Energy Conservation Standards
Rulemaking Framework Document for
General Service Fluorescent Lamps and
Incandescent Reflector Lamps
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U.S. Department of Energy
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LIST OF ABBREVIATIONS

AEO	Annual Energy Outlook (Annual energy forecast published by EIA)
BPAR	bulged parabolic aluminized reflector (reflector lamp shape)
BR	bulged reflector (reflector lamp shape)
BT	Building Technologies Program
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CBECS	Commercial Buildings Energy Consumption Survey by EIA
CCT	correlated color temperature
CFR	Code of Federal Regulations
CFL	compact fluorescent lamp
CO2	carbon dioxide
CSPAR	Cross-State Air Pollution Rule (replaces CAIR)
CSL	candidate standard level (energy-efficiency level)
DOE	U.S. Department of Energy
EIA	Energy Information Administration (statistical and analytical agency within DOE)
EISA 2007	Energy Independence and Security Act of 2007
EL	efficacy level
EPA	U.S. Environmental Protection Agency
EPAct 1992	Energy Policy Act of 1992
EPAct 2005	Energy Policy Act of 2005
EPCA	Energy Policy and Conservation Act of 1975
ER	elliptical reflector (reflector lamp shape)
FR	Federal Register
GRIM	Government Regulatory Impact Model
GSFL	general service fluorescent lamp
GSIL	general service incandescent lamp
Hg	mercury
HIR	halogen infrared
INPV	industry net present value
IRL	incandescent reflector lamp
K	degrees Kelvin (an absolute temperature scale equal to –273.15 ^{o}C)
LCC	life-cycle cost
LMC	U.S. Lighting Market Characterization Volume I
max-tech	maximum technologically-feasible CSL
MECS	Manufacturer Energy Consumption Survey (performed for EIA by the Census Bureau)
MIA	Manufacturer Impact Analysis
NEMS	National Energy Modeling System (developed and used by EIA)
NEMS-BT	National Energy Modeling System – Building Technologies
NES	national energy savings
NIA	National Impact Analysis
NOPR	notice of proposed rulemaking
NO_X	nitrogen oxides
NPV	net present value
PAR	parabolic aluminized reflector (reflector lamp shape)

PBP	payback period
R	reflector (reflector lamp shape)
RCFL	reflector compact fluorescent lamp
RECS	Residential Energy Consumption Survey by EIA
RIA	regulatory impact analysis
SBA	U.S. Small Business Administration
SEC	U.S. Securities and Exchange Commission
SO_2	sulfur dioxide
TSD	technical support document
U.S.C.	United States Code
V	volts
W	watts

Rulemaking Framework Document for General Service Fluorescent Lamps and Incandescent Reflector Lamps

1. Introduction

The purpose of this document is to describe the procedural and analytical approaches the U.S. Department of Energy (DOE) anticipates using to evaluate energy conservation standards for general service fluorescent lamps (GSFLs) and incandescent reflector lamps (IRLs). It is intended to inform interested parties and to encourage and facilitate their input during the rulemaking. This document is the starting point for developing standards and not a definitive statement with respect to any issue to be determined in the rulemaking.

Sections 1 and 2 discuss the rulemaking process. Sections 3 through 18 outline the analyses DOE intends to conduct to fulfill the statutory requirements and guidance for this standards rulemaking. Although DOE is combining rulemaking activities for GSFLs and IRLs, it is conducting separate analyses for each lamp type to determine whether amended energy conservation standards are technologically feasible and economically justified. For each of the two lamp types examined in this rulemaking, DOE is performing separate analyses, including an engineering analysis, a lifecycle cost (LCC) payback period analysis (PBP), national impact analysis (NIA), and manufacturer impact analysis (MIA).

Information regarding this rulemaking will be maintained on the DOE website at: www.eere.energy.gov/buildings/appliance_standards/residential/incandescent_lamps.html.

While DOE invites stakeholder comment on all aspects of the material presented in this document, specific issues on which DOE seeks comment are highlighted by comment boxes. These comment boxes include questions on the approaches DOE is proposing for the analyses required for the standard rulemaking. These text in the boxes is assembled in Appendix A.

1.1 Authority and Background

Title III of Energy Policy and Conservation Act of 1975 (EPCA) (42 U.S.C. 6291 *et seq.*) sets forth a variety of provisions designed to improve energy efficiency. Part B of Title III (42 U.S.C. 6291-6309) established the "Energy Conservation Program for Consumer Products Other Than Automobiles," which includes major household appliances.[1] Subsequent amendments expanded Title III of EPCA to include additional consumer products and certain commercial and industrial equipment, including certain fluorescent and incandescent lamps—the products that are the focus of this document. In particular, amendments to EPCA in the Energy Policy Act of 1992 (EPAct 1992), P.L. 102-486, established energy conservation standards for certain classes of GSFLs and IRLs, and authorized DOE to conduct two rulemaking cycles to determine whether these standards should be amended. (42 U.S.C. 6291(1), 6295(i)(1) and (3)-(4)) EPCA also authorized DOE to adopt standards for additional GSFLs, if such standards were warranted. (42 U.S.C. 6295(i)(5))

[1]Part B was re-designated Part A on codification in the U.S. Code for editorial reasons.

DOE completed the first cycle of amendments by publishing a final rule in July 2009 (referred to as the 2009 Lamps Rule in this document). 74 FR 34080 (July 14, 2009). The 2009 Lamps rule addressed two statutory directives under 42 U.S.C. 6295(i) by amending existing energy conservation standards for GSFLs and IRLs (42 U.S.C. 6295(i)(3)) and adopting standards for additional GSFLs (42 U.S.C. 6295(i)(5)). This rule also amended the definition of "colored fluorescent lamp" and "rated wattage" and adopted test procedures applicable to the newly covered GSFL. Information regarding the 2009 Lamps Rule can be found on DOE's website at: www.eere.energy.gov/buildings/appliance_standards/residential/incandescent_lamps_standards_final_rule.html.

The EPAct 1992 amendments to EPCA added as covered products certain IRLs with wattages of 40 watts (W) or higher, and established energy conservation standards for these IRLs. In defining the term "incandescent reflector lamp," EPAct 1992 excluded lamps with elliptical reflector (ER) and bulged reflector (BR) bulb shapes, and with diameters of 2.75 inches or less. Therefore, such IRLs were neither included as covered products nor subject to EPCA's standards for IRLs.

Section 322(a)(1) of the Energy Independence and Security Act of 2007 (EISA 2007) subsequently amended EPCA to expand the Act's definition of "incandescent reflector lamp" to include lamps with a diameter between 2.25 and 2.75 inches, as well as lamps with ER, BR, bulged parabolic aluminized reflector (BPAR), or similar bulb shapes. (42 U.S.C. 6291(30)(C)(ii) and (F)) Section 322(b) of EISA 2007, in amending EPCA to set forth revised standards for IRLs in new section 325(i)(1)(C), exempted from these standards the following categories of IRLs: (1) lamps rated 50 watts or less that are ER30, BR30, BR40, or ER40; (2) lamps rated 65 watts that are BR30, BR40, or ER40 lamps; and (3) R20 incandescent reflector lamps rated 45 watts or less. (42 U.S.C. 6295(i)(C)) Lamps that have a diameter of 2.5 inches or less, such as R20 lamps, are commonly referred to as small diameter lamps. (DOE refers to these three categories of lamps collectively as "certain reflector (R), ER and BR IRLs.")

DOE has concluded, for the reasons that follow, that it has the authority under EPCA to adopt standards for these R, ER, and BR IRLs, and that these lamps are covered by the directive in 42 U.S.C. 6295(i)(3) to amend EPCA's standards for IRLs. First, by amending the definition of "incandescent reflector lamp" (42 U.S.C. 6291(30)(C)(ii) and (F)), EISA 2007 effectively brought these R, ER and BR IRLs into the Federal energy conservation standards program as covered products, thereby subjecting them to DOE's regulatory authority. Second, although 42 U.S.C 6295(i)(1)(C) exempts these R, ER and BR IRLs from the standards specified in 42 U.S.C. 6295(i)(1)(B), EPCA directs that DOE amend the standards laid out in 42 U.S.C 6295(i)(1), which includes subparagraph (C). As a result, the statutory text exempted these bulbs only from the standards specified in 42 U.S.C. 6295(i)(1), not from future regulation. Consequently, DOE is considering energy conservation standards for these R, ER and BR IRLs. DOE initiated a new rulemaking for these products by publishing a framework document and publishing a notice announcing its availability. 75 FR 23191 (May 3, 2010). DOE held a public meeting on May 26, 2010 to seek input from interested parties on its proposals, methodologies, assumptions, and data sources.

This framework document and the associated public meeting represent the first step in the process to consider a second review of existing energy conservation standards for GSFLs and IRLs, other than the certain R, ER, and BR IRLs discussed in the preceding paragraphs. As part of amending existing conservation standards for GSFL, this rulemaking will also consider adopting standards for additional types of GSFL.

2. Overview of Rulemaking Process

2.1 Test Procedures

DOE's test procedures for fluorescent and incandescent lamps are set forth at 10 CFR part 430, subpart B, appendix R. These test procedures provide instructions for measuring GSFL and IRL performance, as well as performance attributes of GSIL, largely by incorporating industry standards. These test procedures were updated in a final rule published in July 2009 (2009 test procedure final rule). 74 FR 31829 (July 6, 2009). The rule updated citations and references to the industry standards currently referenced in DOE's test procedures, and made several technical modifications. The amendments also provided test methods for some GSFLs based on new product designs. Test procedures for additional GSFLs included in 2009 Lamps Rule were adopted as part of the standards rulemaking. DOE is revising GSFL and IRL test procedures in a separate rulemaking, in which DOE is considering updates to the latest versions of the relevant industry standards currently referenced in DOE's test procedures.

DOE is also reevaluating the metric for measuring IRL efficacy. Currently, IRL standards are based on lamp efficacy measured as the lumen output of the lamp per watt supplied to the lamp. Another potential metric is application efficacy, the average luminous flux[2] within a specific solid angle of interest per unit power. It is measured in lumens per steradian[3] (lm/sr) or candelas per watt (cd/W). Application efficacy is based on the principle that the effectiveness of the lamp should be quantified in terms of the lamp delivering light to locations where it is needed. DOE will consider this metric as it reassesses the most appropriate metric for IRLs in these revised standards and the concurrent test procedure rulemaking.

Item 1 *DOE welcomes comment on establishing a new metric for IRL standards.*

2.2 Rulemaking Process and Stakeholder Participation

When DOE evaluates any new or amended energy conservation standard for "covered products," EPCA, as amended, specifies that any standard DOE prescribes for consumer products must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Moreover, the Secretary may not establish an amended standard if such standard would not result in a

[2] Luminous flux is the time rate of flow of radiant energy, evaluated in terms of a standardized visual response.
[3] Steradian is a solid angle subtended at the center of the sphere by an area on the surface of the sphere equal to the square of the sphere radius. The amount of light given into one steradian by a point of source with a luminous intensity of one candela placed at the center of the sphere is one lumen.

significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) In determining whether a standard is economically justified, DOE must consider, to the greatest extent practicable, the following seven factors:

> (1) The economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard;
> (2) The savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;
> (3) The total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;
> (4) Any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard;
> (5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;
> (6) The need for national energy and water conservation; and
> (7) Other factors the Secretary considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)-(VII))

The process of developing efficiency standards involves analysis, public notice, and consultation with interested parties. Such interested parties generally include manufacturers, consumers, energy conservation and environmental advocates, State and Federal agencies, and any other groups or individuals with an interest in energy conservation standards and test procedures. DOE considers participation of interested parties to be a very important part of the rulemaking process. Accordingly, DOE actively encourages the participation and interaction of all interested parties during the comment period provided at each stage of the rulemaking. The broad array of interested parties who routinely provide comments promotes a balanced discussion of critical information required to conduct the standards rulemaking, beginning with public comment on the Framework Document.

In conducting the test procedure rulemakings and the energy (and water) conservation standards rulemakings, DOE involves interested parties through a variety of means. As discussed in further detail below, the standards rulemaking process typically involves three public notices in addition to the notice of availability of the framework document. All of these notices are published in the *Federal Register*. Publication of the framework document, preliminary analysis, and notice of proposed rulemaking (NOPR) are typically accompanied by public meetings to solicit comment from interested parties to enhance the rulemaking process.

- *Preliminary Analysis and Notice of Public Meeting* (section 2.3). The preliminary analysis is designed to publicly vet the models and tools that DOE will use in the rulemaking, and to facilitate public participation before the proposed rule stage. Candidate standard levels (CSLs), which are levels that span the range of efficiencies from baseline products to the most efficient technology, are the basis for demonstrating the functionality of the models and tools.

- *Notice of Proposed Rulemaking* (section 2.4). The NOPR presents a discussion of comments received in response to the preliminary analysis; DOE's analysis of the impacts of potential standards on consumers, manufacturers, and the nation; DOE's weighing of these impacts; and the proposed standard levels for public comment.

- *Final Rule* (section 2.5). The final rule presents a discussion of comments received in response to the NOPR; the revised analysis of the impacts of standards; DOE's weighting of the impacts; and the standard levels DOE is adopting. The final rule also sets out the compliance date of the standards based on statuatory requrements.

DOE has prepared the preliminary schedule below for the GSFL and IRL rulemaking.

Table 2.1 Preliminary Rulemaking Schedule for GSFL and IRL Energy Conservation Standards

Deliverable	**Publication Date**
Framework Document	August 2011
Preliminary Analysis	September 2012
NOPR	August 2013
Final Rule	April 2014

Any final energy conservation standards for GSFLs and IRLs would require compliance three years after the final rule is published, which is projected to be April 2017 (*see* 42 U.S.C. 6295(i)(4)).

2.3 Preliminary Analyses and Notice of Public Meeting

During the preliminary analysis phase of the rulemaking, DOE presents the models and tools it will use to conduct the four principal analyses that comprise the preliminary analysis–the engineering analysis, life-cycle cost analysis, national impact analysis, and preliminary manufacturer impact analysis. Before conducting the engineering analysis, DOE typically identifies technology options to increase efficiency and then preliminarily determines whether to retain that option for detailed analysis or to eliminate it from further consideration. The process for consideration of technology options includes a market and technology assessment (section 4) and a screening analysis (section 5). DOE applies four screening criteria in the screening analysis to determine which technology options to eliminate from further consideration: (1) technological feasibility; (2) practicability to manufacture, install, and service; (3) adverse impacts on product utility or availability; and (4) adverse impacts on health or safety. Technology options that remain after screening analysis are referred to as design options in the engineering analysis. DOE consults with interested parties and independent technical experts to identify the design options, efficiency levels, or key issues that DOE will consider in the rulemaking.

Next, DOE considers design options or efficiency levels for each product class. DOE collects manufacturer cost data, historical shipment data, shipment-weighted average efficiency

data, and preliminary manufacturer impact data (*e.g.*, capital conversion expenditures, marketing costs, and research and development costs) based on these design options or efficiency levels. DOE then conducts the principal analyses, including: (1) the engineering analysis (section 6); (2) the LCC and PBP analyses (section 6); (3) the NIA, which considers national energy savings (NES) and consumer net present value (NPV) (section 11); and (4) a preliminary MIA (section 13). DOE will present the results of these analyses in the preliminary analysis technical support document (TSD).

Based on the results of the preliminary analysis described above, DOE selects CSLs from among the energy efficiency levels considered in the preliminary analysis. Publication of DOE analysis of various CSLs in the preliminary analysis will enable interested parties to review the spreadsheet models (also posted on DOE's website) that underpin the analyses and provide DOE with comments so that the models can be refined. In the next stage of rulemaking, the NOPR, DOE generally considers energy efficiency levels or design options that span technologically achievable efficiencies. The range of levels DOE typically analyzes includes:

- The baseline efficiency level (the minimum level) set by the product with the lowest energy efficiency level currently sold on the market for a given category; For product categories where minimum federal energy conservation standards already exist, this is typically defined by the existing energy conservation standard;

- The CSL with the lowest LCC or greatest LCC savings;

- The highest energy efficiency CSL or lowest energy consumption CSL that is technologically feasible (maximum technologically-feasible (max-tech)); and

- CSLs that incorporate technologies of significance or fill in large gaps between other efficiency levels considered.

At the preliminary analysis stage, DOE uses analytical models and tools to assess the different product classes at each CSL analyzed. Many of these analytical models and tools are in the form of spreadsheets, which are also used to conduct the LCC and PBP analyses and to determine the national energy savings and NPV of CSLs.

DOE will make the spreadsheet tools used in the preliminary analysis and results of the preliminary analysis available on its website for review. DOE will also make a TSD available containing the details of all the analyses performed to date when it publishes the preliminary analysis. After publication of the preliminary analysis, DOE will provide a public comment period and hold a public meeting. In addition, as stated above, DOE encourages interested parties to make joint recommendations for CSLs and to submit them to DOE for consideration.

2.4 Notice of Proposed Rulemaking (NOPR)

For the proposed Rule, DOE reviews and considers all the comments received after the publication of the preliminary analysis. This process may result in revisions or refinements to the preliminary analyses, including the engineering analysis and life-cycle cost analysis. DOE also

will conduct additional economic and environmental impact analyses at this stage of the rulemaking. These analyses generally include a consumer LCC subgroup analysis (see section 12), a complete manufacturer impact analysis (see section 13), a utility impact analysis (see section 14), an employment impact analysis (see section 15), an environmental assessment (see section 16, and a regulatory impact analysis (see section 18).

DOE describes the methodology used and posts the results of all the analyses on its website for review and comments. Based on comments by stakeholders, further revisions to the analysis may be undertaken. This analytical process ends with the proposal of standard levels in the NOPR. DOE proposes standard levels based on the trial standard levels (TSLs) analyzed during the NOPR phase of the rulemaking. The NOPR, published in the *Federal Register*, documents the evaluation and selection of the proposed standard level(s), along with a discussion of other TSLs considered but not selected (and the reasons for not selecting them).

The selection process for proposed efficiency standards generally runs as follows. For each product class, DOE will identify the max tech efficiency level. If DOE proposes a level lower than the max tech level, it will sequentially explain the reasons for eliminating higher levels beginning with the highest level considered. DOE will present the analytical results in the NOPR and the analysis details in an accompanying TSD.

DOE considers many factors in selecting proposed standards, as described above in section 2.2. These factors and criteria are prescribed by EPCA and take into consideration the impacts of energy conservation standards. In addition, as stated previously, DOE encourages stakeholders to make joint recommendations for standard levels. DOE carefully considers such recommendations in its decision process.

When DOE publishes the NOPR, it will provide the Department of Justice (DOJ) with a copy of the NOPR and TSD to solicit DOJ review of the impact of the proposed standard levels on competition in the lighting industry. Publication of the NOPR is followed by a 60-day public comment period.

2.5 Final Rule

After the publication of the NOPR, DOE will consider public comments it receives on the proposal and supporting analyses. On the basis of the public comments, DOE will review the supporting analyses and proposed standards and consider modifications where necessary. Before the final rule is issued, DOE also will consider DOJ comments on the NOPR relating to the impacts of the proposed standard levels on competition to determine whether changes to these standard levels are needed.

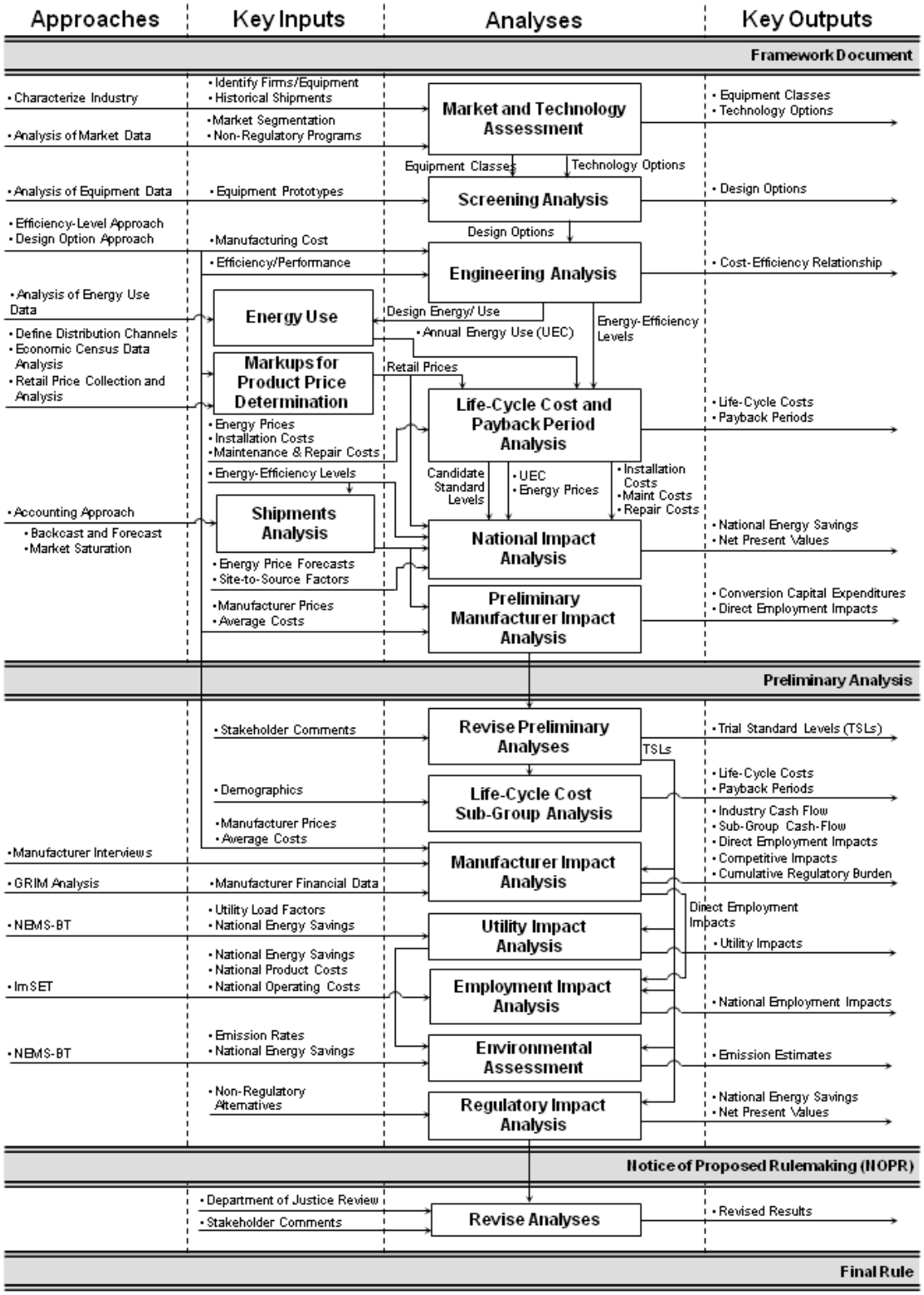
The standards rulemaking will conclude with the publication of the final rule. DOE will select the final standard level based on the complete record of the standards rulemaking. The final rule will promulgate the final standard level and the compliance date and explain the basis for its selection. The final rule will be accompanied by a final TSD.

2.6 Overview of Analyses for Rulemaking

The purpose of the analyses conducted in support of the standards rulemaking is to ensure that DOE selects energy conservation standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in significant energy savings. Economic justification includes the consideration of economic impacts on domestic manufacturers and consumers, national benefits including environmental impacts, issues of consumer utility, and impacts from any lessening of competition. DOE expects the selection of such standards to achieve the maximum energy savings that are economically justified without imposing excessive financial burden on any particular party.

Figure 2.1 summarizes the analytical components of the standards-setting process. The "analyses" are presented in the center column. Each analysis has a set of "key inputs," which are data and information required for the analysis. "Approaches" are the methods that DOE will use to obtain key inputs, which may vary depending on the information in question. For example, some key inputs exist in public databases; DOE will collect other information from stakeholders or experts with special knowledge, and DOE will gather other information in support of this rulemaking. The results of each analysis are "key outputs," which feed directly into the rulemaking. Arrows indicate the flow of information between the various analyses. DOE ensures a consistent approach to its analyses throughout the rulemaking by considering each analysis as a part of the overall standards-setting framework.

Figure 2.1 Flow Diagram of Analyses for the General Service Fluorescent Lamps and Incandescent Reflector Lamps Energy Conservation Standard Rulemaking Process



3. Scope of Coverage

3.1 General Service Fluorescent Lamps

As previously mentioned, DOE is conducting its second review to determine whether existing standards for GSFLs should be amended in this rulemaking. In implementing 42 U.S.C. 6295(i)(5), the 2009 Lamps Rule expanded the definition of "fluorescent lamp" to include additional lamp wattages and two additional lamp types.[4] The definitions of "fluorescent lamp" and "general service fluorescent lamp" are provided below and also in Appendix B:

> *Fluorescent lamp* means a low pressure mercury electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into light, including only the following:
> (1) Any straight-shaped lamp (commonly referred to as 4-foot medium bipin lamps) with medium bipin bases of nominal overall length of 48 inches and rated wattage of 25 or more;
> (2) Any U-shaped lamp (commonly referred to as 2-foot U-shaped lamps) with medium bipin bases of nominal overall length between 22 and 25 inches and rated wattage of 25 or more;
> (3) Any rapid start lamp (commonly referred to as 8-foot high output lamps) with recessed double contact bases of nominal overall length of 96 inches;
> (4) Any instant start lamp (commonly referred to as 8-foot slimline lamps) with single pin bases of nominal overall length of 96 inches and rated wattage of 52 or more;
> (5) Any straight-shaped lamp (commonly referred to as 4-foot miniature bipin standard output lamps) with miniature bipin bases of nominal overall length between 45 and 48 inches and rated wattage of 26 or more; and
> (6) Any straight-shaped lamp (commonly referred to 4-foot miniature bipin high output lamps) with miniature bipin bases of nominal overall length between 45 and 48 inches and rated wattage of 49 or more.
>
> *General service fluorescent lamp* means any fluorescent lamp which can be used to satisfy the majority of fluorescent lighting applications, but does not include any lamp designed and marketed for the following nongeneral application:
> (1) Fluorescent lamps designed to promote plant growth;
> (2) Fluorescent lamps specifically designed for cold temperature applications;
> (3) Colored fluorescent lamps;
> (4) Impact-resistant fluorescent lamps;
> (5) Reflectorized or aperture lamps;
> (6) Fluorescent lamps designed for use in reprographic equipment;
> (7) Lamps primarily designed to produce radiation in the ultra-violet region of the spectrum; and
> (8) Lamps with a Color Rendering Index of 87 or greater.

10 CFR 430.2

[4] As explained previously, DOE concluded that the directive of 42 U.S.C. 6295(i)(5) to consider additional GSFL was not restricted to the four specific lamp types in the definition of "fluorescent lamp" in the U.S. Code.

In this second review, DOE will consider adoption of standards for additional types of GSFL with shapes and lengths other than the ones already covered by standards. Some additional GSFL types DOE is considering include:

- Pin-based compact fluorescent lamps (CFLs)
- Non-linear fluorescent lamps (e.g. circline)
- Fluorescent lamps with alternate lengths (e.g. 2-,3-,5-foot)

If DOE determines that standards for additional types of GSFL would require further amendment to the definition of "fluorescent lamp" which lists covered lamp types, DOE will consider such amendments in this rulemaking. In determining whether to make standards applicable to additional GSFL types, DOE will evaluate lamps that meet the statutory definition of "general service fluorescent lamp."

3.2 Incandescent Reflector Lamps

DOE is also conducting this second review to determine whether existing standards for IRLs should be amended in this rulemaking. The definition of "incandescent reflector lamp" is provided below and also in Appendix B.

> *Incandescent reflector lamp* (commonly referred to as a reflector lamp) means any lamp in which light is produced by a filament heated to incandescence by an electric current, which: is not colored or designed for rough or vibration service applications that contains an inner reflective coating on the outer bulb to direct the light; has an R, PAR, ER, BR, BPAR, or similar bulb shapes with an E26 medium screw base; has a rated voltage or voltage range that lies at least partially in the range of 115 and 130 volts; has a diameter that exceeds 2.25 inches; and has a rated wattage that is 40 watts or higher.

10 CFR 430.2

DOE is considering the certain R, ER and BR IRL discussed in section 1.1 in a separate rulemaking. Therefore, DOE is not considering amending standards for these products in this rulemaking.

With respect to wattage, EISA 2007 amends EPCA to define IRL as a lamp that "has a rated wattage that is 40 watts or higher." (42 U.S.C. 6291(30)(C), (C)(ii), and (F)) Current IRL standards are set for the 40-205W range. Similar to the 2009 Lamps Rule, DOE is not considering IRL with rated wattages greater than 205W because these comprise a very small portion of the market and therefore do not represent significant potential energy savings. 74 FR 34080, 34092 (July 14, 2009).

Item 2 *DOE welcomes comment on additional GSFLs and IRLs that should be included for this rulemaking. For suggested additional lamp types, DOE requests market and shipment information as well as potential for efficacy improvements and energy savings.*

4. Market and Technology Assessment

The market and technology assessment will provide information about the manufacturers of general service fluorescent lamps and incandescent reflector lamps, and specifics about the performance attributes of these lamps. This assessment is used to develop product classes and identify technology options to improve lamp efficacy for each of the lamp types. EPCA defines "lamp efficacy" as the lumen output of a lamp divided by its wattage, expressed in lumens per watt (LPW).

4.1 Market Assessment Overview

As part of the market assessment, DOE will qualitatively and quantitatively characterize the structure of the general service fluorescent and incandescent reflector lamp market. DOE will identify and characterize the manufacturers, estimate market shares and trends, address regulatory and non-regulatory initiatives intended to improve the energy efficiency or reduce the energy consumption of covered lamps, and explore the potential for technological improvements in the design and manufacturing of such products.

This market assessment will serve as a resource to guide the analyses that follow. For example, DOE may use historical shipments and prices as an indicator of future shipments and prices. Similarly, DOE plans to use market structure data for the manufacturer impact analysis, data which will be particularly useful for assessing competitive impacts. This phase also allows DOE to start updating design options by reviewing product literature and industry publications.

DOE has already gathered a large amount of information in support of the 2009 Lamps Rule. DOE recognizes, however, that additional data may have become available since the publication of that rule. In addition, DOE recognizes that there may be limited public information regarding recent trends in national shipments, manufacturing costs, channels of distribution, and manufacturers' market shares of GSFLs and IRLs. This type of data is an important input for analyses that determine if energy conservation standards are economically justified and will result in significant energy savings. Therefore, DOE encourages stakeholders to submit data that pertains to these issues and would improve DOE's understanding of recent trends in the GSFL and IRL market.

Stakeholders may submit confidential data to DOE, indicating in writing which data should remain confidential. To prevent public disclosure of the data due to actions taken by a third party, stakeholders providing confidential information to DOE must submit that data according to 10 CFR 1004.11. Under 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies. One copy of the document shall include all the information believed to be confidential, and the other copy of the document shall have the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination. DOE prepares aggregated results from the data submitted for use in DOE's analyses. These aggregated results do not divulge the sensitive nature of the individual raw data, but enable other stakeholders to review and comment on the aggregated dataset.

DOE is updating its database of commonly-available products based on recent catalogs from manufacturers of GSFL and IRL, including both small and large market participants. DOE will use the resulting knowledge about product availability to evaluate how the market may respond to various standard levels (e.g., consumers substituting lamps that are not subject to regulation), and to gain additional insight on the performance attributes of various commercially-available GSFL and IRL technologies.

Item 3 *DOE welcomes information on shipments, product-feature and efficiency trends, distribution channels and estimates of market shares for the lamps considered in this rulemaking. For the data to be used to conduct energy savings calculations, please provide appropriate groupings (e.g., by product class and wattage).*

4.2 Product Classes

DOE divides covered products into classes by: (a) the type of energy used; (b) the capacity of the product; or (c) any other performance-related feature that justifies different standard levels, such as features affecting consumer utility. (42 U.S.C. 6295(q)) For this rulemaking, the DOE intends to analyze product classes for GSFL and IRL separately.

4.2.1 General Service Fluorescent Lamps

As in the 2009 Lamps Rule, DOE plans to establish product classes for GSFLs based on the following three factors: (1) physical constraints of lamps (*i.e.*, lamp shape and length); (2) lumen package (*i.e.*, standard versus high output); and (3) correlated color temperature (CCT).

The shape and geometry of a lamp affect its efficacy. At the same time, lamp shape and length provide unique utility and cannot always be used as replacements in a given fixture. For example, a 2-foot U-shaped lamp, while having the same overall tube length, is less efficacious than a 4-foot linear lamp due in part to the fact that the electrical arc within the tube has to bend to conform to the shape of the lamp. However, a linear-shaped lamp cannot substitute for a U-shaped lamp due to the size of the fixture. Additionally, while 8-foot lamps generally have higher efficacy values than 4-foot lamps, they usually require different fixtures. Thus, DOE is considering establishing a separate product class based on the physical constraints of lamps.

DOE is considering separate product classes based on lumen package. Lumen package refers to the quantity of light that a lamp-and-ballast system provides to a consumer. DOE notes that efficacy decreases as a fluorescent lamp is driven harder to increase its light output. For example, the efficacy of high output 8-foot lamps is approximately 7 to 10 percent lower than that of slimline 8-foot lamps. DOE believes that lumen package provides utility because consumers tend to prefer systems with different lumen packages for different applications. For example, high-lumen-output systems appear more likely to be installed in high-ceiling or outdoor applications, where large quantities of light are needed. Alternatively, standard-lumen-output systems are more likely to be installed in lower-ceiling applications such as offices or hospitals, where the distance between the light source and the illuminated surfaces is not as large.

Thirdly, DOE is considering separate product classes for lamps with a CCT less than or equal to 4500K and greater than 4500K. CCT is a measure of the perceived color of the white light emitted from a lamp. As the spectral emission from the lamp is modified to change the CCT, the lamp efficacy can vary. For example, due to their greater blue light content, higher CCT fluorescent lamps tend to have lower efficacies. DOE recognizes that the CCT of fluorescent lamps provides a distinct utility (*e.g.*, the light emitted by the fluorescent lamp has different qualities). Given the impact of CCT on efficacy and utility, DOE established separate product classes based on CCT.

Using these three criteria, similar to the 2009 Lamps Rule, DOE is considering establishing 12 product classes, which are listed in Table 4.1 below. 74 FR 34080, 34099 (July 14, 2009). DOE may consider additional product classes resulting from consideration of new GSFL lamp types. In the 2009 Lamps Rule, DOE had created a separate product class for T5 lamps because physical constraints prevent them from serving as direct replacements for T8 and T12 lamps and the lamps are generally considered too bright for use in direct lighting. DOE requests comment on maintaining separate product classes for T5 lamps in this rulemaking. In general, DOE requests comment on the approach for establishing product classes and the product classes under consideration for GSFLs.

Table 4.1. 2009 Lamps Rule Product Classes for GSFL

Lamp Type	CCT
4-foot medium bipin	≤4500 K
	>4500 K
2-foot U-shaped	≤4500 K
	>4500 K
8-foot single pin slimline	≤4500 K
	>4500 K
8-foot recessed double contract high output	≤4500 K
	>4500 K
4-foot T5, miniature bipin standard output	≤4500 K
	>4500 K
4-foot T5, miniature bipin high output	≤4500 K
	>4500 K

Item 4 *DOE welcomes comment on the product classes it is considering for general service fluorescent lamps. In particular, DOE welcomes comment on maintaining separate product classes for T5 lamps.*

4.2.2 Incandescent Reflector Lamps

As in the 2009 Lamps Rule, DOE plans to establish product classes based on: (1) lamp spectrum; (2) lamp diameter; and (3) rated voltage.

Modified-spectrum lamps can provide features such as ensuring better color discrimination and often appearing more similar to natural daylight. DOE understands that the

technologies that modify the spectral emission from these lamps also decrease their efficacy. This is because a portion of the light emission is absorbed by the coating. Modified-spectrum lamps provide unique utility to consumers, in that they offer a different spectrum of light from the typical incandescent lamp, much like two fluorescent lamps with different CCT values. Thus, DOE is considering separate product classes for modified-spectrum and standard-spectrum lamps.

DOE found that a smaller diameter lamp has an inherently lower optical efficiency than a larger diameter lamp given a similar filament size. Further, it is not technically feasible to incorporate some technologies proven to increase efficacy, such as double-ended burners, in small-diameter lamps due to space constraints. In addition, DOE believes small diameter lamps provide a distinct utility (such as the ability to be installed in smaller fixtures). Therefore, DOE is considering separate product classes for IRL with diameters less than or equal to 2.5 inches and greater than 2.5 inches.

DOE is aware that a large number of consumers actually operate 130 V-rated lamps at 120 V, which increases lifetime but decreases efficacy. If lamps with different rated voltages were combined in the same product class, it would effectively lead to a lower efficacy requirement for 130 V lamps that are run at 120 V, compared to 120 V lamps run at 120 V. These 130 V lamps would not require the same level of technology as 120 V-rated lamps to meet the same standard, and would therefore be cheaper to produce. Without a separate standard, consumers may purchase 130V lamps because they are less expensive. When consumers operate these lamps at 120V to obtain sufficient light output, they may migrate to higher wattages and use more energy than standards-compliant 120 V lamps. For these reasons, DOE is considering separate product classes based on input voltage.

Similar to the 2009 Lamps Rule, DOE is considering adopting the product class structure outlined in Table 4.2 for this rule. 74 FR 34080, 34082 (July 14, 2009).

Table 4.2 2009 Lamps Rule Product Classes for IRL

Lamp Type	Diameter (in inches)	Voltage
Standard Spectrum	> 2.5	≥125 V
		<125 V
	≤ 2.5	≥125 V
		<125 V
Modified Spectrum	> 2.5	≥125 V
		<125 V
	≤ 2.5	≥125 V
		<125 V

Item 5 *DOE welcomes comment on the product classes it is considering for incandescent reflector lamps.*

4.3 Technology Assessment

The technology assessment centers on understanding how energy is used by the product, and what changes are possible that would reduce that energy consumption. Measures that improve the energy efficiency of the products are called technology options, and they are based on existing technologies, as well as working prototypes. DOE develops a list of technology options, which are then considered against four screening criteria discussed in the following section. Those technology options that pass the four screening criteria are called design options and will be considered as ways to improve the efficacy of the products in the engineering analysis and will assist DOE in determining the max-tech design.

In the 2009 Lamps Rule, DOE reviewed manufacturer catalogs, recent trade publications, technical journals, and patent filings; and consulted with technical experts to determine technology options. Table 4.3 and Table 4.4 respectively list the technology options DOE identified to improve the efficacy of GSFL and IRL in the 2009 Lamps Rule. DOE is considering using the same technology options in this rule. See chapter 3 of the technical support document for the 2009 Lamps Rule for a more complete discussion of the technology options.

Table 4.3 GSFL Technology Options

Name of Technology Option	Description	2009 Lamps Rule TSD Reference
Highly Emissive Electrode Coatings	Improved electrode coatings will allow electrons to be more easily removed from electrodes, reducing lamp power and increase overall efficacy.	Chapter 3, Section 3.3.1.1
Higher Efficiency Lamp Fill Gas Composition	Fill gas compositions to improve cathode thermionic emission or increase mobility of ions and electrons in the lamp plasma.	Chapter 3, Section 3.3.1.2
Higher Efficiency Phosphors	Techniques to increase the conversion of ultraviolet light into visible light.	Chapter 3, Section 3.3.1.3
Glass Coatings	Coatings on inside of bulb enabling the phosphors to absorb more UV energy, so that they emit more visible light.	Chapter 3, Section 3.3.1.4
Higher Efficiency Lamp Diameter	Vary the lamp diameter to improve its efficacy.	Chapter 3, Section 3.3.1.5
Multi-Photon Phosphors	Emitting more than one visible photon for each incident UV photon.	Chapter 3, Section 3.3.1.6

Table 4.4 IRL Technology Options

Name of Technology Option	Description	2009 Lamps Rule TSD Reference
Higher-Temperature Operation	Operating the filament at higher temperatures, the spectral output shifts to lower wavelengths, increasing its overlap with the eye sensitivity curve.	Chapter 3, Section 3.3.2.1
Microcavity Filaments	Texturing, surface perforations, microcavity holes with material fillings.	Chapter 3, Section 3.3.2.2
Novel Filament Materials	More-efficacious filament alloys that have a high melting point, low vapor pressure, high strength, high ductility, or good radiating characteristics.	Chapter 3, Section 3.3.2.3
Thinner Filaments	Thinner filaments to increase operating temperature. This measure may shorten the operating life of the lamp.	Chapter 3, Section 3.3.2.4
Efficient Filament Coiling	Coiling the filament to increase surface area, thus increasing light output.	Chapter 3, Section 3.3.2.5

Crystallite Filament Coatings	Layers of micron or submicron crystallites deposited on the filament surface that increases emissivity of the filament.	Chapter 3, Section 3.3.2.6
Efficient Filament Orientation	Positioning (horizontal or vertical) the incandescent filament to increase light emission from the lamp. Vertical orientation, used by majority of lamps, allows for greater light emission.	Chapter 3, Section 3.3.2.7
Higher-Efficiency Inert Fill Gas	Filling lamps with alternative gases, such as Krypton, to reduce heat conduction.	Chapter 3, Section 3.3.2.8
Luminescent Gas	Fill gases that react with wavelengths not detected by the human eye, converting portions of the invisible incandescent spectrum into visible light.	Chapter 3, Section 3.3.2.9
Higher-Pressure Tungsten-Halogen Lamps	Increased halogen bulb capsule pressurization.	Chapter 3, Section 3.3.2.11
Non-Tungsten-Halogen Regenerative Cycles	Novel filament materials that regenerate.	Chapter 3, Section 3.3.2.12
Infrared Glass Coatings When used with a halogen capsule, this is referred to as a halogen infrared reflector (HIR) lamp.	Infrared coatings on the inside of the bulb to reflect some of the radiant energy back onto the filament.	Chapter 3, Section 3.3.2.13
Infrared Phosphor Glass Coating	Infrared phosphor coating on the surface of the bulb that harvest emitted infrared energy and convert it to visible light.	Chapter 3, Section 3.3.2.14
Integrally-Ballasted Low-Voltage Lamps	An integral ballast converts the operating voltage of the lamp from line voltage to a lower voltage.	Chapter 3, Section 3.3.2.15
Higher-Efficiency Reflector Coatings	Alternative reflector coatings such as gold, with higher reflectivity increase the amount of directed light.	Chapter 3, Section 3.3.2.16
Trihedral Corner Reflectors	Individual corner reflectors in the cover glass that reflect light directly back in the direction from which it came.	Chapter 3, Section 3.3.2.17
Efficient Filament Placement	Placement of the filament so that a portion of the spectrum emitted by the filament is focused back into the filament, increasing operating temperature.	Chapter 3, Section 3.3.2.18

DOE is aware that some attempts to improve lamp efficacy may also modify lamp performance or other lamp characteristics. For example, in incandescent reflector lamps operating filaments at higher temperatures can increase lamp efficacy but may also shorten the operating life of the lamp. DOE will consider these tradeoffs in the subsequent analyses and will eliminate any technology options that increase efficacy by decrease lamping lifetime such that they have a significant adverse impact on utility, pursuant to the screening criteria discussed below.

Item 6 *DOE welcomes comments on all of the technology options it is considering for this rule, including any omissions or revisions for the GSFLs and IRLs covered in this rulemaking. DOE also requests information on the feasibility, performance, impacts, and cost of the technology options—especially those reflecting recent technological developments.*

5. Screening Analysis

The purpose of the screening analysis is to screen out technologies that will not be considered further in the analysis. After making an initial list of technologies (during the market and technology assessment), DOE will review and evaluate each technology based on the following four criteria, as specified by 10 CFR part 430, subpart C, Appendix A, sections 4(a)(4) and 5(b):

1. Technological feasibility. DOE will consider technologies incorporated in commercial products or in working prototypes to be technologically feasible.
2. Practicability to manufacture, install, and service. If mass production and reliable installation and servicing of a technology in commercial products could be achieved on the scale necessary to serve the relevant market at the time the standard requires compliance, then DOE will consider that technology practicable to manufacture, install, and service.
3. Adverse impacts on product or equipment utility to consumers or availability. If DOE determines a technology would have a significant adverse impact on the utility of the product to significant subgroups of consumers, or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not consider that technology further.
4. Adverse impacts on health or safety. If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider that technology further.

DOE will fully document its reasons for eliminating any technology options during the screening analysis, and will publish this documentation for stakeholder review and comment as part of the preliminary analysis. Those technology options not screened out by the above four criteria are called “design options” and are considered as possible methods of improving efficacy in the engineering analysis.

In the 2009 Lamps Rule, DOE screened out several technology options. For GSFL, DOE screened out the multi-photon phosphor technology because of concerns related to technological feasibility and practicability to manufacture, install and service. Development of this technology remained in the research phase and DOE was unaware of any prototypes or commercialized products that incorporate multi-photon phosphors. For IRLs, several technologies were screened out: microcavity filaments, novel filament materials, crystallite filament coatings, luminescent gas, non-tungsten-halogen regenerative cycles, infrared phosphor coatings, and trihedral corner reflectors. Table 5.1 is a list of the IRL technologies screened out and the criteria on which they were eliminated. Many of the technology options were screened out because DOE was unaware of any commercially available products with the specific technology, which affected its practicability to be manufactured, installed, and serviced. See chapter 4 of the TSD for the 2009 Lamps Rule for more details on technology options.

Table 5.1 IRL Technology Options Screened Out of the Analysis

Design Option Excluded	Screening Criteria
Microcavity Filaments	Adverse Impacts on Product Utility Practicability to manufacture, install, and service
Novel Filament Materials	Adverse Impacts on Product Utility Practicability to manufacture, install, and service
Crystallite Filament Coatings	Practicability to manufacture, install, and service
Luminescent Gas	Technological feasibility
Non-Tungsten-Halogen Regenerative Cycles	Practicability to manufacture, install, and service Adverse Impacts on Product Utility
Infrared Phosphor Glass Coating	Practicability to manufacture, install, and service
Trihedral Corner Reflectors	Practicability to manufacture, install, and service

Item 7 *DOE welcomes comments regarding the technologies that were screened out for the 2009 Lamps Rule, including whether it is still appropriate to screen out these technologies and whether any additional technology options should be screened out for this rule.*

6. Engineering Analysis

The engineering analysis identifies potential, increasing efficacy levels above the level of the baseline model for each product class. Those technologies not eliminated in the screening analysis (design options) are inputs to this process. As in the 2009 Lamps Rule, to ensure that efficacy levels analyzed are technologically feasible, DOE plans to concentrate its efforts on developing product efficacy levels associated with lamp designs that incorporate a range of design options based upon commercially available lamps or working prototypes. 74 FR 34080, 34102 (July 14, 2009).

6.1 Engineering Analysis Overview

The purpose of the engineering analysis is to determine the relationship between the manufacturers' selling price and efficacy of the covered products. The engineering analysis identifies potential, increasing efficacy levels above the level of the baseline model for each product class. In energy conservation standard rulemakings for other products, DOE typically develops cost-efficiency relationships in the engineering analysis. For this rulemaking, as in the 2009 Lamps Rule, DOE will develop efficacy levels in the engineering analysis and end-user prices in the product price determination. By combining the results of the engineering analysis and the product price determination, DOE will derive typical inputs for use in the LCC and NIA. See the section 8 of this framework document for further details on the product price determination.

For this rulemaking, DOE is using the same methodology for the engineering analysis that was detailed in the 2009 Lamps Rule. 74 FR 34080, 34102-08 (July 14, 2009). The following is a summary of the steps DOE plans to take in the engineering analysis:

- Step 1: Select Representative Product Classes
- Step 2: Select Baseline Lamps
- Step 3: Identify Higher-Efficacy Lamp Replacements
- Step 4: Develop Efficacy Levels.

A more detailed discussion of the methodology DOE followed to perform the engineering analysis can be found in chapter 5 of the TSD for the 2009 Lamps Rule.

Item 8 *DOE welcomes comments on the overall methodology for the engineering analysis.*

6.2 Representative Product Classes

As discussed previously in this framework document, DOE is considering establishing twelve product classes for GSFLs and eight product classes for IRLs. Similar to the approach in the 2009 Lamps Rule, DOE is not planning to directly analyze every product class. Instead, DOE will select certain product classes to analyze, and then scale its analytical findings for those representative product classes to other product classes that are not analyzed. DOE typically chooses representative product classes based on the highest shipment volumes.

As discussed in section 4.2.1 DOE is considering establishing product classes for GSFLs based on the following three factors: (1) physical constraints of lamps (*i.e.*, lamp shape and length); (2) lumen package (*i.e.*, standard versus high output); and (3) correlated color temperature (CCT). Similar to the 2009 Lamps Rule, DOE plans to establish the following as representative product classes: 4-foot medium bipin (MBP), 8-foot single pin (SP) slimline, 8-foot recessed double contact (RDC) high output (HO), 4-foot miniature bipin (MiniBP) standard output (SO), and 4-foot MiniBP HO lamps with a CCT less than or equal to 4,500 Kelvin (K). DOE does not plan to explicitly analyze U-shaped lamps because they represent a small portion of the market. 74 FR 34080, 34102 (July 14, 2009).

As discussed in section 4.2.2, DOE is considering establishing product classes for IRLs based on the following factors: (1) lamp spectrum (modified versus standard spectrum); (2) lamp diameter (greater than 2.5 inches or less than or equal to 2.5 inches); and (3) rated voltage (less than 125V or greater than or equal to 125V). After analyzing catalog data and talking to industry experts for the 2009 Lamps Rule, DOE found that standard-spectrum lamps were more common than modified-spectrum lamps, lamps with voltage ratings less than 125V were more common than lamps with higher voltage ratings, and lamps with diameters greater than 2.5 inches were significantly more common than lamps of smaller diameters. Therefore, in this rulemaking, DOE is considering analyzing IRL with standard-spectrum, voltage ratings less than 125V and diameters greater than 2.5 inches as representative. 74 FR 34080, 34102 (July 14, 2009). See chapter 5 of the TSD for the 2009 Lamps Rule for more discussion on representative product classes.

Item 9 *DOE welcomes comments on the product classes that it has selected to analyze as representative for this rulemaking.*

6.3 Baseline Lamps

Once DOE identifies the representative product classes for analysis, DOE selects representative units (baseline lamps) from within the representative product classes. These

baseline units are generally what DOE believes to be the most-common, least-efficacious lamps in their respective product classes.

Similar to the 2009 Lamps Rule, DOE plans to establish baseline lamps by analyzing manufacturer catalogs and compliance data to determine the most common, least efficacious lamps that just meet existing standards. 74 FR 34080, 34102 (July 14, 2009). Where necessary, DOE plans to analyze more than one baseline lamp. For example, in the 2009 Lamps Rule, DOE considered both T8 and T12 lamps as baselines for 4-foot MBP, 8-foot HO, and 8-foot slimline lamps. Table 6.1 and Table 6.2 list the standards adopted in the 2009 Lamps Rule for respectively, GSFL and IRL.

Table 6.1 GSFL Standards Adopted in 2009 Lamps Rule

Lamp/Tube type	Correlated color temperature (CCT)	Minimum average lamp efficacy (lm/W)
4-foot medium bipin	≤4,500K	89
	>4,500K and ≤7,000K	88
2-foot U-shaped	≤4,500K	84
	>4,500K and ≤7,000K	81
8-foot slimline	≤4,500K	97
	>4,500K and ≤7,000K	93
8-foot high output	≤4,500K	92
	>4,500K and ≤7,000K	88
4-foot miniature bipin standard output	≤4,500K	86
	>4,500K and ≤7,000K	81
4-foot miniature bipin high output	≤4,500K	76
	>4,500K and ≤7,000K	72

Table 6.2 IRL Standards Adopted in 2009 Lamps Rule

Rated Lamp Wattage	Lamp Spectrum	Lamp Diameter (inches)	Rated Voltage	Minimum average lamp efficacy (lm/W)
40-205	Standard Spectrum	>2.5	≥125V	$6.8*P^{0.27}$
			<125V	$5.9*P^{0.27}$
		≤2.5	≥125V	$5.7*P^{0.27}$
			<125V	$5.0*P^{0.27}$
40-205	Modified Spectrum	>2.5	≥125V	$5.8*P^{0.27}$

			<125V	$5.0*P^{0.27}$
		≤2.5	≥125V	$4.9*P^{0.27}$
			<125V	$4.2*P^{0.27}$

For GSFLs and IRLs, DOE is considering as baselines lamps that just meet the standards adopted in the 2009 Lamps Rule. For GSFLs, these baseline lamps, listed in Table 6.3, were based off of the full-wattage (as opposed to reduced-wattage) representative units analyzed at TSL 4 in the 2009 Lamps Rule (the adopted level, see Table 6.1). DOE requests comment on whether these lamps represent the lowest efficacy lamps expected to be available in 2012.

Additionally, based on the assumption that most commercially available T12 lamps will not be able to meet the standards adopted in the 2009 Lamps Rule, DOE is currently considering not analyzing T12 lamps as baselines in this rulemaking. However, DOE notes that several manufacturers have claims on their websites that some T12 lamps would be able to meet standards. Therefore, DOE requests comment on its proposal to not analyze T12 lamps as baselines.

Table 6.3 GSFL Baseline Lamp Characteristics Under Consideration

Baseline Lamp	**Lamp Diameter**	**Nominal Wattage**	**Rated Wattage**	**Rated Efficacy**	**Initial Light Output**	**Mean Light Output**	**Life**	**CRI**
		W	W	Lm/W	lm	lm	hr	
4-Foot MBP	T8	32	32.5	92.3	3,000	2,850	24,000	85
8-Foot SP Slimline	T8	59	60.1	98.2	5,900	5,428	15,000	82
8-Foot RDC HO	T8	86	86	91.9	7,900	7,100	24,000	78
8-Foot RDC HO	T8	86	86	93.0	8,000	7,200	18,000	75
4-Foot T5 MiniBP SO	T5	28	27.8	104.3	2,900	2,660	20,000	85
4-Foot T5 MiniBP HO	T5	54	53.8	92.9	5,000	4,600	20,000	85

For IRLs, DOE is considering the halogen infrared (HIR) technologies that uses both halogen and glass coatings that reflect infrared light. The baseline lamps DOE is considering are listed in Table 6.4. As noted these lamps just meet the standards adopted in the 2009 Lamps Rule (see Table 6.2) and were identified in that rulemaking as equivalent lumen replacements for 50W, 75W, and 90W IRLs. DOE requests comment on whether the 40W, 55W, and 66W IRL baselines are representative of IRL wattages on the market in 2012.

Table 6.4 IRL Baseline Lamp Characteristics Under Consideration

Baseline Lamp	Design Option	**Initial Light Output**	**Efficacy**	**Lamp Lifetime**
		lm	*lm/W*	hr

40W PAR30	Improved HIR	680	17.0	4,000
55W PAR38	Improved HIR	1,050	19.1	4,000
66W PAR38	Improved HIR*	1,310	19.8	4,000

*IRL lamp designs with an asterisk are model lamp designs developed in the 2009 Lamps Rule. These model lamp designs were not commercially available at the time and were developed by DOE based on technical literature and confidential information from manufacturers on incandescent design lamp options

Item 10 *DOE welcomes comments on the baseline lamps it is considering for GSFLs in this rulemaking and whether they are representative of products sold on the market in 2012. In particular, DOE requests comment on whether the baseline lamps under consideration have lower efficacies than their catalog-rated efficacy values. Additionally, DOE requests comment on whether it is appropriate to analyze only a T8 baseline for GSFL.*

Item 11 *DOE welcomes comments on the baseline lamps it is considering for IRLs in this rulemaking and whether they are representative of the products expected to be sold on the market in 2012. In particular, DOE requests comment on the expected lifetime and wattage of IRL.*

6.4 Identify Higher-Efficacy Lamp Replacements

DOE selects more efficacious lamps for each baseline lamp by considering technologies not eliminated in the screening analysis. DOE considers these technologies in the engineering analysis, either by modeling potential efficacy improvements due to the design options or by analyzing commercially available lamps in which the design options are incorporated. In identifying more efficacious lamp-and-ballast designs, DOE recognizes that a lamp's lumen package and performance characteristics are important design criteria for consumers. DOE chooses substitute lamps with performance characteristics similar to those of the baseline lamps.

Similar to the 2009 Lamps Rule, DOE plans to account for lumen output when it establishes lamp designs for its analyses. In its analysis, DOE considers lamps that emit lumens equal to the lumen output of the baseline lamp, or below that lamp by no more than 10 percent; and result in energy savings. This approach will help accurately characterize the cost-effectiveness of a particular efficacy level if a consumer makes an informed decision that maintains light output. However, DOE considers consumer behaviors resulting in under-illumination, over-illumination, or no energy savings in the NIA.

In identifying more efficacious substitutes, DOE plans to use a database of commercially-available lamps for GSFLs and IRLs and develop model lamps as it did in the 2009 Lamps Rule. These models will incorporate designs that may not be commercially available for certain lamp types and wattages, but use commercially-available technologies. DOE will verify with manufacturers whether the designs considered by DOE are technologically feasible and whether they meet DOE's screening criteria. See chapter 5 of the TSD for the 2009 Lamps Rule for more discussion on the selection of higher-efficacy lamp replacements.

Item 12 *DOE welcomes comments on the methodology it is considering to select higher-efficacy lamp designs.*

6.5 Efficacy Levels

After identifying the more efficacious substitutes for each baseline lamp or lamp-and-ballast system, DOE develops efficacy levels (ELs) based on three factors: (1) the design options associated with the specific lamps being studied (e.g., grades of phosphor for fluorescent lamps, the use of halogen IR coatings for IRLs, etc.); (2) the ability of lamps across wattages to comply with the EL of a given product class;[5] and (3) the maximum technologically-feasible efficacy level. DOE is considering adopting the same methodology to determine efficacy levels in this rulemaking.

Similar to the 2009 Lamps Rule, DOE plans to use catalog data on commercially-available lamps to develop continuous equations that represent the potential efficacy achieved by a particular design option. DOE plans to establish the minimum efficacy requirements for each efficacy level by comparing the catalog data with data submitted to DOE by manufacturers for the purpose of compliance with existing energy conservation standards. When DOE does not have compliance report data on every lamp design analyzed, DOE plans to use compliance report data of lamps with similar design options to determine the appropriate minimum efficacy requirement.

In the 2009 Lamps Rule, DOE identified five efficacy levels for both GSFLs and IRLs. For all lamp types except for 4-foot T5 MiniBP HO lamps, the adopted standard level represented the second highest efficacy level identified. Therefore, for this rulemaking, DOE is generally considering establishing the 2009 Lamps Rule's maximum technologically feasible level as CSL1, as depicted in Table 6.5 and Table 6.6. For 4-Foot T5 MiniBP HO lamps, only one standard level was proposed and subsequently adopted in the 2009 Lamps Rule. DOE is currently not aware of full-wattage T5 HO lamps with efficacy levels that exceed those adopted for 4-Foot T5 MiniBP HO lamps in the 2009 Lamps Rule. DOE notes that there are commercially-available reduced-wattage T5 HO lamps with lamp efficacies that significantly exceed the levels adopted in the 2009 Lamps Rule. However, due to reduced wattage lamps' potential application limitations (inability to operate at cold temperatures or in drafty environments) DOE has preliminarily decided that the baseline represents the maximum technologically feasible level (as indicated by commercially available products). DOE requests comment on whether candidate standard levels should be based on reduced wattage lamps, and whether these lamps represent equivalent utility as full-wattage lamps. In addition, DOE requests comment on whether higher efficacy levels than those depicted in the Table 6.5 and Table 6.6 can be achieved through redesign of commercially available products.

Table 6.5 GSFL Efficacy Levels Under Consideration

Baseline Lamp	CCT	Efficacy Level *lm/W*

[5] Efficacy levels span multiple lamps of different wattages. In selecting ELs, DOE considered whether lamps of different wattages can meet the efficacy levels prescribed by those ELs.

4-Foot MBP	≤ 4,500K	93
8-Foot SP Slimline Lamps	≤ 4,500K	98
8-Foot RDC HO Lamps	≤ 4,500K	95
4-Foot T5 MiniBP SO Lamps	≤ 4,500K	90

Table 6.6 IRL Efficacy Level Under Consideration

Lamp Type	Diameter	Voltage	Efficacy Level Equation *lm/W*
Standard-spectrum	> 2.5 inches	< 125	$6.4P^{0.27}$

Additionally, in the 2009 Lamps Rule, DOE established that the efficacy requirement for IRL varies according to the following equation: $A*P^{0.27}$, where "A" is a constant specifying the technology level and "P" is the rated wattage of the lamp. For this rulemaking, DOE is considering using the same type of power law equation for IRL.

Item 13 *DOE also welcomes comments on the potential efficacy levels identified and whether higher efficacy levels can be achieved through redesign of commercially available product. In addition DOE requests comments on whether GSFL efficacy levels should be based on reduced-wattage lamps.*

6.6 Scaling to Product Classes Not Analyzed

As mentioned previously, DOE plans to select certain product classes as representative and concentrate its analytical effort on those classes. Standards for non-representative product classes are determined by scaling standards from product classes that were directly analyzed.

Similar to the 2009 Lamps Rule, DOE will develop scaling factors for GSFLs by comparing the efficacy level of the representative product classes to efficacies of commercially-available lamps from the non-representative product classes. For 2-foot U-shaped lamps with CCT less than or equal to 4,500K scaling factors will be based on efficacy levels of 4-foot MBP lamps. For lamps with CCTs above 4,500K scaling factors will be based on efficacy levels of corresponding lamp types with CCTS less than or equal to 4,500K. DOE is considering using the reduction factor of 6.5 percent developed in the 2009 Lamp Rule for 2-foot U-Shaped lamps in this rulemaking. DOE is considering using reduction factors within the range of 1.1 to 6.0 percent developed in the 2009 Lamps Rule for lamps with CCTs above 4,500K in this rulemaking.

For IRLs, DOE plans to create scaling factors to develop efficacy levels for lamps with modified spectrum, diameters less than or equal to 2.5 inches (small-diameter), and operating voltages greater than or equal to 125V based on respectively, efficacy levels of lamps with standard-spectrum, diameters greater than 2.5 inches (large-diameter), and voltage ratings less than 125V.

In the 2009 Lamps Rule, DOE assessed the efficacy differences between standard- and modified-spectrum IRL by measuring the efficacies of commercially-available standard- and modified-spectrum lamps. DOE is considering using the resulting determination of a 15 percent reduction for modified-spectrum IRL from the standard-spectrum efficacy levels in this rulemaking. DOE is also planning to use the reduction factor of 15.5 percent developed in the 2009 Lamps Rule for small-diameter lamps from large-diameter efficacy levels in this rulemaking.

In the 2009 Lamps Rule, using IESNA Lighting Handbook[6] equations relating life, voltage and lumens and confidential information on incandescent lamp design, DOE determined that a lamp operating at 130V would be 15-percent more efficacious than a lamp of a similar wattage operating at 120V. DOE is considering using the same 15 percent increase for IRLs operating at greater than 120V from IRLs operating at less than 120V in this rulemaking.

See chapter 5 of the TSD for the 2009 Lamps Rule for a more complete discussion of how efficacy levels were scaled to non-representative product classes.

Item 14 *DOE welcomes comments on the methodology to scale to products not directly analyzed and the specific scaling factors it is considering.*

6.7 Proprietary Designs

DOE will 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 5. However, DOE will consider a proprietary design in the subsequent analyses 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. DOE will reject a standard level that can be met only with a proprietary technology because it could result in an anti-competitive market, a principle consistently applied in past DOE rulemakings as economically unjustifiable. However, if a given energy efficiency level can be achieved by a number of design approaches, including a proprietary design, DOE will continue to examine the given efficiency level.

DOE is aware of manufacturer concerns about proprietary designs and will take steps to maintain the confidentiality of any proprietary data provided by manufacturers. This information will provide input to the competitive impacts assessment and other economic analyses.

Item 15 *DOE welcomes comments on proprietary designs it should be aware of for the GSFLs and IRLs that are the subject of this rulemaking.*

[6] Rea, M. S., ed., The IESNA Lighting Handbook: Reference and Application, 9th Edition. New York: Illuminating Engineering Society of North America. IESNA (2000).

6.8 Outside Regulatory Changes Affecting the Engineering Analysis

In conducting an engineering analysis, DOE considers the effects of regulations outside DOE's statutory energy conservation standards rulemaking process that can affect manufacturers of the covered products. Some regulatory requirements can also affect the efficacy or energy consumption of the covered lamps. DOE will attempt to identify other regulatory requirements that could affect the engineering analysis. The consideration of these requirements is closely related to the cumulative regulatory burdenassessment that DOE will conduct as part of the manufacturer impact analysis. Based on consideration of the comments received on the engineering analysis, DOE will make any necessary changes to its analysis.

Item 16 *DOE welcomes comments on regulatory burdens or changes that should be considered in the engineering analysis.*

Item 17 *DOE welcomes comments on other engineering issues that could affect the engineering analysis.*

7. Energy Use Characterization

The purpose of the energy-use characterization is to identify how products are used by consumers, and thereby determine the energy savings potential of energy efficiency improvements. DOE determines the energy consumption of lamps through the rated power (rated in watts) and the way consumers use the lamp (operating hours per year). This analysis, which is meant to represent typical energy consumption in the field, is an input to both the LCC and PBP analyses and the NIA. DOE derives the annual energy consumption of lamps by multiplying the power rating by the number of hours of operation per year.

As in the 2009 Lamps Rule, DOE plans to use the U.S. Lighting Market Characterization: Volume I (LMC)[7] to determine operating hours. The LMC is based on thousands of building audits and surveys and provides national-level data on operating hours by building type and lamp category for all sectors. Within the commercial sector, the distributions were broken down by application, and within the residential sector, the distribution was broken down by room type. In conjunction with data from the LMC, DOE plans to use data from the recent versions of Energy Information Administration's (EIA) Commercial Building Energy Consumption Survey (CBECS)[8], Residential Energy Consumption Survey (RECS)[9], and the Manufacturing Energy

[7] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Energy Conservation Program for Consumer Products: Final Report: U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and Energy Consumption Estimate (2002). Available at: www.eere.energy.gov/buildings/info/documents/pdfs/lmc_vol1_final.pdf.

[8] U.S. Department of Energy, Energy Information Administration, Commercial Building Energy Consumption Survey: Micro-level data, file 2 Building Activities, Special Measures of Size, and Multi-building Facilities (2003). Available at: www.eia.doe.gov/emeu/cbecs/public_ use.html.

[9] U.S. Department of Energy, Energy Information Administration, Residential Energy Consumption Survey: File 1: Housing Unit Characteristic (2006). Available at: www.eia.doe.gov/emeu/recs/recs2001/publicuse2001.html.

Consumption Survey (MECS).[10] These EIA studies provide information on the distribution of buildings within the U.S., by building type and Census Division. DOE plans to use the LMC's operating hour data by building type and the EIA's data by building type and Census Division to derive operating hours by Census Division. This would allow DOE to correlate the electricity price distribution and sales tax distribution with the operating hour distribution by Census Division in the LCC spreadsheet. DOE also plans to determine average operating hours for the residential, commercial, and industrial sectors. As in the 2009 Lamps Rule, however, DOE does not plan to analyze IRL in the industrial sector. See chapter 6 of the TSD for the 2009 Lamps Rule for a more complete discussion on the energy-use characterization.

Item 18 *DOE welcomes comments on the methodology it is considering to determine energy use. In particular, DOE requests comments on its approach to calculate operating hours for the covered lamps.*

8. Product Price Determination

The purpose of the engineering analysis and product price determination together is to provide an analysis of the relationship between the efficacy and end-user price for GSFL and IRL. As in the 2009 Lamps Rule, DOE intends to obtain manufacturers' published end-user price schedules for lamps (hereafter called the manufacturer's "blue book" or "lamp price schedules") as well as information on discounts applied to those price schedules from distributors, State contracts, and other publicly-available information sources. In addition, DOE intends to obtain information on distributor pricing (what a distributor would pay) for commercial, industrial, and institutional consumers of lamps. 74 FR 34080, 34110-11 (July 14, 2009). Starting from lamp price schedules provided by manufacturers, DOE intends to look at publicly-available prices in State procurement contracts, at large electrical supply distributors, home improvement/hardware stores, and other sources of publicly-available end-user prices, such as Internet retailers.

For the 2009 Lamps Rule, in its review of publicly-available market prices, DOE observed a range of end-user prices paid for a given lamp, depending on the distribution channel through which it was purchased and the volume at which it was purchased. DOE observed that State procurement contracts typically negotiated a discount of around 70 to 90 percent off the blue book price. In the majority of instances, these discounts applied uniformly to all products on a price schedule irrespective of the volume of a particular lamp. Internet retailers, electrical supply distributors, and home-improvement/hardware stores generally reflected prices paid by consumers in the medium-to-high range of prices. These channels usually applied different discounts to lamps depending on their sales volume. Since many high-efficacy lamps are low-volume products, DOE observed that they were generally less discounted than commodity lamps.

Using this information, DOE calculated three sets of discounts from the blue books, representing the range of low, medium, and high lamp prices for GSFL and IRL for the 2009 Lamps Rule. To reflect future commoditization of higher-efficacy lamps when they become the minimum complying products, the discounts DOE applied to blue book prices to derive the low,

[10] U.S. Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey, Table 1.4: Number of Establishments by First Use of Energy for All Purposes (Fuel and Nonfuel) (2002). Available at: www.eia.doe.gov/emeu/mecs/mecs2002/data02/ shelltables.html.

medium, and high prices were a constant markdown across all lamps. For those lamps where commercial (blue book) pricing was not available, DOE extrapolated pricing from available lamps.

Once DOE calculated end-user prices, DOE added sales tax and, if appropriate, installation costs to derive the total, installed end-user cost. For the reference case in the LCC, DOE used the medium lamp prices, but it also conducted analysis at the low and high lamp prices, to ascertain the impact of these other price points. In the NIA, DOE used only the medium prices because this price scenario represents the average purchase price for a variety of consumers nationwide. In this rulemaking DOE is considering using the same methodology to develop prices. 74 FR 34080, 34110-11 (July 14, 2009).

In the 2009 Lamps Rule, DOE presented figures that represented State and local sales taxes that were applied to the consumer product price. 74 FR 34080, 34111 (July 14, 2009). It was a multiplicative factor that increased the consumer product price. DOE derived State and local taxes from data provided by the Sales Tax Clearinghouse.[11] The data represented weighted averages that included county and city rates. DOE is considering using the same methodology to estimate sales tax estimates for this rulemaking. For more information on product price determination, see chapter 7 of the 2009 Lamps Rule TSD.

In addition, as part of the product price determination DOE will also conduct a price trends analysis. As noted in a Notice of Data Availability published by DOE, economic literature and historical data suggest that the real costs of many covered products have trended downward over time according to ‘‘experience’’ curves. 76 FR 9696, 9697 (Feb. 22, 2011). DOE will investigate various methods for forecasting future prices of GSFL and IRL in the base case.

Item 19 *DOE welcomes comments on the methodology it is considering for lamp prices and sales tax estimates for this rulemaking. DOE also welcomes comment on the price forecasting methodologies it is considering.*

9. Life-Cycle Cost and Payback Period Analysis

The effects of increased energy conservation standards on consumers include a change in their operating expenses (usually decreased) and a change in the purchase price (usually increased) they pay. The LCC of a product is the cost a product incurs over its lifetime, taking into account both purchase price, operating costs (including energy expenditures), and installation costs. The payback period (PBP) represents the time it takes to recover the additional installed cost of the more-efficient product through annual operating cost savings. DOE analyzes the net effect on consumers by calculating the LCC and PBP using the engineering performance data (section 6), the energy-use and end-use load characterization data (section 7), and the product price determination (section 8). Inputs to the LCC calculation include the installed cost to the consumer (purchase price plus installation cost), operating expenses (energy expenses, and, if applicable, repair costs and maintenance costs), the lifetime of the product or other defined period of analysis, and a discount rate. Inputs to the payback period calculation include

[11] Sales Tax Clearinghouse, Aggregate State Tax Rates (2007). Available at: thestc.com/STrates.stm.

the installed cost to the consumer and annual operating costs. DOE will conduct the LCC and PBP analyses using a spreadsheet model developed in Microsoft Excel, similar to the one developed for the 2009 Lamps Rule. When combined with the *Crystal Ball* model (a commercially-available software program), the LCC and PBP model generates a Monte Carlo[12] simulationto perform the analysis by incorporating uncertainty and variability considerations.

The life-cycle cost of a particular lamp design is composed of the total installed cost (which includes manufacturer selling price, sales taxes, distribution chain mark-ups, and any installation cost), operating expenses (energy, repair, and maintenance costs), product lifetime, and discount rate. 74 FR 34080, 34108 (July 14, 2009). In the 2009 Lamps Rule, DOE also incorporated a residual value calculation to account for any remaining lifetime of lamps at the end of the analysis period. *Id*. The residual value is an estimate of the product's value to the consumer at the end of the life-cycle cost analysis period. This residual value recognizes that a lamp system may continue to function beyond the end of the analysis period. DOE calculates the residual value by linearly prorating the product's initial cost consistent with the methodology described in the *Life-Cycle Costing Manual for the Federal Energy Management Program*.[13]

As in the 2009 Lamps Rule, DOE plans to use a "simple" PBP for this rulemaking which is the ratio of the increase in purchase cost (i.e., from a less efficient design to a more efficient design) to the decrease in annual operating expenditures. The "simple" PBP does not take into account other changes in operating expenses over time or the time value of money, and is calculated at an effective discount rate of zero. 74 FR 34080, 34113 (July 14, 2009). As inputs to the PBP analysis, DOE used the total installed cost of the product to the consumer for each efficacy level, as well as the first year annual operating costs for each efficacy level. The calculation requires the same inputs as the LCC, except for energy price trends and discount rates; only energy prices for the year the standard takes effect are needed.

Section 325(o)(2)(B)(iii) of EPCA states that there is a rebuttable presumption that an energy conservation standard is economically justified if the increased installed 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, as calculated under the applicable DOE test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential energy conservation standards, which includes, but is not limited to, the three-year payback period contemplated under the rebuttable presumption test. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE to evaluate the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification).

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[12] Monte Carlo simulations model uncertainty by utilizing probability distributions instead of single values for certain inputs and variables.

[13] Fuller, Sieglinde K. and Stephen R. Peterson, National Institute of Standards and Technology Handbook 135 (1996 Edition); Life-Cycle Costing Manual for the Federal Energy Management Program (Prepared for U. S. Department of Energy, Federal Energy Management Program, Office of the Assistant Secretary for Conservation and Renewable Energy)(Feb. 1996). Available at: fire.nist.gov/fire/firedocs/build96/PDF/b96121.pdf.

See chapter 8 of the TSD for the 2009 Lamps Rule for a more detailed discussion of the LCC and PBP analysis. Table 9.1 summarizes the approach and data that DOE intends to use to derive the inputs to the LCC and PBP calculations for this rulemaking. The following sections discuss several of these inputs not addressed by other analyses DOE conducts.

Table 9.1 Summary of Inputs and Key Assumptions Used for the LCC Analyses

Inputs	Description
Consumer Product Price	Applies discounts to manufacturer catalog ("blue-book") pricing in order to represent low, medium, and high prices for all lamp categories. Discounts were also applied to develop a price for ballasts. See Product Price Determination.
Sales Tax	Derives weighted-average tax values for each Census Division and large State from data provided by the Sales Tax Clearinghouse. See Product Price Determination.
Installation Cost	Derives costs using the *RS Means Electrical Cost Data* to obtain average labor times for installation, as well as labor rates for electricians and helpers based on wage rates, benefits, and training costs. For GSFLs, included 2.5 minutes of installation time to the new construction, major retrofit, and renovation events in the commercial and industrial sectors to capture the time needed to install luminaire disconnects.
Disposal Cost	GSFL: Includes a recycling cost of 10 cents per linear foot in the commercial and industrial sectors. IRL: Not included.
Annual Operating Hours	Determines operating hours by associating building-type-specific operating hours data with regional distributions of various building types using the U.S. Lighting Market Characterization and the Energy Information Administration's (EIA) Commercial Building Energy Consumption Survey (2003) and Residential Energy Consumption Survey (2009). See Energy Use Characterization.
Product Energy Consumption Rate	Determines lamp input power (or lamp-and-ballast system input power for GSFL) based on published manufacturer literature. See Engineering Analysis.
Electricity Prices	Price: Based on EIA's most recent, 2009 Form EIA-861 data. Variability: Regional energy prices determined for 13 regions
Electricity Price Trends	Forecasts with EIA's *Annual Energy Outlook* (*AEO) 2011*.
Lifetime	Lamp lifetime based on the most recent published manufacturer literature where available. Where manufacturer literature is not available, DOE derives lamp lifetimes as part of the engineering analysis.
Discount Rate	Residential: Approach based on the finance cost of raising funds to purchase lamps either through the financial cost of any debt incurred to purchase product or the opportunity cost of any equity used to purchase equipment, based on the Federal Reserve's Survey of Consumer Finances data for 1989, 1992, 1995, 1998, 2001, 2004, and 2007. Uses data from the Cost of Savings Index dataset covering 1984 to 2008. Commercial and Industrial: Derives discount rates using the cost of capital of publicly-traded firms in the sectors that purchase lamps, based on data in CBECS, Damodaran Online, Ibbotson's Associates, the 2007 Value Line Investment survey, Office of Management and Budget (OMB) Circular No. A-94, 2008 State and local bond interest rates, and the U.S. Bureau of Economic Analysis.
Analysis Period	Commercial and industrial GSFL: Based on the longest baseline lamp life in a product class divided by the annual operating hours of that lamp. Residential GSFL: Based on the useful lifetime of the baseline lamp.
Lamp Purchasing Events	Commercial and industrial sectors: DOE will assess five events: lamp failure, standards-induced retrofit, ballast failure (GSFL only), ballast retrofit (GSFL only), and new construction/renovation. Residential sector: DOE assessed three events: lamp failure, ballast failure (GSFL only), and new construction/renovation.

9.1 Installation Costs

As detailed in the 2009 Lamps Rule, DOE considers the total installed cost of a lamp to be the consumer product price (including sales taxes) plus the installation cost. 74 FR 34080, 34108 (July 14, 2009). For the commercial and industrial sectors, DOE assumes an installation cost that was the product of the average labor rate and the time needed to install a lamp. DOE assumes that in the residential sector, the homeowner replaces individual lamps; thus, DOE applies installation costs only to lamp-and-ballast systems in the residential sector.

As in the 2009 Lamps Rule, DOE plans to derive costs using the "RS Means Electrical Cost Data, 2007[14]" to obtain average labor times for installation, as well as labor rates for electricians and helpers based on wage rates, benefits, and training costs. DOE uses "RS Means Electrical Cost Data, 2007," because labor costs in RS Means are based on labor union agreements and construction wages, as well as actual working conditions in 30 major U.S. cities. 74 FR 34080, 34109 (July 14, 2009). In the 2009 Lamps Rule, DOE estimated that the rates for electricians and electrician's helpers in 2007 dollars are $55.41 per hour and $27.70 per hour, respectively. DOE also determined the lamp replacement labor rate to be $15.94 per hour in 2007 dollars. 74 FR 34080, 34109 (July 14, 2009). DOE is considering using the same installation rates for this rulemaking. See chapter 8 of the TSD for the 2009 Lamps Rule for a more complete discussion of installation costs.

9.2 Energy Prices and Trends

As in the 2009 Lamps Rule, DOE plans to determine energy prices by deriving regional average prices for 13 geographic areas consisting of the nine U.S. Census Divisions, with four large states (New York, Florida, Texas, and California) treated separately. 74 FR 34080, 34109 (July 14, 2009). DOE intends to base the derivation of prices on data in EIA's Form EIA-861.[15]

DOE plans to use projections of national average electricity prices to estimate future energy prices and energy bill savings in its LCC analysis. DOE will use the most recently available edition of EIA's *Annual Energy Outlook* (*AEO*) as the default source of projections for future energy prices.

9.3 Analysis Period

The analysis period is the time span over which the LCC is calculated and is based on the lifetime of the product. To account for variability in lifetime of lamp designs, DOE creates a consistent analytical time period—comparing more-efficacious lamps against a baseline lamp over the lifetime of the longest-lived baseline lamp in a particular product class. When this analysis period is shorter than the lifetime of the replacement lamp, DOE accounts for the remaining life of the replacement lamp as a residual value. When the analysis period is longer than the lifetime of the replacement lamp, a second replacement lamp is installed, and if any operating life of that second replacement lamp remains at the end of the analysis period, then its

[14] R. S. Means Company, Inc., *2007 RS Means Electrical Cost Data* (2007).
[15] Energy Information Administration, *Form EIA-861 Final Data File for 2006* (2006)(Last accessed June 20, 2008).

residual value is added back into the LCC. By using the annual operating hours paired with published lamp lifetimes, DOE calculates the lamp service lifetime in years.

As in the 2009 Lamps Rule, for the IRL and the commercial and industrial sector GSFL LCC analyses, DOE intends to base the analysis period on the longest baseline lamp life in a certain product class divided by the annual operating hours of that lamp. DOE plans to account for two types of GSFL consumer behavior in the residential sector. In the first kind of consumer behavior, consumers disposed of their lamps when replacing a ballast, regardless of how much lifetime the lamps had remaining. Because a lamp failure for these consumers would not occur under average operating hours of 791 hours per year (as the fixture would be removed before the lamp would reach the end of its rated life), DOE plans to use only high operating hours in the lamp failure event for these consumers. In the second kind of consumer behavior, residential-sector GSFL consumers preserve their lamps when replacing a fixture, then install the lamps on the new fixture. This allows the lamps to live for their entire rated lifetimes in situations of average operating hours, and DOE plans to model a lamp failure event for average operating hours. See chapter 8 of the TSD for the 2009 Lamps Rule for a more complete discussion of the analysis period.

9.4 Discount Rates

The calculation of consumer LCC requires the use of an appropriate discount rate. DOE uses the discount rate to determine the present value of lifetime operating expenses. The discount rate used in the LCC analysis represents the rate from an individual consumer's perspective.[16]

DOE is considering using the same approach that it relied on to develop discount rates for the 2009 Lamps Rule. For the residential sector, DOE would derive the discount rates from estimates of the interest or "finance cost" to purchase residential products. 74 FR 34080, 34109 (July 14, 2009). The finance cost of raising funds to purchase these products can be interpreted as: (1) the financial cost of any debt incurred to purchase products (principally interest charges on debt), or (2) the opportunity cost of any equity used to purchase products (principally interest earnings on household equity). Household equity is represented by holdings in assets such as stocks and bonds, as well as the return on homeowner equity. Much of the data required, which involves determining the cost of debt and equity, comes from the Federal Reserve Board's triennial *Survey of Consumer Finances*.[17]

For the commercial sector and industrial sector, DOE would derive the discount rate from the cost of capital of publicly-traded firms in the sectors that purchase lamps. 74 FR 34080, 34113 (July 14, 2009). Most companies use both debt and equity capital to fund investments; for most companies, therefore, the cost of capital is the weighted average of the cost to the firm of equity and debt financing. DOE estimates the cost of equity financing using the Capital Asset Pricing Model (CAPM). DOE is considering using the same method for determining LCC

[16] The consumer discount rate is in contrast to the discount rates used in the national impact analysis, which are intended to represent the rate of return of capital in the U.S. economy as well as the societal rate of return on private consumption.
[17] Available at: www.federalreserve.gov/pubs/oss/oss2/scfindex.html.

discount rates for this rulemaking. See chapter 8 of the TSD for the 2009 Lamps Rule for a more complete discussion of the discount rates.

Item 20 *DOE welcomes comments on the approach it is considering to conduct the LCC and PBP analyses.*

10. Shipments Analysis

DOE forecasts product shipments to calculate the national impacts of standards on energy consumption, NPV, and future manufacturer cash flows. DOE plans to create shipment forecasts based on an analysis of key market drivers for GSFLs and IRLs.

10.1 Base Case Forecast and Accounting Methodology

To evaluate the various impacts of standards, DOE must develop a base case forecast against which to compare forecasts for higher efficacy levels. The base case forecast is designed to depict what will happen to energy consumption and energy costs over time if DOE does not adopt amended energy conservation standards for the products covered by this rulemaking. In determining the base case forecast, DOE will consider historical shipments, the mix of efficacies sold under current standards, and how that mix might change over time.

In the 2009 Lamps Rule, NEMA provided shipment data on GSFL and IRL spanning from 2001 to 2005. 74 FR 34080, 34115-16 (July 14, 2009). DOE used this data to calculate an installed stock in 2005 and then projected the installed stock from 2006 to 2042. DOE based forecasted growth for GSFL and IRL on historical residential building growth from RECS and historical commercial and industrial floor space growth from CBECS and MECS (see Table 9.1). DOE then applied growth, replacement rate, and emerging technologies assumptions to develop shipments estimates over the analysis period.

In this rulemaking, DOE plans to review NEMA data and any other data that becomes available to determine the most appropriate distribution of shipments among product classes and the most appropriate forecast for installed stock. Specifically, as it did for the 2009 Lamps Rule, DOE plans to follow a four-step process to forecast shipments. First, DOE would use 2001-to-2005 historical shipment data from NEMA and other publicly-available sources to estimate the total historical shipments (i.e., NEMA member and non-NEMA member shipments) of each lamp type analyzed. Second, based on these historical shipments and the average service lifetime of each lamp type, DOE would calculate the installed stock of lamps in 2005. Third, by applying growth, emerging technologies, and shipment assumptions, DOE would project lamp stock from 2017 to 2046. DOE would then calculate the lamp shipments required to meet the lamp stock projections based on operating hours and lifetimes. Finally, DOE would develop base-case and standards-case market-share matrices as another model input. The market-share matrices characterize the efficacy, power rating, light output, and lifetime of the lamp designs. For lamp and ballast retirements, DOE would use the same product lifetimes that it generates for the LCC and PBP analysis.

Item 21 *DOE seeks information on historical shipments of GSFLs and IRLs for each product class covered under this rulemaking, as well as industry-trend data regarding relative growth in each product class.*

10.2 Impacts of Standards on Shipments

For each product class, DOE plans to forecast shipments over the 30-year analysis period for each of the potential standards analyzed. These standards case forecasts would be used to evaluate the impacts of standards on shipments. Standards case forecasts are derived using the same data-sets as base case forecasts; however, because the standards case forecasts take into account the increase in purchase price and the decrease in operating costs caused by new or amended standards, forecasted shipments could deviate from the base case. The magnitude of the difference between the standards case and base case shipment forecasts depends on the estimated purchase-price-increase as well as the operating-cost-savings caused by the standard. Because the purchase price tends to have a larger impact than operating cost on purchase decisions, standards case forecasts typically show a drop in shipments relative to the base case.

Programs such as consumer rebates that encourage the purchase of more-efficient products and manufacturer tax credits that encourage the production of more-efficient products also affect standards case forecasts. When such programs exist at the federal level, DOE considers their impact on the forecast of both standards case and base case shipments.

Item 22 *DOE requests input on the potential impact of new energy conservation standards on shipments of GSFLs and IRLs. DOE also requests input on any other federal programs that currently exist to promote the adoption of more-efficient lamps.*

11. National Impact Analysis

The NIA provides DOE's assessment of the aggregate impacts of potential efficiency standards at the national level. Measures of impact that DOE will report include future NES from CSLs (*i.e.*, the cumulative incremental primary energy savings from an increased energy conservation standard relative to a base case that assumes no change in the energy conservation national standard over a specific forecast period) and the NPV for consumers in the aggregate from CSLs (*i.e.*, the cumulative incremental LCC from an increased energy conservation standard relative to the base case over a specific forecast period).

11.1 Inputs to Forecasts

Analyzing impacts of Federal energy conservation standards for products covered in this rule requires comparison of projected energy consumption in the United States with, and without, new energy conservation standards. The forecasts contain projections of unit energy consumption of new lamps, annual product shipments, the prices of purchased products, and base-case and standards-case forecasted efficacies. The base-case shipments forecasts are derived in section 10. Approaches to determine retail prices for products are described in section 8, while approaches to determine unit energy consumption are described in section 7. Table 11.1 describes some of the major inputs DOE anticipates using for the NIA.

Table 11.1 Input to the National Impact Analysis

Inputs	Description
Shipments	Annual shipments based on DOE's shipment forecasts.
Stock of GSFL and IRL	Calculated from the GSFL and IRL service life developed in the Life-Cycle Cost analysis and annual shipments developed in the Shipments Analysis.
Standard Compliance Date	2017
Analysis Period	2017 to 2046 (30 years based on an estimate of the longest baseline lamp life in a certain product class divided by the annual operating hours of that lamp)
Base-Case Forecasted Efficacy	Distribution of base-case shipments by efficacy level over time developed as described in the Shipment Analysis.
Standards-Case Forecasted Efficacy	Distribution of shipments by efficacy level for each standards case over time as described in the Shipment Analysis.
Unit Energy Consumption (kilowatt-hour (kWh)/yr)	Established in the Energy-Use Characterization for each lamp analyzed.
Total Installed Cost	Established in the product price determination and LCC Analysis for each lamp analyzed.
Electricity Price Forecast	Based on *AEO2011* forecasts to 2030 and an extrapolation beyond 2030
Energy Site-to-Source Conversion	Varies yearly and is generated by DOE/ EIA's National Energy Modeling System (NEMS) program (a time-series conversion factor; includes electric generation (by fuel), transmission, and distribution losses). Conversion factors beyond 2030 were held constant.
Rebound Effect	1% of total energy savings in the commercial and industrial sectors. 8.5% of total energy savings in the residential sector.
Discount Rate	3% and 7% real.
Present Year	Future costs and savings will be discounted to 2012.

The site-to-source conversion factor is the multiplicative factor DOE uses for converting site-energy consumption (the energy used at the end-use site) into primary or source energy consumption (the energy used at the source before transmission or conversion losses). For electricity, the conversion factors vary over time due to projected changes in generation sources (*i.e.*, the power plant types projected to provide electricity to the country). As in the 2009 Lamps Rule, DOE intends to calculate annual average site-to-source conversion factors using DOE/EIA's National Energy Modeling System (NEMS) program (a time-series conversion factor; includes electric generation, transmission, and distribution losses). 74 FR 34080, 34114-15 (July 14, 2009). Conversion factors for beyond 2030 were held constant. See chapter 11 of the TSD for the 2009 Lamps Rule for a more complete discussion on site-to-source conversion.

The rebound effect is another input to the NIA. Consumers that encounter lower operating costs associated with more energy-efficient products may use that product more often than the less-efficient product. DOE's rebound effect analysis accounts for any increase in consumer use. As in the 2009 Lamps Rule, DOE plans to incorporate the rebound effect that occurs after installation of energy-efficient lighting equipment. 74 FR 34080, 34115 (July 14, 2009) The existence of the rebound effect in certain (e.g. residential) markets is uncontroversial. However, debate continues as to the size and importance of the effect in real world situations. In the 2009 Lamps Rule, DOE examined a summary of the literature regarding the rebound effect in

relation to lighting equipment. Based on four studies, the summary estimated that, for a 100 percent increase in energy efficiency, values of "take-back" or rebound for residential lighting were between 5 and 12 percent of the energy consumption savings. In addition, with regards to a commercial firm's response to higher-efficiency lighting, the summary estimated 0 to 2 percent for values of rebound for lighting. Therefore, in the calculation of national energy savings due to energy conservation standards on lighting, DOE plans to use the rebound rate of 8.5 percent in the residential sector and 1 percent in the commercial sector estimated in the 2009 Lamps Rule. See chapter 11 of the TSD for the 2009 Lamps Rule for a more complete discussion on the rebound effect.

Item 23 *DOE welcomes comment on the data sources it anticipates using to develop inputs for the national impact analysis.*

Item 24 *DOE welcomes comments on the quantitative and theoretical underpinnings of the rebound effect as well as results from newer studies of the size and sign of the rebound effect for residential, commercial, industrial, and municipal consumers.*

11.2 Calculation of National Energy Savings

DOE intends to calculate national energy consumption for each year beginning with the expected compliance date of the standards. DOE would calculate national energy consumption for the base case and each standard level analyzed. DOE plans to perform this calculation through the use of a spreadsheet model that effectively multiplies annual stock forecasts by efficiency level (based on shipments and retirements in each year) by unit electricity use at the site of use, for each efficiency level. DOE then plans to multiply the site electricity use by year-by-year marginal site-to-source conversion factors that account for energy losses in generation, transmission, and distribution of electricity in order to estimate national primary energy savings. As in the 2009 Lamps Rule, DOE would base the site-to-source conversion factors on modeled savings of primary energy in the electric utility industry of EIA's National Energy Modeling System (NEMS) that corresponds to EIA most recent Annual Energy Outlook. DOE plans to use the same methodology for this rulemaking.

In response to comments by interested parties who asked for a simple, transparent model, DOE developed NES spreadsheet models for its standards rulemakings starting in 1996. These models project energy savings and demonstrate how to account for the growth in efficiency over time.[18] See chapter 11 of the TSD for the 2009 Lamps Rule for a more complete discussion on the NES calculation. DOE expects the NES spreadsheet model to provide a credible, stand-alone forecast of national energy savings and aggregate consumer NPV for GSFLs and IRLs. Based on consideration of comments DOE may receive on the preliminary analysis, DOE will make any necessary changes to the analysis. It will reflect those changes in the NOPR.

[18] Several examples of NES spreadsheet models from previous rulemakings can be found on DOE's website at www.eere.energy.gov/buildings/appliance_standards

Item 25 *DOE welcomes comments on the NES spreadsheet models it plans to use for estimating national impacts of amended energy conservation standards for GSFLs and IRLs. DOE also welcomes comments on the inputs to the models and the sources used for determining the inputs.*

11.3 Net Present Value

DOE calculates the national net present value (NPV) of the standards in conjunction with the NES. It calculates annual energy expenditures from annual energy consumption by incorporating forecasted energy prices, using the shipment forecasts described in the Shipment Analysis and electricity savings forecasts. DOE calculates annual product expenditures by multiplying the price per unit by the forecasted shipments. The difference between a base case and a standards case scenario gives the national energy bill savings and increased product expenditures in dollars. The difference each year between energy bill savings and increased product expenditures is the net savings (if positive) or net cost (if negative). DOE discounts these annual values to the present time and sums them to give an NPV. Since the national cost of capital may differ from the consumer cost of capital, the discount rate used in the NIA can be different from the rate used in the LCC. In accordance with OMB guidance, DOE will conduct two NPV calculations, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[19] Based on consideration of the comments received for the preliminary analysis, DOE will make any necessary changes to the analysis and the CSLs.

Item 26 *DOE welcomes comments on the inputs and methodology to calculate NES and NPV.*

12. Life-Cycle Cost Subgroup Analysis

The LCC (consumer) subgroup analysis evaluates economic impacts on selected groups of consumers who might be adversely affected by a change in the national energy conservation standards for the considered products. DOE evaluates impacts on particular subgroups of consumers primarily by analyzing the LCC impacts and PBP for those particular consumers. For this rulemaking, DOE intends to evaluate impacts of standards on low-income consumers, institutions of religious worship, and institutions serving low-income consumers. In the 2009 Lamps Rule DOE defined low-income consumers as residential consumers with incomes at or below the poverty line as defined by the U.S. Census Bureau. DOE seeks input regarding which consumer subgroups it should consider in this rulemaking.

In comparing potential impacts on the different consumer subgroups, DOE will evaluate variations in energy prices, energy use, and installation costs that might affect the impacts of a standard on the consumer subgroups.

Item 27 *DOE plans to assess the impacts on low-income households, institutions of religious worship, and institutions serving low-income consumers, and seeks input regarding which other consumer subgroups it should consider in this rulemaking.*

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

13. Manufacturer Impact Analysis

The purpose of the MIA is to identify and quantify the likely impacts of amended energy conservation standards on manufacturers of GSFLs and IRLs. During the NOPR stage of analysis, DOE will analyze and consider a wide range of quantitative and qualitative industry impacts that may occur due to amended energy conservation standards. DOE will identify and analyze these impacts through industry research, public comments, and interviews with manufacturers and other interested parties. Other sources of information will include reports published by industry groups, trade journals, the U.S. Census Bureau, and U.S. Securities and Exchange Commission (SEC) 10-K filings.

Initially, DOE will profile the covered GSFL and IRL industry by updating pertinent qualitative and quantitative financial and market information, including industry cost structures, employment metrics, and competitive behavior. Next, DOE will conduct detailed interviews with manufacturers of the covered lamps to gain insight into the potential impact of amended standards on sales, direct employment, capital assets, and industry competitiveness. DOE will use the information gathered in the industry profile to facilitate discussion with manufacturers on production costs, shipment projections, product mix, conversion costs, markups, competitive impacts, manufacturing capacity, and other relevant information. Because standards may have differential impacts on groups of manufacturers with different cost structures or business models, DOE will also identify and characterize any such subgroups during interviews.

DOE is aware that amended standards may require additional investment, raise production costs, and affect manufacturers' revenue through higher prices. To quantify these potential impacts on manufacturers, DOE will calculate standards-induced changes in industry and subgroup cash flows using the Government Regulatory Impact Model (GRIM). The model results will enable DOE to derive a base-case and standards-case industry net present value. To quantitatively assess the impacts of energy conservation standards on manufacturing employment, DOE will use GRIM to estimate the impact on domestic labor expenditures and number of employees. The inputs to the GRIM will include financial information, manufacturing costs, shipment forecasts, and price forecasts from other analyses. Based on the information gathered during interviews and other research, DOE will assess impacts on competition, manufacturing capacity, employment, and regulatory burden.

Item 28 *DOE welcomes comments on its methodology for assessing the impacts on manufacturers of products covered under this rulemaking. DOE also requests information on manufacturing costs.*

14. Utility Impact Analysis

To estimate the effects of energy conservation standards for covered GSFLs and IRLs on the electric utility industry, DOE plans to use a variant of EIA's NEMS that is tailored to DOE's Building Technologies Program (NEMS-BT). The utility impact analysis is a comparison between the NEMS-BT model results for the base case (the *AEO* reference case from the latest year available) and standards cases. The utility impact analysis reports the changes in installed electric capacity and generation that result for each standard level by plant type. DOE will model

the impacts from amended energy conservation standards using NEMS-BT to generate standards case forecasts.[20]

Item 29 *DOE welcomes comments on the approach it is considering to assess the impacts of potential standards under this rulemaking on electric utilities.*

15. Employment Impact Analysis

The promulgation of energy conservation standards can affect employment both directly and indirectly. Direct employment impacts, often occurring as a result of manufacturing process changes, are changes in the number of employees at the plants that produce the covered products, along with employment at affiliated distribution and service companies, resulting from the standards. DOE will evaluate direct employment impacts through the use of the GRIM in the MIA (see section 13 for more information).

Indirect employment impacts may result from expenditures shifting between goods (the substitution effect) and changes in income and overall expenditure levels (the income effect) that occur due to the standards. DOE defines indirect employment impacts from standards as net jobs eliminated or created in the general economy as a result of increased spending driven by the increased product prices and reduced spending on energy.

The indirect employment impacts will be investigated in the employment impact analysis using an input/output model of the U.S. economy called Impact of Sector Energy Technologies (ImSET), version 3.1.1. ImSET is a spreadsheet model of the U.S. economy that focuses on 187 sectors most relevant to industrial, commercial, and residential building energy use.[21] ImSET is a special purpose version of the "U.S. Benchmark National Input-Output" (I–O) model, designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 187 sectors. ImSET's national economic I–O structure is based on a 1997 U.S. benchmark table[22] (specially aggregated to the 187 sectors. DOE will estimate changes in expenditures using the NIA spreadsheet and using ImSET, DOE will estimate the net national, indirect-employment impacts by sector.

Item 30 *DOE welcomes comments on the approach it is considering to assess indirect employment impacts as a result of energy conservation standards.*

16. Environmental Assessment

[20] Several descriptions of NEMS-BT models from previous rulemakings, including general service fluorescent lamps and incandescent reflector lamps, can be found on DOE's website at: www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/ch_14_lamps_standards_final_tsd.pdf.

[21] Roop, J. M., M. J. Scott, and R. W. Schultz, ImSET 3.1: Impact of Sector Energy Technologies (PNNL-18412 Pacific Northwest National Laboratory) (2008). Available at www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf.

[22] Lawson, Ann M., Kurt S. Bersani, Mahnaz Fahim-Nader, and Jiemin Guo, "Benchmark Input-Output Accounts of the U.S. Economy, 1997," Survey of Current Business (Dec. 2002) pp. 19–117

Pursuant to the National Environmental Policy Act of 1969 and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a), DOE intends to prepare an environmental assessment of the impacts of amended energy conservation standards for the GSFL and IRL covered by this rulemaking. The primary environmental effects of these standards would be reduced power plant emissions resulting from reduced consumption of electricity. DOE will assess these environmental effects by using NEMS-BT to provide key inputs to its analysis. The portion of the environmental assessment that will be produced by NEMS-BT considers carbon dioxide (CO_2), nitrogen oxides (NO_x), and mercury (Hg). The environmental assessment also considers impacts on SO_2 emissions and discusses particulate matter (PM) emissions. After a brief discussion of general methodology, this section will address each of the relevant emissions. The following section, section 17, explains how DOE plans to monetize the benefits associated with emissions reductions.

16.1 Carbon Dioxide

In the absence of any Federal emissions control regulation of power plant emissions of CO_2, a DOE standard is likely to result in reductions of these emissions. The CO_2 emission reductions likely to result from a standard will be estimated using NEMS-BT and national energy savings estimates drawn from the NIA spreadsheet model. The net benefit of the standard is the difference between emissions estimated by NEMS-BT at each standard level considered and the *AEO* Reference Case. NEMS-BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

16.2 Sulfur Dioxide

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap and trading programs, and DOE has preliminarily determined that these programs create uncertainty about the potential standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous states and the District of Columbia (D.C.). SO_2 emissions from 28 eastern states and D.C. are also limited under the Clean Air Interstate Rule (CAIR, 70 Fed. Reg. 25162 (May 12, 2005)), which created an allowance-based trading program. [23]

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, and under the proposed Transport Rule, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emissions allowances, there would be

[23] CAIR was remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit), see *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008), and remained in effect consistent with the D.C. Circuit's earlier opinion in *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008). On July 6, 2010, EPA issued the Transport Rule proposal, a replacement for CAIR, which would limit emissions from EGUs in 32 states, potentially through the interstate trading of allowances, among other options. 75 FR 45210 (Aug. 2, 2010) and 76 FR 48208 (August 8, 2011). On July 6, 2011, EPA issued the final transport rule, entitled the Cross-State Air Pollution Rule (http://www.epa.gov/airtransport/, last visited July 15, 2011). DOE will consider the impacts of this rule in its analyses as appropriate.

an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the NEMS-BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2. [24]

16.3 Nitrogen Oxides

A cap on NO_x emissions, affecting electric generating units in the CAIR region, would mean that the standards for GSFL and IRL may have little or no physical effect on NO_x emissions in the 28 eastern states and the D.C. covered by CAIR or any states covered by the proposed Transport Rule.. The standards would, however, reduce NO_x emissions in those 22 states not affected by the CAIR. As a result, DOE plans to use NEMS-BT to estimate the emissions reductions from possible standards in the states where emissions are not capped.[25]

16.4 Mercury

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

16.5 Particulate Matter

DOE acknowledges that particulate matter (PM) exposure can impact human health. Power plant emissions can have either direct or indirect impacts on PM. A portion of the pollutants emitted by a power plant are in the form of particulates as they leave the smoke stack. These are direct, or primary, PM emissions. However, the great majority of PM emissions associated with power plants are in the form of secondary sulfates, which are produced at a significant distance from power plants by complex atmospheric chemical reactions that often involve the gaseous (non-particulate) emissions of power plants, mainly SO_2 and NO_x. The quantity of the secondary sulfates produced is determined by a very complex set of factors including the atmospheric quantities of SO_2 and NO_x, and other atmospheric constituents and conditions. Because these highly complex chemical reactions produce PM comprised of different constituents from different sources, EPA does not distinguish direct PM emissions from power

[24] As noted above, EPA issued the Cross-State Air Pollution Rule on July 6, 2011. DOE will determine the impacts of this regulation on its analyses in this rulemaking.

[25] DOE will also determine the impacts of the Cross-State Air Pollution rule on its NO_x analysis.

plants from the secondary sulfate particulates in its ambient air quality requirements, PM monitoring of ambient air quality, or PM emissions inventories. For these reasons, it is not currently possible to determine how the amended standard impacts either direct or indirect PM emissions. Therefore, DOE is not planning to assess the impact of these standards on PM emissions. Further, as described previously, it is uncertain whether efficiency standards will result in a net decrease in power plant emissions of SO_2, which are now largely regulated by cap and trade systems.

Item 31 *DOE seeks input on its plans to use NEMS-BT to conduct the environmental assessment for the products covered by this rulemaking.*

17. Monetizing Carbon Dioxide and Other Emissions Reductions

DOE plans to consider the estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that are expected to result from each of the standard levels considered.

In order to estimate the monetary value of benefits resulting from reduced emissions of CO_2, DOE plans to use the most current Social Cost of Carbon (SCC) values developed and/or agreed to by an interagency process. The SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damage from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

At the time of this notice, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010, expressed in 2010$, were $4.9, $22.3, $36.5, and $67.6 per metric ton avoided. For emissions reductions that occur in later years, these values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although DOE will give preference to consideration of the global benefits of reducing CO_2 emissions. To calculate a present value of the stream of monetary values, DOE will discount the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

DOE recognizes that scientific and economic knowledge continues to evolve rapidly as to the contribution of CO_2 and other GHG to changes in the future global climate and the potential resulting damages to the world economy. Thus, these values are subject to change.

DOE also intends to estimate the potential monetary benefit of reduced NO_X emissions resulting from the standard levels it considers. For NO_x emissions, available estimates suggest a very wide range of monetary values for NO_X emissions, ranging from $450 to $4,623 per ton in

2010$).[26] In accordance with U.S. Office of Management and Budget (OMB) guidance, DOE will conduct two calculations of the monetary benefits derived using each of the economic values used for NO_x, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[27]

DOE does not plan to monetize estimates of Hg in this rulemaking. DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg in its rulemakings.

18. Regulatory Impact Analysis

In the NOPR and final rule stages of this rulemaking, DOE will prepare a regulatory impact analysis, which addresses the potential for non-regulatory approaches to supplant or augment energy conservation standards to improve the efficacy of GSFL and IRL on the market. DOE recognizes that voluntary or other non-regulatory efforts by manufacturers, utilities, and other interested parties can result in substantial efficiency improvements. DOE intends to analyze the likely effects of non-regulatory initiatives on product energy use, consumer utility, and LCC. DOE will attempt to base its assessment on the actual impacts of any such initiatives to date, but will also consider historical information presented regarding the impacts that any existing initiative might have in the future. DOE will use the NES spreadsheet model to calculate the NES and NPV for the non-regulatory alternatives.

Item 32 *DOE welcomes comments on the methodology it is considering for the regulatory impact analysis.*

APPENDIX A – LIST OF ITEMS FOR COMMENT

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

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

APPENDIX B – DEFINITIONS

This appendix provides the CFR (10 CFR section 430.2) and U.S.C. (statutory) (42 U.S.C. 6291(30)) definitions for the products covered under this rulemaking.

The definitions are as follows:

Color Terms

> The term "color rendering index" or "CRI" means the measure of the degree of color shift objects undergo when illuminated by a light source as compared with the color of those same objects when illuminated by a reference source of comparable color temperature.

42 U.S.C. 6291(30)(J)

> The term "correlated color temperature" or "CCT" means the absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source.

42 U.S.C. 6291(30)(K)

Efficacy

> The term "lamp efficacy" means the lumen output of a lamp divided by its wattage, expressed in lumens per watt (LPW).

42 U.S.C. 6291(30)(M)

> Lamp Efficacy (LE) means the measured lumen output of a lamp in lumens divided by the measured lamp electrical power input in watts expressed in units of lumens per watt (LPW).

10 CFR 430.2

Fluorescent Lamps

> The term "fluorescent lamp" means a low pressure mercury electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into light, including only the following:
>
> (i) Any straight-shaped lamp (commonly referred to as 4-foot medium bi-pin lamps) with medium bi-pin bases of nominal overall length of 48 inches and rated wattage of 28 or more.
>
> (ii) Any U-shaped lamp (commonly referred to as 2-foot U-shaped lamps) with medium bi-pin bases of nominal overall length between 22 and 25 inches and rated wattage of 28 or more.
>
> (iii) Any rapid start lamp (commonly referred to as 8-foot high output lamps) with recessed double contact bases of nominal overall length of 96 inches and 0.800 nominal amperes, as defined in ANSI C78.1–1978 and related supplements.

(iv) Any instant start lamp (commonly referred to as 8-foot slimline lamps) with single pin bases of nominal overall length of 96 inches and rated wattage of 52 or more, as defined in ANSI C78.3–1978 (R1984) and related supplement ANSI C78.3a–1985.

42 U.S.C. 6291(30)(A)

Fluorescent lamp means a low pressure mercury electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into light, including only the following:

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

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

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

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

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

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

10 CFR 430.2

Rated wattage means:

(1) With respect to fluorescent lamps and general service fluorescent lamps:

(i) If the lamp is listed in ANSI C78.81 (incorporated by reference; *see* §430.3) or ANSI C78.901 (incorporated by reference; *see* §430.3), the rated wattage of a lamp determined by the lamp designation of Clause 11.1 of ANSI C78.81 or ANSI C78.901;

(ii) If the lamp is a residential straight-shaped lamp, and not listed in ANSI C78.81 (incorporated by reference; *see* §430.3), the wattage of a lamp when operated on a reference ballast for which the lamp is designed; or

(iii) If the lamp is neither listed in one of the ANSI standards referenced in (1)(i) of this definition, nor a residential straight-shaped lamp, the electrical power of a lamp when measured according to the test procedures outlined in appendix R to subpart B of this part.

10 CFR 430.2

General Service Fluorescent Lamp

The term “general service fluorescent lamp” means fluorescent lamps which can be used to satisfy the majority of fluorescent applications, but does not include any lamp designed and marketed for the following nongeneral lighting applications:

(i) Fluorescent lamps designed to promote plant growth.

(ii) Fluorescent lamps specifically designed for cold temperature installations.

(iii) Colored fluorescent lamps.

(iv) Impact-resistant fluorescent lamps.

(v) Reflectorized or aperture lamps.

(vi) Fluorescent lamps designed for use in reprographic equipment.

(vii) Lamps primarily designed to produce radiation in the ultra-violet region of the spectrum.

(viii) Lamps with a color rendering index of 87 or greater.

42 U.S.C. 6291(30)(B)

General service fluorescent lamp means any fluorescent lamp which can be used to satisfy the majority of fluorescent lighting applications, but does not include any lamp designed and marketed for the following nongeneral application:

(1) Fluorescent lamps designed to promote plant growth;

(2) Fluorescent lamps specifically designed for cold temperature applications;

(3) Colored fluorescent lamps;

(4) Impact-resistant fluorescent lamps;

(5) Reflectorized or aperture lamps;

(6) Fluorescent lamps designed for use in reprographic equipment;

(7) Lamps primarily designed to produce radiation in the ultra-violet region of the spectrum; and

(8) Lamps with a Color Rendering Index of 87 or greater.

10 CFR 430.2

Cold temperature fluorescent lamp means a fluorescent lamp specifically designed to start at −20 °F when used with a ballast conforming to the requirements of ANSI C78.81 (incorporated by reference; see §430.3) and ANSI C78.901 (incorporated by reference; see §430.3), and is expressly designated as a cold temperature lamp both in markings on the lamp and in marketing materials, including catalogs, sales literature, and promotional material.

10 CFR 430.2

Colored fluorescent lamp means a fluorescent lamp designated and marketed as a colored lamp and not designed or marketed for general illumination applications with either of the following characteristics:

(1) A CRI less than 40, as determined according to the method set forth in CIE Publication 13.3 (incorporated by reference; see §430.3); or

(2) A correlated color temperature less than 2,500K or greater than 7,000K as determined according to the method set forth in IESNA LM–9 (incorporated by reference; see §430.3).

10 CFR 430.2

Incandescent Reflector Lamp

The term “incandescent reflector lamp” means a lamp described in subparagraph (C)(ii).
42 U.S.C. 6291(30)(F)

…

Any lamp (commonly referred to as a reflector lamp) which is not colored or designed for rough or vibration service applications, that contains an inner reflective coating on the outer bulb to direct the light, an R, PAR, ER, BR, BPAR, or similar bulb shapes with E26 medium screw bases, a rated voltage or voltage range that lies at least partially within 115 and 130 volts, a diameter which exceeds 2.25 inches, and has a rated wattage that is 40 watts or higher.
42 U.S.C. 6291(30)(C)(ii)

Incandescent reflector lamp (commonly referred to as a reflector lamp) means any lamp in which light is produced by a filament heated to incandescence by an electric current, which: is not colored or designed for rough or vibration service applications that contains an inner reflective coating on the outer bulb to direct the light; has an R, PAR, ER, BR, BPAR, or similar bulb shapes with an E26 medium screw base; has a rated voltage or voltage range that lies at least partially in the range of 115 and 130 volts; has a diameter that exceeds 2.25 inches; and has a rated wattage that is 40 watts or higher.
10 CFR 430.2

BPAR incandescent reflector lamp means a reflector lamp as shown in figure C78.21–278 on page 32 of ANSI C78.21–2003 (incorporated by reference; *see* §430.3).

BR incandescent reflector lamp means a reflector lamp that has—
(1) A bulged section below the major diameter of the bulb and above the approximate baseline of the bulb, as shown in figure 1 (RB) on page 7 of ANSI C79.1–1994, (incorporated by reference, see §430.3); and
(2) A finished size and shape shown in ANSI C78.21–1989 (incorporated by reference; see §430.3), including the referenced reflective characteristics in part 7 of ANSI C78.21–1989.

ER incandescent reflector lamp means a reflector lamp that has—
(1) An elliptical section below the major diameter of the bulb and above the approximate baseline of the bulb, as shown in figure 1 (RE) on page 7 of ANSI C79.1–1994, (incorporated by reference; see §430.3); and
(2) A finished size and shape shown in ANSI C78.21–1989, (incorporated by reference; see §430.3).

Colored incandescent lamp means an incandescent lamp designated and marketed as a colored lamp that has—
(1) A color rendering index of less than 50, as determined according to the test method given in CIE 13.3 (incorporated by reference; see §430.3); or
(2) A correlated color temperature of less than 2,500K, or greater than 4,600K, where correlated temperature is computed according to the “Computation of Correlated Color

Temperature and Distribution Temperature," Journal of the Optical Society of America, (incorporated by reference; see §430.3).

Rough or vibration service incandescent reflector lamp means a reflector lamp: in which a C–11 (5 support), C–17 (8 support), or C–22 (16 support) filament is mounted (the number of support excludes lead wires); in which the filament configuration is as shown in Chapter 6 of the 1993 *Illuminating Engineering Society of North America Lighting Handbook*, 8th Edition (see 10 CFR 430.22); and that is designated and marketed specifically for rough or vibration service applications.

10 CFR 430.2

APPENDIX C – EPCA DIRECTIVES ON FLUORESCENT AND INCANDESCENT LAMPS

This appendix provides a copy of the current requirements the EPCA sets forth for the Department regarding fluorescent and incandescent lamps under EPCA, 42 U.S.C. 6295(i), as well as those prescribed in the Code of Federal Regulations (CFR) at 10 CFR 430.32(n).

The following are the relevant requirements set forth in 42 U.S.C. 6295(i):

General service fluorescent lamps, general service incandescent lamps, intermediate base incandescent lamps, candelabra base incandescent lamps, and incandescent reflector lamps

(1) Standards.—

(A) Definition of effective date.— In this paragraph (other than subparagraph (D)), the term "effective date" means, with respect to each type of lamp specified in a table contained in subparagraph (B), the last day of the period of months corresponding to that type of lamp (as specified in the table) that follows October 24, 1992.

(B) Minimum standards.— Each of the following general service fluorescent lamps and incandescent reflector lamps manufactured after the effective date specified in the tables contained in this paragraph shall meet or exceed the following lamp efficacy and CRI standards:

FLUORESCENT LAMPS				
Lamp Type	**Nominal Lamp Wattage**	**Minimum CRI**	**Minimum Average Lamp Efficacy (LPW)**	**Effective Date (Months)**
4-foot medium bi-pin	35 W	69	75.0	36
	35 W	45	75.0	36
2-foot U-shaped	35 W	69	68.0	36
	35 W	45	64.0	36
8-foot slimline	65 W	69	80.0	18
	65 W	45	80.0	18

8-foot high output	100 W	69	80.0	18
	100 W	45	80.0	18

INCANDESCENT REFLECTOR LAMPS		
Nominal Lamp Wattage	**Minimum Average Lamp Efficacy (LPW)**	**Effective Date (Months)**
40–50	10.5	36
51–66	11.0	36
67–85	12.5	36
86–115	14.0	36
116–155	14.5	36
156–205	15.0	36

(C) Exemptions**.—** The standards specified in subparagraph (B) shall not apply to the following types of incandescent reflector lamps:
(i) Lamps rated at 50 watts or less that are ER30, BR30, BR40, or ER40 lamps.
(ii) Lamps rated at 65 watts that are BR30, BR40, or ER40 lamps.
(iii) R20 incandescent reflector lamps rated 45 watts or less.

(D) Effective dates.—
(i) ER, br, and bpar lamps.— The standards specified in subparagraph (B) shall apply with respect to ER incandescent reflector lamps, BR incandescent reflector lamps, BPAR incandescent reflector lamps, and similar bulb shapes on and after January 1, 2008.
(ii) Lamps between 2.25–2.75 inches in diameter.—The standards specified in subparagraph (B) shall apply with respect to incandescent reflector lamps with a diameter of more than 2.25 inches, but not more than 2.75 inches, on and after the later of January 1, 2008, or the date that is 180 days after December 19, 2007.

(2) Notwithstanding section 6302 (a)(5) of this title and section 6302 (b) of this title, it shall not be unlawful for a manufacturer to sell a lamp which is in compliance with the law at the time such lamp was manufactured.

(3) Not less than 36 months after October 24, 1992, the Secretary shall initiate a rulemaking procedure and shall publish a final rule not later than the end of the 54-month period beginning on October 24, 1992, to determine if the standards established under paragraph (1) should be amended. Such rule shall contain such amendment, if any, and provide that the amendment shall apply to products manufactured on or after the 36-month period beginning on the date such final rule is published.

(4) Not less than eight years after October 24, 1992, the Secretary shall initiate a rulemaking procedure and shall publish a final rule not later than nine years and six months after October 24, 1992, to determine if the standards in effect for fluorescent lamps and incandescent lamps should be amended. Such rule shall contain such amendment, if any, and provide that the amendment shall apply to products manufactured on or after the 36-month period beginning on the date such final rule is published.

(5) Not later than the end of the 24-month period beginning on the date labeling requirements under section 6294 (a)(2)(C) of this title become effective, the Secretary shall initiate a rulemaking procedure to determine if the standards in effect for fluorescent lamps and incandescent lamps should be amended so that they would be applicable to additional general service fluorescent [2] and shall publish, not later than 18 months after initiating such rulemaking, a final rule including such amended standards, if any. Such rule shall provide that the amendment shall apply to products manufactured after a date which is 36 months after the date such rule is published.

The following are the relevant requirements set forth in 10 CFR 430.32(n):

(n) *General service fluorescent lamps and incandescent reflector lamps.* (1) Except as provided in paragraphs (n)(2) and (n)(3) of this section, each of the following general service fluorescent lamps manufactured after the effective dates specified in the table shall meet or exceed the following lamp efficacy and CRI standards:

Lamp type	**Nominal lamp wattage**	**Minimum CRI**	**Minimum average lamp efficacy (lm/W)**	**Effective date**
4-foot medium bipin	>35W	69	75.0	Nov. 1, 1995.
	≤35W	45	75.0	Nov. 1, 1995.
2-foot U-shaped	>35W	69	68.0	Nov. 1, 1995.
8-foot slimline	≤35W	45	64.0	Nov. 1, 1995.
	>65W	69	80.0	May 1, 1994.
	>65W	45	80.0	May 1, 1994.
8-foot high output	>100W	69	80.0	May 1, 1994.
	≤100W	45	80.0	May 1, 1994.

(2) The standards described in paragraph (n)(1) of this section do not apply to:
(i) Any 4-foot medium bipin lamp or 2-foot U-shaped lamp with a rated wattage less than 28 watts;
(ii) Any 8-foot high output lamp not defined in ANSI C78.81 (incorporated by reference; see §430.3) or related supplements, or not 0.800 nominal amperes; or

(iii) Any 8-foot slimline lamp not defined in ANSI C78.3 (incorporated by reference; see §430.3).
(3) Each of the following general service fluorescent lamps manufactured after July 14, 2012, shall meet or exceed the following lamp efficacy standards shown in the table:

Lamp type	**Correlated color temperature**	**Minimum average lamp efficacy (lm/W)**
4-foot medium bipin	≤4,500K	89
	>4,500K and ≤7,000K	88
2-foot U-shaped	≤4,500K	84
	>4,500K and ≤7,000K	81
8-foot slimline	≤4,500K	97
	>4,500K and ≤7,000K	93
8-foot high output	≤4,500K	92
	>4,500K and ≤7,000K	88
4-foot miniature bipin standard output	≤4,500K	86
	>4,500K and ≤7,000K	81
4-foot miniature bipin high output	≤4,500K	76
	>4,500K and ≤7,000K	72

(4) Except as provided in paragraph (n)(5) of this section, each of the following incandescent reflector lamps manufactured after November 1, 1995, shall meet or exceed the lamp efficacy standards shown in the table:

Nominal lamp wattage	**Minimum average lamp efficacy (lm/W)**
40–50	10.5
51–66	11.0
67–85	12.5
86–115	14.0
116–155	14.5
156–205	15.0

(5) Each of the following incandescent reflector lamps manufactured after July 14, 2012, shall meet or exceed the lamp efficacy standards shown in the table:

Rated lamp wattage	**Lamp spectrum**	**Lamp diameter (inches)**	**Rated voltage**	**Minimum average lamp efficacy equation (lm/W)**
40–205	Standard Spectrum	>2.5	≥125V	$6.8*P^{0.27}$
			<125V	$5.9*P^{0.27}$
		≤2.5	≥125V	$5.7*P^{0.27}$
			<125V	$5.0*P^{0.27}$
40–205	Modified Spectrum	>2.5	≤125V	$5.8*P^{0.27}$
			<125V	$5.0*P^{0.27}$
		≤2.5	≥125V	$4.9*P^{0.27}$
			<125V	$4.2*P^{0.27}$

Note 1: P is equal to the rated lamp wattage, in watts.
Note 2: Standard Spectrum means any incandescent reflector lamp that does not meet the definition of modified spectrum in 430.2.

(6) (i)(A) Subject to the exclusions in paragraph (n)(6)(ii) of this section, the standards specified in this section shall apply to ER incandescent reflector lamps, BR incandescent reflector lamps, BPAR incandescent reflector lamps, and similar bulb shapes on and after January 1, 2008.

(B) Subject to the exclusions in paragraph (n)(6)(ii) of this section, the standards specified in this section shall apply to incandescent reflector lamps with a diameter of more than 2.25 inches, but not more than 2.75 inches, on and after June 15, 2008.

(ii) The standards specified in this section shall not apply to the following types of incandescent reflector lamps:

(A) Lamps rated at 50 watts or less that are ER30, BR30, BR40, or ER40 lamps;

(B) Lamps rated at 65 watts that are BR30, BR40, or ER40 lamps; or

(C) R20 incandescent reflector lamps rated 45 watts or less.