the proposed methods of analyzing these levels, and the potential for any lessening of the utility or the performance through the prohibition of the sale of probe-start ballasts in newly sold fixtures;

27. The applicability and appropriateness of the adder to MPC of electronic ballasts for 120 V auxiliary power functionality and the adders to the MPC of fixtures with electronic ballasts for thermal management and transient protection;

28. The appropriateness of the derived MSPs presented in this NOPR;

29. Methods to improve DOE's energy use analysis, as well as any data supporting alternate operating hour estimates or assumptions regarding fixture dimming;

30. The impact and feasibility of a compliance date of January 1, 2015;

31. The assumptions and methodology for estimating annual operating hours, which were based on data from the 2010 U.S. Lighting Market Characterization, and assumed to be 3,615 hours per year in the commercial sector, 6,113 hours per year in the industrial sector, and 4,493 hours per year for the outdoor stationary sector;

32. Methods to improve DOE's fixture price projections beyond the assumption of constant real prices, as well as any data supporting alternate methods;

33. The reasonableness of assuming a zero percent rebound effect (the tendency for customers to increase MHLF usage in response to life-cycle cost savings associated with more efficient ballasts used in new fixtures);

34. Whether the shipment scenarios under various policy scenarios are reasonable and likely to occur;

35. The impediments that prevent users of metal halide lamp fixtures from switching to LED lighting to garner further energy savings;

36. The expected impact of new and revised standards on the rate at which MHLF customers transition to non-MHLF technology;

37. The methodology applied to determine the product and capital conversion costs;

38. The degree to which the manufacturers' ability to recoup investment, combined with the opportunity cost of investment, would encourage manufacturers to exit the metal halide lamp fixture market;

39. The appropriateness of proposed trial standard levels;

40. The presence of features or attributes of the more energy efficient ballasts used in new fixtures that manufacturers would produce to meet the standards in this proposed rule that might affect the welfare, positively or negatively, of customers who purchase metal halide lamp fixtures;

41. The possibility that the more widespread use of electronic ballasts would involve any performance or reliability effects for either 70-watt or 150-watt fixtures, and how any such effects should be weighed in the choice of standards for these two wattage categories for the final rule;

42. The appropriateness of choosing TSL 3 energy conservation standards; and

43. The potential impacts of new and amended standards on the small metal halide ballast and metal halide lamp fixture manufacturers.

IX. Approval of the Office of the Secretary

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

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Reporting and recordkeeping requirements.

Issued in Washington, DC, on August 13, 2013.

David T. Danielson,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, DOE proposes to amend part 431 of Chapter II, subchapter D of title 10 of the Code of Federal Regulations, as set forth below:

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

■ 2. Section 431.322 is amended by adding in alphabetical order definitions for ''general lighting application,'' ''high-frequency electronic metal halide ballast,'' and ''nonpulse-start electronic ballast,'' to read as follows:

§ 431.322 Definitions concerning metal halide ballasts and fixtures.

* * * * *

General lighting application means lighting that provides an interior or exterior area with overall illumination.

High-frequency electronic metal halide ballast means an electronic ballast that operates a lamp at an output frequency of 1000 Hz or greater.

* * * * *

Nonpulse-start electronic ballast means an electronic ballast with a starting method other than pulse-start.

* * * * *

■ 3. Section 431.324 is amended by:

■ a. Revising paragraphs (b)(1)(i), (b)(3) and (c)(1); and

■ b. Adding paragraphs (b)(1)(iii), and (b)(1)(iv).

The additions and revisions read as follows:

§ 431.324 Uniform test method for the measurement of energy efficiency and standby mode energy consumption of metal halide ballasts.

* * * * *

(b) * * *

(1) * * *

(i) *Test Conditions.* The power supply, ballast test conditions (with the exception of input voltage), lamp position, lamp stabilization, and test instrumentation except as specified in paragraph (b)(1)(iii) of this section shall all conform to the requirements specified in section 4.0, ''General Conditions for Electrical Performance Tests,'' of ANSI C82.6 (incorporated by reference; see § 431.323). Ambient temperatures for the testing period shall be maintained at 25 °C ± 5 °C. Airflow in the room for the testing period shall be ≤0.5 meters/second. The ballast shall be operated until equilibrium. Lamps used in the test shall conform to the general requirements in section 4.4.1 of ANSI C82.6 and be seasoned for a minimum of 100 hours prior to use in ballast tests. Basic lamp stabilization shall conform to the general requirements in section 4.4.2 of ANSI C82.6, and stabilization shall be reached when the lamp's electrical characteristics vary by no more than 3-percent in three consecutive 10- to 15-minute intervals measured after the minimum burning time of 30 minutes. After the stabilization process has begun, the lamp shall not be moved or repositioned until after the testing is complete. In order to avoid heating up the test ballast during lamp stabilization, which could cause resistance changes and result in unrepeatable data, it is necessary to warm up the lamp on a standby ballast. This standby ballast should be a commercial ballast of a type similar to the test ballast in order to be able to switch a stabilized lamp to the test ballast without extinguishing the lamp. Fast-acting or make-before-break switches are recommended to prevent the lamps from extinguishing during switchover.

* * * * *

(iii) *Instrumentation for High-Frequency Electronic Metal Halide Ballasts.* If the output frequency of the ballast (frequency of power supplied to the lamp) is greater than 1000 Hz, the testing instrumentation shall conform to the following paragraphs (b)(1)(iii)(A), (b)(1)(iii)(B), and (b)(1)(iii)(C) of this section. Instrumentation for determination of the output frequency shall be compliant with section 4.0 of ANSI C82.6 (incorporated by reference; see § 431.323).

(A) *Power Analyzer.* In addition to the specifications in ANSI C82.6, the power analyzer shall have a maximum 100 pF capacitance to ground and frequency response between 40 Hz and 1 MHz.

(B) *Current Probe.* In addition to the specifications in ANSI C82.6, the current probe shall be galvanically isolated and have frequency response between 40 Hz and 20 MHz.

(C) *Lamp Current.* For the lamp current measurement, the full transducer ratio shall be set in the power analyzer to match the current probe to the power analyzer.

Full Transducer Ratio =

$$\frac{I_{in}}{V_{out}} \times \frac{R_{in}}{R_{in} + R_s}$$

Where:

I_{in} is current through the current transducer
V_{out} is the voltage out of the transducer
R_{in} is the power analyzer impedance
R_s is the current probe output impedance.

(iv) *Input Voltage for Tests.* For ballasts designed to operate lamps rated less than 150 W that have 120 V as an available input voltage, testing shall be performed at 120 V. For ballasts designed to operate lamps rated less than 150 W that do not have 120 V as an available voltage, testing shall be performed at the highest available input voltage. For ballasts designed to operate lamps rated greater than or equal to 150 W that have 277 V as an available input voltage, testing shall be conducted at 277 V. For ballasts designed to operate lamps rated greater than or equal to 150 W that do not have 277 V as an available input voltage, testing shall be conducted at the highest available input voltage.

* * * * *

(3) *Efficiency Calculation.* The measured lamp output power shall be divided by the ballast input power to determine the percent efficiency of the ballast under test to the nearest tenth of a percent.

(i) A fractional number at or above the midpoint between two consecutive decimal places shall be rounded up to the higher of the two decimal places; or

(ii) A fractional number below the midpoint between two consecutive decimal places shall be rounded down to the lower of the two decimal places.

(c) * * *

(1) *Test Conditions.* (i) The power supply, ballast test conditions with the exception of input voltage, and test instrumentation with the exception of high-frequency electronic ballasts shall all conform to the requirements specified in section 4.0, ''General Conditions for Electrical Performance Tests,'' of the ANSI C82.6 (incorporated by reference; see § 431.323). Ambient temperatures for the testing period shall be maintained at 25 °C ± 5 °C. Send a signal to the ballast instructing it to have zero light output using the appropriate ballast communication protocol or system for the ballast being tested.

(ii) *Input Voltage for Tests.* For ballasts less than 150 W that have 120 V as an available input voltage, ballasts are to be tested at 120 V. For ballasts less than 150 W that do not have 120 V as an available voltage, ballasts are to be tested at the highest available input voltage. For ballasts greater than or equal to 150 W and less than or equal to 2000 W that have 277 V as an available input voltage, ballasts are to be tested at 277 V. For ballasts greater than or equal to 150 W and less than or equal to 2000 W that do not have 277 V as an available input voltage, ballasts are to be tested at the highest available input voltage.

(iii) *Instrumentation for High-Frequency Electronic Metal Halide Ballasts.* If the output frequency of the ballast (frequency of power supplied to the lamp) is greater than 1000 Hz, the testing instrumentation shall conform to paragraphs (b)(1)(iii)(A), (b)(1)(iii)(B), and (b)(1)(iii)(C) of this section. Instrumentation for determination of the output frequency shall be compliant with section 4.0 of ANSI C82.6 (incorporated by reference; see § 431.323).

(A) *Power Analyzer.* In addition to the specifications in ANSI C82.6, the power analyzer shall have a maximum 100 pF capacitance to ground and frequency response between 40 Hz and 1 MHz.

(B) *Current Probe.* In addition to the specifications in ANSI C82.6, the current probe shall be galvanically isolated and have frequency response between 40 Hz and 20 MHz.

(C) *Lamp Current.* For the lamp current measurement, the full transducer ratio shall be set in the power analyzer to match the current probe to the power analyzer.

Full Transducer Ratio =

$$\frac{I_{in}}{V_{out}} \times \frac{R_{in}}{R_{in} + R_s}$$

Where:

I_{in} is current through the current transducer
V_{out} is the voltage out of the transducer
R_{in} is the power analyzer impedance
R_s is the current probe output impedance.

* * * * *

■ 4. Section 431.326 is amended by adding paragraphs (c), (d), and (e) to read as follows:

§ 431.326 Energy conservation standards and their effective dates.

* * * * *

(c) Except when the requirements of paragraph (a) of this section are more stringent (i.e., require a larger minimum efficiency value) or as provided by paragraph (e) of this section, each metal halide lamp fixture manufactured on or after January 1, 2015 shall contain a metal halide ballast with an efficiency not less than the value determined from the appropriate equation in the following table:

Rated lamp wattage	Tested input voltage [‡‡]	Minimum standard equation %
≥50 W and ≤100 W	Tested at 480 V	99.4/(1 + 2.5 * P ∧ (−0.55)) [††].
≥50 W and ≤100 W	All others	100/(1 + 2.5 * P ∧ (−0.55)).
>100 W and <150 [†]. W	Tested at 480 V	99.4/(1 + 0.36 * P ∧ (−0.30)).
>100 W and <150 [†] W	All others	100/(1 + 0.36 * P ∧ (−0.30)).
≥150 [‡] W and ≤250 W	Tested at 480 V	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0 * 10 ∧ (−2) * P + 76.0.
≥150 [‡] W and ≤250 W	All others	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0 * 10 ∧ (−2) * P + 74.0.
>250 W and ≤500 W	Tested at 480 V	91.0.
>250 W and ≤500 W	All others	91.5.
>500 W and ≤2000 W	Tested at 480 V	For >500 W to <1000 W: 0.994 * (3.2 * 10 ∧ (−3) * P + 89.9). For ≥1000 W to ≤2000 W: 92.5.
>500 W and ≤2000 W	All others	For >500 W to <1000 W: 3.2 * 10 ∧ (−3) * P + 89.9. For ≥1000 W to ≤2000 W: 93.1.

[†] Includes 150 W fixtures specified in paragraph (b)(3) of this section, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

[‡] Excludes 150 W fixtures specified in paragraph (b)(3) of this section, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

[††] P is defined as the rated wattage of the lamp the fixture is designed to operate.

[‡‡] Tested input voltage is specified in 10 CFR 431.324.

(d) Except as provided in paragraph (e) of this section, metal halide lamp fixtures manufactured on or after January 1, 2015 that operate lamps with rated wattage >500 W to ≤2000 W shall not contain a probe-start metal halide ballast.

(e) The standards described in paragraphs (c) and (d) of this section do not apply to—

(1) Metal halide lamp fixtures with regulated-lag ballasts; and

(2) Metal halide lamp fixtures that use electronic ballasts that operate at 480 volts.

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