DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE–2015–BT–STD–0006]

RIN 1905–AD51

Energy Conservation Program: Energy Conservation Standards for Fluorescent Lamp Ballasts

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

ACTION: Notice of proposed determination and request for comment.

SUMMARY: The Energy Policy and Conservation Act of 1975, as amended (EPCA), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including fluorescent lamp ballasts. EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would result in significant energy savings. In this notice of proposed determination (NOPD), DOE has initially determined that energy conservation standards for fluorescent lamp ballasts do not need to be amended and also asks for comment on this proposed determination and associated analyses and results.

DATES:

Meeting: DOE will hold a webinar on Wednesday, October 30, 2019, from 10:00 a.m. to 3:00 p.m. See section V, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants. If no participants register for the webinar than it will be cancelled. DOE will hold a public meeting on this proposed determination if one is requested by November 5, 2019.

Comments: Written comments and information are requested and will be accepted on or before December 23, 2019.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *http://www.regulations.gov.* Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2015–BT–STD–0006, by any of the following methods:

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

(2) *Email: FluorLampBallast2015STD0006@ee.doe.gov.* Include the docket number EERE–2015–BT–STD–0006 in the subject line of the message.

(3) *Postal Mail:* Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, Mailstop EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 287–1445. If possible, please submit all items on a compact disc (''CD''), in which case it is not necessary to include printed copies.

(4) *Hand Delivery/Courier:* Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza SW, 6th Floor, Washington, DC 20024. Telephone: (202) 287–1445. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

No telefacsimiles (faxes) will be accepted. For detailed instructions on submitting comments and additional information on this process, see section VII of this document.

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

The docket web page can be found at *https://www.regulations.gov/document?D=EERE-2015-BT-STD-0006.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. See section VII, ''Public Participation,'' for further information on how to submit comments through *http://www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT:

Ms. Lucy deButts, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121. Email: *ApplianceStandardsQuestions@ee.doe.gov.*

Ms. Sarah Butler, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–1777. Email: *Sarah.Butler@hq.doe.gov.*

For further information on how to submit a comment or review other public comments and the docket contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Synopsis of the Proposed Determination

Title III, Part B [1] of the Energy Policy and Conservation Act of 1975, as amended (EPCA),[2] established the Energy Conservation Program for Consumer Products Other Than Automobiles. (42 U.S.C. 6291–6309) These products include fluorescent lamp ballasts, the subject of this NOPD.

DOE is issuing this NOPD pursuant to the EPCA requirement that not later than 6 years after issuance of any final rule establishing or amending an energy conservation standard for a covered product, DOE must publish either a notice of determination indicating that standards for the product do not need to be amended, or a notice of proposed rulemaking (NOPR) including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1)(A) and (B))

For this proposed determination, DOE analyzed fluorescent lamp ballasts subject to standards specified in 10 CFR 430.32(m). In addition, DOE evaluated whether current standards should be extended to additional fluorescent lamp ballasts. Specifically, DOE considered standards for dimming ballasts and 4-foot T8 medium bipin (MBP) programmed start (PS) ballasts with an average current less than 140 mA (hereafter low-current PS ballasts). Hence, potential amended energy conservation standards in this NOPD refer not only to changes to existing standards but also extension of standards to additional fluorescent lamp ballasts.

DOE first analyzed the technological feasibility of more efficient fluorescent lamp ballasts. For those fluorescent lamp ballasts for which DOE determined it to be technologically feasible to have higher standards or be subject to standards, DOE estimated energy savings that would result from potential energy conservation standards by conducting a national impacts analysis (NIA). DOE evaluated whether these amended standards would be cost effective by conducting life-cycle cost (LCC) and payback period (PBP) analyses, and estimated the net present value (NPV) of the total costs and benefits experienced by consumers. In addition to the consideration of these criteria, DOE conducted a manufacturer impact analyses (MIA).

Based on the results of these analyses summarized in section V of this document, DOE has tentatively determined that current standards for fluorescent lamp ballasts do not need to be amended because amended standards would not be cost effective.

II. Introduction

The following section briefly discusses the statutory authority underlying this proposed determination, as well as some of the relevant historical background related to the establishment of standards for fluorescent lamp ballasts.

A. Authority and Background

Title III, Part B of EPCA includes the fluorescent lamp ballasts that are the subject of this proposed determination. (42 U.S.C. 6292(a)(13)) EPCA prescribed energy conservation standards for these products. (42 U.S.C. 6295(g)(5)) EPCA directed DOE to (1) conduct two rulemaking cycles to determine whether these standards should be amended; and (2) for each rulemaking cycle, determine whether the standards in effect for fluorescent lamp ballasts should be amended so that they would be applicable to additional fluorescent lamp ballasts. (42 U.S.C. 6295(g)(7)(A) and (B)) Through amendments to EPCA under the Energy Policy Act of 2005 (EPACT 2005), Public Law 109–58, Congress promulgated new energy conservation standards for certain fluorescent lamp ballasts. (EPACT section 135(c)(2); codified at 42 U.S.C. 6295(g)(8)(A))

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

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6295(o)(3)(A) and (r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for fluorescent lamp ballasts appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix Q.

Federal energy conservation requirements generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a) through (c)) DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with

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

[2] All references to EPCA in this document refer to the statute as amended through America's Water Infrastructure Act of 2018, Public Law 115–270 (October 23, 2018).

the procedures and other provisions set forth under 42 U.S.C. 6297(d)).

Pursuant to the amendments contained in the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110–140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single 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) and (B)) DOE's current test procedures for fluorescent lamp ballasts address standby mode and off mode energy use. In this analysis DOE considers such energy use in its determination of whether energy conservation standards need to be amended.

DOE is issuing this proposed determination pursuant to 42 U.S.C. 6295(m), which states that DOE must periodically review its already established energy conservation standards for a covered product no later than 6 years from the issuance of a final rule establishing or amending a standard for a covered product. As a result of this review, DOE must either publish a determination that standards do not need to be amended or a NOPR, including new proposed standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) EPCA further provides that, not later than 3 years after the issuance of a final determination not to amend standards, DOE must make a new determination and publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(3)(B)) DOE must make the analysis on which the determination is based publicly available and provide an opportunity for written comment. (42 U.S.C. 6295(m)(2)) A determination that amended standards are not needed must be based on consideration of whether amended standards will result in significant conservation of energy, are technologically feasible, and are cost effective. (42 U.S.C. 6295(m)(1)(A) and (n)(2)) An evaluation of cost effectiveness requires that DOE consider 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 of, or initial charges for, or maintenance expenses of, the covered products that are likely to result from the standard. (42 U.S.C. 6295(n)(2) and (o)(2)(B)(i)(II))

1. Current Standards

In a final rule published on November 14, 2011, DOE prescribed the current energy conservation standards for fluorescent lamp ballasts manufactured on and after November 14, 2014 (2011 FL Ballast Rule). 76 FR 70548. These standards require a minimum power factor of 0.9 or greater for ballasts that are not residential ballasts or 0.5 or greater for residential ballasts and a minimum ballast luminous efficiency (BLE) as set forth in DOE's regulations at 10 CFR 430.32(m) and repeated in Table II.1.

TABLE II.1—FEDERAL ENERGY CONSERVATION STANDARDS FOR FLUORESCENT LAMP BALLASTS

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

Description	A	B	C
Instant start and rapid start ballasts (not classified as residential) that are designed to operate:			
4-foot medium bipin lamps, 2-foot U-shaped lamps, 8-foot slimline lamps	0.993	0.27	0.25
Programmed start ballasts (not classified as residential) that are designed to operate:			
4-foot medium bipin lamps, 2-foot U-shaped lamps, 4-foot miniature bipin standard output lamps, 4-foot miniature bipin high output lamps	0.993	0.51	0.37
Instant start and rapid start ballasts (not classified as sign ballasts) that are designed to operate 8-foot high output lamps	0.993	0.38	0.25
Programmed start ballasts (not classified as sign ballasts) that are designed to operate 8-foot high output lamps	0.973	0.70	0.37
Sign ballasts that operate 8-foot high output lamps	0.993	0.47	0.25
Instant start and rapid start residential ballasts that operate:			
4-foot medium bipin lamps, 2-foot U-shaped lamps, 8-foot slimline lamps	0.993	0.41	0.25
Programmed start residential ballasts that are designed to operate:			
4-foot medium bipin lamps, 2-foot U-shaped lamps	0.973	0.71	0.37

2. History of Standards Rulemakings for Fluorescent Lamp Ballasts

On September 19, 2000, DOE published a final rule in the **Federal Register**, which completed the first of the two rulemaking cycles to evaluate and amend the energy conservation standards for fluorescent lamp ballasts (2000 FL Ballast Rule). 65 FR 56740. The rulemaking established a standard reflecting a recommendation presented in a joint comment submitted by members of the fluorescent lamp ballast (FLB) industry and energy efficiency advocacy organizations. (*Id.*)

On October 18, 2005, DOE published a final rule in the **Federal Register** codifying the new FLB standards established in EPACT 2005 section 135(c)(2) into the CFR at 10 CFR 430.32(m). 70 FR 60407. These standards established ballast efficiency requirements for ballasts that operate ''energy saver'' versions of full-wattage lamps, such as the F34T12 lamp.

Following the amendments from EPACT 2005, the second rulemaking cycle required by 42 U.S.C. 6295(g)(7) was completed with publication of the 2011 FL Ballast Rule. 76 FR 70548. The 2011 FL Ballast Rule changed the metric required for fluorescent lamp ballasts from ballast efficacy factor (BEF) to ballast luminous efficiency (BLE) and set new and amended energy conservation standards.

In support of the present review of the fluorescent lamp ballast energy conservation standards, DOE prepared the ''Energy Conservation Standards Rulemaking Framework Document for Fluorescent Lamp Ballasts'' (Framework Document), which describes the procedural and analytical approaches DOE anticipated using to evaluate energy conservation standards for fluorescent lamp ballasts. On June 23, 2015, DOE published a notice announcing the availability of the Framework document. 80 FR 35886. The Framework document is available at *https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=3.*

DOE held a public meeting on July 17, 2015, at which it described the various analyses that DOE would conduct as part of its review of the energy conservation standards for fluorescent lamp ballasts, such as the engineering analysis, the LCC and PBP analyses, and the NIA. Representatives for manufacturers, trade associations, environmental and energy efficiency advocates, and other interested parties attended the meeting.[3]

III. General Discussion

DOE developed this proposed determination after considering oral and written comments, data, and information from interested parties that represent a variety of interests. This notice addresses issues raised by these commenters.

A. Product Classes and Scope of Coverage

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or other performance-related features that justify differing standards. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (42 U.S.C. 6295(q)) The product classes for this proposed determination are discussed in further detail in section IV.A.5. This proposed determination covers fluorescent lamp ballasts defined as a device which is used to start and operate fluorescent lamps by providing a starting voltage and current and limiting the current during normal operation. 10 CFR 430.2. The scope of coverage is discussed in further detail in section IV.A.1.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE's current energy conservation standards for fluorescent lamp ballasts are expressed in terms of BLE. (See 10 CFR 430.32(m).)

DOE published a test procedure final rule on October 22, 2009, establishing standby mode energy consumption test procedures for fluorescent lamp ballasts (2009 Standby Test Procedure). 74 FR 54445. DOE published a test procedure final rule on May 4, 2011, establishing revised active mode test procedures for fluorescent lamp ballasts (2011 Active Mode Test Procedure). 76 FR 25211. The test procedures for fluorescent lamp ballasts are codified in appendix Q to subpart B of part 430.[4]

Subsequently, DOE published several final rules further refining the test procedures for fluorescent lamp ballasts. On February 4, 2015, in a final rule, DOE adopted amendments to further specify the appropriate test procedure and that followed the intent of the 2011 Active Mode Test Procedure to support any new or revised energy conservation standards at the time those standards require compliance. 80 FR 5896. On June 5, 2015, in a final rule, DOE revised definitions and test setup, modified organization of requirements, and deleted obsolete requirements. 80 FR 31971. On April 29, 2016, in a final rule, DOE replaced all instances of ballast efficacy factor (BEF) with BLE as applicable, added rounding instructions for BLE and power factor, clarified represented value instructions for power factor, and clarified lamp-ballast pairings for testing. 81 FR 25595.

In the Framework document, DOE requested comments on the current test procedures for fluorescent lamp ballasts and whether amendments are needed. Pacific Gas and Electric Company, Southern California Gas Company, San Diego Gas and Electric Company, and Southern California Edison, collectively referred to herein as the California investor-owned utilities (CA IOUs), and the Northwest Energy Efficiency Alliance (NEEA) recommended that DOE begin a review of its test procedure for fluorescent lamp ballasts if it is considering expanding the scope of standards to dimming ballasts. (CA IOUs, No. 10 at p. 3; NEEA, Public Meeting Transcript, No. 5 at p. 68) The National Electrical Manufacturers Association (NEMA) and Philips Lighting North America Corporation (Philips)[5] stated that some technical experts have been considering an alternative testing procedure that would require preheating potted ballasts. They asserted that this alternative test procedure would remove the need to acquire large amounts of data and save time but yield comparable results to the current DOE test procedure. (Philips, No. 8 at p. 2; NEMA, No. 12 at p. 2)

DOE appreciates the feedback on DOE's current test procedures for fluorescent lamp ballasts. DOE initiated a review of the test procedures and on March 18, 2019, published a notice of proposed rulemaking for FLB test procedures in which it discusses these comments in detail (hereafter ''FLB TP NOPR''). 84 FR 9910.

C. Technological Feasibility

1. General

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

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) Practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii)–(iv) Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.A.4 of this document discusses the results of the screening analysis for fluorescent lamp ballasts, particularly the designs DOE considered, those it screened out, and

[3] A transcript of the public meeting and supporting documents are available in the docket for this proposed determination at: *https://www.regulations.gov/docket?D=EERE-2015-BT-STD-0006.*

[4] The 2011 Active Mode Test Procedure Final Rule established appendix Q1 to subpart B of part 430, which was subsequently redesignated as appendix Q to subpart B of part 430 by the clarification rule published in 2015. 80 FR 31971 (June 5, 2015).

[5] Between the time of the public meeting and the publication of this NOPD, Philips Lighting changed its name to Signify. However, because at the time, the name was Philips, as well as comments in the docket were provided under the Philips name, throughout this document, its comments will refer to the company name at the time of the public meeting.

those that are the basis for the standards considered in this proposed determination. For further details on the screening analysis for this proposed determination, see chapter 4 of the NOPD technical support document (TSD).

2. Maximum Technologically Feasible Levels

When DOE considers amended standards for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such a product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for fluorescent lamp ballasts, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this analysis are described in section IV.B of this proposed determination and in chapter 5 of the NOPD TSD.

D. Energy Savings

1. Determination of Savings

For each efficiency level (EL) evaluated, DOE projected energy savings from application of the EL to the fluorescent lamp ballast purchased in the 30-year period that begins in the assumed year of compliance with the potential standards (2023–2052). The savings are measured over the entire lifetime of the fluorescent lamp ballasts purchased in the previous 30-year period. DOE quantified the energy savings attributable to each EL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its NIA spreadsheet model to estimate national energy savings (NES) from potential amended standards for fluorescent lamp ballasts. The NIA spreadsheet model (described in section IV.G of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports NES in terms of both site and source energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. DOE also calculates NES in terms of full-fuel-cycle (FFC) energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[6] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.G of this document.

2. Significance of Savings

In determining whether amended standards are needed, DOE must consider whether such standards will result in significant conservation of energy. (42 U.S.C. 6295(m)(1)(A)) In the Proposed Procedures for Use in New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Commercial/Industrial Equipment (''Proposed Process Rule''), DOE recently proposed to define a significant energy savings threshold. (84 FR 3910, February 13, 2019). Specifically, DOE stated that it is considering using two step approach that would consider both a quad threshold value and a percentage threshold value to ascertain whether a potential standard satisfies 42 U.S.C. 6295(o)(3)(B) to ensure that DOE avoids setting a standard that ''will not result in significant conservation of energy.'' 84 FR 3924. In a subsequent Notice of Data Availability, DOE noted that because EPCA uses a household energy consumption metric as a threshold for setting standards for new covered products (42 U.S.C. 6295(l)(1)), DOE believes that site energy would be the most appropriate metric for evaluating energy savings across rulemakings. (86 FR 36037, July 26, 2019) As a result, DOE provided national site energy savings data from its past rulemakings for public comment to help inform DOE's decision regarding whether (and how) to define a threshold for significant energy savings. Consistent with this approach, in addition to source energy savings and FFC energy savings, DOE's analysis presents site energy savings. In addition, DOE's conclusions with respect to significance of energy savings are based on site energy savings. DOE's updates to the Process Rule have not yet been finalized.

[6] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).

E. Cost Effectiveness

In making a determination of whether amended energy conservation standards are needed, EPCA requires DOE to consider the cost effectiveness of amended standards in the context of the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(m)(1)(A), (n)(2), and (o)(2)(B)(i)(II))

In determining cost effectiveness of amending standards for fluorescent lamp ballasts, DOE conducted LCC and PBP analyses to evaluate the economic effects on individual consumers of potential energy conservation standards for fluorescent lamp ballasts. To further inform DOE's consideration of the cost effectiveness of amended standards, DOE considered the NPV of total costs and benefits estimated as part of the NIA. The inputs for determining the NPV of the total costs and benefits experienced by consumers are (1) total annual installed cost, (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings.

F. Other Analyses

In addition, DOE conducted a MIA that determines the potential economic impact of amended standards on FLB manufacturers.

The analyses employed by DOE in its consideration of each of the criteria applied are discussed in the following sections.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE performed for this proposed determination with regard to fluorescent lamp ballasts. Separate subsections address each component of DOE's analyses. DOE used several analytical tools to estimate the impact of potential energy conservation standards. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential energy conservation standards. The NIA uses a second spreadsheet set that provides shipments projections and calculates NES and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (GRIM), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the website: *https://*

www.regulations.gov/docket?D=EERE-2015-BT-STD-0006.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly available information. The subjects addressed in the market and technology assessment for this proposed determination include (1) a determination of the scope and product classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends, and (6) technologies or design options that could improve the energy efficiency of fluorescent lamp ballasts. The key findings of DOE's market assessment are summarized in the following sections. See chapter 3 of the NOPD TSD for further discussion of the market and technology assessment.

1. Scope of Coverage and Product Classes

Fluorescent lamp ballast means a device which is used to start and operate fluorescent lamps by providing a starting voltage and current and limiting the current during normal operation. 10 CFR 430.2. In this analysis, DOE relied on the definition of ''fluorescent lamp'' in 10 CFR 430.2, which provides the specific lamp lengths, bases, and wattages included by the term. Any product meeting the definition of fluorescent lamp ballast is included in DOE's scope of coverage, though all products within the scope of coverage may not be subject to standards.

As part of its review of energy conservation standards for fluorescent lamp ballasts, DOE also evaluated whether current standards should be extended to additional fluorescent lamp ballasts.

Fluorescent lamp ballasts manufactured on or after November 14, 2014, that are designed and marketed to operate at an input voltage at or between 120 volts (V) and 277 V, to operate with an input current frequency of 60 hertz, and for use with fluorescent lamps as defined in 10 CFR 430.2, are currently required to comply with the energy conservation standards at 10 CFR 430.32(m)(1).

Fluorescent lamp ballasts manufactured on or after November 14, 2014, that are designed and marketed to operate at an input voltage at or between 120 and 277 V, to operate with an input current frequency of 60 hertz, for dimming to 50 percent or less of the maximum output of the ballast, and to operate one or two F34T12 lamps, two F96T12 Energy Saver (ES) lamps, or two F96T12 high output (HO) ES lamps are required to comply with the energy conservation standards at 10 CFR 430.32(m)(2).

The following fluorescent lamp ballasts are exempt from standards: (1) A dimming ballast designed and marketed to operate exclusively lamp types other than one F34T12, two F34T12, two F96T12/ES, or two F96T12HO/ES lamps; (2) a low frequency ballast that is designed and marketed to operate T8 diameter lamps; is designed and marketed for use in electromagnetic-interference-sensitive-environments only; and is shipped by the manufacturer in packages containing 10 or fewer ballasts; or (3) a programmed start ballast that operates 4-foot medium bipin T8 lamps and delivers on average less than 140 milliamperes (mA) to each lamp. 10 CFR 430.32(m)(3).

In the Framework document, DOE considered extending the scope of standards to the following: (1) All dimming ballasts, (2) 4-foot T8 MBP programmed start (PS) ballasts with an average current less than 140 mA, and (3) ballasts that operate on an input voltage of 480 V. DOE did not consider extending the scope of standards to low frequency ballasts that are designed and marketed to operate T8 diameter lamps and for use in electromagnetic-interference-sensitive-environments (EMI-sensitive-environments) only.

DOE received several general comments on its consideration of extending standards to additional fluorescent lamp ballasts. Philips noted that such consideration should account for the declining ballast market that is reducing annually by about 20 percent. (Philips, No. 8 at p. 16) NEMA noted that no new products or categories of ballasts are under development. (NEMA, No. 12 at p. 5) However, CA IOUs stated that DOE has the opportunity to capture significant energy savings for fluorescent lamp ballasts by expanding the scope of standards to previously exempted products (*e.g.,* dimming ballasts). CA IOUs recommended that DOE evaluate the market and utility for ballasts used in EMI environments, ballasts that operate at input voltages of 480 V, and low-current PS ballasts to determine if exemptions for these products are still warranted. (CA IOUs, No. 10 at p. 1) The Appliance Standards Awareness Project (ASAP) similarly stated that DOE should consider expanding the scope of standards to include other fluorescent lamp ballasts to avoid potential loopholes. (ASAP, No. 7 at p. 3) Lutron noted that because light-emitting diode (LED) technology is still new and already more efficacious than fluorescent technology, it is premature to subject LED drivers to standards. (Lutron, No. 9 at p. 3)

DOE conducted an assessment of whether standards should be extended to certain fluorescent lamp ballasts that are not currently subject to standards. DOE also evaluated whether current exemptions from standards should be maintained. DOE notes that this proposed determination addresses only fluorescent lamp ballasts and not any other technology such as LED drivers. The following sections discuss DOE's consideration of extending the scope of standards to additional fluorescent lamp ballasts.

a. Dimming Ballasts

Currently, only certain dimming ballasts are subject to standards.[7] In the Framework document, DOE stated it would consider extending standards to all dimming ballasts. Several stakeholders did not support DOE considering standards for all dimming ballasts. Universal Lighting Technologies (ULT) asserted that energy savings from improving the efficiency of dimming ballasts were likely to be smaller than energy savings from the use of controls in a space. (ULT, No. 6 at p. 2) NEMA stated that its business market survey data indicated that dimming ballasts are about 2.29 percent of the linear FLB market. (NEMA, No. 12 at pp. 3–4) Philips stated that while the fixed output ballast market has declined overtime and dimming ballasts have become a larger portion of the overall mix, in absolute numbers, dimming ballasts have not increased as indicated by NEMA's market data from the past 12 quarters. Further, Philips noted that it will be difficult to justify costs to improve efficiency of dimming ballasts over investment in solid-state lighting (SSL) development. (Philips, No. 8 at pp. 10–11) NEMA, Philips, and ULT indicated that the dimming ballast market will shrink due to the penetration of solid-state lighting. (ULT,

[7] Fluorescent lamp ballasts manufactured on or after November 14, 2014, that are designed to operate at an input voltage at or between 120 and 277 V and with an input current frequency of 60 hertz, for dimming to 50 percent or less of the maximum output of the ballast, and to operate one or two F34T12 lamps, two F96T12 ES lamps, or two F96T12 HO ES lamps. 10 CFR 430.32(m)(2)

No. 6 at p. 2; Philips, No. 8 at pp. 10–11; NEMA, No. 12 at p. 4)

Several stakeholders expressed support for DOE analyzing standards for all dimming ballasts. ASAP requested that DOE consider standards for fluorescent lamp ballasts capable of dimming below 50 percent of full output, and to include digitally addressable or networkable ballasts. (ASAP, No. 7 at p. 2) ASAP and CA IOUs stated that the California Title 24 (CA Title 24 [8]) building code will greatly increase sales of ballasts capable of dimming below 50 percent of full light output, which currently are not subject to DOE standards. Therefore, ASAP and CA IOUs stated that the majority of ballasts purchased for new construction projects (as well as some retrofit projects according to CA IOUs) in California will not be regulated by DOE. (CA IOUs, No. 10 at p. 2; ASAP, No. 7 at p. 2; CA IOUs, Public Meeting Transcript, No. 5 at p. 106) ASAP added that it expects that these changes in California will occur across the country as new dimming ballasts become more widely available. (ASAP, No. 7 at p. 2)

However, ULT and NEMA asserted that PS fixed output ballasts that are controlled by occupancy sensors or other control devices can meet the requirements of California building codes and ASHRAE standards (when adopted) and are already covered by DOE standards. ULT added that outside of a specific room (*e.g.,* conference room) a continuously dimmed product is not necessary. Further, ULT noted that solid-state lighting already comes standard with the ability to continuously dim. (ULT, No. 6 at p. 2; NEMA, No. 12 at p. 4)

DOE appreciates the feedback regarding the shipment trends of fluorescent lamp ballasts as a whole and that of dimming ballasts. However, DOE has observed that since the 2011 FL Ballast Rule, product offerings of dimming ballasts have increased. DOE's review of manufacturer catalogs indicates a wide range of dimming ballast products are now available for use with several lamp types.[9] Further, DOE has observed a range of efficiencies for dimming ballasts, indicating that less efficient products can be improved. Additionally, as noted by stakeholders, state and local regulations and building codes with increased dimming and/or lighting control requirements (*e.g.,* CA Title 24 and ANSI/ASHRAE/IES Standard 90.1–2016 [10]) will continue to support installation of dimming ballasts in the near future. Therefore, DOE considers that standards for dimming ballasts could result in potential energy savings.

Lutron and NEMA stated that regulations on dimming ballast efficiency may reduce their availability and may limit potential energy savings from dimming systems. (Lutron, No. 9 at p. 2; NEMA, No. 12 at pp. 3–4) Lutron agreed with extending standards to dimming ballasts if the standards accommodate functionality and features of dimming ballasts when used in an intelligent light system, noting that these systems will result in more energy savings than improving the efficiency of dimming ballasts. (Lutron, No. 9 at p. 2)

In evaluating potential standards, DOE's analysis contemplates that performance characteristics (including reliability), features, sizes, capacities, and volumes available to the consumer would remain available at improved efficiencies of the product.

In summary, in this analysis DOE considered standards for dimming ballasts and presents the results of an analysis of the technological feasibility, energy savings, and cost effectiveness of standards for dimming ballasts.

b. Ballasts Operating at 480 V

Currently only fluorescent lamp ballasts designed and marketed to operate at nominal input voltages at or between 120 and 277 V are subject to standards. 10 CFR 430.32(m)(1)(i), (2)(i). ASAP requested that DOE change the scope of current standards to include ballasts that operate at 120 V to 480 V. (ASAP, No. 7 at p. 3) However, ULT, General Electric (GE), and NEMA stated that the market for ballasts that operate at 480 V is very small, and regulation of these products would not result in a lot of energy savings. (GE, Public Meeting Transcript, No. 5 at p. 38; ULT, No. 6 at p. 3; NEMA, No. 12 at p. 5) Philips agreed and noted that current standards cover the vast majority of the market by regulating ballasts that operate at input voltages of 120 V to 277 V. (Philips, No. 8 at pp. 11–12)

ASAP and CA IOUs raised concerns that even if the market for these products is small, they may become a loophole in industrial applications because fluorescent technology has been replacing high-intensity discharge (HID) lighting in high bay applications that are often on 377 V or 480 V circuits. They encouraged DOE to determine if this shift to fluorescent technology, particularly in the retrofit market, will continue to increase in the future. (ASAP, No. 7 at p. 3; CA IOUs, No. 10 at p. 10)

ULT stated that ballasts that operate at 480 V are typically used in the industrial applications that function on highly transient power (*i.e.,* ''dirty power''). ULT and NEMA stated that these ballasts have added circuitry to ensure that they can withstand high transient lines, which also makes them expensive. (ULT, Public Meeting Transcript, No. 5 at p. 37; ULT, No. 6 at p. 3; NEMA, No. 12 at p. 5) GE added that because these ballasts are niche products, manufacturers would not expend time and effort to redesign them. (GE, Public Meeting Transcript, No. 5 at p. 38) NEMA asserted that if regulated they would become obsolete. (NEMA, No. 12 at p. 5)

When considering extending coverage to additional ballasts, DOE considers whether potential energy conservation standards for these products would result in significant energy savings. In the 2011 FL Ballast Rule, DOE examined the ballast market and found input voltages of 120 V to 277 V to be common to the U.S. market. Ballasts outside this range were primarily designed for foreign markets, such as 347 V ballasts for the Canadian market. 76 FR 70548, 70559. In this analysis, based on DOE's review of manufacturer catalogs, fluorescent lamp ballasts designed to operate at 120 V to 277 V remain the most common, and product offerings for ballasts designed to operate at voltages higher than 277 V were minimal. Further, based on manufacturer feedback and DOE research, a shift from HID to fluorescent technology will likely be minor as SSL technology continues to penetrate the lighting market.[11] Based on DOE's assessment, standards for fluorescent lamp ballasts operating at 480 V would not likely result in significant energy savings. Hence, DOE is not considering extending the scope of standards to fluorescent lamp ballasts designed and marketed to operate at voltages higher than 277 V.

[8] California Energy Commission. *2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings.* CEC-400-2012-004–CMF–REV2. Sacramento, CA: CEC, 2012. Available at *http://www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf.*

[9] Specifically, 4-foot MBP lamps, 2-foot U-shaped lamps, 4-foot MiniBP SO lamps, and 4-foot MiniBP HO lamps.

[10] American Society of Heating, Refrigerating, and Air-Conditioning Engineers. *ANSI/ASHRAE/IES Standard 90.1–2016—Energy Standard for Buildings Except Low-Rise Residential Buildings.* Atlanta, GA: ASHRAE, 2016.

[11] There was no increase in shift from HID technology to fluorescent technology in high-bay applications from 2012 to 2014 according to the DOE *Adoption of Light-Emitting Diodes in Common Lighting Applications.* Available at *http://energy.gov/sites/prod/files/2015/07/f24/led-adoption-report_2015.pdf.*

c. Low-Current PS Ballasts

Currently DOE exempts from standards a PS ballast that operates 4-foot T8 MBP lamps and delivers on average less than 140 milliamperes (mA) to each lamp (*i.e.,* low-current PS ballast). 10 CFR 430.32(m)(3)(iii). In the Framework document, DOE stated it will reevaluate the justification for this exemption. (Framework Document, No. 1 at p. 13)

NEMA, ULT, and GE stated that DOE should continue to exempt low-current PS ballasts from standards as they are a niche market. (ULT, Public Meeting Transcript, No. 5 at p. 37; NEMA, No. 12 at p. 5; GE, Public Meeting Transcript, No. 5 at p. 38; Philips, No. 8 at p. 11) ULT added that energy savings from standards would be offset by those resulting from the low light output. (ULT, Public Meeting Transcript, No. 5 at pp. 35–36)

ASAP raised concerns that low-current PS ballasts may become a loophole in the future as they could serve as a low-cost option in markets for inefficient equipment. (ASAP, Public Meeting Transcript, No. 5 at p. 33) ULT responded that to operate at a low ballast factor, a ballast must have an open current voltage, flicker control, as well as cathodes, all of which add cost to such products. (ULT, Public Meeting Transcript, No. 5 at pp. 35–36)

Further, NEMA and ULT stated that if regulated, these products would not comply with DOE efficiency standards and become obsolete as their low volume would not warrant redesign, eliminating a unique utility. (NEMA, No. 12 at p. 5; ULT, No. 6 at p. 3) ASAP and CA IOUs stated that the unique utility of low-current PS ballasts is unclear. (ASAP, No. 7 at p. 3; CA IOUs, No. 10 at p. 10) ASAP stated that there are multiple more-efficient lamp-and-ballast combinations available on the market that can provide light output comparable to low-current PS ballast systems. (ASAP, No. 7 at p. 3) CA IOUs suggested alternatives such as using reduced-wattage lamps or fewer lamps and/or fixtures as efficient replacements. However, CA IOUs stated that if DOE does find the low-current PS ballasts have a unique utility, DOE should ensure that they are operating as efficiently as possible. (CA IOUs, No. 10 at p. 10)

During the 2011 FL Ballast Rule, DOE determined that ballasts designed to operate 4-foot T8 MPB lamps are required to use some level of cathode power when operating lamps at currents less than 155 mA to maintain lamp life. Through testing, DOE learned the ballast factor of these ballasts was similar to or less than 0.7, offering a unique utility of low light output. Such ballasts also offered energy savings from their low power levels and use with occupancy sensors. However, DOE concluded that, because BLE decreases as current is decreased, none of the PS ballasts tested with an average current of less than 140 mA were able to meet the maximum efficiency levels analyzed in the PS product class. Therefore, DOE exempted these low-current PS ballasts from standards. 76 FR 70548, 70558.

In this analysis, DOE evaluated whether DOE should continue to maintain the exemption of low-current PS ballasts. DOE has tentatively determined that alternative options such as using PS ballasts with operating current at 140 mA or higher, paired with reduced-wattage lamps or decreasing the number of lamps in the system could provide low light output levels comparable to those attained using low-current PS ballasts. DOE identified lamp-and-ballast replacements that maintained system light output within 10 percent of a lamp-and-ballast system using a low-current PS ballast and saved energy.

Because there are reasonable alternatives to providing the low light output utility offered by low-current PS ballasts, the low-light feature provided may no longer be unique to these products as when DOE evaluated them for the 2011 Ballast Rule. As such, DOE included in its current analysis potential standards for PS ballasts that operate 4-foot T8 MBP lamps and deliver on average less than 140 mA to each lamp.

d. Low Frequency EMI Ballasts

Currently DOE exempts low frequency ballasts designed and marketed to operate T8 diameter lamps for use in EMI environments only (''low frequency EMI ballasts''). They must be shipped by the manufacturer in packages containing 10 or fewer ballasts. 10 CFR 430.32(m)(3)(ii) For applications in which EMI has been or is expected to pose safety concerns, magnetic ballasts that operate at low frequency are typically recommended. Because these EMI-related safety concerns still exist, in the Framework document, DOE stated it did not plan to remove this exemption.

NEMA, GE, ULT, and Philips agreed that low frequency EMI ballasts should not be subject to standards. (ULT, No. 6 at p. 3; Philips, No. 8 at p. 12; NEMA, No. 12 at p. 5; GE, Public Meeting Transcript, No. 5 at p. 43) GE added that these are a low volume, niche product and the best solution for EMI-sensitive environments. (GE, Public Meeting Transcript, No. 5 at p. 43) ASAP stated that the exemption of these ballasts made sense to the extent that EMI from technology continues to be a concern. (ASAP, Public Meeting Transcript, No. 5 at pp. 42–43)

In the 2011 FL Ballast Rule, DOE conducted research and interviews with FLB and fixture manufacturers to identify several applications as potentially sensitive to EMI. Applications potentially sensitive to EMI include but are not limited to medical operating room telemetry or life support systems, airport control systems, electronic test equipment, radio communication devices, radio recording studios, correctional facilities, clean rooms, facilities with low signal-to-noise ratios, and aircraft hangars or other buildings with predominantly metal construction. 76 FR 70548, 70557. In this analysis, DOE tentatively finds that EMI from fluorescent lamp ballasts continues to be a safety concern.

ASAP asked for more information regarding the definition of EMI-sensitive environments, Federal Communications Commission's (FCC's) authority on this issue, and the method of sales and shipment to restrict leakage of EMI-labeled product into other applications. (ASAP, Public Meeting Transcript, No. 5 at pp. 42–43) FCC in 47 CFR part 18 regulates industrial, scientific, and medical (ISM) equipment that emits electromagnetic energy on frequencies within the radio frequency spectrum in order to prevent harmful interference to authorized radio communication services. 47 CFR 18.101. Falling under the category of radio frequency lighting devices, fluorescent lamp ballasts would be subject to certain conduction limits. 47 CFR 18.307(c). (The Department of Defense (DoD) also has its own EMI requirements.[12]) The FCC should be consulted for further information on regulating products that emit electromagnetic energy.

ASAP stated DOE should examine the full range of existing low EMI, energy efficient fluorescent lamp technology options. (ASAP, No. 7 at p. 4) CA IOUs stated instead of magnetic ballasts designed and labeled specifically for use in EMI-sensitive environments,

[12] The DoD MIL–STD–461G section CE102 applies to conducted emissions from power leads between 10 kilohertz (kHz) and 10 megahertz (MHz) while the standards in section RE102 apply to radiated emissions between 10 kHz and 18 gigahertz (GHz). These standards establish ''interface and associated verification requirements for the control of the EMI emission and susceptibility characteristics of electronic, electrical, and electromechanical equipment and subsystems designed or procured for use by activities and agencies of the Department of Defense (DoD).''

consumers can use ''hybrid'' magnetic/electronic ballasts and remote-mounted electronic ballasts, as well as LED light sources. CA IOUs encouraged DOE to reconsider the need for these less efficient products when alternatives are available. (CA IOUs, No. 10 at p. 10)

The source of EMI in a fluorescent lamp-and-ballast system consists mainly of switching components (transistors) in the ballast and the fluorescent lamp and lead wires. In high-frequency electronic ballasts, switching components create rapidly changing electric fields eventually resulting in interference with other circuits on the line. Low-frequency magnetic ballasts do not have switching components, dramatically reducing EMI generation. Additionally, lamp and lead wires create a loop that in the presence of a rapidly switching alternating current (AC) waveform creates an antenna for radiated EMI. This phenomenon is more pronounced with electronic ballasts compared to magnetic ballasts. For these reasons, magnetic ballasts are typically recommended for use in EMI-sensitive environments.

In the 2011 FL Ballast Rule, DOE examined alternative options such as use of external EMI filters with electronic ballasts as well as shielding the ballast with conductive material to mitigate the effects. However, DOE could not confirm that such methods would definitely prevent issues related to EMI. In this analysis, DOE again researched alternative options. In general, DOE found limited product offerings for hybrid magnetic/electronic ballasts and remote-mounted electronic ballasts. DOE's research indicated that the hybrid magnetic/electronic ballasts would not meet existing efficiency standards. Further remote-mounted electronic ballasts would require separate fixtures for the lamp and for the ballast and require installation of additional components such as EMI shielding on the leads and ferrite clamp on the output wires to safeguard against EMI issues.[13] While the typical LED systems in which AC power is converted to DC would cause the same EMI issues as electronic ballasts, direct DC-powered LED systems do have the potential to mitigate EMI issues. However, these also would require a fixture change. Further, because these products are not designed specifically for EMI-sensitive applications, it is not clear that they adequately mitigate the effects of EMI.

[13] Philips states remote mounting impacts EMI behavior and additional measures may be necessary to reduce EMI: *http://images.philips.com/is/content/PhilipsConsumer/PDFDownloads/United%20States/ODL20160330_001_UPD_en_US_PAd-1615DG_Advance_Xitanium_Indoor_Driver_20160324.pdf#page=5.*

ASAP stated that because residential ballasts are subject to less stringent energy efficiency standards than commercial ballasts due to being subject to more stringent FCC EMI requirements, DOE should at least subject the low frequency EMI ballasts to the current residential FLB energy efficiency standards. (ASAP, No. 7 at p. 4)

DOE's evaluation indicates that magnetic ballasts continue to not meet existing standards, including those for residential ballasts.

ASAP also stated that DOE should evaluate if it is necessary to further limit the language ''designed, labeled, and marketed for use in EMI-sensitive environments only'' used to specify the exemption as it creates a significant opportunity for low EMI, low price, and energy inefficient ballasts to gain significant market share. ASAP encouraged DOE to collect sales data on ballasts specified as low EMI and intended for commercial use. (ASAP, No. 7 at pp. 3–4; ASAP, Public Meeting Transcript, No. 5 at p. 43) Philips stated that EMI environments are very specific (*e.g.,* nuclear power plants, military bases) and because of the low volume, these ballasts are more expensive. Therefore, it is unlikely that they would start replacing electronic ballasts or LED technology with low frequency EMI ballasts. (Philips, Public Meeting Transcript, No. 5 at pp. 43–44)

DOE currently describes the exemption as ''A low frequency ballast that is designed and marketed to operate T8 diameter lamps; is designed and marketed for use in EMI environments only; and is shipped by the manufacturer in packages containing 10 or fewer ballasts.'' 10 CFR 430.32(m)(3)(ii) DOE finds that because the definition requires the application to be stated in all publicly available documents and caps the amount of ballasts sold in one package, it is a sufficient deterrent to potential unintended use of these ballasts. Further, based on a review of manufacturer catalogs, DOE did not find a substantial number of magnetic ballasts designed and marketed for use in EMI-sensitive environments only, which might have indicated an increasing market share.

Because magnetic ballasts are the only option that can definitively address safety concerns regarding EMI and they do not meet existing standards, DOE is not considering removing the current exemption for low frequency EMI-sensitive ballasts.

2. Metric

a. Active Mode Energy Consumption

Current energy conservation standards for fluorescent lamp ballasts are applicable to active mode energy use and are based on BLE. This metric is a ratio of the power provided by the ballast to the lamp divided by the input power to the ballast. The metric also includes an adjustment factor to account for the reduced system efficacy associated with operation at low-frequency (*i.e.,* 60 Hertz). DOE continues to use the BLE metric in this proposed determination to assess active mode energy use.

DOE received comments recommending it adopt a weighted BLE metric for dimming ballasts. CA IOUs stated that they had supported California Energy Commission (CEC) in developing Title 20 state appliance energy efficiency standards for fluorescent lamp ballasts and strongly suggested DOE take this analysis into consideration in this effort. (CA IOUs, No. 10 at p. 2) CA IOUs stated that dimming ballasts have a large potential for energy savings because not all products dim the same way, and prior to the CEC rule regarding dimming ballasts, there was no description of ballast performance at dimmed settings. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 72–73)

Due to this lack of data, CA IOUs tested dimming ballasts to understand performance below full light output using the DOE's test procedure for fixed output ballasts. (These data are publicly available in CEC's rulemaking docket: #14–AAER–1.) Specifically, CA IOUs tested 34 T8 dimming ballasts that operate from one lamp up to four lamps, which were selected from 180 T8 dimming ballasts listed by the Consortium for Energy Efficiency (CEE) as qualifying commercial lighting products. In addition they tested seven T5 dimming ballasts that operate two lamps. CA IOUs stated that this testing, while not comprehensive of the full market, was a good starting point. CA IOUs measured the performance of dimming ballasts at 100 percent full output and then at input powers decreasing by 5 percent increments until reaching zero light output using DOE's current test procedure. Based on these data, CA IOUs noted that ballasts that have the same efficiency at full light output may not perform the same at lower light output levels. For instance, two ballasts may have the same performance at full light output, but may have a 3–5 W difference in power consumption at 50 percent of full output. (CA IOUs, No. 10 at pp. 2–3, 8;

CA IOUs, Public Meeting Transcript, No. 5 at pp. 17, 54)

Because of this difference in efficiency at lower light outputs, CA IOUs stated that CEC has proposed standards for dimming fluorescent lamp ballasts based on weighting the ballast efficiency measurements at 100 percent, 80 percent, and 50 percent of full arc power in order to generate one BLE value. CA IOUs stated that 80 percent is a typical setting when tuning light and a built-in assumption for savings in certain utility lighting programs, and 50 percent is a representative operating setting for bi-level dimming ballasts. CA IOUs also stated that these levels were established after consulting with major FLB manufacturers and stakeholders who agreed that accurate and repeatable measurements could be taken at each of those operating levels. CA IOUs stated that DOE consider using these two points but supported additional test points below 50 percent of full light output and recommended DOE conduct further analysis on the feasibility of measurements at lower output levels. (CA IOUs, No. 10 at pp. 2–3; CA IOUs, Public Meeting Transcript, No. 5 at pp. 17, 54) ASAP agreed with CA IOUs that the test procedure and metric should be amended to measure BLE at partial light output for dimming ballasts, specifically testing at 80 and 50 percent of full light output in addition to 100 percent. (ASAP, No. 7 at pp. 2–3)

The efficiency of a dimming ballast may differ at different light outputs, and the efficiency at full light output may not reflect the efficiency at which the ballast always performs in application. However, DOE notes several issues with the accuracy and consistency in determining the performance of dimming ballasts using a weighted metric approach. First, the lack of conclusive data makes it difficult to determine the appropriate weightings to assign to reduced light output levels to reflect the most common use of dimming ballasts. For example, the weightings proposed by CEC are based on approximate average energy savings of dimming ballasts determined from a study on energy savings from institutional tuning including the use of dimming ballasts and switches (*i.e.,* light levels adjusted based on location-specific needs or building policies).[14] This study determines energy savings for one scenario of dimming ballast usage and is not necessarily representative of the common application nor actual operating hours of these products.

Second, as data provided by CA IOUs show, there is no consistent trend between efficiency and light output at lower levels across products. Manufacturers apply a range of acceptable cathode powers at lower currents and choose to do so through various techniques (*i.e.,* step, gradual) resulting in varied performance at lower light output levels. The range of acceptable cathode powers for T8 fluorescent dimming systems is provided by NEMA LL 9,[15] and both ballast and lamp manufacturers design their products accordingly. Hence, the cathode power required by a lamp may vary by lamp manufacturer. A manufacturer who produces both ballasts and lamps may design both products to provide/use the minimum amount of cathode heat. However, a manufacturer who produces only ballasts may design their product to provide the maximum amount of cathode heat so that it can operate all lamps available on the market. DOE finds that it is important to allow for this flexibility in designing ballasts and a metric should not favor one approach over another.

Hence, it is unclear if a weighted BLE metric would be an accurate representation of dimming ballasts in application or provide an approach for appropriately measuring performance across dimming products. Therefore, DOE evaluates the efficiency of dimming ballasts as the BLE at full light output, which reflects the most energy consumptive state. Measuring BLE at full light output ensures the accuracy of measured values and provides a consistent basis for comparing efficiencies across fluorescent lamp ballasts. DOE seeks comments on its evaluation of the efficiency of dimming ballasts as BLE at full light output. See section VII.C for a list of issues on which DOE seeks comment.

For dimming ballasts, Philips recommended a ballast efficiency metric that would include cathode power as opposed to the BLE metric which does not. Philips explained that to dim light output the lamp power and thereby cathode power is reduced. To prevent the resulting possibility of shortening lamp life and unstable lamp operation, most dimming ballasts utilize added cathode power in dimming mode. Philips presented an example of a 2L T8 MBP 32 W ballast showing that at full light output BLE and ballast efficiency are the same but at lower light output levels, ballast efficiency is higher because it includes total lamp arc power plus cathode power while BLE includes total lamp arc power. Philips concluded that using the BLE metric at lower light output levels would underrepresent the efficiency of the ballast. (Philips, No. 8 at pp. 16–29) Therefore, Philips asserted and NEMA agreed that including cathode power in the metric is important because it provides utility to dimming ballasts at lower light output levels. (Philips, No. 8 at pp. 16–29; NEMA, No. 12 at p. 7) Philips noted that measuring ballast efficiency would require more measurements, but testing time could be reduced with the use of a multiport power analyzer. (Philips, No. 8 at pp. 16–29)

Because DOE is using a metric of BLE measured at full light output for dimming ballasts, the exclusion of cathode power from this measurement would not underrepresent the efficiency of dimming ballasts operating at lower light output levels. DOE is aware that the BLE metric represents cathode power as a loss and that ballasts that use cathode power will therefore appear less efficient than ballasts that do not. DOE accounts for this potential difference in efficiency by establishing separate product classes based on starting method. 10 CFR 430.32(m)(1)(ii)(B).

Philips also commented that the use of dimming ballasts is different than fixed output ballasts because they are always part of a lighting control system, whether or not it is a simple control. Philips stated that if dimming ballasts are required to use less energy, then to meet such requirements manufacturers will move control and communications designs from within the ballast to a separate extender box. Hence, while the ballast may be more efficient, the total efficiency of the system may not increase. Therefore, Philips suggested that DOE consider the entire system as opposed to only the ballast efficiency in its analysis. (Philips, Public Meeting Transcript, No. 5 at p. 119)

The scope of this proposed determination is fluorescent lamp ballasts and not an entire fluorescent lighting system. DOE finds that BLE adequately captures the efficiency of all fluorescent lamp ballasts. DOE does analyze energy use of the lamp-and-ballast system and uses this assessment of system energy use in its downstream analyses (*i.e.,* LCC, NIA, etc.).

CA IOUs stated that it is likely that their analysis of efficiencies of dimming ballasts in the dimming range below 140 mA will also be useful in understanding the cathode heating needs and determining appropriate standard levels

[14] Williams, Alison, Barbara Atkinson, Karina Garbesi, and Francis Rubinstein. *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings.* Ernest Orlando Lawrence Berkeley National Laboratory. September 2011.

[15] NEMA LL 9–2011, *Dimming of T8 Fluorescent Lighting Systems* (approved April 12, 2011).

for fixed-output, low current ballasts. (CA IOUs, No. 10 at p. 10)

DOE appreciates the data provided by CA IOUs. As noted, DOE evaluates all fluorescent lamp ballasts in this analysis based on BLE measured at full light output.

b. Standby Mode Energy Consumption

EPCA requires energy conservation standards adopted for a covered product after July 1, 2010, to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) EPCA defines active mode as 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. (42 U.S.C. 6295)(gg)(1)(A)(i)) Standby mode is defined as 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. (42 U.S.C. 6295)(gg)(1)(A)(iii)) Off mode is defined as 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. (42 U.S.C. 6295)(gg)(1)(A)(ii))

In the 2009 Standby Test Procedure, DOE determined that fluorescent lamp ballasts do not exhibit off mode energy use. In addition, DOE stated that the only ballasts subject to standby mode power measurements would be those that incorporate some electronic circuit enabling the ballast to communicate with and be part of a lighting control system (*e.g.,* a digitally addressable lighting interface, DALI). 74 FR 54445, 54448.

Based on DOE's characterization of ballasts capable of operating in standby mode in the 2009 Standby Test Procedure, NEMA and Philips concluded that DOE considers ballasts capable of operating in standby mode as digitally controlled ballasts, such as DALI. (NEMA, No. 12 at p. 3; Philips, No. 8 at pp. 5–6) ULT and NEMA stated that DALI ballasts are mostly used in conference rooms for atmospheric lighting and are shrinking in market size. They stated that the most common linear fluorescent lamp ballasts are operated as discrete devices from a centralized control panel that sends on/off and dimming commands and do not operate in standby mode. Further, ULT and NEMA asserted that 99 percent of the ballasts in the scope of this analysis do not operate in standby mode. (ULT, No. 6 at p. 2; NEMA, No. 12 at pp. 2–3) Lutron noted that DALI is not the only communication protocol used in ballasts capable of standby mode power consumption. (Lutron, Public Meeting Transcript, No. 5 at p. 49)

ASAP stated DOE should include digitally addressable or networkable ballasts and consider the associated standby losses of these products. ASAP expected dimming ballasts with digital control will be part of luminaire level lighting control, which involves independently controlling each luminaire in a space through integrated, programmable, network sensors. ASAP added that in such scenarios while the ballast may reduce active mode power consumption, it may also continue to consume power when switched ''off'' and not emitting light. Therefore, ASAP recommended that DOE should consider both standby losses and the benefits of increased controllability in its consideration of coverage for additional dimming ballasts. ASAP advised DOE to develop a better definition for ''network standby.'' (ASAP, No. 7 at p. 2) Additionally, CA IOUs recommended that DOE amend its standby mode test procedure to specify that a communications network (if applicable) should be connected to the ballast during testing to capture energy use in ''network standby.'' CA IOUs stated that this is important because ballasts will likely be consuming additional energy while actively ''listening'' for commands when connected to a communications network. (CA IOUs, No. 10 at p. 3)

NEMA stated that it is not easy to define a power consumption standard for a networked product because the standby and full mode power consumptions will vary based on the particular design and extent of functionality. (NEMA, Public Meeting Transcript, No. 5 at pp. 49–50) NEEA agreed with NEMA but noted that DOE would likely have to look at network standby if it decides to regulate dimming ballasts. (NEEA, Public Meeting Transcript, No. 5 at p. 50) Philips stated that DOE's determination of ballasts capable of operating in standby mode prevents conflict with other modes of operation defined in standards such as IEC 62301, which distinguishes between standby mode power and network mode power. (Philips, No. 8 at pp. 5–7) Philips also recommended that DOE develop a standby mode power test method that accounts for the wide range of input voltages. (Philips, No. 8 at p. 8)

EPCA requires DOE to address the standby mode consumption of a product. (42 U.S.C. 6295(gg)(3)) Based on DOE's definition of standby mode, DOE continues to consider a ballast is in standby mode if it has some electronic circuit enabling the ballast to communicate with and be part of a lighting control system and if at zero light output the ballast is standing by, connected to a main power source without being disconnected by an on/off switch or other type of relay. 74 FR 54445, 54448. Therefore, standby mode energy consumption of a ballast encompasses any communication by the ballast at zero light output. DOE finds that additional definitions to capture communication through specific types of protocols or systems (*i.e.,* network) are not necessary.

CA IOUs stated standby mode power constitutes a significant portion of the overall dimming ballast annual energy use and noted that CEC proposed a separate standard for standby mode power consumption for dimming ballasts. (CA IOUs, No. 10 at p. 4) CA IOUs reported that testing done according to DOE's test procedure showed dimming ballasts to have standby mode power consumption ranging from 0.3 to 1.9 W. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 15–16) ASAP supported CA IOUs comments recommending testing of standby mode energy consumption of ballasts similar to that proposed by CEC. (ASAP, No. 7 at p. 3)

NEMA and Philips noted that standby power energy use in the U.S. lighting industry varies greatly due to the wide range of functionality provided by digital ballasts. (NEMA, No. 12 at p. 3; Philips, No. 8 at p. 8) NEMA cautioned against overly restrictive limits on standby power, as they could reduce consumer-demanded functionality and DOE should note that lighting may become the point of connection for smart products. (NEMA, Public Meeting Transcript, No. 5 at pp. 49–50; NEMA, No. 12 at p. 3)

DOE tentatively finds in this analysis that a separate standard for standby power is unnecessary. Currently FLB standards for active mode are based on BLE, which is a ratio of the power provided by the ballast to the lamp divided by the input power to the ballast. DOE finds that for ballasts that are capable of standby mode operation, the measurement of input power for BLE in active mode would include standby mode power. Thus, DOE finds that energy conservation standards based on measuring the BLE of the ballast in active mode also capture the energy consumption in standby mode, where applicable. Further, DOE's analysis of standards for fluorescent lamp ballasts includes consideration of the continued availability of products that provide consumer utility presently provided.

3. Technology Options

In the Framework document, DOE identified several technology options that would be expected to improve the efficiency of fluorescent lamp ballasts, as measured by the DOE test procedure. To develop a list of technology options, DOE reviewed manufacturer catalogs, recent trade publications and technical journals, and consulted with technical experts. Specifically, DOE identified technology options identified in the 2011 FL Ballast Rule: magnetic FLB design, electronic FLB design, varying lamp diameter, higher grade components, and improved circuit design. In addition, DOE considered the following improved components as technology options:

- Increasing the number of steel laminations to lower core losses,
- Using optimized-gauge copper to increase the conductor cross section to reduce winding losses,
- Using wire with multiple smaller coils instead of one larger coil to increase the number of turns of wire, and
- Using shape-optimized winding to reduce the proximity effect losses.

In the Framework document, DOE requested comments on technology options for improving the BLE of fluorescent lamp ballasts. NEMA pointed out that core losses in the transformers and inductors used in electronic ballasts can be minimized by using low-loss ferrite materials. (NEMA, No. 12 at p. 6) In this analysis, DOE also considered the option of using low-loss ferrite materials to reduce the proximity effect.

CA IOUs recommended that DOE analyze the technology options for improving efficiency listed in the 2011 FL Ballast Rule, including improved components such as magnetics, diodes, capacitors, and transistors, as well as improved circuit design. (CA IOUs, No. 10 at p. 5)

Philips stated that the only way to increase efficiency would be to move to a different technology. ULT, Philips, and GE added that they and the industry are focusing on solid-state lighting, specifically LED. (ULT, Public Meeting Transcript, No. 5 at pp. 45–46; Philips, Public Meeting Transcript, No. 5 at p. 58; GE, Public Meeting Transcript, No. 5 at p. 67) Further, NEMA, GE, Philips, and ULT commented that fluorescent lamp ballasts are already at or close to their maximum achievable efficiency, and that the currently regulated products have no margin to improve efficiency. (NEMA, Public Meeting Transcript, No. 5 at pp. 9–11; GE, Public Meeting Transcript, No. 5 at p. 67; Philips, No. 8 at pp. 13–14; ULT, No. 6 at p. 5) NEMA, GE, and ULT asserted that the last rulemaking compressed the available levels of efficiency such that the current market only consists of a maximum and a minimum level, with very little room for differentiation among manufacturers. (NEMA, No. 12 at p. 7; GE, Public Meeting Transcript, No. 5 at p. 67; ULT, Public Meeting Transcript, No. 5 at pp. 45–46) Philips and ULT added that technology options such as transistors with reduced resistance, lowering impedance value on capacitors, increasing steel laminations, reducing winding resistance, increasing the turns of wire, and reducing proximity effect losses are already incorporated in current products. (Philips, Public Meeting Transcript, No. 5 at p. 58; ULT, No. 6 at p. 5) Lutron stated DOE should assume that all the dimming ballasts that are going to be available after any rule becomes effective are already on the market. (Lutron, Public Meeting Transcript, No. 5 at p. 104) Philips and GE noted that because fluorescent technology is on the decline, there are no new investments in fluorescent lamp ballasts. (Philips, Public Meeting Transcript, No. 5 at p. 58; GE, Public Meeting Transcript, No. 5 at p. 67)

Based on DOE's review of the product offerings and their efficiencies in manufacturer catalogs and DOE's Compliance Certification Management System (CCMS) database, there are ballasts on the market at multiple levels of efficiencies. DOE finds that the technology options identified, individually and/or in combination, are being utilized to improve the efficiency of products. Therefore, DOE continues to consider these technology options as a means to improve the efficiency of fluorescent lamp ballasts.

Based on their test data for dimming ballasts, CA IOUs asserted that cathode cutout is a major efficiency improvement opportunity for dimming ballasts and is currently employed by multiple dimming ballast manufacturers. CA IOUs compared two 3-lamp dimming ballasts, one that saved energy by using less than the allowable cathode power at lower currents and cutout cathode power at higher currents, and another that saved less energy by employing a continuous maximum amount of allowable cathode power. (CA IOUs, Public Meeting Transcript, No. 5 at p. 57; CA IOUs, No. 10 at pp. 5–7)

NEMA commented that there are several patents on how to employ cathode cutout technology and urged DOE to exercise caution not to inadvertently favor one method over another. (NEMA, Public Meeting Transcript, No. 5 at pp. 58–59) CA IOUs responded that based on conservative assumptions for hot cathode resistance per the maximum voltage allowance at lower currents defined by NEMA LL 9–2011, any ballast can use anywhere from 0 up to 5.6 W per lamp of cathode power at lower currents. CA IOUs stated that while not all manufacturers may have access to every piece of technology, this range provided enough space for achieving significant energy savings. CA IOUs added that based on their analysis for CEC's proposed standards for dimming ballasts, all major manufacturers had products meeting standards, and they determined that the necessary technology is not being limited to one or two manufacturers due to intellectual property issues. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 59–61; CA IOUs, No. 10 at pp. 5–7)

DOE agrees that cathode cutout can improve ballast efficiency and considered it as a technology option in this analysis. Information obtained in manufacturer interviews indicated that patents may apply to certain methods of achieving cathode cutout, but achievement of the highest levels of efficiency analyzed in this proposed determination did not require use of technologies subject to a patent.

CA IOUs stipulated that improved components and other circuit design approaches are also viable methods for improving dimming ballast efficiency, and encouraged DOE to explore the full range of technology options available to manufacturers. (CA IOUs, Public Meeting Transcript, No. 5 at p. 57; CA IOUs, No. 10 at pp. 5–7)

DOE considers the full range of technology options identified, for both dimming and fixed-output ballasts. DOE notes it considers the same metric (*i.e.,* BLE at full light output) for dimming ballasts as it does for fixed-output ballasts (see section IV.A.2 for further details).

NEMA commented that steel laminations comprise a very small percentage of magnetics in an electronic ballast and are used for line frequency ballasts. Further, they are typically used for dedicated line voltage such as 120 V AC. (NEMA, No. 12 at p. 6) Philips stated that use of amorphous steel doesn't provide for an effective work product and it will continue to use it only for magnetic ballasts. (Philips, Public Meeting Transcript, No. 5 at p. 64)

DOE determined that using laminated sheets of steel to create the core of the inductor may not minimize losses in ballasts that operate at high frequencies. Therefore, because the ballasts analyzed in this proposed determination are electronic ballasts and operate at high frequencies, DOE did not consider laminated sheets of amorphous steel or increasing the number of steel laminations to lower core losses as technology options.

DOE agrees that the use of low-loss ferrite materials can minimize losses in transformers and inductors used in ballasts. Ferrite is already widely used in electronic ballasts. However, DOE determined that ferrite can be optimized to reduce losses by changing the percent composition from three principal oxides: Manganese oxide, zinc oxide, and iron (III) oxide. If the ideal amounts of each oxide are selected, the ferrite can have lower losses.[16] For example, manganese-zinc ferrite is a common solid core material selected for its size efficiency and can be optimized for high frequencies, up to 2 MHz.[17] Hence, in this analysis, DOE is including use of low-loss ferrite materials to create the core of the inductor in the transformer of the ballast as a technology option to increase ballast efficiency.

NEMA also added that the technology option, as described by DOE, which involves using wire with multiple smaller coils instead of one larger coil is poorly defined. They indicated that this technology option should refer to litz wire and added that most electronic ballast manufacturers already use litz wire where appropriate. (NEMA, No. 12 at p. 6)

The technology option of using wire with multiple smaller coils (instead of the technology option of using one larger coil to increase the number of turns of wire) describes a way to increase the inductance of a coil and therefore the induced voltage of the transformer. The magnitude of the induced voltage is based on the magnetic field in the transformer (which is based on the inductance), the frequency of operation, number of turns of the coil, and the cross sectional area of the transformer. For the same length of wire, a series of smaller coils will have a larger number of turns than one coil that has a core with a large cross sectional area. The additional number of turns of the wire will increase the induced voltage, and thereby minimize losses from the transformer. Provided that the number of turns is increased more than the cross sectional area is reduced, the series of smaller coils would have fewer losses than one large coil. This technology option is different from the use of litz wire. Litz wire refers to a bundle of thin insulated wires braided together such that the same sides of the two wires are not interacting with one another the entire time, thereby minimizing the magnetic effects between wires that negatively affect current flow. In this analysis DOE continues to consider both use of multiple smaller coils and litz wire as technology options to increase the efficiency of the ballast.

In summary, for this analysis, DOE considers the technology options shown in Table IV.1. Detailed descriptions of these technology options can be found in chapter 3 of the NOPD TSD.

TABLE IV.1—FLUORESCENT LAMP BALLAST TECHNOLOGY OPTIONS

Technology option	Description
Electronic Ballast	Use an electronic ballast design.
Improved Components:	
Transformers/Inductors	Use litz wire to reduce winding losses.
	Use wire with multiple smaller coils instead of one larger coil to increase the number of turns of wire.
	Use optimized-gauge copper to increase the conductor cross section to reduce winding losses.
	Use shape-optimized winding to reduce the proximity effect losses.
	Use low-loss ferrite materials to create the core of the inductor.
Diodes	Use diodes with a lower voltage drop.
Capacitors	Use capacitors with a lower effective series resistance.
Transistors	Use transistors with low drain-to-source resistance.
Improved Circuit Design:	
Cathode Cutout or Cutback	Remove or reduce cathode/filament heating after lamp has started.
Integrated Circuits	Substitute discrete components with an integrated circuit.
Starting Method	Use of instant start (IS) starting method instead of a rapid start (RS) starting method.

4. Screening Analysis

DOE uses the following four screening criteria to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking:

(1) *Technological feasibility.* Technologies that are not incorporated in commercial products or in working prototypes will not be considered further.

(2) *Practicability to manufacture, install, and service.* If it is determined that mass production and reliable installation and servicing of a technology in commercial products could not be achieved on the scale necessary to serve the relevant market at the time of the projected compliance date of the standard, then that technology will not be considered further.

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

(4) *Adverse impacts on health or safety.* If it is determined that a technology would have significant adverse impacts on health or safety, it will not be considered further.

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

In summary, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed four criteria, it will be excluded from further consideration in

[16] *Standard Recommendations: Soft Ferrite Cores, A User's Guide.* 2011.

[17] McLyman, C. *Transformer and Inductor Design Handbook.* 2011. Boca Raton, FL: CRC Press.

the engineering analysis. Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level.

DOE received some general comments regarding the screening methodology and its application to fluorescent lamp ballasts. Philips commented that occasionally the criterion of manufacturing practicality has been slanted toward being theoretically possible rather than economically justifiable for a ballast manufacturer and consumer. Philips stated that DOE should be cognizant of the costs associated with design-in, approbation, marketing, and implementation of that new, revised design into luminaires and that it might not have a positive business case. (Philips, No. 8 at p. 15)

When determining manufacturing practicality, DOE will only consider a technology option practical to manufacture if mass production and reliable installation and servicing of the technology can be achieved in the appropriate scale and timeframe. DOE finds that the technology options under consideration are being utilized in ballast designs for commercially available ballasts and, therefore, meet the criteria of practicable to manufacture. Regarding the costs associated with design options, DOE considers economic impacts including costs to the individual customers, manufacturers, and the nation of efficiency levels incorporating design options under consideration in the LCC, NIA, and MIA analyses.

DOE received several comments regarding the impact of the technology options under consideration on the size of the ballast. Philips and NEMA commented that any improvements in efficiencies will likely cause an increase in the ballast footprint. (Philips, No. 8 at p. 11; NEMA, No. 12 at p. 11) ULT, Philips, and NEMA emphasized that avoiding technology and efficiency improvements that necessitate changes in the physical size outside the normal ballast case footprint would be an ideal approach. (ULT, No. 6 at p. 9; Philips, No. 8 at pp. 13–14; NEMA, No. 12 at p. 11) NEMA added that implementing efficiency changes causing fluorescent lamp ballasts to have designs outside of standard case sizes would increase maintenance costs. (NEMA, No. 12 at p. 11) ULT also noted that any changes in technology that increase ballasts' physical volume would be disruptive to the original equipment manufacturer (OEM) and replacement channels. (ULT, No. 6 at p. 5) Philips stated that while incremental design improvements leading to additional energy savings with efficiency gains of 1 to 2 percent are theoretically possible, they will result in a negative impact on luminaire compliance with existing, size-based electrical requirements. (Philips, No. 8 at pp. 13–14)

When determining adverse impacts to consumer utility and product availability, DOE takes into account whether a technology option will result in lessening of utility to the consumer. Therefore, in its analysis, DOE accounts for scenarios in which a technology option increases the size of the ballast making it unusable in an application in which it is currently used. DOE found no evidence that the technology options identified could not be utilized in a manner that would maintain the size of the ballast.

Regarding impacts of technology options on costs, DOE does not consider cost as a factor for screening out technology options. DOE considers the economic impacts and costs on individual customers, manufacturers, and the nation in the LCC, NIA, and MIA analyses.

DOE also received specific comments regarding the screening of technology options under consideration. In the Framework document, DOE considered using optimized-gauge copper or increasing the conductor cross section to reduce winding losses, using wire with multiple smaller coils, and using shape-optimized winding to improve the transformer component of the ballast. ULT stated that industry already considers the technology options of using optimized-gauge copper, wire with multiple smaller coils, and using shape-optimized winding in the development of their product and any adjustments would increase the physical volume of these products. (ULT, No. 6 at pp. 4–5) NEMA commented that copper losses can be minimized by increasing the cross section of the conductor, but increasing the wire gauge can result in larger, more costly magnetics. (NEMA, No. 12 at p. 6) Philips stated that optimized-gauge copper or increasing the conductor cross section may also increase the size of the ballast and increase manufacturing costs. (Philips, No. 8 at p. 14)

Implementing certain technology options to increase ballast efficiency may increase the size of the ballast. However, as noted in manufacturer comments, these technology options are likely already being used in certain commercially available products; therefore, DOE believes it is possible to utilize them while maintaining the size of the ballast so it would not impact the application in which it is used.

Philips noted that the use of multiple smaller coils is a good approach that has been in use for a long time and is optimized at this point; and while manufacturers could use smaller multiple coils, it would increase the complexity of the process, possibly making the coil wire easier to break. (Philips, No. 8 at p. 14)

Because DOE has observed ballasts at multiple efficiencies, manufacturers are likely utilizing different levels of technology options under consideration including the number of small coils used. Therefore, DOE continues to consider the use of multiple smaller coils as a design option.

Regarding shape-optimized wiring, Philips stated that while this technique can reduce proximity effect losses in industries such as motors, it is more complex and expensive for ballast manufacturers. Philips added that if it used a special process to make an EF25 [18] coil to reduce the proximity effect losses, it will increase efficiency by 0.1 percent. (Philips, No. 8 at p. 14)

In identifying design options, DOE does not consider costs, which are analyzed in separate analyses. DOE identifies technology options that will improve efficiency. However, improvement in efficiency is not a criteria used to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking. 10 CFR part 430, subpart C, appendix A, 4(a)(4) Therefore, DOE continues to consider shape-optimized wiring as a design option.

a. Screened-Out Technologies

For this analysis, DOE did not screen out any technology options identified.

b. Remaining Technologies

After reviewing each technology, DOE tentatively concludes that all of the identified technologies listed in section IV.A.3 pass all four screening criteria to be examined further as design options in this analysis. In summary, DOE did not screen out the following technology options and considers them as design options in the engineering analysis:

(1) Electronic Ballasts
(2) Improved Components
  (a) Use litz wire to reduce winding losses.
  (b) Use wire with multiple smaller coils instead of one larger coil to increase the number of turns of wire.
  (c) Use optimized-gauge copper or increase the conductor cross section

[18] An EF25 coil is a coil for an E-shaped ferrite core that is 25 mm high.

to reduce winding losses.
  (d) Use shape-optimized winding to reduce the proximity effect losses.
  (e) Use diodes with lower losses.
  (f) Use capacitors with a lower effective series resistance.
  (g) Use transistors with low drain-to-source resistance.
  (h) Use low-loss ferrite to create the core of the inductor.
(3) Improved Circuit Design
  (a) Remove filament heating after the lamp has started.
  (b) Substitute discrete components with an integrated circuit.

DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially available products or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (*i.e.,* practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety). For additional details, see chapter 4 of the NOPD TSD.

5. Product Classes

In general, when evaluating and establishing energy conservation standards, DOE divides the covered product into classes by (1) the type of energy used, (2) the capacity of the product, or (3) any other performance-related feature that affects energy efficiency and justifies different standard levels, considering factors such as consumer utility. (42 U.S.C. 6295(q))

DOE received some general comments regarding product classes. ULT and NEMA commented that current product class definitions should not be changed. (ULT, No. 6 at p. 4; NEMA, No. 12 at p. 5) Giving the example of a dimming ballast that can adjust the cathode power for a specific lamp based on the lamp's filament impedance, Philips commented that DOE should ensure that within the dimming product class, dimming ballasts with added features not be eliminated because they consume more energy than a standard dimming ballast. (Philips, Public Meeting Transcript, No. 5 at p. 61)

In this analysis, DOE reviewed FLB types to identify those with a capacity or other performance-related feature which other FLBs do not have, and considered whether such feature would justify a higher or lower standard compared to all other ballast types. In the following sections, DOE discusses the resulting product classes DOE considered for analysis and responds to comments on specific product class setting factors.

a. Existing Product Classes

In the Framework document, DOE considered maintaining the product classes for ballasts currently subject to standards. The product classes are currently divided based on starting method, lumen package, sign ballasts, and residential versus commercial application.

Both rapid start (RS) and PS ballasts use cathode power; however, PS ballasts limit the voltage across the lamp to prevent glow discharge during initial cathode heating resulting in an increase in lifetime during on/off cycling, and the cathode heat can be removed or reduced after the lamp is in full conduction. Therefore, DOE considers PS ballasts to offer a performance-related feature that justifies a different efficiency level compared to instant start (IS) ballasts. Hence, DOE maintains a separate product class for ballasts with the PS starting method in this analysis. See chapter 3 of the NOPD TSD for further details.

To obtain a higher lumen package (*i.e.,* amount of light from a lamp-and-ballast system), certain lamps are designed to operate with ballasts that run the lamps at high currents. Unlike ballasts generally, ballasts designed to operate HO lamps are typically used in high ceiling or outdoor applications. Ballasts operating HO lamps operate at higher total lamp arc powers compared to standard output (SO) lamps. BLE generally increases with total lamp arc power. However, DOE found that even though 8-foot HO ballasts have higher lamp arc powers, they generally have lower BLEs when compared to 8-foot single pin (SP) slimline ballasts. This may be because this ballast type has a different topology, or circuit design, than other ballast types (*e.g.,* 4-foot MBP and 8-foot SP slimline ballasts). Because the lumen package provides a feature that other ballasts do not and that feature justifies a different efficiency requirement compared to other ballasts, DOE maintains a separate product class for ballasts that operate 8-foot HO lamps. See chapter 3 of the NOPD TSD for further details.

Ballasts that are designed for use in outdoor signs offer performance-related features that other ballasts generally do not. To operate in outdoor environments and to be able to handle numerous lamp combinations, sign ballasts contain more robust components compared to regular 8-foot HO ballasts in the commercial sector. Thus, sign ballasts are inherently less efficient. Therefore, DOE maintains a separate product class for sign ballasts that operate 8-foot HO lamps. See chapter 3 of the NOPD TSD for further details.

Finally, DOE noted in the Framework document that it planned to maintain separate product classes for residential and commercial ballasts. DOE received several comments on this consideration. ASAP encouraged DOE to consider the rationale for a product class for residential ballasts. (ASAP, Public Meeting Transcript, No. 5 at pp. 50–51) NEEA agreed asserting that commercial ballasts work just as well in a house and have no obvious impact on anything in the house. (NEEA, Public Meeting Transcript, No. 5 at pp. 51–52) ASAP and CA IOUs recommended DOE revisit its analysis of residential ballasts to account for changes in the market, such as cost of higher quality components, trends in ballast efficiency, or other factors that may have changed since standards from the 2011 FL Ballast Rule took effect. (CA IOUs, No. 10 at p. 9; ASAP, No. 7 at pp. 4–5; ASAP, Public Meeting Transcript, No. 5 at p. 50–51)

Philips noted that residential ballasts are subject to more stringent FCC EMI requirements, and some customers may have sensitive equipment that requires extra protection. Further, Philips stated that even if residential customers were satisfied with commercial ballasts, because of the FCC requirements, manufacturers must produce separate ballasts that include additional EMI filtering for the residential market. (Philips, Public Meeting Transcript, No. 5 at p. 52) Lutron agreed with Philips comments. (Lutron, Public Meeting Transcript, No. 5 at p. 52) Philips added that whereas incremental design improvements leading to additional energy savings with efficiency gains of 1 to 2 percent are theoretically possible, they will result in a negative impact on ballast compliance with FCC EMI requirements as specified in 47 CFR part 18. (Philips, No. 8 at pp. 13–14)

CA IOUs referred to a comment made in the 2011 FL Ballast Rule by Acuity Brands Lighting, Inc. (Acuity) stating that a residential ballast that achieves the same efficiency as the most efficient commercial products would be 50 percent more expensive. CA IOUs stated that this indicated it is technically feasible to improve the efficiency of residential ballasts, though it may be more expensive. (CA IOUs, No. 10 at p. 9) Further, ASAP and CA IOUs stated that the increasing affordability and confidence in LED technology will provide consumers with more cost-effective, efficient technology options while regulations from EISA will limit the availability of less energy-efficient options. Therefore, the potential risk of residential fluorescent lighting users ''backsliding'' to less efficient lighting technologies due to the possibly higher cost of energy efficient residential fluorescent lamp ballasts has been significantly reduced. (CA IOUs, No. 10 at p. 9; ASAP, No. 7 at pp. 4–5; ASAP, Public Meeting Transcript, No. 5 at pp. 50–51)

Further, ASAP and CA IOUs stated that compared to commercial ballasts, more stringent EMI filter requirements for residential ballasts may lower efficiency, but the less stringent power factor requirements can increase efficiency by not requiring more robust power factor control devices. CA IOUs and ASAP suggested that DOE analyze how these two factors impact achievable efficiency through additional testing and/or modeling, as necessary, and develop an adjustment factor that can be applied to the current standard for commercial ballasts to define an appropriate standard level for residential ballasts. Further, CA IOUs and ASAP suggested that DOE not limit itself to available commercial products and model achievable efficiency levels for residential ballasts based on the same set of technology options available to commercial ballasts. (CA IOUs, No. 10 at p. 9; ASAP, No. 7 at pp. 4–5; ASAP, Public Meeting Transcript, No. 5 at pp. 50–51)

In the 2011 FL Ballast Rule, DOE determined that the FCC requires residential ballasts to have more stringent or maximum allowable EMI and per American National Standards Institute (ANSI) standards [19] have a lower minimum power factor than commercial ballasts. Based on these differing requirements, DOE concluded that residential ballasts serve distinct market sectors and applications. 76 FR at 70564. In this analysis, DOE finds that these requirements continue to exist. Further, DOE's review of ballast efficiencies showed that residential ballasts are unable to achieve similar maximum efficiencies as commercial ballasts. Therefore, because residential ballasts serve distinct market sectors and applications, and are unable to meet commercial efficiency levels, DOE continues to consider separate product classes for residential ballasts.

DOE did not model efficiencies for residential ballasts. Based on its review of patents and product offerings, DOE did not find more efficient prototypes or commercially available products with design requirements similar to residential ballasts that could serve as a basis for modeling higher efficiencies. Further, without a physical model to test, it would be difficult to confirm that design changes made to improve ballast efficiency would continue to allow the ballast to meet FCC's EMI filter requirements. See chapter 5 of the NOPD TSD for the assessment of efficiency levels of residential ballast product classes.

NEMA commented that as this rulemaking proceeds and other regulatory impacts are discussed, NEMA and Electrofed Canada have been in discussions with FCC and Industry Canada regarding revisions to emissions requirements for lighting products in North America. They expect the forthcoming binational negotiations to determine the appropriate emissions limits may take a few years. NEMA stated it will keep DOE informed of the progress of these negotiations as this FLB rulemaking progresses. NEMA cautioned that if emissions requirements become more stringent across the board, added functionality and filtering could impact price and efficiency. (NEMA, Public Meeting Transcript, No. 5 at pp. 52–53)

DOE appreciates information on discussions regarding emissions requirements for lighting products and looks forward to learning of their progress.

b. Additional Product Classes

In the Framework document, DOE considered product classes for dimming fluorescent lamp ballasts based on the following four factors: (1) Residential versus commercial, (2) lamp type operated by the ballast, (3) continuous versus step dimming, and (4) dimming communication protocol.

Lutron and NEMA commented that proprietary control systems can save the same or more energy than standardized control interfaces such as DALI, and DOE should broadly define a product class to be ''digitally-controlled dimming ballasts, such as DALI'' and should only include ballasts that operate 4-foot T5 and T8 lamps. Lutron and NEMA added that digital dimming ballasts have energy-saving advantages such as the ability to react to demand response events and report power usage as well as to allow for independent occupancy-sensed and daylighting zones. They stated that these features require off-state power consumption for which digital ballasts should be given an allowance. (Lutron, No. 9 at p. 2; NEMA, No. 12 at pp. 5–6)

CA IOUs noted that CEC proposed one single product class for all dimming ballasts including T5 and T8 dimming ballasts, irrespective of number of lamps. However, CA IOUs shared initial test results suggesting dimming ballasts operating 2L T5 may be able to achieve higher efficiencies than those operating 2L T8 ballasts. CA IOUs recommended that DOE test a full range of dimming ballasts that operate T5 lamps to determine whether a separate product class is necessary to set more appropriate standard levels for these ballasts. (CA IOUs, No. 10 at pp. 4–5)

Unlike other ballasts, dimming ballasts allow consumers to control the level of light output. Further, DOE's research and feedback from manufacturer interviews indicate that due to the added circuitry, dimming ballasts are less efficient than standard ballasts. Therefore, for this analysis, DOE maintains a separate product class for dimming ballasts.

DOE recently published a request for information (RFI) on the emerging smart technology appliance and equipment market. 83 FR 46886 (Sept. 17, 2018). In that RFI, DOE sought information to better understand market trends and issues in the emerging market for appliances and commercial equipment that incorporate smart technology. DOE's intent in issuing the RFI was to ensure that DOE did not inadvertently impede such innovation in fulfilling its statutory obligations in setting efficiency standards for covered products and equipment. In this NOPD, DOE seeks comment on the same issues presented in the RFI as they may be applicable to fluorescent lamp ballasts.

DOE analyzed one product class for all types of dimming FLBs regardless of use in sector, lamp type, or communication protocol used. DOE did not identify any dimming ballasts designed and marketed only for residential use. While some communication protocols used with dimming ballasts provide added features, DOE's evaluation of dimming ballast efficiencies indicated that these features did not affect efficiency, and analysis of separate product classes based on communication protocols was not necessary. Hence, for this analysis DOE does not consider a separate product class for ballasts with digital communication protocols.

Additionally, DOE's evaluation of the dimming ballast market and feedback from manufacturer interviews did not indicate that consideration of a separate product class (or classes) based on the lamp type operated by a dimming ballast was justified. DOE's analysis showed that with the exception of digital ballasts, the efficiency of dimming ballasts operating T8 lamps is

[19] ANSI C82.77–2002 requires residential ballasts to have a minimum power factor of 0.5 and commercial ballasts to have a minimum power factor of 0.9. *American National Standard for Lighting Equipment—Harmonic Emissions Limits—Related Power Quality Requirements for Lighting Equipment* (Approved January 17, 2002).

comparable to those operating T5 lamps. Regarding digital ballasts, product offerings showed that digital ballasts that operate T5 lamps are slightly more efficient than digital ballasts that operate T8 lamps. Manufacturer catalogs also indicated that there are more product offerings for digital ballasts that operate T5 lamps than T8 lamps. DOE identified digital ballasts that operate T8 MBP lamps as lower volume products, and tentatively determined that the lower efficiencies are not due to the dimming function but instead because these ballasts are likely not utilizing the most advanced technologies and the efficiencies of these ballasts can be improved. As such, DOE tentatively determined that a separate product class for digital ballasts that operate T8 MBP lamps would not be justified.

As noted in section IV.A.1.c, DOE includes in the scope of this analysis standards for low-current PS ballasts. In the Framework document, DOE considered a separate product class for such ballasts, based on factors such as lamp type operated by the ballast, starting method, and ballast input voltage. DOE's review of efficiency data indicates that low-current PS ballasts have a lower efficiency than comparable PS ballasts. These ballasts typically have ballast factors equal to or below 0.7 allowing them to offer low light outputs. However, DOE finds that the ability to provide low light outputs can be achieved by using ballasts with higher ballast factors paired with reduced-wattage lamps or by decreasing the number of lamps in the system. Therefore, because the ability to provide low light output is not limited to low-current PS ballasts, DOE did not consider a separate product class for these ballasts for the purpose of this analysis.

c. Summary

In summary, DOE assessed the product classes shown in the following list in its analysis. In describing product classes, DOE includes the types of lamps each class of ballast operates. In this analysis, DOE updated the list of lamp types based on a review of the latest product offerings on the market and added 4-foot T5 SO and 4-foot T5 HO lamp types for the IS/RS (not classified as residential), IS/RS residential, and PS residential product classes. See chapter 3 of the NOPD TSD for further discussion.

(1) IS and RS ballasts (not classified as residential) that operate
  (a) 4-foot MBP lamps
  (b) 2-foot U-shaped lamps
  (c) 4-foot T5 SO lamps
  (d) 4-foot T5 HO lamps
  (e) 8-foot SP slimline lamps
(2) PS ballasts (not classified as residential) that operate
  (a) 4-foot MBP lamps
  (b) 2-foot U-shaped lamps
  (c) 4-foot T5 SO lamps
  (d) 4-foot T5 HO lamps
(3) IS and RS ballasts (not classified as sign ballasts) that operate
  (a) 8-foot HO lamps
(4) PS ballasts (not classified as sign ballasts) that operate
  (a) 8-foot HO lamps
(5) Sign ballasts that operate
  (a) 8-foot HO lamps
(6) IS and RS residential ballasts that operate
  (a) 4-foot MBP lamps
  (b) 2-foot U-shaped lamps
  (c) 4-foot T5 SO lamps
  (d) 4-foot T5 HO lamps
  (e) 8-foot SP slimline lamps
(7) PS residential ballasts that operate
  (a) 4-foot MBP lamps
  (b) 2-foot U-shaped lamps
  (c) 4-foot T5 SO lamps
  (d) 4-foot T5 HO lamps
(8) Dimming ballasts that operate
  (a) 4-foot MBP lamps
  (b) 2-foot U-shaped lamps
  (c) 4-foot T5 SO lamps
  (d) 4-foot T5 HO lamps

B. Engineering Analysis

In the engineering analysis, DOE selects representative product classes to analyze, selects baseline ballasts within those representative product classes, and identifies more-efficient substitutes for the baseline ballasts. DOE uses these more-efficient ballasts to develop efficiency levels.

For this proposed determination, DOE selected more efficient substitutes in the engineering analysis and determined the consumer prices of those substitutes in the product price determination. DOE estimated the consumer price of ballasts directly because reverse-engineering ballasts is impractical due to the use of potting, a black pitch added to the ballast enclosure to reduce vibration damage and act as a heat sink for the circuit board. Potting does not allow for the visual observation and identification of individual components of the ballast making it infeasible to apply a reverse-engineering approach. By combining the results of the engineering analysis and the product price determination, DOE derived typical inputs for use in the LCC analysis and NIA. Section IV.C discusses the product price determination (see chapter 6 of the NOPD TSD for further detail).

The methodology for the engineering analysis consists of the following steps: (1) Selecting representative product classes, (2) selecting baseline lamps, (3) identifying more efficient substitutes, (4) developing efficiency levels by directly analyzing representative product classes, and (5) scaling efficiency levels to non-representative product classes. The details of the engineering analysis are discussed in chapter 5 of the NOPD TSD.

1. Significant Data Sources

DOE received several comments on data used in the engineering analysis. To ensure DOE analyzes currently available compliant products, Philips advised DOE to only use ballasts in DOE's CCMS database to analyze the performance of fixed output ballasts. (Philips, No. 8 at p. 30) Regarding dimming ballasts, low-current PS ballasts, or 480 V ballasts, ULT and NEMA commented that these products have not been evaluated in terms of efficiency or test method changes, and such assessments are necessary to ensure a meaningful analysis. (ULT, No. 6 at p. 5; NEMA, No. 12 at p. 7)

CA IOUs suggested DOE take into account the analysis they had conducted in support of developing CEC's proposed standards for fluorescent lamp ballasts. CA IOUs stated that for this analysis they tested 34 T8 dimming ballasts selected from 180 T8 dimming ballasts listed by the CEE as qualifying commercial lighting products and additionally tested seven T5 dimming ballasts. CA IOUs noted that this testing, while not comprehensive of the full market, was a good starting point. (CA IOUs, No. 10 at p. 8) Further, CA IOUs added that it is likely that their analysis of efficiencies of low-current PS dimming ballasts will also be useful in understanding the cathode heating needs and determining appropriate standard levels for fixed-output, low-current ballasts. (CA IOUs, No. 10 at p. 10)

For this analysis, DOE developed a database of ballasts based on manufacturer catalogs and DOE's CCMS public database.[20] For ballasts currently subject to energy conservation standards, DOE used BLE values in the CCMS database. For ballasts not subject to standards, BLE values are not present in the CCMS database, and DOE determined BLE values using catalog data. This method was used for low-current PS ballasts and dimming ballasts designed and marketed to operate exclusively lamp types other than one F34T12, two F34T12, two

[20] Compliance data are publicly available on DOE's Compliance Certification Database available at *http://www.regulations.doe.gov/certification-data/.*

F96T12/ES, or two F96T12HO/ES lamps.

DOE used the test data for dimming ballasts provided by CA IOUs to understand the general performance of these types of ballasts. However, for the engineering analysis DOE relied on catalog data as it allowed for an analysis of all dimming products available on the market. Further, because DOE considered only standards based on a BLE value at full light output, it did not analyze BLEs at lower light outputs to develop ELs.

Additionally, DOE paired baseline and more-efficient ballasts with full-wattage and/or reduced-wattage lamps, where appropriate, to reflect the most common configurations of lamp-and-ballast systems. DOE reviewed the lamp market and identified performance characteristics common for the chosen lamps and determined the system initial and mean lumen outputs. The tables provided in the sections that follow specify only the characteristics of the representative unit with a full wattage-lamp. The complete list of pairings of lamps with selected representative units is available in chapter 5 of the NOPD TSD.

2. Representative Product Classes

In the case where a covered product has multiple product classes, DOE identifies and selects certain product classes as ''representative'' and concentrates its analytical effort on those classes. For fluorescent lamp ballasts, DOE chose product classes as representative primarily because of their high market volumes. Within certain representative product classes, DOE also selected multiple representative ballast types to account for multiple high volume units within the same product class.

In response to the Framework document, Philips commented that most dimming ballasts use a 0–10 V communication protocol and nearly all are in the commercial sector especially if it includes retail space but noted that they do not have full visibility into application-specific dimming habits. (Philips, No. 8 at p. 33)

In selecting representative product classes, DOE took into account comments from stakeholders and also reviewed product offerings and feedback from manufacturer interviews regarding market shares of ballast types. Based on its assessment, DOE analyzed as representative 6 product classes and 13 ballast types as shown (in grey shading) in Table IV.2. This includes analyzing ballasts using a 0–10 V communication protocol as representative in the dimming product class.

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Table IV.2 Representative Product Classes and Ballast Types

Product Class Description*	Representative Ballast Type(s)
IS/RS Commercial IS/RS Commercial that operate: • 4-foot MBP • 2-foot U-shaped • 4-foot T5 SO • 4-foot T5 HO • 8-foot SP slimline lamps	2L 4-foot MBP 4L 4-foot MBP 2L 8-foot SP slimline
PS Commercial PS Commercial that operate: • 4-foot MBP • 2-foot U-shaped • 4-foot T5 SO • 4-foot T5 HO lamps	2L 4-foot MBP 4L 4-foot MBP 2L 4-foot MiniBP SO 2L 4-foot MiniBP HO
IS/RS 8-foot HO IS/RS ballasts that operate 8-foot HO lamps	2L 8-foot recessed double contact (RDC) HO
PS 8-foot HO PS ballasts that operate 8-foot HO lamps	N/A
Sign Sign ballasts that operate 8-foot HO lamps	4L 8-foot RDC HO
IS/RS Residential IS/RS Residential ballasts that operate: • 4-foot MBP • 2-foot U-shaped • 4-foot T5 SO • 4-foot T5 HO • 8-foot SP slimline lamps	2L 4-foot MBP
PS Residential PS Residential ballasts that operate: • 4-foot MBP • 4-foot T5 SO • 4-foot T5 HO • 2-foot U-shaped	N/A
Dimming Dimming ballasts that operate: • 4-foot MBP • 4-foot T5 SO • 4-foot T5 HO • 2-foot U-shaped	2L 4-foot MBP 0-10V 2L 4-foot MiniBP SO 0-10 V 2L 4-foot MiniBP HO 0-10 V

*Grey shading indicates a representative product class.

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3. Baseline Ballasts

For each representative product class, DOE selected a baseline ballast as a reference point against which to measure changes resulting from energy conservation standards. Typically the baseline ballast is the most common, least efficient ballast that meets existing energy conservation standards. In this analysis, DOE selected as baselines the least efficient ballast meeting standards that operated the most common lamp type (*i.e.,* wattage and diameter) and where possible, has the most common ballast factor, input voltage, and operating voltage type[21] for the product class. DOE used the BLE values from the CCMS database to identify baseline ballasts for all product classes except dimming. Because most dimming ballasts are not currently subject to standards and therefore do not have CCMS data, DOE determined BLE values by using catalog input power and associated total lamp arc power based on the catalog ballast factor of the ballast.

In summary, DOE directly analyzed the baseline ballasts shown in Table

[21] Operating voltage type denotes whether the ballast can operate multiple voltages and is considered universal or can only operate one voltage and is considered dedicated.

IV.3. See chapter 5 of the NOPD TSD for more detail.

TABLE—IV.3 BASELINE BALLASTS

Product class	Ballast type	Lamp type	Starting method	Input voltage/ operating voltage* (V)	Power factor	Ballast factor	Input power (W)	BLE
IS/RS Commercial	2L 4-foot MBP	32 W T8	IS	277, Universal	0.97	0.89	57.6	0.903
	4L 4-foot MBP	32 W T8	IS	277, Universal	0.98	0.88	112.2	0.916
	2L 8-foot SP slimline	59 W T8	IS	277, Universal	0.98	0.88	109.2	0.920
PS Commercial	2L 4-foot MBP	32 W T8	PS	277, Universal	0.90	0.88	57.1	0.900
	4L 4-foot MBP	32 W T8	PS	277, Universal	0.90	0.87	110.5	0.920
	2L 4-foot MiniBP SO	28 W T5	PS	277, Universal	0.98	1.00	62.4	0.891
	2L 4-foot MiniBP HO	54 W T5	PS	277, Universal	0.98	0.99	116.8	0.912
IS/RS 8-foot HO	2L 8-foot RDC HO	110 W T12	RS	277, Universal	0.99	0.89	197.7	0.900
Sign	4L 8-foot RDC HO	110 W T12	RS	120, Dedicated	0.90	**0.61	271.6	0.898
IS/RS Residential	2L 4-foot MBP	32 W T8	IS	120, Dedicated	0.50	0.88	58.9	0.872
Dimming	2L 4-foot MBP 0–10V	32 W T8	PS	277, Universal	0.98	0.88	59.0	0.871
	2L 4-foot MiniBP SO 0–10V	28 W T5	PS	277, Universal	0.98	1.00	64.0	0.869
	2L 4-foot MiniBP HO 0–10V	54 W T5	PS	277, Universal	0.98	1.00	118.0	0.912

* Universal indicates that the ballast can operate multiple voltages (*i.e.,* 120 V or 277 V); dedicated indicates it can only operate the voltage specified.
** DOE found limited information on ballast factors of ballasts in the Sign product class. Based on this information, DOE used the most common ballast factor found in catalogs for the product class for representative units that did not specify ballast factor.

4. More-Efficient Substitutes

DOE selected more-efficient ballasts as replacements for each of the baseline ballasts by considering technologies not eliminated in the screening analysis. DOE considered these technologies in the engineering analysis, either by modeling potential efficiency improvements due to the design options or by analyzing commercially available ballasts in which the design options are incorporated.

As fluorescent lamp ballasts are designed to operate fluorescent lamps, DOE considered properties of the entire lamp-and-ballast system in the engineering analysis. Fluorescent lamp ballasts are capable of operating several different configurations and wattages of lamps, so DOE chose the most common fluorescent lamp used with each ballast type for analysis. Further, DOE selected a more-efficient fluorescent lamp ballast with the same or similar ballast factor as the baseline ballast, so that light output would be maintained without needing to change the spacing of the fixture. Specifically, DOE ensured that potential substitutes maintained the system light output within 10 percent of the baseline lamp-and-ballast system light output.

Finally, DOE selected more-efficient substitutes that showed an improvement in BLE and a reduction in input power. As with the baseline ballasts, DOE used the BLE values from the CCMS database for all product classes except those dimming classes which are not currently subject to standards and therefore do not have CCMS data. For dimming ballasts, DOE determined BLE values by using catalog input power and associated total lamp arc power based on the catalog ballast factor of the ballast.

ULT and NEMA commented that the data manufacturers submit to DOE's CCMS database should be reproducible and, therefore, could be used in modeling. (ULT, No. 6 at p. 6; NEMA, No. 12 at p. 8) Regarding modeling potential system efficiency, NEMA and ULT encouraged DOE to take into account factors such as form factor, ability to reproduce in manufacturing, and tolerance of all incorporated parts, and then conduct physical tests of any models and design projections not available in the market or dismiss them from analysis. (NEMA, No. 12 at p. 7; ULT, No. 6 at p. 6) ULT also asserted that the HID rulemaking had modeled products at efficiency levels that could not be manufactured. (ULT, Public Meeting Transcript, No. 5 at p. 70)

When evaluating more-efficient substitutes, DOE can model potential efficiency improvements based on design options identified in the screening analysis. As noted in section IV.A.4, the technology options identified as design options must be technologically feasible; practicable to manufacture, install, and service; have no adverse impacts on product utility or product availability; and have no adverse impacts on health or safety.

For the IS/RS 2L 8-foot SP slimline representative ballast type, DOE modeled a representative unit at EL 3 (EL values are provided in Table IV.4). As noted, in most cases BLE increases with increasing total lamp arc power for fluorescent lamp ballasts. DOE found that 4L 4-foot MBP ballasts, which operate similar total lamp arc powers as 2L 8-foot SP slimline ballasts, are able to meet EL 3. Further, DOE found that ballasts operating 2L 8-foot T12 SP slimline lamps also meet EL 3. Therefore, DOE determined that design options in commercially available ballasts meeting EL 3 could be applied to a ballast operating two 8-foot T8 SP slimline lamps to achieve a higher efficiency. DOE assumed the modeled ballast would have characteristics common to the product class such as universal operating voltage, normal ballast factor, and 0.98 power factor (PF). Using a common ballast factor for the product class, DOE determined the lamp arc power and BLE for a ballast operating two 8-foot T8 SP slimline lamps that would meet EL 3. The performance characteristics of the modeled 2L 8-foot SP slimline ballast are shown in Table IV.4.

ULT and NEMA stated that while reduced-wattage lamp-and-ballast systems are common and the first step to offering higher energy savings, the ballasts in these systems have added features that make them less efficient. ULT noted that ballasts designed to operate reduced-wattage lamps require higher open circuit voltages and flicker control. (ULT, No. 6 at p. 7; ULT, Public Meeting Transcript, No. 5 at pp. 82–83; NEMA, No. 12 at p. 9)

As noted previously, DOE chose baseline and more-efficient substitute representative units that operate the most common lamps, which in many cases are full-wattage lamps. DOE's review of products in the market indicates that highly efficient ballasts operating full-wattage lamps can also operate reduced-wattage lamps. DOE notes sign ballasts as an exception, which predominantly operate full-wattage 8-foot T12 recessed double contact (RDC) HO lamps and have limited reduced-wattage options. Therefore, the analysis accounts for any potential impacts on efficiency due to added features required for operating reduced-wattage lamps.

ASAP recommended that reference lamps rather than ballast manufacturer's specified lamps be used in DOE's analysis of total system energy consumption of the lamp-and-ballast system. (ASAP, Public Meeting Transcript, No. 5 at pp. 71–72)

DOE paired baseline and more-efficient ballasts with full-wattage and/or reduced-wattage lamps, where appropriate, to reflect the most common configurations of lamp-and-ballast systems. DOE reviewed the lamp market and identified performance characteristics common for the chosen lamps and determined the system initial and mean lumen outputs. The complete list of pairings of lamps with selected representative units is available in chapter 5 of the NOPD TSD.

5. Efficiency Levels

After identifying more-efficient substitutes for each of the baseline ballasts, DOE developed ELs based on the consideration of several factors, including: (1) The design options associated with the specific ballasts being studied, (2) the ability of ballasts across wattages to comply with the standard level of a given product class, and (3) the max-tech level.

In this analysis, DOE used the same equation-based approach used in the 2011 FL Ballast Rule. DOE determined that a power law equation best modeled the observed trend between total lamp arc power and average BLE. Specifically, DOE used the following equation that relates the total lamp arc power operated by a ballast to BLE to develop ELs:

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

where power = average total lamp arc power and A, B, and C are constants that vary by product class.

DOE conducted extensive testing in the 2011 FL Ballast Rule to develop the above equation. Based on this testing, DOE determined the exponent C, which relates power to ballast losses, to be 0.25 for the IS starting method and 0.37 for the PS starting method. Further, DOE applied an adjustment factor A to reflect BLE values representative of testing at the average test lab. DOE developed coefficient B based on the tested BLE values for each product class and adjusted it to reflect different levels of efficiencies based on representative characteristics of the product class. Based on DOE's analysis of data in this proposed determination, DOE determined that the methodology used in the 2011 FL Ballast Rule to determine exponent C and adjustment factor A remain valid.

DOE received some general comments on ballast efficiency levels. ASAP stated that the shift to solid-state lighting will come with higher costs of drivers and light sources, and fluorescent lamp ballasts should not become the lowest common denominator in terms of price and performance. (ASAP, Public Meeting Transcript, No. 5 at pp. 31–32) ULT and NEMA commented that because manufacturing was close to the implementation date of the last rulemaking, all products on the market manufactured after November 2014 will be at the minimum or slightly higher than the minimum BLE standard. Therefore, these products reflect both the minimum and maximum technology efficiency levels. (ULT, No. 6 at p. 5; NEMA, No. 12 at p. 7) Philips agreed that ballast technology is already close to its maximum potential. (Philips, No. 8 at p. 15)

DOE identified several commercially available ballasts performing at efficiency levels higher than existing standards. The efficiencies determined from manufacturer catalogs and certification data indicate several efficiency levels higher than the existing standard. Thus, manufacturers appear to be utilizing more advanced technologies than required to just meet the standard level.

DOE based initial ELs on the more-efficient representative units selected for each product class. For product classes with multiple representative ballast types, DOE established ELs after considering the representative units of all representative ballast types in the product class.

To establish final minimum efficiency requirements for each EL, DOE evaluated whether any adjustments were necessary to the initial ELs to ensure ballasts were available across a range of lamp arc powers and ballast factors representative of each product class. For example, DOE found ballasts operating certain lamp arc powers or ballasts factors do not meet the highest efficiency level. DOE reviewed these products and found they are low volume and are likely not using the most recent advanced technologies. Some of them operated a total lamp arc power that was between the total lamp arc powers operated by ballasts that did comply with the highest standard level analyzed. Based on this review, these FLBs appear to not have been fully optimized to achieve the highest efficiency levels, and can be improved. Based on its observations and analysis, DOE tentatively determined that no additional adjustments to the initial ELs were necessary.

The ELs and characteristics of the representative units are summarized in Table IV.4 through Table IV.9. Grey shading indicates the modeled unit for the two-lamp 8-foot SP slimline representative ballast type operating a T8 lamp. See chapter 5 of the NOPD TSD for more detail.

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Table IV.4 IS/RS Commercial Representative Units

Product Class	EL	Ballast Type	Lamp Type	Starting Method	Input Voltage/ Operating Voltage* V	Power Factor	Ballast Factor	Input Power W	BLE
IS/RS Commercial	EL 1	2L 4-foot MBP	32 W T8	IS	277, Universal	0.98	0.88	56.3	0.913
		4L 4-foot MBP	32 W T8	IS	277, Universal	0.98	0.88	110.9	0.927
		2L 8-foot SP slimline	59 W T8	IS	277, Universal	0.98	0.88	108.5	0.926
	EL 2	2L 4-foot MBP	32 W T8	IS	277, Universal	0.98	0.88	55.7	0.923
		4L 4-foot MBP	32 W T8	IS	277, Universal	0.98	0.88	109.7	0.937
		2L 8-foot SP slimline	59 W T8	IS	277, Universal	0.98	0.87	106.4	0.934
	EL 3	2L 4-foot MBP	32 W T8	IS	277, Universal	0.99	0.89	55.3	0.940
		4L 4-foot MBP	32 W T8	IS	277, Universal	0.98	0.87	107.0	0.950
		2L 8-foot SP slimline**	59 W T8	IS	277, Universal	0.98	0.87	105.1	0.945

* Universal indicates that the ballast can operate multiple voltages (*i.e.*, 120 V or 277 V).

** Grey shading indicates a modeled product.

As shown in Table IV.4 for the IS/RS commercial representative product class, three ELs are analyzed. The baseline, presented in Table IV.3, represents a basic ballast with an efficiency near the existing standard level. EL 1 represents an improved ballast with more-efficient components (*e.g.,* transformers, diodes, capacitors, transistors) that minimize losses and circuit design (*e.g.,* integrated circuitry). EL 2 represents an advanced ballast with improved components and improved circuit design. EL 3 is the maximum technologically feasible level and represents a ballast with the most efficient combination of improved components and circuit design.

TABLE IV.5—PS COMMERCIAL REPRESENTATIVE UNITS

Product class	EL	Ballast type	Lamp type	Starting method	Input voltage/ operating voltage* (V)	Power factor	Ballast factor	Input power (W)	BLE
PS Commercial	EL 1	2L 4-foot MBP	32 W T8	PS	277, Universal	0.97	0.88	56.3	0.913
		4L 4-foot MBP	32 W T8	PS	277, Universal	0.98	0.87	109.5	0.928
		2L 4-foot MiniBP SO	28 W T5	PS	277, Universal	0.98	1.00	61.4	0.905
		2L 4-foot MiniBP HO	54 W T5	PS	277, Universal	0.97	1.00	115.9	0.928
	EL 2	2L 4-foot MBP	32 W T8	PS	277, Universal	0.98	0.88	53.9	0.953
		4L 4-foot MBP	32 W T8	PS	277, Universal	0.99	0.87	107.6	0.944
		2L 4-foot MiniBP SO	28 W T5	PS	277, Universal	0.98	1.00	59.8	0.929
		2L 4-foot MiniBP HO	54 W T5	PS	277, Universal	0.98	1.00	113.6	0.947

* Universal indicates that the ballast can operate multiple voltages (*i.e.,* 120 V or 277 V).

As shown in Table IV.5 for the PS commercial product class, two ELs are analyzed. The baseline, presented in Table IV.3, represents a basic ballast with an efficiency near the existing standard level. EL 1 represents an improved ballast with more-efficient components (*e.g.,* transformers, diodes, capacitors, transistors) that minimize losses and circuit design (*e.g.,* integrated circuitry). EL 2 is the maximum technologically feasible level and represents a ballast with the most efficient combination of improved components and circuit design.

Table IV.6 IS/RS 8-foot HO Representative Units

Product Class	EL	Ballast Type	Lamp Type	Starting Method	Input Voltage/ Operating Voltage* V	Power Factor	Ballast Factor	Input Power W	BLE
IS/RS 8-foot HO	EL 1	2L 8-foot RDC HO	110 W T12	RS	277, Universal	0.98	0.90	192.7	0.934
	EL 2	2L 8-foot RDC HO**	110 W T12	RS	277, Universal	0.98	0.90	188.0	0.957

* Universal indicates that the ballast can operate multiple voltages (*i.e.*, 120 V or 277 V).
** Grey shading indicates a modeled product.

As shown in Table IV.6 for the IS 8-foot HO commercial product class, two ELs are analyzed. The baseline, presented in Table IV.3, represents a basic ballast with an efficiency near the existing standard level. EL 1 represents an improved ballast with more-efficient components (*e.g.,* transformers, diodes, capacitors, transistors) that minimize losses and circuit design (*e.g.,* use of cathode cutout technology, integrated circuitry). EL 2 is the maximum technologically feasible level and represents a ballast with the most efficient combination of improved components and circuit design.

TABLE IV.7—SIGN REPRESENTATIVE UNITS

Product class	EL	Ballast type	Lamp type	Starting method	Input voltage/ operating voltage * (V)	Power factor	Ballast factor **	Input power (W)	BLE
Sign	EL 1	4L 8-foot RDC HO	110 W T12	IS	120, Dedicated	0.99	0.61	265.1	0.920
	EL 2	4L 8-foot RDC HO	110 W T12	IS	120, Dedicated	0.90	0.61	258.4	0.944

* Dedicated indicates it can only operate the voltage specified.
** DOE found limited information for ballast factor, and therefore used the most common ballast factor found in product class for representative units that did not specify ballast factor.

As shown in Table IV.7 for the sign product class, two ELs are analyzed. The baseline, presented in Table IV.3, represents a basic ballast with an efficiency near the existing standard level. EL 1 represents an improved ballast with more-efficient components (*e.g.,* transformers, diodes, capacitors, transistors) that minimize losses and circuit design (*e.g.,* integrated circuitry). EL 2 is the maximum technologically feasible level and represents a ballast with the most efficient combination of improved components and circuit design.

TABLE IV.8—IS/RS RESIDENTIAL REPRESENTATIVE UNITS

Product class	EL	Ballast type	Lamp type	Starting method	Input voltage/ operating voltage * (V)	Power factor	Ballast factor	Input power (W)	BLE
IS/RS Residential	EL 1	2L 4-foot MBP	32 W T8	IS	120, Dedicated	0.56	0.85	56.2	0.884
	EL 2	2L 4-foot MBP	32 W T8	IS	120, Dedicated	0.56	0.85	55.2	0.899
	EL 3	2L 4-foot MBP	32 W T8	IS	120, Dedicated	0.55	0.83	53.1	0.913

* Dedicated indicates it can only operate the voltage specified.

As shown in Table IV.8 for the IS/RS residential product class, three ELs are analyzed. The baseline, presented in Table IV.3, represents a basic ballast with an efficiency near the existing standard level. EL 1 represents an improved ballast with more-efficient components (*e.g.,* transformers, diodes, capacitors, transistors) that minimize losses and circuit design (*e.g.,* integrated circuitry). EL 2 represents an advanced ballast with improved components and improved circuit design. EL 3 is the maximum technologically feasible level and represents a ballast with the most efficient combination of improved components and circuit design.

CA IOUs stated DOE has the opportunity to capture significant energy savings by raising standards for residential ballasts to levels closer to those of commercial ballasts. (CA IOUs, No. 10 at p. 1) ASAP agreed that DOE should reassess the market and set more appropriate levels for residential ballasts to capture additional energy savings. (ASAP, No. 7 at p. 4)

Based on DOE's review of ballast efficiencies discussed previously, residential ballasts are unable to achieve maximum efficiencies similar to commercial ballasts. DOE identified the more-efficient substitute representative units for residential ballasts and identified the efficiency levels specified in Table IV.8. Based on the methodology and data, DOE finds these efficiency levels to be appropriate for the residential ballast product class.

Table IV.9 Dimming Representative Units

Product Class	EL	Ballast Type	Lamp Type	Starting Method	Input Voltage/ Operating Voltage*	Power Factor	Ballast Factor	Input Power W	BLE
Dimming	EL 1	2L 4-foot MBP 0-10V	32 W T8	PS	277, Universal	0.98	0.87	57.0	0.891
		2L 4-foot MiniBP SO 0-10V	28 W T5	PS	277, Universal	0.98	1.00	63.0	0.883
		2L 4-foot MiniBP HO 0-10 V	54 W T5	PS	277, Universal	0.98	1.00	118.0	0.912
	EL 2	2L 4-foot MBP 0-10V**							
		2L 4-foot MiniBP SO 0-10V	28W T5	PS	277, Universal	0.98	1.00	62.0	0.897
		2L 4-foot MiniBP HO 0-10 V**							
	EL 3	2L 4-foot MBP 0-10V	32 W T8	PS	277, Universal	0.99	0.88	56.0	0.918
		2L 4-foot MiniBP SO 0-10V	28 W T5	PS	277, Universal	0.99	1.00	61.0	0.911
		2L 4-foot MiniBP HO 0-10V	54 W T5	PS	277, Universal	0.98	1.00	115.9	0.928

* Universal indicates that the ballast can operate multiple voltages (*i.e.*, 120 V or 277 V).
**Grey shading indicates levels at which products did not exist.

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As shown in Table IV.9 for the dimming product class, three ELs are analyzed. The baseline, presented in Table IV.3, represents a basic ballast with an efficiency near the existing standard level. EL 1 represents an improved ballast with more-efficient components (*e.g.,* transformers, diodes, capacitors, transistors) that minimize losses and circuit design (*e.g.,* use of cathode cutout technology, integrated circuitry). EL 2 represents an advanced ballast with improved components and improved circuit design. EL 3 is the maximum technologically feasible level and represents a ballast with the most efficient combination of improved components and circuit design.

CA IOUs requested DOE review their work in support of developing CEC's standards for dimming ballasts and noted that they have provided numerous associated documents to the docket of this rulemaking including results from testing performance of dimming ballasts from 100 percent full light output down to the minimum dimming level where the lamp is still producing light. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 72–73; CA IOUs, No. 10 at p. 2) CA IOUs stated that while they supported DOE's consideration of dimming ballasts for standards, they recommended that DOE not adopt a less stringent standard than the one proposed by CEC for dimming ballasts. (CA IOUs, No. 10 at p. 2)

However, NEMA stated that DOE should not simply implement the standards proposed by CEC for T8 and T5 dimming ballasts because if those dimming ballasts were tested using DOE's current test method, no dimming ballasts would be available for sale in the United States. (NEMA, Public Meeting Transcript, No. 5 at pp. 9–11) Lutron asserted that the market in California will be driving dimming ballast sales as it is the only state that has building code requirements for dimming ballasts. Therefore, Lutron questioned the need for standards stricter than those already adopted by California for dimming ballasts as no one will manufacture separate products for California and the rest of the country. (Lutron, Public Meeting Transcript, No. 5 at pp. 61–62)

DOE recognizes that certain products evaluated for this NOPD may be subject to State regulation. As noted, DOE is conducting this evaluation of FLB pursuant to the direction in EPCA (see section II.A). Consistent with that statutory direction DOE is evaluating a potential standard for dimming ballasts based on BLE at full light output rather than based on a weighted metric.

Table IV.10 summarizes the efficiency requirements at each EL for the representative product classes. DOE seeks comment on the ELs under consideration for the representative product classes, including the max tech levels. See section VII.C for a list of issues on which DOE seeks comment.

TABLE IV.10—SUMMARY OF ELS FOR REPRESENTATIVE PRODUCT CLASSES

Representative product class	Efficiency level	BLE = A/(1+B*total lamp arc power∧ − C) where A, B, and C are as follows:		
		A	B	C
IS/RS Commercial	EL 1	0.993	0.24	0.25
	EL 2		0.21	
	EL 3		0.16	
PS Commercial	EL 1	0.993	0.43	0.37
	EL 2		0.31	
IS/RS Residential	EL 1	0.993	0.33	0.25
	EL 2		0.28	
	EL 3		0.24	
IS/RS 8-foot HO	EL 1	0.993	0.24	0.25
	EL 2		0.14	
Sign	EL 1	0.993	0.32	0.25
	EL 2		0.24	
Dimming	EL 1	0.993	0.56	0.37
	EL 2		0.48	
	EL 3		0.40	

6. Scaling to Other Product Classes

DOE identified and selected certain product classes as representative and analyzed these product classes directly. DOE chose these representative product classes primarily due to their high market volumes. The ELs for product classes that were not directly analyzed (''non-representative product classes'') were then determined by scaling the ELs of the representative product classes. Specifically, DOE did not analyze PS 8-foot HO ballasts or PS residential ballasts directly. NEMA and ULT recommended that DOE test all products to be covered because scaling may not produce the correct values. (NEMA, No. 12 at p. 8; ULT, No. 6 at p. 6)

In this analysis, DOE developed ELs for the PS 8-foot HO product class by scaling the ELs of the IS/RS 8-foot HO product class and the ELs for PS residential product class by scaling the ELs of the IS/RS residential product class. The primary difference between these sets of product classes is the starting method. Hence, DOE developed scaling factors by identifying pairs of the same ballast type manufactured by the same manufacturer, within the same product family, that differed only by starting method. The tested and certified efficiency values submitted to the DOE CCMS as well as manufacturer catalog data for these ballast pairs were used to calculate the scaling factors. From this analysis DOE determined that the ballasts with a PS starting method are 2 percent less efficient than those with IS starting method. DOE then applied this reduction in BLE to develop the appropriate EL equation curves for the PS 8-foot HO and PS residential product class. Because it is based on tested CCMS and manufacturer-provided catalog values, DOE has tentatively determined that this an accurate method for developing the ELs of the PS 8-foot HO and PS residential product classes. See chapter 5 of the NOPD TSD for more details.

Table IV.11 summarizes the efficiency requirements at each EL for the non-representative product classes. DOE seeks comment on the ELs under consideration for the non-representative product classes, including the max-tech levels. See section VII.C for a list of issues on which DOE seeks comment.

TABLE IV.11—SUMMARY OF ELS FOR NON-REPRESENTATIVE PRODUCT CLASSES

Non-representative product class	Efficiency level	BLE = A/(1+B*total lamp arc power∧ − C) where A, B, and C are as follows:		
		A	B	C
PS 8-foot HO	EL 1	0.973	0.45	0.37
	EL 2		0.26	
PS Residential	EL 1	0.973	0.54	0.37
	EL 2		0.46	
	EL 3		0.39	

7. Proprietary Designs

In the Framework document, DOE explained it would consider in its engineering and economic analyses all design options that are commercially available or present in a working prototype, including proprietary designs, that meet the screening criteria discussed in section IV.A.4. DOE will consider a proprietary design in the subsequent analysis only if it does not represent a unique path to a given efficiency level. If the proprietary design is the only approach available to achieve a given efficiency level, then DOE will eliminate the efficiency level from further analysis. However, if the efficiency level can be achieved by a number of design approaches, including a proprietary design, DOE will continue to examine the given efficiency level.

NEMA and ULT commented that as long as DOE follows the methodology laid out in the Framework document, they will not have an issue with the examination of proprietary designs. (NEMA, No. 12 at p. 8; ULT, No. 6 at p. 6) NEMA reiterated its comments made in CEC rulemaking proceedings on cathode cutout that there may be various interlinked patents regarding cathode cutout and encouraged DOE to exercise caution not to inadvertently favor one patented method over another. (NEMA, Public Meeting Transcript, No. 5 at pp. 58–59)

DOE received feedback in manufacturer interviews that while there are various patents related to ballast efficiency, the efficiencies of ballasts can be improved without reliance on a patented technology. DOE is not aware of any efficiency level under consideration that can only be achieved by a proprietary design.

C. Product Price Determination

Typically, DOE develops manufacturer selling prices (MSPs) for covered products and applies markups to create end-user prices to use as inputs to the LCC analysis and NIA. Because fluorescent lamp ballasts are difficult to reverse-engineer (*i.e.,* not easily disassembled due to potting), DOE directly derives end-user prices for the ballasts covered in this proposed determination.

In the Framework document, DOE stated that for commercial and industrial ballast designs, fluorescent lamp ballasts can go through two types of distribution channels: sold within fixtures and sold as replacement ballasts. In the fixture distribution channel, the manufacturer sells the ballast to an OEM—in this case, the fixture manufacturer—who in turn sells the ballast in a fixture to an electrical wholesaler (*i.e.,* distributor). The distributor sells it to a contractor, who passes it on to the end-user. In the replacement distribution channel, the manufacturer sells the ballast to an electrical wholesaler, who sells it to a contractor, who passes it on to the end-user. For residential ballast designs, DOE assumes that the manufacturer sells the ballast to an OEM who in turn sells it in a fixture to a home improvement retailer, where it is purchased by the consumer.

GE commented that the distribution channels considered in the Framework document analysis are similar to the 2011 FL Ballast Rule and appear to be appropriate. (GE, Public Meeting Transcript, No. 5 at p. 91) Philips agreed that the value chain had been accurately mapped out. (Philips, No. 8 at p. 34)

In this analysis, DOE retained the basic structure of distribution channels described in the Framework document with minor modifications based on additional research and information learned through manufacturer interviews. DOE determined that ballasts can be sold by electrical wholesalers to the end-user in large volume via a contractor; in large volume without a contractor; and in low volume without a contractor (*e.g.,* homeowners). Based on estimated shipments, DOE assigned a weighting of 85 percent for large volume via contractor; 10 percent for large volume without a contractor; and 5 percent for low volume without a contractor. DOE accounted for all three scenarios in developing end-user prices for representative units identified in the engineering analysis.

ULT and NEMA commented that the best way to understand the cost of products is to work with individual manufacturers under a confidentiality agreement. They stated that teardown analysis or bottom-up analysis would be difficult because of the use of potting material in ballast design, which is still very common. (ULT, Public Meeting Transcript, No. 5 at p. 75; ULT, No. 6 at p. 6; NEMA, No. 12 at p. 8) Philips commented that product teardowns should not be used for market pricing predictions, but only for possible product manufacturing cost analysis and reverse engineering because market prices are not determined on a cost plus basis. Further, Philips noted that while blue book prices may be directionally accurate, they will not account for additional discounts and pricing programs available in the value chain. Philips commented that NEMA data on market units and dollars could be useful in making pricing assumptions and suggested DOE work directly with NEMA to obtain relevant data by channel, and if that was not possible they could provide DOE with their local market analysis expert. (Philips, No. 8 at pp. 30, 34)

DOE was unable to obtain blue book prices (*i.e.,* manufacturer suggested prices) for ballasts and did not utilize the teardown approach due to use of potting in ballasts. To develop end-user prices for fluorescent lamp ballasts, DOE began with a consistent set of prices by determining an average electrical wholesaler price for each representative unit. DOE determined that in addition to electrical distributors such as Grainger, internet retailers can also serve as wholesalers of fluorescent lamp ballasts. Therefore, DOE collected prices from electrical distributors and internet retailers for each representative unit and/or ballast with similar performance characteristics to develop an average wholesaler price.

For the replacement channel, DOE used this average wholesaler price to determine the end-user prices for ballasts going through each wholesaler pathway: Large volume (no contractor), large volume (with contractor), and low volume (no contractor). DOE used the average wholesaler price as the large volume (no contractor) end-user price. DOE applied a contractor markup of 13 percent to the average wholesaler price to develop the large volume (with contractor) end-user price. DOE determined that ballasts sold through the low volume pathway would be sold by home centers. However, DOE found limited price data for representative units at home centers. Therefore, based on manufacturer feedback DOE applied an estimated 20 percent markup to the average wholesaler price to determine the low volume (no contractor) consumer price. DOE then weighted the large volume (with contractor) price by 85 percent; large volume (no contractor) price by 10 percent; and low volume (no contractor) price by 5 percent to develop an average weighted end-user price for each representative unit.

For the fixture channel, DOE applied an OEM markup of 21 percent to the average weighted end-user price determined for the replacement channel.

Based on manufacturer feedback, DOE determined that the estimated shipments going through the replacement channel and fixture channel are each 50 percent. DOE applied this weighting to the average end-user prices for the replacement and OEM channels to develop the final end-user price of a representative unit. Once DOE calculated end-user prices, DOE added sales tax and, if appropriate, installation costs to derive the total, installed end-user cost. See chapter 6 of the NOPD TSD for pricing results and further details on the pricing methodology.

DOE received comments on price trends for dimming ballasts. Although CA IOUs and CEC used slightly different methods to understand the cost effectiveness of dimming ballasts, CA IOUs stated that both methods showed cost-effective results. They encouraged DOE to review both CEC methodology, which was more similar to a tear down approach, and the CA IOU methodology, which was more of a statistical analysis of ballast prices on the market. (CA IOUs, Public Meeting Transcript, No. 5 at p. 75)

CA IOUs stated that they completed a multivariable regression analysis on dimming fluorescent lamp ballasts available from online retailers to evaluate cost effectiveness of a standard for dimming ballasts. Through this research, CA IOUs found no statistical correlation between product efficiency and price, but rather the results of the regression model suggested that dimming FLB price is more strongly correlated to manufacturer, how many lamps it can operate, and whether or not it is digitally controllable, rather than efficiency. CA IOUs referred to a graphical representation of data they had collected, which indicated that there is no clear trend suggesting that higher efficiency ballasts are generally more expensive than lower efficiency ballasts. CEC's cost-effectiveness evaluation focused on the cost of implementing cathode cutout technology to make the dimming ballasts more efficient. Based on the TSD from the 2011 FL Ballast Rule, CEC assumed that the incremental cost of cathode cutout was $0.89 for a 2-lamp ballast, which was scaled by $0.10 per lamp, resulting in the highest incremental cost for a 4-lamp ballast as $1.09. (CA IOUs, No. 10 at pp. 8–9)

In the product price determination, DOE developed end-user prices for each representative unit. As noted in the engineering analysis, these representative ballasts incorporate the design options to achieve the EL under consideration. Therefore, DOE's end-user prices would include the use of the cathode cutout design option used in a representative unit. DOE's evaluation of prices for dimming ballasts indicate that end-user price does increase with the efficiency of dimming ballast. Further, in interviews, manufacturers indicated that generally all things considered equal, prices will increase with FLB efficiency. DOE seeks comment on the methodology and results for estimating end-user prices for fluorescent lamp ballasts in this analysis. See section VII.C for a list of issues on which DOE seeks comment. Chapter 6 of the NOPD TSD provides details on DOE's development of end-user prices for fluorescent lamp ballasts.

D. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of fluorescent lamp ballasts at different BLE in representative U.S. commercial and industrial buildings, outdoor installations, and single-family homes and multi-family residences, and to assess the energy savings potential of increased BLE for fluorescent lamp ballasts. The energy use analysis estimates the range of energy use of fluorescent lamp ballasts in the field (*i.e.,* as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended standards.

The energy conservation standards for fluorescent lamps are not within the scope of this analysis; however, the input power of the complete lamp-and-ballast system is considered for the energy use analysis because ballasts are not intended to operate without lamps. The energy use characterization provides estimates of annual energy use for representative lamp-and-ballast systems that DOE evaluates in the LCC and PBP analyses and the NIA. To develop annual energy use estimates, DOE multiplied annual usage (in hours per year) by the system input power (in watts).

DOE selected the most common fluorescent lamps used with each analyzed ballast to develop representative lamp-and-ballast systems. DOE developed the system input power estimates in the engineering analysis. To characterize the country's average use of fluorescent lamp ballasts for a typical year, DOE developed annual operating hours by sector, using data from the 2015 U.S. Lighting Market Characterization (LMC), which was published in 2017.[22]

Philips stated that it was unclear how DOE would assign each ballast type into one or more sectors. Many types of ballasts can be used in both commercial and industrial applications that would affect their usage profile. Philips expected DOE to use an appropriate method to assign the different ballasts the various sectors. (Philips, No. 8 at p. 31) DOE agrees that fluorescent lamp ballasts are used in many applications, and a single ballast model could be used within different sectors. In chapter 7 of the NOPD TSD, DOE analyzed the typical operating hours of the different sectors. DOE then weighted the ballast operation by sector to develop average operating hours.

1. Reduced Wattage Fluorescent Lamps

ULT stated that the use of reduced wattage (also known as energy saving) lamps in the marketplace is very common. (ULT, No. 6 at p. 7) NEMA, SCE, and ULT stated that reduced wattage lamps are the first step in energy savings for a large portion of the market. (NEMA, No. 12 at p. 9; SCE, Public Meeting Transcript, No. 5 at pp. 81–82; ULT, No. 6 at p. 7) DOE agrees and modeled a mixture of full wattage and multiple reduced wattage options (where they exist) for many of the fluorescent lamps operated by the fluorescent lamp ballasts. See chapter 5 of the NOPD TSD for more details.

2. Occupancy Sensors

NEMA and ULT stated that occupancy sensors will be in the off mode more than the on mode with the exception of those installed in offices. In general, these are installed in areas that are not frequently occupied. Spaces can include but are not limited to bathrooms, stairwells, closets, hallways, and warehouse aisles, where sensors are off most of the time. For occupancy sensors used in offices to turn lights off after a preset time of inactivity, the time in the on mode would be difficult to generalize because it would differ greatly from installation to installation. (NEMA, No. 12 at p. 4; ULT, No. 6 at p. 8) NEMA and Lutron directed DOE to review work conducted by Lawrence Berkeley National Laboratory (LBNL) for additional data on occupancy sensors.[23] (NEMA, No. 12 at pp. 9–10; Lutron, No. 9 at pp. 2–3) DOE reviewed the LBNL reports and one report specifically mentioned by Lutron states that energy savings from occupancy controls per zone were 27 percent. However, savings primarily occurred at night between 6 p.m. and 1 a.m. and during early morning and evening hours when occupancy tended to be irregular.[24]

DOE stated in the Framework document that in the 2011 FL Ballast Rule, DOE adjusted the annual operating hours for the ballasts in the commercial sector that are controlled by occupancy sensors by roughly 30 percent compared to the other ballasts. Lutron and NEMA stated that reduced hours are high for intelligent systems using dimming ballasts with multiple control types. Occupancy sensors and time clock operation have the potential to dramatically reduce operating hours. For this analysis, DOE also reduced the operating hours for MBP lamps in the PS commercial product class by 30

[22] U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy. 2015 U.S. Lighting Market Characterization. November 2017. *https://energy.gov/eere/ssl/2015-us-lighting-market-characterization.*

[23] A technical publications list is available at Lawrence Berkeley National Laboratory. DOE relied primarily on *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings,* available at *https://eta.lbl.gov/publications/meta-analysis-energy-savings-lighting.*

[24] Lawrence Berkeley National Laboratory. *Monitored Lighting Energy Savings from Dimmable Lighting Controls in the New York Times Headquarters Building.* 2013. Available at *https://windows.lbl.gov/publications/monitored-lighting-energy-savings-dimmable-lighting-controls-new-york-times.*

percent to account for the use of occupancy sensors.

NEMA and ULT stated that operating hours can vary for the same model of a ballast installed in different applications. NEMA and ULT suggested that it would be best to develop an average usage number to apply to ballasts and that to figure all scenarios would be virtually impossible. (NEMA, No. 12 at p. 9; ULT, No. 6 at p. 7) DOE agrees and assigned a single average usage to each of the different ballast types. Within the LCC analysis, DOE includes a distribution of operating hours in the Crystal Ball ™ (a commercially available software program) analysis used to determine the average LCC savings as well as the percentage of net customers experiencing a net cost. Resultant average values calculated from the Crystal Ball ™ distributions were used in the NIA.

3. Dimming Ballasts

During the framework public meeting, both GE and CA IOUs stated that dimming ballasts will have an operating profile different from fixed-output (non-dimming) ballasts. Dimming ballasts are typically operating in advanced systems, and as a result, might have fewer operating hours or be operating in a dim mode compared to a standard static system. GE stated that dimming ballasts will have a lower energy use profile, which might be difficult to determine, but it will be less than a non-dimming ballast profile of 100 percent output, 100 percent of the time. (GE, Public Meeting Transcript, No. 5 at pp. 78–79, 88–89; CA IOUs, Public Meeting Transcript, No. 5 at p. 89)

To develop the energy usage profile for dimming ballasts, DOE reviewed *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings* by LBNL.[25] GE suggested this document as a potential source on the effects of controls on lighting systems but cautioned that there is a broad range of results from even the same control type. (GE, Public Meeting Transcript, No. 5 at pp. 86–87) Lutron also stated during the public meeting that they would provide references in written comments. (Lutron, Public Meeting Transcript, No. 5 at p. 88) Lutron and NEMA both referenced in written comments an LBNL study on energy savings using controls with dimming ballasts. (Lutron, No. 10 at p. 3; NEMA, No. 12 at p. 10) The LBNL study referenced in the written comments is a different version but includes the same data as the LBNL meta-analysis previously cited.[26]

DOE reviewed the meta-analysis and found that Tables 3 and 4 in the LBNL study present the average savings for each control type by building and by control type for peer-reviewed and non-peer-reviewed papers, respectively. Energy savings greater than 30 percent were common from daylighting and personal tuning (controls typically utilizing dimming technology).

Lutron and NEMA stated that dimming ballasts and associated controls and sensors have the potential to save energy in the form of a reduced load and not solely in the reduction of operating hours. (Lutron, No. 10 at p. 3; NEMA, No. 12 at p. 10) DOE agrees and developed a duty cycle of operation to characterize the energy use of the dimming ballast.

Southern California Edison (SCE) suggested that DOE consider dimming ballasts operating below 50 percent. (SCE, Public Meeting Transcript, No. 5 at pp. 38–39) CA IOUs recommended that DOE review documents generated for and submitted to CEC's efforts to develop state requirements for dimming ballasts. CA IOUs submitted these documents to DOE as part of their written comments. (CA IOUs, No. 10 at p. 2) In addition, CA IOUs stated that California's duty cycle for fluorescent dimming ballasts was designed to coincide with elements in California's energy code, Title 24, and involves output at 100 percent, 80 percent, and 50 percent light output. (CA IOUs, Public Meeting Transcript, No. 5 at p. 86)

California's analysis assumes that the dimming ballast operates 20 percent of the time at 100 percent light output, 50 percent of the time at 80 percent light output, and 30 percent of the time at 50 percent light output.[27] Compared to 100 percent of the time at 100 percent light output, this California duty cycle results in an energy savings of 26 percent. In contrast for this preliminary analysis, DOE analyzed a different duty cycle. DOE analyzed a duty cycle that yielded energy savings closer to the values reported in the LBNL meta-analysis. DOE used 10 percent of the time at 100 percent light output, 30 percent of the time at 70 percent light output, and 60 percent of the time at 30 percent light output.

Dimming ballasts have very limited use in residential applications. Both Lutron and NEEA reiterated the low use of dimming ballasts in residential applications. (Lutron, Public Meeting Transcript, No. 5 at pp. 87–88; NEEA, Public Meeting Transcript, No. 5 at p. 87) DOE agrees and assumed 98 percent of dimming ballasts were in commercial applications and 2 percent were in residential applications.

GE and ULT stated that reduced wattage lamps are not used with dimming ballasts because of difficulties with dimming these lamps and other reasons. (GE, Public Meeting Transcript, No. 5 at p. 80; ULT, Public Meeting Transcript, No. 5 at pp. 81–82) Because dimming ballasts are compatible with reduced wattage lamps, some dimming ballasts and reduced wattage systems are likely in use. DOE accounts for this low usage in its weighting of such systems.

4. Tubular LEDs

ULT stated that although tubular LEDs (TLEDs) are becoming prevalent, the ballasts in the field were not designed to operate TLEDs. NEMA and ULT highlighted that standards bodies require certification that the ballast and given lamp can operate. (ULT, Public Meeting Transcript, No. 5 at p. 83; NEMA, Public Meeting Transcript, No. 5 at pp. 84–85) Both NEMA and ULT cautioned that some incompatibility between the ballast and the TLED may occur in the field. NEMA and ULT recommended to not include these lamps in the analysis and if necessary address TLEDs separate from the ballast. (NEMA, No. 12 at p. 9; ULT, No. 6 at p. 7) DOE agrees with ULT that TLEDs are becoming prevalent. DOE also reiterates that the scope of this analysis is the fluorescent lamp ballast and only includes TLEDs in the analysis because the operation of these lamps by the ballast affects the energy use, and that in the field fluorescent lamp ballasts are operated, to a degree, with TLEDs.

ASAP referenced research by other DOE programs that TLEDs operating in a luminaire designed for a fluorescent lamp are significantly less energy efficient than dedicated LED luminaires. (ASAP, No. 7 at p. 5) DOE agrees that differences exist between modified fluorescent luminaires using a TLED and a luminaire designed solely to operate LEDs. DOE notes that LED luminaires are not part of this analysis.

[25] Lawrence Berkeley National Laboratory. *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings.* Available at *https://eta.lbl.gov/publications/meta-analysis-energy-savings-lighting.*

[26] Williams et al. *Lighting Controls in Commercial Buildings.* Leukos: The Journal of the Illuminating Engineering Society. 2012. 8(3): pp. 161–180. Available at *https://eaei.lbl.gov/publications/lighting-controls-commercial.*

[27] Table 4.3 Average Energy Use for Qualifying Products. p. 16 CA IOUS. *Dimming Fluorescent Lamp Ballasts. Codes and Standards Enhancement (CASE) Initiative for PR2013: Title 20 Standards Development.* (TN 78109) Updated version dated August 5, 2013. Available at *https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=12-AAER-02B.*

ASAP recommended analyzing the TLED market to evaluate its effect on the overall energy savings over time. (ASAP, No. 7 at p. 5) GE and Philips stated that the prevalence of TLEDs is growing rapidly. GE speculated that TLEDs are currently a low percentage of the overall installed base. (GE, Public Meeting Transcript, No. 5 at p. 80; Philips, No. 8 at p. 32) DOE includes a change in TLED penetration over time in this analysis. As the mixture of lamps operated by the ballast changes to include differing amount of TLEDs, the energy use of the ballast changes.

Philips discussed that there is an inverse relationship with the use of TLEDs on fluorescent lamp ballasts. As a general rule, the combination of fluorescent lamp ballast and TLED results in a lower power draw, but the operation of a fluorescent lamp ballast and fluorescent lamp results in a greater ballast efficiency. (Philips, No. 8 at p. 32) Philips also stated that it manufactures a ballast to be paired with specific fluorescent lamps and does not know if the ballast is being paired with a TLED or if the wattage of the TLED is 14, 15, 17 or some other wattage value. (Philips, Public Meeting Transcript, No. 5 at pp. 83–84) Philips stated that TLEDs are available in the 12 to 17 W range and offer significant energy savings when used with compatible fluorescent lamp ballasts. (Philips, No. 8 at p. 32) Philips stated that the power draw for TLEDs will continue to decrease into the future. (Philips, Public Meeting Transcript, No. 5 at p. 82) DOE agrees that ballast efficiency can differ for the same ballast operating a fluorescent lamp and a TLED. DOE used the operating power for TLEDs in the analysis. DOE also analyzed the larger TLED market to determine representative values of fluorescent lamp ballasts operating TLEDs.

DOE seeks comment on the methods to improve DOE's energy-use analysis, as well as any data supporting alternate operating hour estimates or assumptions regarding dimming of fluorescent lamp ballasts. DOE seeks comment on the type, prevalence, and operating hour reductions related to the use of lighting controls used separately in commercial, industrial, and residential sectors. DOE seeks comment on the assumptions and methodology for estimating annual operating hours. See section VII.C for a list of issues on which DOE seeks comment. Chapter 7 of the NOPD TSD provides details on DOE's energy use analysis for fluorescent lamp ballasts.

E. Life-Cycle Cost and Payback Period Analysis

DOE conducted LCC and PBP analyses to evaluate the economic effects on individual consumers of potential energy conservation standards for fluorescent lamp ballasts. In particular, DOE performed LCC and PBP analyses to evaluate, in part, the savings in operating costs throughout the estimated average life of fluorescent lamp ballasts at different ELs compared to any associated increase in costs of fluorescent lamp ballasts likely to result from standards at each EL. The effect of amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure effects on the consumer:

- The LCC (life-cycle cost) is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.
- The PBP (payback period) is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of fluorescent lamp ballasts in the absence of new or amended energy conservation standards. Similarly, the PBP for a given efficiency level is measured relative to the baseline reflecting the efficiencies customers are estimated to select absent an amended standard.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally representative set of potential customers. Fluorescent lamp ballasts are used widely in commercial, industrial, and residential settings. For each ballast class, DOE identified the types of customers likely to use the ballasts, the number of hours per year each customer type would likely use the ballasts, and a probability of selection for each customer type in the Monte Carlo analysis.

Inputs to the calculation of total installed cost include the cost of the product—which includes manufacturer production costs (MPCs), manufacturer markups, retailer and distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. DOE created distributions of values for product lifetime, energy prices, annual operating hours (which determines energy consumption), discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC and PBP, which incorporates Crystal Ball™, relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations sample input values from the probability distributions and FLB user samples. The model calculated the LCC and PBP for products at each efficiency level for 10,000 FLB installations per simulation run.

DOE calculated the LCC and PBP for all consumers of fluorescent lamp ballasts as if each were to purchase a new product in the expected year of required compliance with potential amended standards. Any amended standards would apply to fluorescent lamp ballasts manufactured 3 years after the date on which any amended standard is published. (42 U.S.C. 6295(m)(4)(A)) For purposes of its analysis, DOE used 2023 as the first year of compliance with any amended standards for fluorescent lamp ballasts.

Table IV.12 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the NOPD TSD and its appendices.

TABLE IV.12—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *

Inputs	Source/method
Product Cost	Derived by multiplying product costs from the engineering analysis by (one plus) sales tax rates.
Installation Costs	Baseline installation cost determined with data from RSMeans. Assumed no change with efficiency level.
Annual Energy Use	The total annual energy use multiplied by the hours per year. Average number of hours based 2015 LMC.
Energy Prices	Based on the Energy Information Administration's (EIA's) Form 861 data for 2017.[28] Average energy prices determined for 50 states plus the District of Columbia.
Energy Price Trends	Based on *Annual Energy Outlook 2019* (*AEO2019*) price projections.
Repair and Maintenance Costs.	Assumed no change with efficiency level.
Product Lifetime	Average: 12.5 Years for commercial installations (approximately 38,000 hours), 12.5 years for outdoor installations (approximately 41,000 hours), 11.4 years for industrial installations (50,000 hours), and 15 years for residential installations (approximately 10,800 hours).
Discount Rates	For residential product class, the calculations involve identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. For other product classes, the calculations involve estimating weighted average cost of capital for large numbers of companies and using the results to develop discount rate distributions. Primary data were from the Damodaran online web site[29] and the Federal Reserve Board.[30]
Rebound Effect	Rebound is not assumed to be present among FLB consumers. Most consumers are commercial and industrial consumers, and the FLB/light user tends to not see the bills so there would be no perceived change in the cost of using the light.
Compliance Date	2023.

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

1. Product Cost

As noted in section IV.C, DOE rulemaking analyses typically calculate consumer product costs by multiplying MPCs developed in the engineering analysis by the markups along with sales taxes. For fluorescent lamp ballasts, the engineering analysis determined customer prices directly; therefore, for the LCC analysis, the only adjustment was to add sales taxes.

In prior energy conservation standards rulemakings, DOE estimated the total installed costs per unit for equipment and then assumed that costs remain constant throughout the analysis period. This assumption is conservative because equipment costs tend to decrease over time. In 2011, DOE published a notice of data availability (NODA) titled *Equipment Price Forecasting in Energy Conservation Standards Analysis.* 76 FR 9696 (Feb. 22, 2011). In the NODA, DOE proposed a methodology for determining whether equipment prices have trended downward in real terms. The methodology examines so-called price or experiential learning, wherein, with ever-increasing experience with the production of a product, manufacturers are able to reduce their production costs through innovations in technology and process.

Consistent with the February 2011 NODA, DOE examined historical price data specific to electronic ballasts. As discussed in Chapter 8 and Appendix 8C of the NOPD TSD, this analysis yielded learning coefficients indicating a 14.8 percent decrease in ballast prices for every doubling in cumulative ballast shipments. Although this price trend was incorporated into the LCC model, it was excluded from the LCC results presented in this NOPD. With shipments falling from historical values, cumulative shipments do not double relative to 2015 (the last year of historical data) in any shipments scenario, and shipments go to zero in one scenario essentially at the projected start date for amended standards. See section IV.F.1 for further details on shipments. Given this range of possible shipments, for the LCC results presented in this NOPD, the price change over time was assumed to be zero; or, in other words, the price trend coefficient was set to 1.00 for all years of the LCC (and NIA) analyses.

Lamp manufacturing is also subject to the learning process. The focus of this NOPD is the fluorescent lamp ballast. However, fluorescent lamp ballasts are designed to operate fluorescent lamps and therefore, the cost analysis accounts for the lamp-and-ballast system. The analysis assumes a differing mixture of general service fluorescent lamps (GSFL) and TLEDs operated by the ballasts. TLED prices are expected to be affected by price learning and are expected to decline significantly over the next 3 years. Therefore, to better represent the total installed cost of the ballast and lamp systems, price learning was applied to the lamps operated by the fluorescent lamp ballasts.

Because this proposed determination is not analyzing lamps, lamp shipments and price information were not collected for this rulemaking. Rather, price trend information for lamps was developed from the final rule for the general service fluorescent lamps (GSFL) standards rulemaking published in January 2015. 80 FR 4041 (January 26, 2015). As discussed in this FLB NOPD TSD Appendix 8C, the GSFL price trends were incorporated into the LCC analysis to account for learning in the lamp manufacturing process. The distribution of lamps selected for use by consumers is not expected to differ for ballasts at different efficiency levels.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE used data from RSMeans to estimate the baseline installation cost for fluorescent lamp ballasts. For installation and repair costs, both NEMA and ULT found the ones discussed in DOE's Framework document to be reasonable. (NEMA, No. 12 at p. 11; ULT, No. 6 at p. 9) Philips also stated that it is unlikely that installation costs would change for ballasts at different efficiency levels. (Philips, No. 8 at p. 35) However, ULT cautioned that if new ballasts required as part of a potential standard changed in size, maintenance costs could change.

[28] DOE used Average Price by State by Provider (EIA–826), sorted for Total Electric Industry, obtained from the EIA web page *https://www.eia.gov/electricity/data/state/.*

[29] See the data page on Damodaran Online, *http://pages.stern.nyu.edu/~adamodar.*

[30] In addition to the previously referenced Survey of Consumer Finances, DOE used interest rate data obtained from the Federal Reserve Bank of St. Louis' FRED Economic Data tool found at *https://fred.stlouisfed.org/.*

(ULT, Public Meeting Transcript, No. 5 at p. 96; ULT, No. 6 at p. 9) DOE agrees and uses the same installation costs for ballasts at each efficiency level. Per the engineering analysis, the ballasts at the different efficiency levels are not expected to change in size at the different efficiency levels and therefore would not affect installation or maintenance costs as suggested by ULT. DOE found no evidence that installation costs would be affected with increased efficiency levels.

3. Annual Energy Consumption

DOE determined the energy consumption for fluorescent lamp ballasts at different efficiency levels using the approach described previously in section IV.D of this document.

4. Energy Prices

DOE derived average annual electricity prices for 50 states plus the District of Columbia using data from the EIA's Form EIA–861 annual survey.[31] EIA calculated average electric prices by dividing total electric revenues by total kWh energy sales, using data aggregated by customer class and by state. The NOPD analysis used the data for 2017, with prices adjusted to 2018 dollars.

To estimate energy prices in future years, DOE multiplied the average state-level electricity prices by a projection of annual change in regional electricity prices in the *Annual Energy Outlook 2019* (*AEO2019*), which has an end year of 2050.[32] The AEO includes price projections by Census regions, which were used for the analyses presented herein. To estimate future electricity prices, DOE uses the price index for the regions corresponding to each state. To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2040 through 2050.

Both ASAP and ULT stated that electricity prices can vary both between utilities as well as a result of larger national trends like distributed generation or Congressional requirements. ASAP suggested an analysis that addressed uncertainty in the electricity market. (ASAP, Public Meeting Transcript, No. 5 at p. 94; ULT, No. 6 at p. 6) DOE accounted for considerable electricity price variability by using data from 50 states plus the District of Columbia. Although this represents a higher level of aggregation than utility-by-utility, it reflects the considerable variability in electricity prices in the analysis and it captures some of the policy and other trends alluded to by ASAP and ULT insofar as the influx of distributed generation typically follows state-level policies and legislation promoting such.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. Typically, small incremental increases in product efficiency produce no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products. For this NOPD, DOE modeled ballasts as not being repaired, and maintenance costs as lamp replacement costs only. Philips agreed with DOE's proposal during the framework public meeting and in written comments that ballasts are not repaired. (Philips, Public Meeting Transcript, No. 5 at p. 95; Philips, No. 8 at p. 35) DOE agrees and did not include ballast repair costs in the LCC analysis.

6. Product Lifetime

For fluorescent lamp ballasts, DOE used lifetime estimates from manufacturer datasheets. In the Framework document, DOE estimated a life of 50,000 hours for fluorescent lamp ballasts. Both NEMA and ULT stated that the standard warranty period within the lighting industry for fluorescent lamp ballasts is 3 to 5 years, depending on application. (NEMA, No. 12 at p. 11; ULT, No. 6 at p. 9) Philips stated they use 50,000 hours as useful life, but in certain circumstances thermal effects can reduce this rated life value. Philips speculated that, depending on the operating hours of the ballast, this translates to 10–15 years as a reasonable estimate for FLB life. (Philips, No. 8 at p. 35) The number of years can vary in operation, and DOE used a life value in total number of years rather than solely relying on operating hours. For this analysis, DOE used a 12.5-year average lifetime for the commercial sector, 11.4-year average lifetime for the industrial sector, and 12.5-year average lifetime for the outdoor sector. Combining DOE's estimate of 50,000 hours and the average operating hours for fluorescent lamps in the commercial and industrial sectors yielded average ballast lifetimes of 16.6 years and 11.4 years, respectively. However, 16.6 years is significantly longer than the lifetime of commercial ballasts used in the 2011 Ballast Rule. For that final rule, DOE used 12.5 years, a value DOE found consistent with the literature at the time of the analyses, and consistent with the comment from Phillips. (Philips, No. 8 at p. 35) DOE has found no literature confirming that the product lifetime would increase by 33 percent when measured in years and focused instead on searching for evidence contradicting the lifetime of 12.5 years. No such evidence was identified. Thus, for the NOPD DOE assumed commercial ballasts would have a 12.5-year average lifetime which, when multiplied by the average commercial sector operating hours per year, yields a lifetime of approximately 38,000 hours.

Replacement of fluorescent lamps have to be considered because it is a cost that will be incurred by the consumer over the course of the life of the fluorescent lamp ballast. GE stated that in contrast to dimming incandescent lamps, dimming fluorescent lamps does not extend lamp life. In fact, in some cases if not done properly, life can be negatively affected. Overall, GE stated to not increase lamp life for lamps operated on dimming ballasts compared to non-dimming ballasts. (GE, Public Meeting Transcript, No. 5 at p. 95) Philips stated that without knowing the extent of ballast modifications to meet a potential new or amended standard, it was difficult to predict the effect on lamp life. (Philips, No. 8 at p. 35) ASAP stated that the typical operating life of a T8 fluorescent lamp is 20,000 hours and the advertised lifespan range of TLED is 50,000 to 80,000 hours. (ASAP, No. 7 at p. 5) DOE does not expect the fluorescent lamp life to extend as a result of modifications to the ballasts. The life of the fluorescent lamps used in the LCC analysis can be found in the engineering analysis. DOE used a life of 50,000 hours for the TLEDs used in the analysis.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to commercial, industrial, and residential consumers to estimate the present value of future operating costs. DOE estimated a distribution of discount rates for fluorescent lamp ballasts based on consumer financing costs and the opportunity cost of consumer funds.

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[33] DOE notes

[31] Available at *https://www.eia.gov/electricity/data.php#sales.*

[32] U.S. Department of Energy—Energy Information Administration. *Annual Energy Outlook 2019 with Projections to 2050.* 2019. Washington, DC. (AEO2019). Available at *https://www.eia.gov/outlooks/aeo/.*

[33] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost,

that the LCC does not analyze the product purchase decision, so the implicit discount rate is not relevant in this model. The LCC estimates NPV over the lifetime of the product, so the appropriate discount rate will reflect the general opportunity cost of household or business funds, taking this time scale into account. Given the long time frame modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate effect of this rebalancing using the historical distribution of debts and assets.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances [34] (SCF) for 1995, 1998, 2001, 2004, 2007, 2010, 2013, and 2016. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. In the Crystal Ball™ analyses, for each of the 10,000 simulations, the model selects an income group and then selects a discount rate from the distribution for that group.

For commercial and industrial consumers, DOE used the cost of capital to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost to the firm of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital. DOE used currently available economic data in developing discount rates. See chapter 8 of the NOPD TSD for details on the development of consumer discount rates.

8. Energy Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of product efficiencies under the no-new-standards case (*i.e.,* the case without amended energy conservation standards).

To estimate the energy efficiency distribution of fluorescent lamp ballasts for 2023, DOE analyzed the distribution of ballasts in the databases used in the engineering analysis. For the non-dimming ballasts, the main source of information is the CCMS database. For non-dimming ballasts, DOE relied on product offerings in manufacturer catalogs. See chapter 8 of the NOPD TSD for the estimated efficiency distributions.

9. Payback Period Analysis

The PBP is the amount of time it takes the consumer to recover the additional installed cost of more-efficient products, compared to baseline products, through energy cost savings. PBPs are expressed in years. PBPs that exceed the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the product and the change in the first-year annual operating expenditures relative to the baseline. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed.

EPCA, as amended, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the amended standards would be required.

F. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended energy conservation standards on energy use, NPV, and future manufacturer cash flows.[35] The shipments model takes an accounting approach in tracking market shares of each product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock. DOE received many comments on the shipments and trends related to fluorescent lamp ballasts. Overall, the market is declining; however, DOE received comments on the different rates of decline.

Philips stated that DOE should be working with NEMA in order to obtain market shipment data and, if needed, Philips can work with NEMA to supply the data. Philips also stated that they would provide data to DOE during the interview process. (Philips, No. 8 at pp. 12–13) DOE did receive data from NEMA in written comments that provided indexed values of shipments for a recent set of years. (NEMA, No. 12, at p. 4) DOE also used aggregated data gathered from manufacturers to calibrate the current volume of shipments.

Philips suggested resources for projecting lighting shipments, not just FLB shipments, from Strategies Unlimited, other DOE publications, and NEMA. (Philips, No. 8 at p. 39) DOE reviewed the materials suggested by Philips as well as other data sources to generate shipment projections.

NEMA, Philips, and ULT provided in written comments a graph of fluorescent lamp ballasts indexed to 2010 and shipments through 2014 as a percentage of the index year. This figure indicates a declining market for fluorescent lamp ballasts. (NEMA, No. 12 at pp. 4; Philips, No. 8 at p. 39; ULT, No. 6 at pp. 3–4) NEMA attributes the decline to solid-state lighting and expects the decline to continue into the future. (NEMA, No. 12 at p. 11) NEMA and ULT speculated that based on the data in the figure and certain fit functions that circa 2018 that FLB shipments would end. (NEMA, Public Meeting Transcript, No. 5 at pp. 9–11; ULT, No. 6 at pp. 3–4) However, NEMA did speculate that although an analysis of the data provided suggests an end of the

incorporating the influence of several factors: Transaction costs, risk premiums and response to uncertainty, time preferences, and interest rates at which a consumer is able to borrow or lend.

[34] Board of Governors of the Federal Reserve System. *Survey of Consumer Finances.* Available at *http://www.federalreserve.gov/PUBS/oss/oss2/scfindex.html.*

[35] DOE uses data on manufacturer shipments as a proxy for national sales, as aggregate data on sales are lacking. In general, one would expect a close correspondence between shipments and sales.

FLB market in 2018, it is probably not realistic. (NEMA, Public Meeting Transcript, No. 5 at pp. 9–11) DOE agrees that the market for fluorescent lamp ballasts is declining. DOE modeled a rapid decline in shipment scenario #1 based on these data provided. NEMA suggested that the ballast shipments curtailing in 2018 was based on 2010 to 2014 shipment data and a second degree polynomial fit standard S-curve shape function. (NEMA, Public Meeting Transcript, No. 5 at p. 9) Shipment scenario #1 was modeled as a similar S-curve shaped function with shipments curtailing shortly after the start of the analysis period.

Philips stated that the submitted figure indicates the FLB market is declining at a fast rate. Philips speculated that the market was declining at a rate of about 20 percent per year. According to Philips, LED technologies are competing with fluorescent light sources to illuminate the same spaces and LED prices are decreasing whereas fluorescent technologies are mature. This is one of the reasons for declining FLB shipments. (Philips, No. 8 at pp. 16, 39) Philips also commented that it has reduced the number of its factories manufacturing fluorescent lamp ballasts from five to one. (Philips, Public Meeting Transcript, No. 5 at p. 55) Lutron stated that FLB shipments are declining at an accelerating rate and potential new amended standards can only affect shipments. (Lutron, Public Meeting Transcript, No. 5 at p. 41) DOE agrees that the market for fluorescent lamp ballasts is declining. DOE modeled a rate of decline similar to the 20-percent rate suggested by Philips in shipment scenario #2 based on the data provided.

NEEA mentioned that 10 percent of lamps sales are T12 lamps. Although T12 lamps are less efficient, as legacy products they can have a significant life and sizeable volume of shipments. NEEA also stated that ballasts have a longer life than fluorescent lamps. (NEEA, Public Meeting Transcript, No. 5 at pp. 40–41) GE acknowledged that although certain ballasts have long lives and there might be legacy products still in operation, the lighting industry is currently at the trailing end of those systems. (GE, Public Meeting Transcript, No.5 at p. 55)

ULT stated during the framework public meeting that the retrofit market is very small and little retrofitting is occurring in the market. (ULT, Public Meeting Transcript, No. 5 at pp. 105–106)

ULT stated that LED lighting penetration is increasing in the new construction market, and ULT expected 90 to 95 percent penetration near 2017. Beyond new construction, rebates for fluorescent lamp ballasts and FLB retrofit kits are virtually nonexistent as utilities and other energy efficiency programs are incentivizing LED technologies. (ULT, Public Meeting Transcript, No. 5 at pp. 104–106)

NEMA and ULT stated that there is no indication of growth in the FLB market and every segment is declining. Both NEMA and ULT suggested that new construction is moving to SSL and by the effective date of a potential standard all new construction will utilize SSL. Rebates for fluorescent systems have declined and in some markets disappeared. Both NEMA and ULT expected these trends to continue through the analysis period of the potential rule. (NEMA, No. 12 at p. 11; ULT, No. 6 at p. 9) DOE agrees and has modeled all shipment scenarios as declining markets.

CA IOUs stated that it is generally accepted that the LED market is growing quickly as LED performance improves and prices come down, and that as a result, LEDs are generally expected to expand into most applications in the coming years. (CA IOUs, No. 10 at p. 11) DOE agrees and has modeled all shipment scenarios as declining markets.

ASAP stated that the widespread installation of UL Type A TLEDs could create an extended ''hybrid'' phase where an LED light source is driven by a ballast designed for a fluorescent light source. (ASAP, No. 7 at p. 5) DOE agrees that this could be a possibility. Shipment scenarios #3 and #4 differ in rates of decline partially to address this aspect of the use of UL Type A TLEDs, which are designed to operate on existing fluorescent lamp ballasts.

1. Shipment Scenarios Modeled

DOE agrees with the commenters that FLB shipments are declining. DOE modeled four different no-new-standards shipment scenarios. These scenarios include the following:

(1) Scenario #1—declining shipments that all terminate in 2024. This scenario is based on the data supplied by NEMA and others depicting the decline between 2010 and 2014. The scenario also assumes that all new construction migrates to other light sources than fluorescent technology.

(2) Scenario #2—declining shipments that all terminate in 2040. This scenario is based on comments from manufacturers during the interview process and written comments of a reduction in shipments of 10 to 20 percent per year. This scenario assumes that most new construction is utilizing other light sources besides fluorescent technology.

(3) Scenario #3—declining shipments that approach zero near the end of the analysis period. This scenario is based on data of shipments of other lighting technologies publicly available. The rate of decline is less compared to the previous scenarios partially also to address comments received about UL Type A TLEDs operating on fluorescent lamp ballasts.

(4) Scenario #4—declining shipments that terminate near the end of the analysis period. This scenario is based on a slower decline rate in the initial part of the analysis period.

DOE presents in this proposed determination the results of analysis for each of the shipment scenarios, but shipment scenario #3 is the Reference Case. This scenario is consistent with other estimates of fluorescent technology in the analysis period.

Beyond the no-new-standards case, DOE also received comments about potential standards-induced changes to shipments and thus the effects on NIA. CA IOUs stated that DOE should account for additional energy savings resulting from an accelerated shift to LED lighting induced by more stringent standards for fluorescent lamp ballasts. (CA IOUs, No. 10 at p. 11) Philips also commented that it would be worthwhile to consider the effect of a new ballast energy efficiency rule if ballast declines continued at a faster rate. (Philips, No. 8 at p. 39) Philips speculated that if the incremental ballast price from ballast modifications necessary for compliance to a potential new and amended standard does not pay back within 2 years using the incremental energy savings, customers will choose something else and in reality it will lead to greater LED adoption. (Philips, No. 8 at pp. 36–37)

Lutron stated that FLB shipments are declining at an accelerating rate and potential new amended standards can only affect shipments. (Lutron, Public Meeting Transcript, No. 5 at p. 41) CA IOUs stated that first costs can still be a barrier to LED adoption and if potential new energy efficiency standards for fluorescent lamp ballasts increase the costs for the ballasts, the result will likely accelerate the shift towards more efficient LEDs. (CA IOUs, No. 10 at p. 11) NEEA stated during the framework public meeting that shipment rates of different technologies will depend on the price relationship of the different technologies. (NEEA, Public Meeting Transcript, No. 5 at pp. 99–101)

DOE agrees that there is a possibility that standards could induce consumers to opt for different technologies other than fluorescent lamp ballasts. Utilizing the shipments model, DOE modeled within the NIA model a potential standards-induced shift to SSL.

2. Dimming Ballasts

NEMA and manufacturers stated that the dimming ballast market was small, not growing, and possibly that dimming ballasts would not be shipped by the start of the analysis period. In contrast, ASAP, SCE, and CA IOUs speculated growth in the dimming ballast market. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 24, 106)

NEMA stated that dimmable linear fluorescent lamp ballasts are roughly 2 percent of the overall FLB market. NEMA speculated that this small portion did not represent significant energy savings potential. Dimming ballast shipments have been declining for the last 5 years, according to NEMA and Lutron. (Lutron, No. 9 at p. 2; NEMA, No. 12 at pp. 3–4, 11) NEMA believes that dimming ballast shipments will continue to decline into the future like all other linear FLB shipments. Finally, Lutron and NEMA speculated that standards on dimming ballasts may reduce shipments of ballasts. (Lutron, No. 9 at p. 2; NEMA, No. 12 at pp. 3–4, 11)

GE stated that other than in California, that most retrofits of FLB systems do not include dimming ballasts. GE discussed during the framework public meeting that California was considering modifying the requirements of dimming ballasts in retrofit applications in Title 24 because of claims of negative effects on the retrofit market. (GE, Public Meeting Transcript, No. 5 at pp. 25–26)

Lutron commented during the public meeting that the requirements in California's Title 24 had changed and the adoption of dimming ballasts in retrofit applications is unknown at this time. (Lutron, Public Meeting Transcript, No. 5 at pp. 27–28) During the public meeting, Lutron stated that they believe it is prudent for DOE to assume that all dimming ballasts that are going to be available after the rule becomes effective are already in the market. (Lutron, Public Meeting Transcript, No. 5 at p. 104) In contrast, during the framework public meeting, CA IOUs stated that they expected the absolute number or the percentage of dimming FLB shipments to increase. (CA IOUs, Public Meeting Transcript, No. 5 at p. 106)

ULT commented that although California's Title 24 required the installation of dimming ballasts, sites were installing TLEDs to not trigger the energy code. ULT stated that as a result, there would be probably fewer dimming systems than compared to previous analysis. (ULT, Public Meeting Transcript, No. 5 at pp. 29–31)

ASAP stated that the revised California Title 24 would dramatically alter the market for fluorescent lamp ballasts within California, resulting in greater sales of ballasts capable of dimming below 50 percent full light output. ASAP expected the change in California to affect other states and that dimming ballasts will be in greater demand. (ASAP, No. 7 at p. 2)

Utility rebates for most fluorescent lamp ballasts have disappeared, but SCE did state that some rebates still exist for dimming ballasts as they related to demand response. (SCE, Public Meeting Transcript, No. 5 at pp. 109–110)

CA IOUs stated during the framework public meeting that the dimming ballast requirements within California's Title 24 is having a major effect on the dimming ballast market within California. The 2016 version of Title 24 essentially requires new construction to use linear fluorescent and that the ballast be a dimming ballast. Title 24 installation of dimming ballast requirements also apply to retrofit applications. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 23–24) NEEA also added during the framework public meeting that the four states in the Pacific Northwest might have dimming ballast requirements similar to Title 24 by the time any potential rule goes into effect. (NEEA, Public Meeting Transcript, No. 5 at p. 24) NEMA stated that they would review its data to see if it could determine any effects on dimming ballast shipments as a result of the Title 24 requirements. (NEMA, Public Meeting Transcript, No. 5 at p. 25)

As stated earlier, DOE agrees with commenters that the overall FLB market is declining. Although dimming ballasts may be a smaller portion of the entire FLB market, DOE does not have enough information to indicate a significantly different rate of decline for dimming ballasts compared to the larger FLB market. DOE modeled the same rate of decline for dimming ballasts as other similar non-dimming fluorescent lamp ballasts operating the same type and quantity of lamps in each of the four different scenarios.

GE speculated that if a potential new standard resulted in a very expensive fluorescent dimming ballast, it would accelerate new construction use of LEDs if they wanted a system that dims. (GE, Public Meeting Transcript, No. 5 at p. 101) Lutron speculated that setting efficiency standards too aggressively will only hasten the decline of dimming ballasts. (Lutron, No. 9 at p. 3) DOE agrees that potential standards could induce a shift from dimming fluorescent lamp ballasts to solid-state lighting. As part of the NIA analysis, DOE included a secondary analysis of a standards-induced shift from dimming ballasts to SSL.

3. Tubular LEDs

During the framework public meeting, SCE stated that many lighting customers are focused on inexpensive solutions and often consider retrofitting options rather than replacing the entire system. Specifically, replacing fluorescent lamps with TLEDs is an option that many customers consider. (SCE, Public Meeting Transcript, No. 5 at p. 39) CA IOUs agreed with other commenters that LED products are increasing across many applications, but fluorescent lighting is still prevalent across many sectors. Many manufacturers offer UL Type A TLEDs that are designed to operate on existing fluorescent lamp ballasts and thus the potential need for fluorescent lamp ballasts to exist. (CA IOUs, No. 10 at pp. 1–2)

DOE agrees that TLEDs are currently desired as a low-cost initial energy option and that the use of TLEDs is growing. DOE included in the NIA analysis a greater penetration of UL Type A TLEDs through the course of the analysis period.

GE views the retrofitting of fluorescent luminaires with TLEDs as a short-term solution while the larger new installation market moves to dedicated LED systems. In 10 or 15 years, more dedicated LED systems will be installed and fewer TLEDs will be retrofitting fluorescent luminaires. (GE, Public Meeting Transcript, No. 5 at p. 39) ASAP also speculates that if TLEDs have lifetimes equal or longer than the lifetimes of the fluorescent lamp ballasts that operate them, the TLEDs could disrupt the normal fluorescent maintenance and replacement cycle. Currently ballast failure in a fluorescent luminaire can present a cost-effective opportunity for luminaire replacement with a LED luminaire. However, if the fluorescent lamps have been replaced with TLEDs and the ballast fails at a later point, this might no longer present a cost-effective opportunity to convert the fixture to a dedicated LED luminaire. ASAP cautioned that this might increase the volume of UL Type A TLEDs that operate on a fluorescent lamp ballast. (ASAP, No. 7 at p. 5)

ASAP stated that the widespread installation of TLEDs could create an extended ''hybrid'' phase where a LED light source is driven by a ballast designed for a fluorescent light source. (ASAP, No. 7 at p. 5) Philips stated that retrofit jobs using TLEDs to replace linear fluorescent lamps is a big trend, noting that the prevalence of TLEDs operating on fluorescent lamp ballasts is growing rapidly. (Philips, No. 8 at pp. 12, 38)

DOE agrees that the use of UL Type A TLEDs can achieve early energy savings that might prolong the conversion of the lighting system to other technologies. DOE also agrees that this might encourage sites using UL Type A TLEDs to replace a failed fluorescent lamp ballast with another fluorescent lamp ballast to continue the life of the lighting system. Shipment scenarios #3 and #4 incorporate the prolonged shipments of fluorescent lamp ballasts to service systems modified to use UL Type A TLEDs.

Lutron did not believe that there was a scenario where a consumer would purchase a TLED and a fluorescent lamp ballast in a new system. (Lutron, Public Meeting Transcript, No. 5 at p. 84) DOE disagrees with Lutron. DOE's research indicates at least a few UL Type A TLED manufacturers provide warranties for UL Type A TLEDs that are directly related to the installation of a new ballast. However, DOE stipulates that this is rare combination and that the major benefit of UL Type A TLEDs is that this type TLED can operate on the existing fluorescent lamp ballasts, thus reducing initial costs of installation.

DOE seeks comment whether the shipment scenarios under various policy scenarios are reasonable and likely to occur. DOE seeks comment and information on whether dimming ballasts should have a different rate of decline than the similar non-dimming fluorescent lamp ballasts. DOE seeks comments on which shipment scenario most accurately characterizes future dimming FLB shipments. DOE seeks comments on which of the four scenarios best characterize future shipments of fluorescent lamp ballasts. See section VII.C for a list of issues on which DOE seeks comment. Chapter 9 of the NOPD TSD provides details on DOE's shipments analysis for fluorescent lamp ballasts.

G. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from amended standards at specific efficiency levels.[36] (''Consumer'' in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of fluorescent lamp ballasts sold from 2023 through 2052.

DOE evaluates the effects of amended standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each product class in the absence of amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each product class if DOE adopted amended standards at specific energy efficiency levels (*i.e.,* the ELs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each EL. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV.13 summarizes the inputs and methods DOE used for the NIA analysis for the NOPD. Discussion of these inputs and methods follows the table. See chapter 10 of the NOPD TSD for details.

TABLE IV.13—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Modeled Compliance Date of Standard	2023.
Efficiency Trends	No-new-standards case. Standards cases.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each EL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each EL. Incorporates projection of future product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Prices	*AEO2019* projections (to 2050) and extrapolation through 2061.
Energy Site-to-Source and FFC Conversion	A time-series conversion factor based on *AEO2019 and/or the NEMS model.*
Discount Rate	3 percent and 7 percent.
Present Year	2018.

ULT stated that the NIA should rely on input from manufacturers. (ULT, No. 6, at p. 10) Input from manufacturers as well as others was captured via the comment process, and DOE considered the comments in the development of the inputs that affect the NIA. Interviews were conducted with manufacturers as part of the preliminary analysis process, and DOE incorporated aggregated feedback during these interviews into the inputs that feed the NIA.

During the framework public meeting, CA IOUs requested that DOE provide interim values for statewide energy savings and unit savings within the model. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 111–112) NEMA also requested modifications to the typical NIA models during the framework public meeting. NEMA

[36] The NIA accounts for impacts in the 50 states and Washington, D.C.

stated that for other rules, the NIA model is locked and certain inputs cannot be modified or model elements are not readily understandable in the TSD. (NEMA, Public Meeting Transcript, No. 5 at pp. 116–118) DOE acknowledges these requests. The LCC provides unit-level savings. DOE also provides detail as to how the model works and how it can be modified in chapter 10 and appendix 10A of the NOPD TSD.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.E.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with an amended standard.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2023). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the amended standard level, and the market share of products above the standard would remain unchanged.

ASAP recommended analyzing the TLED market to evaluate its effect on the overall energy savings over time. (ASAP, No. 7 at p. 5) DOE includes a change in UL Type A TLED penetration over time in this analysis. As the mixture of lamps operated by the ballast changes to include differing amount of UL Type A TLEDs, the NES is affected.

CA IOUs suggested accounting for energy savings from standards-induced shifts away from fluorescent lamp ballasts. CA IOUs raised a concern if the analysis only examined fluorescent lamp ballasts and not the energy savings of potential shifts to other lighting technologies. (CA IOUs, Public Meeting Transcript, No. 5 at pp. 103–104; CA IOUs, No. 10 at p. 11) Lutron stated that FLB shipments are declining at an accelerating rate and potential new amended standards can only affect shipments. (Lutron, Public Meeting Transcript, No. 5 at p. 41) Also during the framework public meeting, NEEA discussed the possibility of setting a potential standard for dimming ballasts that would eliminate some of the dimming ballasts. NEEA suggested that consumers would switch to LED options. NEEA suggested that there should be a scenario that examines consumers switching to LED systems. (NEEA, Public Meeting Transcript, No. 5 at p. 102)

DOE has included within the NIA model a standards-induced shift scenario in which if EL 1 is selected 25 percent of the consumers would migrate to a new LED technology. If EL 2 is selected 50 percent of the consumers would migrate to a new LED technology, and if EL 3 is selected 75 percent of the consumers would migrate to a new LED technology. Within the NIA model, the percentage of customers migrating away is not fixed and can be changed by the user.

Philips speculated that if the incremental ballast price from ballast modifications necessary for compliance to a potential new, amended standard does not pay back within 2 years using the incremental energy savings, customers will choose something else, and in reality it will lead to additional LED adoption. (Philips, No. 8 at pp. 36–37) CA IOUs stated that first costs can still be a barrier to LED adoption, and if potential new energy efficiency standards for fluorescent lamp ballasts increase the costs for the ballasts, the result will likely accelerate the shift towards more efficient LEDs. (CA IOUs, No. 10 at p. 11)

Within DOEs standard-induced shift away from a FLB scenario, DOE modeled the shift to occur at different increments at each EL and not at a specific PBP or specific increase in FLB price. The PBPs vary for all of the product classes and ballasts. The potential cost differential between the baseline ballast and a more efficient EL ballast vary across the products classes as well.

NEEA stated that although LED replacements of traditional lighting are more expensive than traditional lighting systems, the prices will reduce over time. (NEEA, Public Meeting Transcript, No. 5 at p. 99) However, NEEA also stated that the price of FLB systems is known, whereas the price of LED systems in the future is a much bigger variable. (NEEA, Public Meeting Transcript, No. 5 at pp. 101–102) Philips concurred that although LED prices were initially higher, they have reduced and they will be lower cost in the future. (Philips, Public Meeting Transcript, No. 5 at pp. 102–103)

DOE agrees that the potential LED options may have a greater initial cost than a potential compliant fluorescent lamp ballast. Within the standards-induced shift away from the FLB scenario, DOE assumed an equal mixture of TLEDs (UL Type B and C), LED retrofit kits, and new LED luminaires. DOE researched public pricing for each of these devices and developed and aggregate price for the potential LED option. DOE also developed an aggregate device efficacy for the potential option. Using DOE forecasts for future efficacy improvements circa 2023, DOE modeled the efficacy for the LED option in 2023. Using the engineering analysis and system light output, DOE reverse-engineered the input power and price for the LED option. For more information on the methodology refer to the Appendix 10D of chapter 10 of the NOPD TSD.

DOE seeks comment on the percentage of customers to model in a standards-induced shift that would migrate away from FLB technology. DOE seeks comments on the specific incremental cost in fluorescent lamp ballasts that could trigger a standards-induced shift away from fluorescent lamp ballasts. DOE seeks comment on the approach for input power and price for LED devices considered in a standards-induced shift. See section VII.C for a list of issues on which DOE seeks comment.

DOE seeks comment on any potential impediments that would prevent users of fluorescent lamp ballasts from switching to LED lighting to garner additional energy savings. DOE seeks comment on the expected effect of potential standards on the rate at which FLB consumers transition to non-FLB technology. See section VII.C for a list of issues on which DOE seeks comment. Chapter 10 of the NOPD TSD provides details on DOE's NIA for fluorescent lamp ballasts.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered products between each potential standards case (EL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to source energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2019.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

In 2011, 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 Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the NIA and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [37] that EIA uses to prepare its AEO. The FFC factors incorporate losses in production, and delivery in the case of natural gas, (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the NOPD TSD.

ULT stated that the NIA model needs to include a declining market for fluorescent lamp ballasts. (ULT, No. 6 at p. 10) DOE agrees with ULT and has included declining shipment scenarios within the shipment analysis (chapter 10 of the NOPD TSD). The shipments analysis serves as part of the basis of the NIA model, and thus the NIA model includes a declining shipments scenario for fluorescent lamp ballasts.

NEMA and ULT stated that the NIA model should include the energy reduction from the natural shift to solid-state lighting. (NEMA, No. 12 at p. 12; ULT, No. 6 at p. 10) As stated previously, the preliminary analysis shipment model includes a declining market scenario that includes a shift to solid-state lighting. This decline of fluorescent lamps ballasts in transition to SSL is in the absence of standards (a natural shift). This decline occurs in the no-new-standards case. The NIA model characterizes the energy usage of the fluorescent lamp ballast and compares the energy usage in both a no-new-standards and a standards scenario. However, DOE has included within the NIA model a scenario in which potential standards accelerate the shift away from fluorescent lamp ballasts to SSL (standards-induced shift).

Both NEMA and ULT suggested that the NIA model should focus on the effects of potential standards on drawing resources from lighting manufacturers from other technologies (*i.e.,* SSL) to comply with potential standards. (NEMA, No. 12 at p. 12; ULT, No. 6 at p. 10) DOE has not analyzed the potential effects of standards on resources and investments of manufacturers as part of the NIA. The MIA assesses the investments manufacturers must make to comply with potential standards (see section IV.H).

During the framework public meeting, Lutron inquired whether DOE could take credit for energy savings resulting from dimming ballast standards across the country. California's Title 20 already contains a dimming standard, and therefore Lutron suggested that DOE should only include energy saving projections from the rest of the country and not in California. (Lutron, Public Meeting Transcript, No. 5 at pp. 27–28) The NIA model uses inputs from the shipments analysis factors in distributions of different values of efficiency of ballasts. Therefore, the ballasts that comply with California's Title 20 are incorporated into the shipments model and thus the NIA model. If a potential standard shifts ballasts to the California Title 20 values, any related savings (or lack of savings because of already compliant ballasts) would be captured by the NIA model.

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are (1) total annual installed cost, (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-new-standards case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of each product shipped during the projection period.

DOE developed FLB price trends based on historical pricing information for electronic ballasts. DOE applied the same trends to project prices for each product class at each considered efficiency level. By 2052, which is the end date of the projection period, the average FLB price is projected to drop 8.2 percent relative to 2016. DOE's projection of product prices is described in appendix 8C of the NOPD TSD.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference Case from *AEO2019,* which has an end year of 2050.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPD, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[38] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

H. Manufacturer Impact Analysis

DOE performed an MIA to estimate the financial impacts of potential amended energy conservation standards on manufacturers of fluorescent lamp ballasts. DOE relied on GRIM, an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in research and development (R&D) and manufacturing capital required to produce compliant products. The key GRIM outputs are the industry net present value (INPV), which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact to domestic manufacturing employment. The GRIM calculates cash flows using standard accounting principles and compares

[37] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009), October 2009. Available at *https://www.eia.gov/analysis/pdfpages/0581(2009)index.php.*

[38] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *https://obamawhitehouse.archives.gov/omb/memoranda_m03-21/.*

changes in INPV between the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the amended energy conservation standard on manufacturers. To capture the uncertainty relating to manufacturer pricing strategies following amended standards, the GRIM estimates a range of possible impacts under different markup scenarios.

DOE created initial estimates for the industry financial inputs used in the GRIM (*e.g.,* tax rate; working capital rate; net property plant and equipment expenses; selling, general, and administrative (SG&A) expenses; R&D expenses; depreciation expenses; capital expenditures; and industry discount rate) based on publicly available sources, such as company filings of form 10–K from the SEC or corporate annual reports.[39] DOE then further calibrated these initial estimates during manufacturer interviews to arrive at the final estimates used in the GRIM.

The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of potential standards and extending over a 30-year period following the compliance date of potential standards. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) Creating a need for increased investment, (2) raising production costs per unit, and (3) altering revenue due to higher per-unit prices and changes in sales volumes.

The GRIM spreadsheet uses inputs to arrive at a series of annual cash flows, beginning in 2019 (the reference year of the analysis) and continuing to 2052. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. DOE used a real discount rate of 9.6 percent for FLB manufacturers. This initial discount rate estimate was derived using the capital asset pricing model in conjunction with publicly available information (*e.g.,* 10-year treasury rates of return and company specific betas). DOE then confirmed this initial estimate during manufacturer interviews. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 11 of the NOPD TSD.

[39] 10-Ks are collected from the SEC's EDGAR database: *https://www.sec.gov/edgar.shtml* or from annual financial reports collected from individual company websites.

1. Manufacturer Production Costs

Manufacturing more efficient fluorescent lamp ballasts is typically more expensive because of the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered products can affect the revenues, gross margins, and cash flow of the industry. Typically, DOE develops MPCs for the covered products using reverse-engineering. These costs are used as an input to the LCC analysis and NIA. However, because ballasts are difficult to reverse-engineer, DOE directly derived end-user prices in the engineering analysis and then used the end-user prices in conjunction with markups to calculate the MPCs of fluorescent lamp ballasts. See section IV.C for a further explanation of product price determination.

To determine MPCs of fluorescent lamp ballasts from the wholesale prices calculated in the engineering analysis, DOE divided the wholesale prices by the wholesaler markup to calculate the MSP. DOE then divided the MSP by the manufacturer markup to get the MPCs. DOE determined the wholesaler markup to be 1.23 and the manufacturer markup to be 1.40 for all fluorescent lamp ballasts. Markups are further described in section IV.H.4.

2. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by EL. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections from shipments scenario #3 (reference case, see section IV.F.1) starting in 2019 (the reference year) and ending in 2052 (the end year of the analysis period). See chapter 9 of the NOPD TSD for additional details.

3. Product and Capital Conversion Costs

Potential amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and equipment designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered EL in each product class. 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 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 compliant product designs can be fabricated and assembled.

To evaluate the level of capital conversion costs manufacturers would likely incur to comply with the analyzed energy conservation standards DOE used data submitted during manufacturer interviews and data from the 2011 FL Ballast Rule to estimate costs to update manufacturer production lines by product class. DOE then estimated the number of production lines currently in existence and the number of production lines that would be required to be updated at each analyzed EL using DOE's public Compliance Certification Database. DOE then multiplied these numbers together (*i.e.,* capital conversion costs per production line and number of production lines that would need to be updated) to get the final estimated capital conversion costs for each product class at each analyzed EL.

To evaluate the level of product conversion costs manufacturers would likely incur to comply with the analyzed energy conservation standards, DOE used data submitted during manufacturer interviews and data from the 2011 FL Ballast Rule to estimate per model R&D and testing and certification costs for each product class and EL. DOE then estimated the number of models that would need to be redesigned for each product class at each analyzed EL. DOE then multiplied these numbers together to get the final estimated product conversion costs for each product class at each analyzed EL.

In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the potential amended standards. The conversion cost figures used in the GRIM can be found in Table V.7 and section V.C of this document. For additional information on the estimated capital and product conversion costs, see chapter 11 of the NOPD TSD.

4. Markup Scenarios

To calculate the MPCs used in the GRIM, DOE divided the wholesaler prices calculated in the engineering analysis by the wholesaler markup and the manufacturer markup. The wholesaler markup was calculated in the 2011 FL Ballast Rule by reviewing SEC 10–K reports of electrical wholesalers. DOE also coordinated with the National Association of Electrical Distributors by contacting two representative electrical wholesalers, who confirmed that DOE's calculated markups were consistent with their actual ballast markups. DOE continued to use a wholesaler markup of 1.23 in this analysis.

The manufacturer markup accounts for the non-production costs (*i.e.,* SG&A, R&D, and interest) along with profit. Modifying the manufacturer markup in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of analyzed energy conservation standards: (1) A preservation of gross margin percentage markup scenario; and (2) a preservation of operating profit markup scenario. These scenarios lead to different manufacturer markup values that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' markup across all ELs, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all ELs within a product class. To calculate the preservation of gross margin markup, DOE took the manufacturer markup used in the 2011 FL Ballast Rule and compared it to the manufacturer markups calculated by examining the SEC 10-Ks of all publicly traded FLB manufacturers and confirmed this with manufacturers during interviews. DOE determined that the manufacturer markup used in the 2011 FL Ballast Rule was consistent with the current SEC 10-Ks of the publicly traded FLB manufacturers and most manufacturers agreed during manufacturer interviews. Therefore, DOE used 1.40 as the manufacturer markup in the preservation of gross margin markup scenario. DOE assumes that this markup scenario represents an upper bound to industry profitability under analyzed energy conservation standards.

Under the preservation of operating profit markup scenario, DOE modeled a situation in which manufacturers are not able to increase operating profit in proportion to increases in manufacturer production costs. Under this scenario, as the cost of production increases, manufacturers are generally required to reduce the manufacturer markups to maintain cost competitive offerings in the market. Therefore, gross margin (as a percentage) shrinks in the standards cases in this markup scenario. This markup scenario represents an upper bound of industry impacts (lower profitability) under amended energy conservation standards.

A comparison of industry financial impacts under the two manufacturer markup scenarios is presented in section V.C.1 of this document.

5. Manufacturer Interviews

DOE interviewed manufacturers of fluorescent lamp ballasts and asked them to describe their major concerns regarding a potential rulemaking to amend the standards for FLBs. Manufacturer interviews are conducted under non-disclosure agreements (NDAs), so DOE does not document these discussions in the same way that it does public comments and DOE's responses throughout the rest of this document. Manufacturers identified two major areas of concern regarding potential FLB standards: (1) Shift to SSL (*i.e.,* LEDs) and (2) limited investment in fluorescent lamp ballasts.

a. Shift to Solid-State Lighting

Manufacturers stated that the market is moving from fluorescent lighting to LED lighting. As a result, shipments for fluorescent lamp ballasts are declining. This trend is expected to continue in the future absent amended energy conservation standards. Some manufacturers expected sales in 2020 could decline by more than half compared to 2016. Given this market-driven move in the no-new-standards case from fluorescent lighting to LED lighting, manufacturers commented that an amended energy conservation would accelerate this transition. Specifically, manufacturers stated that consumers of fluorescent lamp ballasts are very price sensitive and any increase in consumer price as a result of potential amended energy conservation standards would significantly reduce FLB shipments.

DOE is aware that consumers of fluorescent lamp ballasts are shifting to purchase all-LED systems. DOE accounts for this in the Reference Case by adjusting shipments of fluorescent lamp ballasts downward during the analysis period. Amended energy conservation standards could accelerate the transition to LED lighting, and DOE accounts for this potential accelerated decline by analyzing an alternate shipment scenario in which there is a standards-induced shift to SSL. (See section IV.F for further information.)

b. Limited Investment in Fluorescent Lamp Ballasts

Manufacturers commented that fluorescent lamp ballasts are a mature technology and increases in efficiency can only be achieved at high expense to the industry. Under potential amended energy conservation standards, manufacturers stated that they might discontinue non-compliant products instead of redesigning them, because investments in fluorescent lamp ballasts would not be cost-effective. Therefore, any amended energy conservation standards could result in reduced product offerings. This would impact consumers in the replacement markets, particularly in those instances in which there is a preference to replace ballasts with exactly the same one. The LCC analysis takes into account such effects on consumers; see section IV.E for further details.

6. Discussion of MIA Comments

DOE received several comments related to assessing the manufacturer impacts of potential amended standards for fluorescent lamp ballasts. NEMA, Lutron, and ULT commented that manufacturers are unlikely to develop or redesign new fluorescent lamp ballasts if energy conservation standards result in the elimination of products from the market. They added that setting efficiency limits will only hasten the existing decline of this product category. (NEMA, No. 12 at p. 11; Lutron, No. 9 at p. 3; ULT, No. 6 at p. 10) Similarly, Philips commented that even though a new ballast could be designed and produced, DOE needs to be very cognizant of the costs associated with design, approbation, marketing, and implementation of that new, revised design into luminaires and there might not be a positive business case. (Philips, No. 8 at p. 15)

The MIA takes conversion costs and the shipment volumes into account when analyzing the impacts on manufacturers. Thus, the results of the MIA present the impacts of redesigning all non-compliant products to comply with the analyzed standard level even if that is not the path that manufacturers will choose.

In addition, NEMA pointed out that fluorescent lamp ballasts have been subject to four energy conservation standards since the early 1990s, including a rulemaking completed in 2011, which NEMA stated had a significant negative impact on manufacturers' INPV. NEMA commented that because of a declining demand for these products, another rulemaking could have a negative impact on INPV. (NEMA, No. 12 at p. 8) Philips and ULT commented that they used to run five and four FLB factories, respectively, and now they are running one factory each as a result of declining sales. (Philips, Public Meeting Transcript, No. 5 at p. 55; ULT, Public Meeting Transcript, No. 5 at p. 56)

In those instances in which DOE proposes amended standards, it analyzes the benefits and burdens of each standard independently and weighs the potential burdens on the industry as one of the factors in determining a final standard. In this notice DOE is proposing a determination to not amend standards for fluorescent lamp ballasts. See section V.D for further details.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for fluorescent lamp ballasts. It addresses the ELs examined by DOE and the projected impacts of each of these levels. Additional details regarding DOE's analyses are contained in the NOPD TSD supporting this document.

A. Economic Impacts on Individual Consumers

DOE analyzed the cost effectiveness (*i.e.,* the savings in operating costs throughout the estimated average life of FLBs compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the FLBs which are likely to result from the imposition of a standard at the EL) by considering the LCC and PBP at each EL. These analyses are discussed in the following sections. DOE usually evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national standard. However, given the tentative conclusion discussed in section V.D, DOE did not conduct a consumer subgroup analysis for this proposed determination.

1. Life-Cycle Cost and Payback Period

In general, higher-efficiency products can affect consumers in two ways: (1) Purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.,* product price plus installation costs), and operating costs (*i.e.,* annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the NOPD TSD provides detailed information on the LCC and PBP analyses.

Table V.1 shows the average LCC and PBP results for the ELs considered for fluorescent lamp ballasts in this analysis.

TABLE V.1—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL

Efficiency level	LCC savings 2018$	Simple payback period *years*
EL 1	0	12
EL 2	1	10
EL 3	2	10

2. Rebuttable Presumption Payback

As discussed in section IV.E.9, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption PBP for each of the considered ELs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedure for fluorescent lamp ballasts. In contrast, the PBPs presented in section V.A.1 were calculated using distributions that reflect the range of energy use in the field. See chapter 8 of the NOPD TSD for more information on the rebuttable presumption payback analysis.

B. National Impact Analysis

This section presents DOE's estimates of the NES and the NPV of consumer benefits that would result from each of the ELs considered as potential amended standards.

1. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for fluorescent lamp ballasts, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each EL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2023–2052). Table V.2 presents DOE's projections of the NES for each EL considered for fluorescent lamp ballasts. The savings were calculated using the approach described in section IV.G of this document.

TABLE V.2—CUMULATIVE NATIONAL ENERGY SAVINGS FOR FLUORESCENT LAMP BALLASTS; 30 YEARS OF SHIPMENTS

[2023–2052]

Shipment scenario	Energy type	Efficiency level		
		1	2	3
		quads		
1	Site Energy	0.000	0.000	0.000
	Source Energy	0.000	0.000	0.000
	FFC Energy	0.000	0.000	0.000
2	Site Energy	0.006	0.019	0.025
	Source Energy	0.017	0.051	0.066
	FFC Energy	0.018	0.054	0.069
3 (Reference Case)	Site Energy	0.018	0.055	0.069

TABLE V.2—CUMULATIVE NATIONAL ENERGY SAVINGS FOR FLUORESCENT LAMP BALLASTS; 30 YEARS OF SHIPMENTS—Continued

[2023–2052]

Shipment scenario	Energy type	Efficiency level		
		1	2	3
		quads		
	Source Energy	0.049	0.145	0.183
	FFC Energy	0.051	0.152	0.192
4	Site Energy	0.037	0.110	0.137
	Source Energy	0.098	0.292	0.365
	FFC Energy	0.102	0.306	0.382

OMB Circular A–4 [40] 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 proposed determination, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of product 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.[41] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to fluorescent lamp ballasts. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.3. The impacts are counted over the lifetime of fluorescent lamp ballasts purchased in 2023–2031.

TABLE V.3—CUMULATIVE NATIONAL ENERGY SAVINGS FOR FLUORESCENT LAMP BALLASTS; 9 YEARS OF SHIPMENTS

[2023–2031]

Shipment scenario	Energy type	Efficiency level		
		1	2	3
		quads		
1	Site Energy	0.000	0.000	0.000
	Source Energy	0.000	0.000	0.000
	FFC Energy	0.000	0.000	0.000
2	Site Energy	0.006	0.018	0.023
	Source Energy	0.016	0.047	0.061
	FFC Energy	0.017	0.049	0.064
3 (Reference Case)	Site Energy	0.012	0.036	0.047
	Source Energy	0.032	0.097	0.124
	FFC Energy	0.034	0.101	0.130
4	Site Energy	0.022	0.065	0.084
	Source Energy	0.058	0.175	0.224
	FFC Energy	0.061	0.183	0.235

2. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the ELs considered for fluorescent lamp ballasts. In accordance with OMB's guidelines on regulatory analysis,[42] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.4 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2023–2052.

[40] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Available at *https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/.*

[41] Section 325(m) of 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. If DOE makes a determination that amended standards are not needed, it must conduct a subsequent review within 3 years following such a determination. As DOE is evaluating the need to amend the standards, the sensitivity analysis is based on the review timeframe associated with amended 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. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some products, the compliance period is 5 years rather than 3 years.

[42] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Available at *https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/.*

TABLE V.4—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR FLUORESCENT LAMP BALLASTS; 30 YEARS OF SHIPMENTS

[2023–2052]

Shipment scenario	Discount rate (percent)	Efficiency level		
		1	2	3
		Billion 2018$		
1	3	(0.000)	0.000	0.000
	7	(0.000)	(0.000)	(0.000)
2	3	(0.050)	(0.013)	(0.031)
	7	(0.053)	(0.054)	(0.080)
3 (Reference Case)	3	(0.146)	(0.075)	(0.159)
	7	(0.133)	(0.149)	(0.228)
4	3	(0.293)	(0.165)	(0.350)
	7	(0.256)	(0.293)	(0.453)

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.5. The impacts are counted over the lifetime of products purchased in 2023–2031. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.5—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR FLUORESCENT LAMP BALLASTS; 9 YEARS OF SHIPMENTS

[2023–2031]

Shipment scenario	Discount rate (percent)	Efficiency level		
		1	2	3
		Billion 2018$		
1	3	(0.000)	0.000	0.000
	7	(0.000)	(0.000)	(0.000)
2	3	(0.046)	(0.010)	(0.025)
	7	(0.050)	(0.051)	(0.074)
3 (Reference Case)	3	(0.096)	(0.030)	(0.066)
	7	(0.101)	(0.106)	(0.157)
4	3	(0.173)	(0.058)	(0.128)
	7	(0.180)	(0.192)	(0.285)

C. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of analyzed energy conservation standards on manufacturers of fluorescent lamp ballasts. The following section describes the expected impacts on fluorescent lamp manufacturers at each EL. Chapter 11 of the NOPD TSD explains the analysis in further detail.

1. Industry Cash Flow Analysis Results

In this section, DOE provides the results from the MIA, which examines changes in the industry that would result from the analyzed standards. The following tables illustrate the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of fluorescent lamp ballasts, as well as the conversion costs that DOE estimates manufacturers of fluorescent lamp ballasts would incur at each EL.

To evaluate the range of cash-flow impacts on the FLB industry, DOE modeled two markup scenarios that correspond to the range of anticipated market responses to potential standards. Each scenario results in a unique set of cash flows and corresponding industry values at each EL. In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and the standards case that result from the sum of discounted cash flows from the reference year (2019) through the end of the analysis period (2052).

To assess the upper (less severe) end of the range of potential impacts on FLB manufacturers, DOE modeled a preservation of gross margin markup scenario. This 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 consumers. To assess the lower (more severe) end of the range of potential impacts, DOE modeled a preservation of operating profit markup scenario. The preservation of operating profit markup scenario assumes that in the standards cases, manufacturers would be able to earn the same operating margin in absolute dollars as they would in the no-new-standards case. This represents the lower bound of industry profitability in the standards cases.

Table V.6 and Table V.7 present the results of the industry cash flow analysis for FLB manufacturers under the preservation of gross margin and preservation of operating profit markup scenarios. See chapter 11 of the NOPD TSD for results of the complete industry cash flow analysis by product class.

TABLE V.6—MANUFACTURER IMPACT ANALYSIS FOR FLUORESCENT LAMP BALLAST—PRESERVATION OF GROSS MARGIN MARKUP SCENARIO

	Units	No-new-standards case	EL 1	EL 2	EL 3
INPV	*2018$ millions*	489.3	436.9	389.1	381.5
Change in INPV	*2018$ millions*		(52.4)	(100.2)	(107.8)
	%		(10.7)	(20.5)	(22.0)
Product Conversion Costs	*2018$ millions*		68.8	132.2	146.7
Capital Conversion Costs	*2018$ millions*		17.8	33.8	36.4
Total Conversion Costs	*2018$ millions*		86.6	166.0	183.1

TABLE V.7—MANUFACTURER IMPACT ANALYSIS FOR FLUORESCENT LAMP BALLAST—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO

	Units	No-new-standards case	EL 1	EL 2	EL 3
INPV	*2018$ millions*	489.3	430.9	375.6	363.3
Change in INPV	*2018$ millions*		(58.4)	(113.7)	(126.0)
	%		(11.9)	(23.2)	(25.8)
Product Conversion Costs	*2018$ millions*		68.8	132.2	146.7
Capital Conversion Costs	*2018$ millions*		17.8	33.8	36.4
Total Conversion Costs	*2018$ millions*		86.6	166.0	183.1

2. Direct Impacts on Employment

DOE typically presents quantitative estimates of the potential changes in production employment that could result from the analyzed energy conservation standard levels. However, for this proposed determination, DOE determined that no manufacturers have domestic FLB production. Further, DOE has tentatively determined that amended energy conservation standards are not needed. Therefore, the proposed determination would not have a significant impact on domestic employment in the FLB industry.

3. Impacts on Manufacturing Capacity

DOE does not anticipate any significant capacity constraints at any of the analyzed energy conservation standards. The more efficient components are currently being used in existing FLB models and worldwide supply would most likely be able to meet the increase in demand given the 3-year compliance period for any potential energy conservation standards.

4. 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 only identified one manufacturer subgroup for fluorescent lamp ballasts, small manufacturers. Given the tentative conclusion discussed in section V.D, DOE did not conduct a manufacturer subgroup analysis on small business manufacturers for this proposed determination.

5. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the product-specific regulatory actions of other Federal agencies that affect the manufacturers of a covered product. While any one regulation may not impose a significant burden on manufacturers, the combined effects of several existing 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 typically conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency. However, given the tentative conclusion discussed in section V.D, DOE did not conduct a cumulative regulatory burden analysis.

D. Proposed Determination

As required by EPCA, this notice analyzes whether amended standards for fluorescent lamp ballasts would result in significant conservation of energy, be technologically feasible, and be cost effective. (42 U.S.C. 6295(m)(1)(A) and (n)(2)) In addition to these criteria, DOE also estimated the impact on manufacturers. The criteria considered under 42 U.S.C. 6295(m)(1)(A) and the additional analysis are discussed below. Because an analysis of potential cost effectiveness and energy savings first require an evaluation of the relevant technology, DOE first discusses the technological feasibility of amended standards. DOE then addresses the cost effectiveness and energy savings associated with potential amended standards.

1. Technological Feasibility

EPCA mandates that DOE consider whether amended energy conservation standards for fluorescent lamp ballasts would be technologically feasible. (42 U.S.C. 6295(m)(1)(A) and (n)(2)(B)) DOE has tentatively determined that there are technology options that would improve the efficiency of fluorescent lamp ballasts. These technology options are being used in commercially available fluorescent lamp ballasts and therefore are technologically feasible. (See section IV.A.3 for further information.) Hence, DOE has tentatively determined that amended energy conservation standards for fluorescent lamp ballasts are technologically feasible.

2. Cost Effectiveness

EPCA requires DOE to consider whether energy conservation standards for fluorescent lamp ballasts would be cost effective through an evaluation of the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard. (42 U.S.C. 6295(m)(1)(A), (n)(2)(C), and (o)(2)(B)(i)(II)) DOE conducted an LCC analysis to estimate the net costs/benefits to users from increased efficiency in the considered fluorescent lamp ballasts. (See results in Table V.1.) DOE then aggregated the results from the LCC analysis to estimate the NPV of the total costs and benefits experienced by the Nation. (See results in Table V.4 and Table V.5.) As noted, the inputs for determining the NPV are (1) total annual installed cost, (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings.

DOE first considered the most efficient level, EL 3 (max tech), which would result in negative NPV at the 3-percent and 7-percent discount rates. On the basis of negative NPV, DOE tentatively determined that EL 3 is not cost effective.

DOE then considered the next most efficient level, EL 2, which would result in negative NPV at a 3-percent and 7-percent discount rate. On the basis of negative NPV, DOE tentatively determined that EL 2 is not cost effective.

DOE then considered the next most efficient level, EL 1, which would result in negative NPV at both a 3-percent and 7-percent discount rate. On the basis of negative NPV, DOE tentatively determined that EL 1 is not cost effective.

3. Significant Conservation of Energy

EPCA also mandates that DOE consider whether amended energy conservation standards for fluorescent lamp ballasts would result in result in significant conservation of energy. (42 U.S.C. 6295(m)(1)(A) and (n)(2)(A)) DOE estimates that amended standards for fluorescent lamp ballasts would result in site energy savings of 0.018 quads at EL 1 and 0.069 quads at max tech levels over a 30-year analysis period (2023–2052). (See results in Table V.2.) However, as provided in the prior section, DOE has tentatively determined that amended standards at the evaluated ELs would not be cost effective.

4. Other Analysis

In this analysis, DOE also conducted an MIA to estimate the impact of potential energy conservation standards on manufacturers of fluorescent lamp ballasts. (See results in Table V.6 and Table V.7.) Each EL for all applicable product classes is estimated to result in FLB manufacturers experiencing a loss in INPV.

5. Summary

In this proposed determination, based on the consideration of cost effectiveness and the initial determination that amended standards would not be cost effective, DOE has tentatively determined that energy conservation standards for fluorescent lamp ballasts do not need to be amended. DOE will consider all comments received on this proposed determination in issuing any final determination.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

This proposed determination has been determined to be not significant for purposes of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993). As a result, the OMB did not review this proposed determination.

B. Review Under Executive Orders 13771 and 13777

On January 30, 2017, the President issued Executive Order (E.O.) 13771, ''Reducing Regulation and Controlling Regulatory Costs.'' E.O. 13771 stated the policy of the executive branch is to be prudent and financially responsible in the expenditure of funds, from both public and private sources. E.O. 13771 stated it is essential to manage the costs associated with the governmental imposition of private expenditures required to comply with Federal regulations.

Additionally, on February 24, 2017, the President issued E.O. 13777, ''Enforcing the Regulatory Reform Agenda.'' E.O. 13777 required the head of each agency to designate an agency official as its Regulatory Reform Officer (RRO). Each RRO oversees the implementation of regulatory reform initiatives and policies to ensure that agencies effectively carry out regulatory reforms, consistent with applicable law. Further, E.O. 13777 requires the establishment of a regulatory task force at each agency. The regulatory task force is required to make recommendations to the agency head regarding the repeal, replacement, or modification of existing regulations, consistent with applicable law. At a minimum, each regulatory reform task force must attempt to identify regulations that:

(1) Eliminate jobs, or inhibit job creation;

(2) Are outdated, unnecessary, or ineffective;

(3) Impose costs that exceed benefits;

(4) Create a serious inconsistency or otherwise interfere with regulatory reform initiatives and policies;

(5) Are inconsistent with the requirements of Information Quality Act, or the guidance issued pursuant to that Act, in particular those regulations that rely in whole or in part on data, information, or methods that are not publicly available or that are insufficiently transparent to meet the standard for reproducibility; or

(6) Derive from or implement Executive Orders or other Presidential directives that have been subsequently rescinded or substantially modified.

DOE initially concludes that this rulemaking is consistent with the directives set forth in these executive orders.

As discussed in this document, DOE is proposing not to amend energy conservation standards for fluorescent lamp ballasts. Therefore, if finalized as proposed, this proposed determination is expected to be an E.O. 13771 other action.

C. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (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 website (*http://energy.gov/gc/office-general-counsel*).

DOE reviewed this proposed determination under the provisions of the Regulatory Flexibility Act and the policies and procedures published on February 19, 2003. Because DOE is proposing not to amend standards for fluorescent lamp ballasts, if adopted, the determination would not amend any energy conservation standards. On the basis of the foregoing, DOE certifies that the proposed determination, if adopted, would have no significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared an IRFA for this proposed determination. DOE will transmit this certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

D. Review Under the Paperwork Reduction Act

Manufacturers of fluorescent lamp ballasts must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for fluorescent lamp ballasts, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including fluorescent lamp ballasts. 76 FR 12422 (March 7, 2011); 80 FR 5099 (Jan. 30, 2015). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 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.

E. Review Under the National Environmental Policy Act of 1969

DOE is analyzing this proposed action in accordance with the National Environmental Policy Act (NEPA) and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for actions which are interpretations or rulings with respect to existing regulations. 10 CFR part 1021, subpart D, Appendix A4. DOE anticipates that this action qualifies for categorical exclusion A4 because it is an interpretation or ruling in regards to an existing regulation and otherwise meets the requirements for application of a categorical exclusion. See 10 CFR 1021.410. DOE will complete its NEPA review before issuing the final action.

F. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed determination and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed determination. 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) Therefore, no further action is required by Executive Order 13132.

G. Review Under Executive Order 12988

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

H. 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) and (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

This proposed determination does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by the private sector. As a result, the analytical requirements of UMRA do not apply.

I. 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 proposed determination 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.

J. Review Under Executive Order 12630

Pursuant to Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 15, 1988), DOE has determined that this proposed determination would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

K. 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 information quality 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 this NOPD under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

L. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor Executive 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.

Because this proposed determination does not propose amended energy conservation standards for fluorescent lamp ballasts, it is not a significant energy action, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects.

M. Information Quality

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

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and has prepared a report describing that peer review.[43] 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. DOE has determined that the peer-reviewed analytical process continues to reflect current practice, and the Department followed that process for developing its determination in the case of the present action.

[43] ''Energy Conservation Standards Rulemaking Peer Review Report.'' 2007. Available at *http://energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0.*

VII. Public Participation

A. Participation in the Webinar

The time and date of the webinar are listed in the **DATES** section at the beginning of this document. If no participants register for the webinar then it will be cancelled. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: *https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=3.* Participants are responsible for ensuring their systems are compatible with the webinar software.

Additionally, you may request an in-person meeting to be held prior to the close of the request period provided in the **DATES** section of this document. Requests for an in-person meeting may be made by contacting Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *Appliance_Standards_Public_Meetings@ee.doe.gov.*

B. Submission of Comments

DOE will accept comments, data, and information regarding this proposed determination no later than the date provided in the **DATES** section at the beginning of this proposed determination. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via *http://www.regulations.gov.* The *http://www.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 *http://www.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 *http://www.regulations.gov* cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *http://www.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 *http://www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or postal mail. Comments and documents submitted via email, hand delivery/courier, or postal mail also will be posted to *http://www.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. If you submit via postal mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles (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. Pursuant 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 that 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).

C. 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) DOE seeks comment on its evaluation of the efficiency of dimming ballasts as BLE at full light output. See section IV.A.2.

(2) DOE seeks comment on the ELs under consideration for the representative and non-representative product classes, including the max tech levels. See section IV.B.5 and IV.B.6.

(3) DOE seeks comment on the methodology and results for estimating end-user prices for fluorescent lamp ballasts in this analysis. See section IV.C.

(4) DOE seeks comment on the methods to improve DOE's energy-use analysis, as well as any data supporting alternate operating hour estimates or assumptions regarding dimming of fluorescent lamp ballasts. See section IV.E.

(5) DOE seeks comment on the type, prevalence, and operating hour reductions related to the use of lighting controls used separately in commercial, industrial, and residential sectors. See section IV.E.

(6) DOE seeks comment on the assumptions and methodology for estimating annual operating hours. See section IV.E.

(7) DOE seeks comment whether the shipment scenarios under various policy scenarios are reasonable and likely to occur. See section IV.F.

(8) DOE seeks comment and information on whether dimming ballasts should have a different rate of decline than the similar non-dimming fluorescent lamp ballasts. See section IV.F.

(9) DOE seeks comments on which shipment scenario accurately characterizes future dimming FLB shipments. See section IV.F.

(10) DOE seeks comments on which of the four scenarios best characterize future shipments of fluorescent lamp ballasts. See section IV.F.

(11) DOE seeks comment on the percentage of customers to model in a standards-induced shift that would migrate away from FLB technology. See section IV.G.1.

(12) DOE seeks comments on the specific incremental cost in fluorescent lamp ballasts that could trigger a standards-induced shift away from fluorescent lamp ballasts. See section IV.G.1.

(13) DOE seeks comment on the approach for determining input power and price for LED devices considered in a standards-induced shift. See section IV.G.1.

(14) DOE seeks comment on the impediments that prevent users of fluorescent lamp ballasts from switching to LED lighting. See section IV.G.

(15) DOE seeks comment on the expected effect of potential standards on

the rate at which FLB consumers transition to non-FLB technology. See section IV.G.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed determination.

Signed in Washington, DC, on October 1, 2019.

Daniel R Simmons,

Assistant Secretary, Energy Efficiency and Renewable Energy.

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