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Energy Conservation Program: Energy Conservation Standards for General Service Fluorescent Lamps and Incandescent Reflector Lamps; Proposed Rule

DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket Number EE–2006–STD–0131]

RIN 1904–AA92

Energy Conservation Program: Energy Conservation Standards for General Service Fluorescent Lamps and Incandescent Reflector Lamps

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

ACTION: Notice of proposed rulemaking.

SUMMARY: The Energy Policy and Conservation Act (EPCA) prescribes energy conservation standards for various consumer products and commercial and industrial equipment, including general service fluorescent lamps (GSFL) and incandescent reflector lamps (IRL), and the statute also requires the Department of Energy (DOE) to subsequently determine whether more stringent, amended standards for GSFL and IRL would be technologically feasible and economically justified, and would save a significant amount of energy. In addition, EPCA directs DOE to consider adoption of standards for additional GSFL not already covered by EPCA-prescribed standards. In this notice, DOE proposes amended energy conservation standards for certain GSFL and IRL and new energy conservation standards for certain additional GSFL not currently covered by standards.

DATES: DOE held a public meeting on Tuesday, February 3, 2009 in Washington, DC. DOE began accepting comments, data, and information regarding this notice of proposed rulemaking (NOPR) at the public meeting, and will continue to accept comments until no later than June 12, 2009. See section VIII, ''Public Participation,'' of this NOPR for details.

ADDRESSES: The public meeting was held at the U.S. Department of Energy, Forrestal Building, Room 1E–245, 1000 Independence Avenue, SW., Washington, DC 20585–0121.

Any comments submitted must identify the NOPR for Energy Conservation Standards for Lighting Products, and provide the docket number EE–2006–STD–0131 and/or regulatory information number (RIN) number 1904–AA92. Comments may be submitted using any of the following methods:

- *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.
- *E-mail: fluorescent_and_incandescent_lamps.rulemaking@ee.doe.gov.* Include the docket number EE–2006–STD–0131and/or RIN 1904–AA92 in the subject line of the message.
- *Postal Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed paper original.
- *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024. Telephone: (202) 586–2945. Please submit one signed paper original.

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

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

FOR FURTHER INFORMATION CONTACT: Ms. Linda Graves, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone: (202) 586–1851. E-mail: *Linda.Graves@ee.doe.gov.*

Mr. Eric Stas or Ms. Francine Pinto, U.S. Department of Energy, Office of the General Counsel, GC–72, Forrestal Building, Mail Station GC–72, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone: (202) 586–9507. E-mail: *Eric.Stas@hq.doe.gov* or *Francine.Pinto@hq.doe.gov.*

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

SUPPLEMENTARY INFORMATION:

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Acronyms and Abbreviations

ACEEE American Council for an Energy Efficiency Economy
AEO Annual Energy Outlook
ANOPR advance notice of proposed rulemaking
ANSI American National Standards Institute
ASAP Appliance Standards Awareness Project
ASE Alliance to Save Energy
BF ballast factor
BLS Bureau of Labor Statistics
BPAR bulged parabolic aluminized reflector
BR bulged reflector (reflector lamp shape)
BT Building Technologies Program
BTU British Thermal Unit
CAIR Clean Air Interstate Act
CAMR Clean Air Mercury Rule
CBECS Commercial Buildings Energy Consumption Survey
CCT correlated color temperature
CFR Code of Federal Regulations
CFL compact fluorescent lamp
CIE International Commission on Illumination
CMH ceramic metal halide
CO_2 carbon dioxide
CRI color rendering index
CSL candidate standard level
DIY do-it-yourself
DOE U.S. Department of Energy
DOJ U.S. Department of Justice
E26 Edison screw-base (incandescent lamp base type)
EERE Office of Energy Efficiency and Renewable Energy
EIA Energy Information Administration
EISA 2007 Energy Independence and Security Act of 2007
EL efficacy level
EPA Environmental Protection Agency
EPACT 1992 Energy Policy Act of 1992
EPACT 2005 Energy Policy Act of 2005
EPCA Energy Policy and Conservation Act
ER elliptical reflector (reflector lamp shape)

FEMP Federal Energy Management Program
FR Federal Register
FTC Federal Trade Commission
GE General Electric Lighting and Industrial
GRIM Government Regulatory Impact Model
GSFL general service fluorescent lamp
GSIL general service incandescent lamp
GW gigawatt
Hg mercury
HID high-intensity discharge
HIR halogen infrared reflector
HO high output
HVAC Heating, Ventilating and Air-Conditioning
IESNA Illuminating Engineering Society of North America
ImSET Impact of Sector Energy Technologies
INPV industry net present value
I–O input-output
IPCC Intergovernmental Panel on Climate Change
IR Infrared
IRFA initial regulatory flexibility analysis
IRL incandescent reflector lamp
K degrees Kelvin
kt kilotons
LCC life-cycle cost
LED Light-Emitting Diode
LMC U.S. Lighting Market Characterization Volume I
Lm/W lumens per watt
MBP medium bipin
MECS Manufacturer Energy Consumption Survey (MECS)
MIA Manufacturer Impact Analysis
MMt million metric tons
Mt metric tons
MW megawatts
NAICS North American Industry Classification System
NCLC National Consumer Law Center
NEEP Northeast Energy Efficiency Partnership
NEMA National Electrical Manufacturers Association
NEMS National Energy Modeling System
NEMS–BT National Energy Modeling System—Building Technologies
NES national energy savings
NIA National Impact Analysis
NIST National Institute of Standards and Technology
NOPR notice of proposed rulemaking
NO_X nitrogen oxides
NPCC Northwest Power and Conservation Council
NPV net present value
NRDC Natural Resources Defense Council
NVLAP National Voluntary Laboratory Accreditation Program
OEM Original Equipment Manufacturer
OIRA Office of Information and Regulatory Affairs
OMB U.S. Office of Management and Budget
PAR parabolic aluminized reflector (reflector lamp shape)
PBP payback period
PG&E Pacific Gas and Electric
quad quadrillion BTU
R reflector (reflector lamp shape)
R–CFL reflector compact fluorescent lamp
R&D research and development
RDC recessed double contact
RECS Residential Energy Consumption Survey
RIA regulatory impact analysis
RoHS Restriction on Hazardous Substances directive
SBA Small Business Administration
SCF Survey of Consumer Finances
SEC Securities and Exchange Commission
SEL spectrally-enhanced lighting
SG&A selling, general, and administrative costs
SO standard output
SO_2 sulfur dioxide
SP single pin
S&P Standard & Poor's
T8, T10, T12 tubular fluorescent lamps, diameters of 1, 1.25 or 1.5 inches, respectively
TSD technical support document
TSL trial standard level
TWh terawatt-hour
UMRA Unfunded Mandates Reform Act
U.S.C. United States Code
UV ultraviolet
V volts
VHO very high output
W watts

I. Summary of the Proposed Rule

The Energy Policy and Conservation Act (EPCA or the Act) (42 U.S.C. 6291 *et seq.*), as amended, requires DOE to consider whether to amend the existing energy conservation standards for GSFL and IRL, and to also consider whether to adopt new energy conservation standards for additional types of GSFL beyond those already covered by EPCA-prescribed standards. (42 U.S.C. 6295(i)(3)–(5)) The Act also specifies that any new or amended energy conservation standard DOE prescribes for certain consumer and/or commercial products, such as GSFL and IRL, shall be designed to ''achieve the maximum improvement in energy efficiency * * * which the Secretary determines is technologically feasible and economically justified.'' (42 U.S.C. 6295(o)(2)(A); 6316(a)) Furthermore, the new or amended standard must ''result in significant conservation of energy.'' (42 U.S.C. 6295(o)(3)(B); 6316(a)) In accordance with these and other statutory provisions discussed in this notice, DOE proposes new and amended energy conservation standards for GSFL and IRL, as shown in Table I.1 and Table I.2. The proposed standards would apply to all products listed in Table I.1 and Table I.2 that are manufactured in or imported into the United States on or after June 30, 2012.

TABLE I.1—SUMMARY OF THE PROPOSED ENERGY CONSERVATION STANDARDS FOR GENERAL SERVICE FLUORESCENT LAMPS

Lamp type	Correlated color temperature	Proposed level lm/W	Percent increase over current standards or baseline
4-Foot Medium Bipin	≤ 4,500K	84	12%
	> 4,500K	78	4%
2-Foot U-Shaped	≤ 4,500K	78	15%/22%*
	> 4,500K	73	7%/14%*
8-Foot Slimline	≤ 4,500K	95	19%
	> 4,500K	91	14%
8-Foot High Output	≤ 4,500K	88	10%
	> 4,500K	84	5%
4-Foot Miniature Bipin Standard Output	≤ 4,500K	103	20%
	> 4,500K	97	13%
4-Foot Miniature Bipin High Output	≤ 4,500K	89	16%
	> 4,500K	85	10%

* For these product classes, EPCA has different efficacy standards for lamps with wattages less than 35W and greater than or equal to 35W.

TABLE I.2—SUMMARY OF THE PROPOSED ENERGY CONSERVATION STANDARD FOR IRL

Lamp type	Diameter	Voltage	Proposed level lm/W	Percent increase over current standards or baseline
Standard Spectrum 40W–205W	> 2.5 inches	≥ 125	$7.1P^{0.27}$	69%–100%
		< 125	$6.2P^{0.27}$	47%–75%
	≤ 2.5 inches	≥ 125	$6.3P^{0.27}$	50%–78%
		< 125	$5.5P^{0.27}$	31%–55%
Modified Spectrum 40W–205W	> 2.5 inches	≥ 125	$5.8P^{0.27}$	38%–63%
		< 125	$5.0P^{0.27}$	19%–41%
	≤ 2.5 inches	≥ 125	$5.1P^{0.27}$	21%–44%
		< 125	$4.4P^{0.27}$	7%–27%

Note: P is equal to the rated lamp wattage, in watts.

DOE's analyses indicate that the proposed standards would save a significant amount of energy—an estimated 3.2 to 7.3 quads (for GSFL) and 1.3 to 2.3 quads (for IRL) of cumulative energy over 31 years (2012–2042). The economic impacts on most GSFL and all IRL individual and commercial consumers (*i.e.*, the average life-cycle cost (LCC) savings) are positive.

The cumulative national net present value (NPV) of total consumer costs and savings of the proposed standards from 2012 to 2042 in 2007$ ranges from $3.2 billion (at a 7-percent discount rate) to $25.7 billion (at a 3-percent discount rate) for GSFL. For IRL, the NPV from 2012 to 2042 in 2007$ ranges from $3.7 billion (at a 7-percent discount rate) to $14.0 billion (at a 3-percent discount rate). This is the estimated total value of future operating-cost savings minus the estimated increased product costs, discounted to 2007. DOE estimates the GSFL industry net present value (INPV) to currently be $575–602 million in 2007$. If DOE were to adopt the proposed standards, it expects that manufacturers may lose up to 24 percent of their INPV, which is approximately $139 million. The NPV of the proposed standards for GSFL consumers (at least $3.2 billion at the 7-percent discount rate) would exceed anticipated industry losses by at least 23 times. DOE estimates the IRL industry net present value to be $207–267 million in 2007$. If DOE were to adopt the proposed standards, it expects that manufacturers may lose 29–46 percent of their INPV, which is approximately $77–94 million. The NPV of the proposed standards for IRL consumers (at least $3.7 billion at the 7-percent discount rate) would exceed anticipated industry losses by at least 39 times.

In addition, the proposed standards would have significant environmental benefits. All of the energy saved would be in the form of electricity, and DOE expects the energy savings from the proposed standards to eliminate the need for approximately 1100 to 3400 megawatts (MW) of generating capacity for GSFL and up to 450 MW for IRL by 2042. This would result in cumulative (undiscounted) greenhouse gas emission reductions of 184 to 395 million metric tons (MMT) of carbon dioxide (CO_2) for GSFL and 59 to 114 MMT for IRL from 2012 to 2042. During this same period, the standard would result in power plant emission reductions of 12 to 623 kilotons (kt) of nitrogen oxides (NO_X) for GSFL and 4 to 181 kt NO_X for IRL. Mercury (Hg) emission reductions would be up to 6.9 tons for GFSL and up to 1.7 tons avoided for IRL.

DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy. DOE further notes that products achieving these standard levels are already commercially available. Based upon the rulemaking analyses culminating in this proposal, DOE found that the benefits (energy savings, consumer LCC savings, national NPV increase, and emission reductions) to the Nation of the proposed standards outweigh the burdens (INPV decrease and LCC increases for some lamp users). DOE considered higher efficacy levels (ELs) as trial standard levels (TSLs), and is still considering them in this rulemaking; however, DOE has tentatively concluded that the burdens of the higher efficiency levels outweigh the benefits. Based upon consideration of public comments and related information, DOE may adopt either higher or lower ELs presented in this proposal or some level in between.

II. Introduction

A. Consumer Overview

EPCA currently prescribes efficacy standards for certain IRL and GSFL. (42 U.S.C. 6295(i)(1)) DOE proposes to raise these standards and to set efficacy standards for certain other GSFL, as shown in Table I.1 and Table I.2 above. The proposed standards would apply to products manufactured in the United States, or imported to it, three years after the final rule is published in the **Federal Register**.[1] Table I.1 and Table I.2 also show the percentage improvement in efficacy that each standard level represents, relative to the current standard levels or to products typically on the market today. The proposed standards represent an overall improvement of approximately 4 to 22 percent and 7 to 100 percent in the efficacies of the GSFL and IRL baselines, respectively, covered by the standards.

DOE's analyses suggest that residential and commercial consumers would see benefits from the proposed standards. Although DOE expects that under the proposed standards, the purchase price of high-efficacy GSFL would be higher (up to three times higher) than the average price of these products today, but that the energy efficiency gains would result in lower energy costs that more than offset such higher costs. When the potential savings due to efficiency gains are summed over the lifetime of the high-efficacy products, consumers would be expected to save up to $56.60 (depending on the lamp type), on average, compared to their expenditures on today's baseline GSFL.

The results of DOE's analyses for IRL follow a similar pattern. Although DOE expects the purchase price of the high-efficacy IRL would be higher (ranging from 56 to 63 percent) than the average price of these products today, the energy efficiency gains would result in lower energy costs that more than offset the higher costs. When these potential

[1] The final rule is expected to be published by June 30, 2009; therefore, the effective date would be June 30, 2012.

savings due to efficiency gains are summed over the lifetime of the high-efficacy IRL, it is estimated that consumers would save between $1.62 and $8.14, on average, compared to their expenditures on today's baseline IRL.

B. Authority

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part A [2] of Title III (42 U.S.C. 6291–6309) established the ''Energy Conservation Program for Consumer Products Other Than Automobiles.'' The program covers consumer products and certain commercial products (referred to hereafter as ''covered products''), including GSFL and IRL. (42 U.S.C. 6292(a)(14) and 6295(i)) EPCA prescribes energy conservation standards for certain GSFL and IRL. (42 U.S.C. 6295(i)(1)) The statute further directs DOE to determine whether the existing standards for fluorescent and incandescent lamps should be amended and whether to adopt standards for additional GSFL. (42 U.S.C. 6295(i)(3)–(5)) This rulemaking represents the first round of amendments to the GSFL and IRL energy conservation standards as directed by 42 U.S.C. 6295(i)(3).

The scope of coverage for these requirements for GSFL and IRL is dictated by EPCA's definitions of these and related terms, as explained below. EPCA defines ''general service fluorescent lamp'' as follows: * * * [F]luorescent 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))

EPCA defines ''incandescent reflector lamp'' as follows: * * * [A] lamp in which light is produced by a filament heated to incandescence by an electric current * * * [and] (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), (C)(ii) and (F))

EPCA further clarifies this definition of IRL by defining the lamp types excluded from the definition: The term ''rough service lamp'' means a lamp that—(i) has a minimum of 5 supports with filament configurations that are C–7A, C–11, C–17, and C–22 as listed in Figure 6–12 of the 9th edition of the IESNA Lighting handbook, or similar configurations where lead wires are not counted as supports; and (ii) is designated and marketed specifically for 'rough service' applications, with (I) the designation appearing on the lamp packaging; and (II) marketing materials that identify the lamp as being for rough service. (42 U.S.C. 6291(30)(X))

The term ''vibration service lamp'' means a lamp that—(i) has filament configurations that are C–5, C–7A, or C–9, as listed in Figure 6–12 of the 9th Edition of the IESNA Lighting Handbook or similar configurations; (ii) has a maximum wattage of 60 watts; (iii) is sold at retail in packages of 2 lamps or less; and (iv) is designated and marketed specifically for vibration service or vibration-resistant applications, with—(I) the designation appearing on the lamp packaging; and (II) marketing materials that identify the lamp as being vibration service only. (42 U.S.C. 6291(30)(AA))

The term ''colored incandescent lamp'' means an incandescent lamp designated and marketed as a colored lamp that has—(i) a color rendering index of less than 50, as determined according to the test method given in C.I.E. publication 13.3–1995; or (ii) a correlated color temperature of less than 2,500K, or greater than 4,600K, where correlated temperature is computed according to the Journal of Optical Society of America, Vol. 58, pages 1528–1595 (1986). (42 U.S.C. 6291(30)(EE)) [3]

The advance notice of proposed rulemaking (ANOPR) in this proceeding (73 FR 13620, 13622, 13625, 13628–29 (March 13, 2008)), as well as subsection II.C and section III below, provide additional detail on the nature and statutory history of EPCA's requirements for GSFL and IRL.

Under the Act, DOE's energy conservation program for covered products consists essentially of four parts: (1) Testing; (2) labeling; (3) Federal energy conservation standards, and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is responsible for labeling, and DOE implements the remainder of the program. Section 323 of the Act authorizes DOE, subject to certain criteria and conditions, to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6293) The test procedures for GSFL and IRL appear at title 10 Code of Federal Regulations (CFR) part 430, subpart B, appendix R.

EPCA provides criteria for prescribing new or amended energy conservation standards for covered products. As indicated above, any new or amended standard for a covered product under Part A 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)), although EPCA precludes DOE from adopting any standard that would not result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) Moreover, DOE may not prescribe a standard: (1) For certain products, including GSFL and IRL, if no test procedure has been established for that type (or class) of product, or (2) if DOE determines by rule that the standard would not result in significant conservation of energy or is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)) The Act also provides that, in deciding whether a standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must do so after receiving comments on the proposed standard and by considering, to the greatest extent practicable, the following seven factors:

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

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

[2] This part was originally titled Part B; however, it was redesignated Part A after Part B was repealed by Pub. L. 109–58.

[3] DOE notes that the publication year of the referenced article in the definition of ''colored incandescent lamp,'' as printed in section 321(a)(1)(B) of EISA, contains two typographical errors. The citation should read as follows: Journal of Optical Society of America, Vol. 58, pages 1528–1535 (1968).

(3) The total projected amount of energy savings likely to result directly from the imposition of the standard;

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

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

(6) The need for national energy conservation; and

(7) Other factors the Secretary considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

Under 42 U.S.C. 6295(o)(2)(b)(iii), EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that ''the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy, and as applicable, water, savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. * * *''

Under 42 U.S.C. 6295(q)(1), EPCA sets forth additional requirements applicable to promulgating a standard for a type or class of covered product that has two or more subcategories. DOE must specify a different standard level than that which applies generally to such type or class of products ''for any group of covered products which have the same function or intended use, if * * * products within such group—(A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard'' than applies or will apply to the other products. *Id.* In determining whether a performance-related feature justifies such a different standard for a group of products, DOE must ''consider such factors as the utility to the consumer of such a feature'' and other factors DOE deems appropriate. *Id.* Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

Federal energy efficiency requirements generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c)) DOE can, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions of section 327(d) of the Act. (42 U.S.C. 6297(d))

C. Background

1. Current Standards

EPCA prescribes the energy conservation standards that are currently applicable to specified types of GSFL and IRL. More specifically, the standards set efficacy levels and color rendering index (CRI) levels for certain GSFL, and efficacy standards for certain IRL. (42 U.S.C. 6295(i)(1); 10 CFR 430.32(n)) These statutory standard levels are set forth in Table II.1 and Table II.2 below.

TABLE II.1—EPCA STANDARD LEVELS FOR GSFL

Lamp type	Nominal lamp wattage	Minimum CRI	Minimum average efficacy lm/W
4-Foot Medium Bipin	> 35W	69	75.0
	≤ 35W	45	75.0
2-Foot U-Shaped	> 35W	69	68.0
	≤ 35W	45	64.0
8-Foot Slimline	> 65W	69	80.0
	≤ 65W	45	80.0
8-Foot High Output	> 100W	69	80.0
	≤ 100W	45	80.0

TABLE II.2—EPCA STANDARD LEVELS FOR IRL

Wattage	Min. avg. 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

2. History of Standards Rulemaking for General Service Fluorescent Lamps, Incandescent Reflector Lamps, and General Service Incandescent Lamps

As stated above, EPCA established energy conservation standards for certain types of GSFL and IRL. (42 U.S.C. 6295(i)(1)) EPCA also requires that DOE conduct two cycles of rulemakings to determine whether to amend these standards, and that DOE initiate a rulemaking to determine whether to adopt standards for additional types of GSFL. (42 U.S.C. 6295(i)(3)–(5)) This rulemaking addresses both the amendment of existing GSFL and IRL standards, and the adoption of standards for additional GSFL.

DOE initiated this rulemaking on May 31, 2006, by publishing on its Web site its ''Rulemaking Framework Document for General Service Fluorescent Lamps, Incandescent Reflector Lamps, and General Service Incandescent Lamps.''[4] DOE also published a notice in the **Federal Register** announcing the availability of the framework document

[4] A PDF copy of the framework document published in May 2006 is available at: *http://www/eere.energy.gov/buildings/appliance_standards/residential/pdfs/lamps_framework.pdf.*

and a public meeting on the document, which requested public comments on the matters raised in the framework document. 71 FR 30834 (May 31, 2006). The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for the products covered by this rulemaking, and it identified various issues to be resolved in conducting the rulemaking.

DOE held the public meeting on June 15, 2006, to present the framework document, describe the analyses it planned to conduct during the rulemaking, seek comments from stakeholders on these subjects, and inform stakeholders about and facilitate their involvement in the rulemaking. At the public meeting and during the comment period, DOE received many comments that both addressed issues raised in the framework document and identified additional issues relevant to this rulemaking.

As the title of the framework document indicates, DOE initially included general service incandescent lamps (GSIL) in this rulemaking. This was done to address the requirement then present in section 325(i)(5) of EPCA that DOE consider energy conservation standards for additional GSIL. (42 U.S.C. 6295(i)(5)) However, section 321(a)(3)(A)(iii) of the Energy Independence and Security Act of 2007,[5] (EISA 2007) amended EPCA to remove this requirement, thereby eliminating DOE's authority to regulate additional GSIL. Instead, section 321(a)(3)(A)(ii) of EISA 2007 amended EPCA to prescribe energy conservation standards for GSIL. Therefore, this rulemaking no longer addresses GSIL.

DOE issued the ANOPR for this rulemaking on February 21, 2008 and published it in the **Federal Register** on March 13, 2008. 73 FR 13620. On February 22, 2008, DOE posted the ANOPR, as well as the complete ANOPR technical support document (TSD), on its Web site.[6] The TSD includes the results of the following DOE preliminary analyses: (1) Market and technology assessment; (2) screening analysis; (3) engineering analysis; (4) energy use characterization; (5) product price determinations; (6) life-cycle cost (LCC) and pay back period (PBP) analyses; (7) shipments analysis; and (8) national impact analysis (NIA).

In the March 2008 ANOPR, DOE invited comment in particular on the following issues: (1) Consideration of additional GSFL; (2) amended definitions; (3) product classes; (4) scaling to product classes not analyzed; (5) screening of design options; (6) lamp operating hours; (7) energy consumption of GSFL; (8) LCC calculation; (9) installation costs; (10) base-case market-share matrices; (11) shipment forecasts; (12) base-case and standards-case forecasted efficiencies; (13) trial standard levels; and (14) period for lamp production equipment conversion. 73 FR 13620, 13686–88 (March 13, 2008).

In the ANOPR, DOE described and sought comment on the analytical framework, models, and tools (*e.g.*, LCC and national energy savings (NES) spreadsheets) DOE was using to analyze the impacts of energy conservation standards for GSFL and IRL. DOE held a public meeting in Washington, DC, on March 10, 2008, to present the methodologies and results for the March 2008 ANOPR analyses. At this meeting, stakeholders recommended that DOE revise certain analyses in the energy conservation standard ANOPR and the scope of covered products. DOE later received written comments from the National Electrical Manufacturers Association (NEMA). In addition, DOE received a joint comment from several stakeholders. The Joint Comment was submitted by the American Council for an Energy Efficient Economy (ACEEE), Alliance to Save Energy (ASE), Appliance Standards Awareness Project (ASAP), National Consumer Law Center, National Grid, Natural Resources Defense Council (NRDC), Northeast Energy Efficiency Partnerships (NEEP), Northwest Power and Conservation Council (NPCC), Pacific Gas and Electric Company (PG&E), and Vermont Energy Investment Corporation. The comments received since publication of the March 2008 ANOPR and during the March 10, 2008 public meeting have contributed to DOE's proposed resolution of the issues in this rulemaking. This NOPR quotes, summarizes, and responds to the issues raised in these public comments. (A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.)

Subsequent to the public meeting and at NEMA's request, DOE and NEMA met on June 26, 2008 to discuss appropriate lumens per watt (lm/W) standards for high correlated color temperature (CCT) fluorescent lamps. (DOE, No. 27)[7] NEMA subsequently submitted a written comment documenting its presentation at this meeting (hereafter the ''June 2008 NEMA meeting''). (NEMA, No. 26) Topics covered at this meeting included the expected market share of high-CCT fluorescent lamps, appropriate efficacy standard scaling factors for GSFL with a CCT greater than 4,500K but less than or equal to 7,000K, and coverage of GSFL with a CCT greater than 7,000K. See sections III.C.2, V.A.1.c, and V.C.7.a.i of this notice for a more detailed discussion of NEMA's comments at this meeting, as well as DOE's responses.

III. Issues Affecting the Scope of This Rulemaking

A. Additional General Service Fluorescent Lamps for Which DOE Is Proposing Standards

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

As discussed above, EPCA established energy conservation standards for certain general service fluorescent lamps, (42 U.S.C. 6295(i)(1)) and directed the Secretary to ''initiate a rulemaking procedure to determine if the standards in effect for fluorescent lamps * * * should be amended so that they would be applicable to additional general service fluorescent [lamps]. * * *'' (42 U.S.C. 6295(i)(5)) Thus, DOE must consider whether to adopt energy efficacy standards for additional GSFL beyond those already covered by the statutorily-prescribed standards.

The March 2008 ANOPR notes that a wide variety of GSFL are not currently covered by energy conservation standards, and they are potential candidates for coverage under 42 U.S.C. 6295(i)(5). 73 FR 13620, 13628–29 (March 13, 2008). However, the requirement that DOE consider additional GSFL appears to conflict with EPCA's definitions of key terms, which it might be argued would preclude coverage of additional GSFL. As explained below, DOE has carefully considered these statutory provisions and is interpreting them in a manner so as to give effect to the requirement to consider additional GSFL.

Specifically, the conflict is centered on the statutory definition of ''general service fluorescent lamp.'' As set forth above and repeated here for purposes of this discussion, ''general service fluorescent lamp'' is defined in 42

[5] Pub. L. 110–140 (enacted Dec. 19, 2007).

[6] PDF copies of the ANOPR and ANOPR TSD published in March 2008 are available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/incandescent_lamps_anopr.html.*

[7] A notation in the form ''DOE, No. 27 '' identifies a written comment that DOE has received and has included in the docket of this rulemaking or a written docket submission. This particular notation refers to a comment: (1) Submitted by DOE; and (2) in document number 27 in the docket of this rulemaking.

U.S.C. 6291(30)(B) to mean: ''fluorescent lamps which can be used to satisfy the majority of fluorescent lamp applications, but does not include any lamp designed and marketed for the following nongeneral lighting applications: [list of eight exclusions not relevant to the present issue].''

As such, the term ''general service fluorescent lamp'' appears to be defined by reference to the term ''fluorescent lamp,'' which is also defined under the statute as follows: ''Except as provided in subparagraph (E), 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) (Emphasis added).

The term ''fluorescent lamp'' is, by its terms, limited to four enumerated types of lamps. Further, the four types of lamps set forth in the definition of ''fluorescent lamp'' have corresponding energy conservation standards prescribed under the statute at 42 U.S.C. 6295(i)(1)(B). Given that the statutory definition of ''fluorescent lamp'' is limited to four specified types of lamps and that the statute prescribes standards for those four lamps, it is not possible to give effect to the congressional directive to consider establishing standards for additional GSFL if the term ''general service fluorescent lamp'' is limited by the definition of ''fluorescent lamp.''

Given this identified conflict, DOE has determined that there is an inherent ambiguity in the statute in terms of how these provisions are to be implemented. In order to move forward with this standards rulemaking, DOE must resolve this legal conundrum.

Although there is no legislative history to clarify this point, there are a number of reasons to believe that Congress did not intend to strictly limit consideration of ''additional'' GSFL. First, Congress adopted both the relevant statutory definitions and the ''additional'' lamps requirement as part of Energy Policy Act of 1992 (EPACT 1992; Pub. L. 102–486). DOE does not believe Congress would intentionally insert a legislative provision that, when read in conjunction with a simultaneously added provision, amounts to a nullity. Second, reading the definition to preclude consideration of additional GSFL would run counter to the energy-saving purposes of EPCA. It is reasonable to assume that Congress would not have intended to limit energy conservation standards to only those technologies available in 1992, but would instead cast a broader net that would achieve energy efficiency improvements in lighting products incorporating newer technologies.

Consequently, DOE interprets these statutory provisions such that, in defining ''general service fluorescent lamp,'' Congress intended to incorporate the term ''fluorescent lamp'' in a broader, more generic sense. DOE understands that the industry routinely refers to ''fluorescent lamps'' as including products in addition to the four enumerated in the statutory definition of that term. In fact, in the March 2008 ANOPR, DOE presented its plan for including additional GSFL for coverage, and did not receive adverse comment. Thus, DOE has determined to read the statutory definition of ''general service fluorescent lamp'' in this broader context.

For these reasons, and for the additional reasons set forth in the March 2008 ANOPR,[8] DOE views ''additional'' GSFL, as that term is used in 42 U.S.C. 6295(i)(5), as lamps that: (1) Meet the technical portion of the statutory definition of ''fluorescent lamp'' (*i.e.*, 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) (42 U.S.C. 6291(30)(A)) without restriction to the four specified lamp types in that definition; (2) can be used to satisfy the majority of fluorescent lighting applications (42 U.S.C. 6291(30)(B)); (3) are not within the exclusions from the definition of GSFL specified in 42 U.S.C. 6291(30)(B); and (4) are ones for which EPCA does not prescribe standards. Such an interpretation does not alter the existing statutory provision or standards for ''fluorescent lamps,'' but it does permit DOE to give effect to section 6295(i)(5) of EPCA by expanding the universe of GSFL open to potential regulation. The scope of coverage reflected in this NOPR is in keeping with the interpretation outlined above.

2. Identification of the Additional Lamps for Which DOE Proposes Standards

As set forth more fully in the March 2008 ANOPR, DOE took the following three steps in terms of identifying additional GSFL for which standard setting might be appropriate. DOE first conducted a comprehensive review of the fluorescent lighting market in order to identify particular types of lamps that meet the four criteria above to determine the additional GSFL for which DOE would consider adopting standards. Second, DOE examined each lamp type to determine potential energy savings that energy conservation standards would bring for that lamp. Third, DOE further evaluated selected lamps to determine if such standards would be technologically feasible and economically justified. In carrying out these steps before issuance of the March 2008 ANOPR, DOE considered comments on these issues that it had received previously. 73 FR 13620, 13629–30 (March 13, 2008).

In implementing the first of these three steps, DOE identified the following categories of GSFL as meeting the four criteria for consideration as ''additional'' GSFL under 42 U.S.C. 6295(i)(5):

- 4-foot, medium bipin (MBP), straight-shaped lamps, rated wattage of < 28W;
- 2-foot, medium bipin, U-shaped lamps, rated wattage of < 28W;
- 8-foot, recessed double contact (RDC), rapid start, high output (HO) lamps not defined in ANSI Standard C78.1–1991 [9] or with current other than 0.800 nominal amperes;
- 8-foot single pin (SP), instant start, slimline lamps with a rated wattage ≥ 52, not defined in ANSI Standard C78.3–1991 [10];
- Very high output (VHO) straight-shaped lamps;
- T5 [11] miniature bipin (MiniBP) straight-shaped lamps;
- Additional straight-shaped and U-shaped lamps other than those listed

[8] 73 FR 13620, 13629 (March 13, 2008).

[9] Titled ''for Fluorescent Lamps—Rapid-Start Types—Dimensional and Electrical Characteristics.''

[10] Titled ''for Fluorescent Lamps—Instant-Start and Cold-Cathode Types—Dimensional and Electrical Characteristics.''

[11] T5, T8, T10, and T12 are nomenclature used to refer to tubular fluorescent lamps with diameters of 0.625, 1, 1.25, and 1.5 inches, respectively.

above (*e.g.*, alternate lengths, diameters, or bases); and

- Additional fluorescent lamps with alternate shapes (*e.g.,* circline, pin-based compact fluorescent lamps (CFL)).

73 FR 13620, 13630 (March 13, 2008).

DOE then assessed the potential energy savings of standards for these GSFL (second step) and whether candidate standards for those GSFL would be technologically feasible and economically justified (third step), in order to determine which GSFL to analyze in depth regarding whether, and at what levels, standards would be warranted under the EPCA criteria in 42 U.S.C. 6295(o). DOE's analytical process related to these additional GSFL categories is discussed generally below.

In a review of 4-foot medium bipin lamps, DOE found that the current market lacked any products with a rated wattage below 25W. Therefore, in the March 2008 ANOPR, DOE preliminarily decided not to extend coverage to 4-foot medium bipin lamps below 25W. In the following section, DOE discusses its consideration in the March 2008 ANOPR of possibly regulating lamps with rated wattages less than 28W and greater than or equal to 25W.

Similar to the 4-foot medium bipin lamps, in the March 2008 ANOPR, DOE investigated the potential for regulating 2-foot U-shaped lamps less than 28W. A review of available manufacturer catalogs found no commercially-available products in that category. Therefore, DOE concluded that lowering the minimum wattage threshold of 2-foot U-shaped lamps would likely not result in substantial energy savings and preliminarily decided not to expand coverage to these lamps.

DOE also considered whether to expand coverage to include VHO fluorescent lamps. While VHO lamps consume large amounts of energy, they are commonly used in outdoor applications where high-intensity discharge (HID) lamps are rapidly gaining market share. Further research indicated that shipments of VHO T12 lamps are declining rapidly. Although individually these products have greater per-lamp energy savings than high output or standard output lamps, the total energy savings resulting from regulation would be small and would be expected to decrease over time as these lamps disappear from the market. Therefore, DOE preliminarily decided not to extend coverage to VHO lamps.

In the March 2008 ANOPR, DOE also preliminarily decided not to expand coverage to T5 fluorescent lamps. DOE's initial analysis showed that T5 lamps currently have a relatively small share of the GSFL market, and, therefore, have limited potential to contribute to total energy savings. Although T5 lamps can serve as a substitute for T8 or T12 lamps, DOE found that T5 lamps tend to have higher efficacy. Research showed that the highest efficacy 32W 4-foot medium bipin T8 lamp is 95 lm/W, compared to 104 lm/W for a standard output 4-foot miniature bipin T5 lamps. Thus, DOE stated that excluding T5 lamps from this rulemaking would be unlikely to undermine any energy savings that would result from a T12 and T8 standard, even if the standard caused increased sales of T5 systems

Lastly, DOE preliminarily decided not to extend coverage to fluorescent lamps that had alternate lengths, diameters, bases, or shapes (or a combination thereof) than the lamps specifically mentioned. DOE reasoned that the products it had already selected for coverage represented the significant majority of the GSFL market, and, thus, the bulk of the potential energy savings. Furthermore, DOE tentatively concluded there was limited potential for lamps with miscellaneous lengths and bases to grow in market share, given the constraint of fixture lengths and socket compatibility.

After eliminating the lamps aforementioned lamps from further consideration for the reasons cited above, DOE was left with the following additional GSFL to consider evaluating in depth for potential standards:

- 4-foot, medium bipin lamps with wattages ≥ 25 and < 28;
- 8-foot, recessed double contact (RDC), rapid start, high output (HO) lamps not defined in ANSI Standard C78.1–1991 or with current other than 0.800 nominal amperes;
- 8-foot single pin (SP), instant start, slimline lamps with a rated wattage ≥ 52, not defined in ANSI Standard C78.3–1991;

73 FR 13620, 13632 (March 13, 2008).

As mentioned in the March 2008 ANOPR, DOE explored extending coverage to 4-foot medium bipin lamps with wattages less than 28W. A product review found that manufacturers marketed and sold 25W 4-foot medium bipin T8 fluorescent lamps as replacements for higher wattage 4-foot medium bipin T8 fluorescent lamps. Thus, DOE concluded that lowering the minimum wattage threshold to include these lamps would mitigate the risk of 25W lamps becoming a loophole and would maximize potential energy savings. In addition, as the technology and incremental costs associated with increased efficacy of 25W lamps are similar to their already regulated 28W counterparts, DOE tentatively concluded that standards for these lamps would be technologically feasible and economically justified.

In the March 2008 ANOPR, DOE also preliminarily decided to extend coverage to 8-foot recessed double contact, rapid start, HO lamps not defined in ANSI Standard C78.1–1991. Due to the ampere specification in the definition, the statutory standards covered only T12 8-foot recessed double contact HO lamps, but none of the T8 8-foot recessed double contact HO lamps (which usually have 0.400 nominal amperes). Since the T8 8-foot lamps serve as substitutes for their T12 counterparts, DOE risked losing potential energy savings unless such lamps are also covered by energy conservation standards. Consequently, DOE preliminarily extended coverage to T8, 8-foot recessed double contact HO lamps, thereby adding lamps previously restricted by the 0.800 nominal ampere limitation in the definition of ''general service fluorescent lamp.''

Furthermore, DOE planned to expand coverage to 8-foot recessed double contact, rapid start, high output fluorescent lamps not listed in ANSI Standard C78.1–1991. DOE made this decision because the ANSI standards referenced in DOE regulations were outdated.[12] As new lamps are introduced to the market, it is likely they would not be covered by the 1991 ANSI standard and potentially even the currently most up-to-date standard. Any of these lamps could serve as substitutes for regulated lamps. To maximize energy savings from these standards, DOE extended coverage to 8-foot recessed double contact, rapid start, high output fluorescent lamps not listed in ANSI Standard C78.1–1991.

Because the technologies of T8, 8-foot recessed double contact HO lamps and the 8-foot recessed double contact HO lamps not listed in the ANSI Standard C78.1–1991 were similar to the technologies of their already-regulated T12 counterparts, DOE tentatively concluded that standards for these lamps would meet the statutory criterion of technological feasibility. Preliminary analysis of these lamps in the LCC and NIA demonstrated substantial economic savings. Therefore, DOE tentatively concluded that energy conservation standards for these lamps would be expected to be economically justified.

[12] ANSI Standard C78.1–1991 has been updated and replaced by ANSI Standard C78.81–2005, ''for Electric Lamps—Double Capped Fluorescent Lamps—Electrical and Dimensional Characteristics.''

Similar to 8-foot recessed double contact HO lamps, in the March 2008 ANOPR, DOE considered extending coverage to 8-foot, single pin, instant start, slimline lamps not included in ANSI Standard C78.3–1991 (which includes T8 lamps as well). DOE's preliminary analysis indicated that regulation of these lamps has the potential to achieve substantial energy savings. Therefore, DOE preliminarily decided to expand the scope of energy conservation standard coverage to 8-foot single pin slimline lamps with a rated wattage greater than or equal to 52W not listed in ANSI Standard C78.3–1991. Since the technologies of T8, 8-foot single pin slimline lamps and the 8-foot single pin slimline lamps not listed in ANSI Standard C78.3–1991 are similar to the technologies of their already-regulated counterparts, DOE tentatively concluded that standards for these lamps would be expected to meet the statutory criterion of technological feasibility. Analyses in the LCC and NIA confirmed the potential for substantial economic savings associated with regulation of these lamp types. As a result, in the March 2008 ANOPR, DOE tentatively concluded that energy conservation standards for these lamps would be economically justified.

During and after the public meeting, DOE received numerous verbal and written comments regarding the lamps included in or excluded from coverage in the March 2008 ANOPR. As a general matter, commenters supported DOE's approach for consideration of additional GSFL for coverage by energy conservation standards. However, commenters urged DOE to consider changes in its approach in two areas, specifically coverage of T5 lamps and extension of lamp wattage ranges. Sections III.A.2.a and III.A.2.b of this notice immediately below discuss the submitted comments and DOE's responses.

a. Coverage of T5 Lamps

At the March 2008 ANOPR public meeting, NEMA announced that it was considering supporting coverage of T5 lamps to prevent the introduction of less-efficient T5 lamps into the market, particularly those containing halophosphors. (Public Meeting Transcript, No. 21 at pp. 71–72) [13] ACEEE likewise suggested that DOE should analyze opportunities involving regulation of T5 lamps. (Public Meeting Transcript, No. 21 at p. 73) In its written comments, NEMA stated that it would not oppose covering newer T5 fluorescent lamp technology (*e.g.*, 28W 4-foot T5 lamps), but would not recommend covering older technology (*i.e.*, T5 preheat fluorescent lamps). (NEMA, No. 22 at p. 3) In addition, the Joint Comment stated that DOE should extend coverage to T5 lamps. These organizations argued that if only T8 and T12 lamps are covered by the standard, it could possibly spur market introduction of less-efficient halophosphor T5 lamps with a lower first cost. Such a development would increase the overall market share of T5 lamps and decrease the potential energy savings associated with this rulemaking. (Joint Comment, No. 23 at pp. 2–5)

DOE agrees with these comments. While most T5 lamps are currently more efficient than the T8 and T12 lamps for which they can be substituted, excluding them from energy conservation standards could provide an incentive for less-efficient T5 lamps to enter the market. Such trend would result in increased market share of less-efficient products, thereby creating the potential for significant energy savings losses unless these lamps are regulated. Because this potential substitution effect is a primary criterion which DOE uses to determine coverage for additional GSFL, DOE is proposing in this NOPR to extend coverage to T5 miniature bipin lamps.

DOE researched the market and product availability of T5 lamps and found they exist in a variety of lengths and wattages. Standard T5 lamps include wattages ranging from 14W to 80W, and lengths ranging from nominally 2 feet to 6 feet. DOE's research indicates that the primary driver of T5 market share growth is substitution for currently regulated 4-foot MBP lamps. Therefore, DOE proposes to cover only the nominally 4-foot lengths of T5 miniature bipin lamps. DOE believes that alternate lengths of T5 lamps are not likely to gain significant market share as they are not easily substitutable for 4-foot MBP systems which represent the majority of the total fluorescent market. In addition, interviews with manufacturers and a review of product literature indicate that standard-output (approximately 28W) and high-output (approximately 54W) lamps are the highest volume T5 miniature bipin lamps. In addition to the full-wattage versions of these lamps, DOE has found that reduced-wattage versions of the standard- and high-output T5 lamp (26W and 51W respectively) are available. Therefore, in this NOPR, DOE proposes to extend coverage to 4-foot nominal, straight-shaped, T5 miniature bipin standard output lamps with rated wattages ≥ 26W and to 4-foot nominal, straight-shaped, T5 miniature bipin high output lamps with rated wattages ≥ 51W, as they present the greatest potential for energy savings. DOE estimates potential energy savings from these lamps of up to 2.05 quads over the analysis period (2012 to 2042). Because higher-efficacy versions of some of these lamps are already present in the market, DOE tentatively concludes that standards for these lamps are technologically feasible.

Based on DOE's LCC and NIA analyses, coverage of the T5 lamps discussed above would be economically justified. These analyses show that T5 lamp coverage has the potential to achieve on average $47.03 per standard-output lamp system and $56.60 per high-output lamp system in LCC savings. In addition, DOE's NIA indicates that regulating these lamps could result in an NPV of up to $6.84 billion to the Nation (discounted at 3 percent). See section VI.B.1.a.i and section VI.B.3 of this document and chapters 8 and 11 of the TSD for more details on these results.

b. Extension of Lamp Wattage Ranges

Regarding fluorescent lamp coverage, the Joint Comment suggested that DOE should extend wattage ranges to cover lower-wattage products. (Joint Comment, No. 23 at p. 4) In relevant part, section 123 of EPACT 1992 amended EPCA to establish standards for 4-foot medium bipin lamps of 28W or more. The Joint Comment notes that since that law took effect, "new products continue to be introduced, and there is an incentive to circumvent standards by producing lamps just outside of the watt range (e.g. the current 25W residential lamp)." *Id.* NEMA commented that while current standards cover 2-foot U-shaped medium bipin lamps greater than or equal to 28W, new products have been introduced at 25W. (Public Meeting Transcript, No. 21 at p. 73) To prevent this trend from continuing, the Joint Comment recommended substantially lowering watt ranges for GSFL product classes to protect the energy savings that would be accomplished by this rule. If niche products exist in the new range, the Joint Comment expressed a preference for using narrowly drawn exemptions rather than limiting the covered watt range. (Joint Comment, No. 23 at p. 4)

[13] A notation in the form "Public Meeting Transcript, No. 21 at pp. 71–72" identifies a written comment that DOE has received and has included in the docket of this rulemaking. This particular notation refers to a comment: (1) Submitted during the public meeting on March 10–11, 2008; (2) in document number 21 in the docket of this rulemaking; and (3) appearing on pages 71 through 72 of the transcript.

DOE agrees with the Joint Comment regarding the appropriateness of extending wattage ranges when commercially-available products exist. As discussed in the March 2008 ANOPR, DOE proposed to extend coverage to 4-foot medium bipin fluorescent lamps with wattages between 25W and 28W. DOE discovered these lamps were being marketed as substitutes for currently regulated lamps subject to the current and amended standards (proposed in this NOPR) on 4-foot medium bipin lamps. Therefore, consistent with that approach, in this NOPR, DOE proposes to extend coverage to 2-foot U-shaped lamps with wattages greater than 25W.

The Joint Comment expressed concern that substitutable products outside the range of covered wattages will emerge in other product classes. It suggested a proactive approach of lowering the watt ranges even further, although no products may currently exist in that range. (Joint Comment, No. 23 at p. 4) While DOE understands the Joint Comment's concern, DOE disagrees with this approach. DOE is required to consider energy conservation standards that are technologically feasible. If a lower wattage lamp does not yet exist, DOE cannot confirm that it would be technologically feasible or economically justified for such a lamp to meet a set energy conservation standard. In addition, lower wattage lamps may provide different lumen outputs, and thereby different utility. Therefore, if DOE were to include these lamps in its coverage without determining if the set energy conservation standard is technologically feasible, DOE could be reducing the utility of covered product or precluding its development entirely. Further, DOE encourages the introduction of lamps at lower wattages. Thus, DOE will only propose to extend wattage ranges for 4-foot medium bipin lamps and 2-foot medium bipin U-shaped lamps to the extent specified in this NOPR.

3. Summary GSFL Lamps to Which DOE Proposes To Extend Coverage

With the exception of the above-discussed comments, DOE received no other input related to coverage of GSFL. In addition, DOE's revised analyses indicate that energy conservation standards for the lamps which DOE preliminarily decided to extend coverage in the March 2008 ANOPR are still expected to be technologically feasible, economically justified, and would result in significant energy savings. Therefore, in summary, DOE is proposing to cover the following additional GSFL:

- 2-foot, medium bipin U-shaped lamps with a rated wattage ≥ 25 and less than < 28;
- 4-foot, medium bipin lamps with a rated wattage ≥ 25 and less than 28;
- 4-foot T5, miniature bipin, straight-shaped, standard output lamps with rated wattage ≥ 26;
- 4-foot T5, miniature bipin, straight-shaped, high output lamps with rated wattage ≥ 51;
- 8-foot recessed double contact, rapid start, HO lamps other than those defined in ANSI Standard C78.1–1991;
- 8-foot recessed double contact, rapid start, HO lamps (other than 0.800 nominal amperes) defined in ANSI Standard C78.1–1991; and
- 8-foot single pin instant start slimline lamps, with a rated wattage ≥ 52, not defined in ANSI Standard C78.3–1991.

B. Exempted Incandescent Reflector Lamps

Section 322(a)(1) of EISA 2007 amended section 321(30)(C)(ii) of EPCA to expand the portion of the definition of ''incandescent lamp'' applicable to incandescent reflector lamps to include lamps with a diameter between 2.25 and 2.75 inches, as well as ER, BR, BPAR, or similar bulb shapes. (42 U.S.C. 6291(30)(C)(ii)) Furthermore, section 322(b) of EISA 2007 incorporates several new exemptions to the IRL standards in the new section 325(i)(1)(C) of EPCA. (42 U.S.C. 6295(i)(1)(C)) These exemptions are as follows: (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.

At the ANOPR stage, DOE concluded that it does not have the authority to set standards for these lamps, for the following reasons. Although Congress included ER, BR, and small-diameter (less than 2.75 inches) lamps in the definition of an ''incandescent lamp,'' it specifically exempted certain wattages and diameters from the prescribed efficacy standards, thereby indicating Congress's intent not to set standards for those products. Furthermore, DOE's reading of 42 U.S.C. 6295(i)(3), which directs DOE to amend the standards in paragraph (1), led it to believe that DOE's authority to amend the standards does not include the authority to amend the exemptions. Specifically, under 42 U.S.C. 6295(i)(1)(C), ''Exemptions,'' the statute refers to ''the standards specified in subparagraph (B),'' whose title is ''Minimum Standards.'' Therefore, in amending the standards in paragraph (1), under 42 U.S.C. 6295(i)(3), DOE reasoned that it had the authority to change the efficacy values but not the exemptions. Accordingly, DOE conducted its ANOPR analyses under the premise that it could not extend coverage to these statutorily-exempted products.

The Joint Comment argued that by covering these products in EISA 2007, Congress effectively brought them into the Federal standards program and, thus, granted DOE the authority to regulate them. The Joint Comment recommended extending coverage to 65-watt ER and BR lamps. In addition, it encouraged DOE to evaluate standards for ER and BR lamps less than 65 watts and for R20 lamps less than 45 watts. The Joint Comment further contended that by failing to extend coverage to these lamps, DOE is not meeting its obligation to maximize energy savings. The Joint Comment argued that the exempted lamps represent a large, growing market share and are a substitute for products that DOE plans to regulate. The Joint Comment stated that because 65-watt BR lamps represent a low-cost, low-efficacy alternative to the more-efficient products covered by the standards, continued exemptions could decrease the potentially significant energy savings associated with the present rulemaking. (Joint Comment, No. 23 at p. 12–14)

Accompanying the Joint Comment were two legal memoranda from the National Consumer Law Center (NCLC), maintaining that not only does DOE have the authority to regulate ER and BR lamps, but that DOE is obligated to regulate them. NCLC pointed out that with the passage of EISA 2007, Congress included BR and ER lamps that have a ''rated wattage that is 40 watts or higher'' within the definition of ''incandescent lamp'' [EISA 2007, section 322(a), amending 42 U.S.C. 6291(30)(C)] and, thus, included these BR and ER lamps as covered products under 42 U.S.C. 6291(2) and 6292(a)(14). NCLC further contended that the only explanation for Congress adding ER and BR lamps to the definition was to include them among the covered products. (Joint Comment, No. 23 at p. 27) NCLC cited the rulemaking for microwave and electric ovens as an example of a rulemaking in which DOE is considering applying standards to products for which no prescriptive efficiency standards exist. (Joint Comment, No. 23 at p. 28)

Through the initial drafting of this NOPR, DOE adhered to its earlier conclusion that it lacked authority to consider standards for ER, BR, and small-diameter lamps that had been specifically exempted by Congress. However, after carefully considering the testimony of the February 3, 2009 NOPR public meeting and reexamining the ANOPR public comments on this issue, DOE reexamined its authority under EPCA to amend standards for ER, BR, and small-diameter lamps and has concluded that its earlier view may have been in error. DOE is further considering if it has authority to consider energy conservation standards for ER, BR, and small-diameter lamps for the reasons that follow.

DOE agrees with the Joint Comment, that prior to enactment of EISA 2007 on December 19, 2007, ER, BR, and small-diameter lamps were by definition excluded from coverage under EPCA; however, once EISA 2007 amended the definition of ''incandescent lamp,'' ER, BR, and small-diameter lamps become products by the new definition. (Joint Comment, No. 23 at p. 27) Congress proceeded to expressly exempt certain types of ER, BR, and small-diameter lamps from the statutorily-set IRL standards established by EISA 2007. However, given that these expressly exempted lamp types constitute the overwhelming majority of the ER, BR, and small-diameter lamps market, DOE's original construction of the relevant statutory provisions (as expressed in the ANOPR) would have the effect of once again moving most ER, BR, and small-diameter lamps beyond the reach of energy conservation standards. Accordingly, DOE is reconsidering whether, under 42 U.S.C 6295(i)(3), the directive to amend the standards in paragraph (1) encompasses both the statutory levels and the exemptions to those standards.

As a practical matter, if DOE does conclude that it has authority to establish standards for ER, BR, and small-diameter lamps, it cannot consider such lamps as part of the present rulemaking because it has not conducted the requisite analyses to propose appropriate standard levels. At the same time, DOE does not wish to delay the present rulemaking (and the accompanying energy savings to the Nation) for the sole reason of considering this subset of ER, BR, and small-diameter lamps. The analyses to consider standards for ER, BR, and small-diameter lamps are severable from the analyses underlying the present rulemaking, so separate treatment would not impact the outcomes for any of the lamp types under consideration in this NOPR. Therefore, DOE has decided to proceed with setting energy conservation standards for the lamps that are the subject of the present rulemaking and to commence a separate rulemaking for ER, BR, and small-diameter lamps. DOE believes that much of the analytical work for the current rulemaking will benefit the ER, BR, and small diameter lamps rulemaking, thereby permitting issuance of a new NOPR and final rule on an accelerated basis, if it determined that it has the authority to do so.

For the purposes of the present NOPR, however, DOE notes that the balance of this notice (analyses and related discussions) assumes that the exempted ER, BR, and small-diameter lamps remain unregulated by energy conservation standards. DOE acknowledges that while such an assumption has no impact on the engineering and life-cycle cost analyses, the regulation of these exempted IRL may affect the future shipment of IRL and thereby the national impact and other downstream analyses. However, DOE believes that its analysis of multiple shipment scenarios (as discussed in section V.E.5) captures the broad range of possible impacts were these exempted lamps to be regulated in the future. Therefore DOE's assumption does not impact the standards proposed in this rulemaking or DOE's reconsideration of its authority, nor does it otherwise constrain DOE's ability to conduct further analyses in a separate rulemaking.

C. Amended Definitions

To clarify the scope of EPCA's coverage of GSFL, IRL, and the recently adopted standards for GSIL, DOE proposes to revise its existing definitions of ''rated wattage'' and ''colored fluorescent lamp.'' These definitional changes are discussed below.

1. ''Rated Wattage''

One element of EPCA's definitions for ''fluorescent lamp'' and ''incandescent reflector lamp'' is a lamp's rated wattage, which helps delineate the lamps for which the statute sets standards. (42 U.S.C. 6291(30)(A), (C)(ii) and (F), and 6295(i)). In addition, section 321(a)(3) of EISA 2007 amended EPCA to prescribe energy conservation standards for GSIL, requiring lamps of particular lumen outputs to have certain maximum rated wattages. (42 U.S.C. 6295(i)) However, EPCA does not define the term ''rated wattage.''

DOE has defined ''rated wattage'' in its regulations, but only for 4-foot medium bipin T8, T10, and T12 fluorescent lamps. 10 CFR 430.2. This definition references ANSI Standard C78.1–1991, ''for Fluorescent Lamps—Rapid-Start Types—Dimensional and Electrical Characteristics.'' *Id.* Although EPCA also uses the term ''rated wattage'' to delineate 2-foot U-shaped lamps (42 U.S.C. 6291(30)(A)(ii)), 8-foot slimline lamps, (42 U.S.C. 6291(30)(A)(iv)), and IRL (42 U.S.C. 6291(30)(C)), DOE has not defined ''rated wattage'' for these lamps. In the March 2008 ANOPR, DOE considered revising and updating the definition of ''rated wattage'' to cite the current version of ANSI Standard C78.1–1991, clarify and improve the definition, and apply the revised definition to those lamps for which rated wattage is a key characteristic but is not currently defined by DOE. In response to the March 2008 ANOPR, DOE received one comment regarding the definition of ''rated wattage.'' NEMA commented that it agrees with DOE's revised definition. (NEMA, No. 22 at p. 4).

Therefore, DOE proposes the following definition for ''rated wattage'':

Rated wattage means:

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

(i) If the lamp is listed in ANSI C78.81–2005 or ANSI C78.901–2005, the rated wattage of a lamp determined by the lamp designation of Clause 11.1 of ANSI C78.81–2005 or ANSI C78.901–2005;

(ii) If the lamp is a residential straight-shaped lamp, and not listed in ANSI C78.81–2005, 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 guides referenced in (1)(i) nor a residential straight-shaped lamp, the wattage of a lamp when measured according to the test procedures outlined in Appendix R to subpart B of this part.

(2) With respect to general service incandescent lamps and incandescent reflector lamps, the wattage measured according to the test procedures outlined in Appendix R to subpart B of this part.

2. ''Colored Fluorescent Lamp''

Colored fluorescent lamps are excluded from EPCA's definition of ''general service fluorescent lamp.'' (42 U.S.C. 6291 (30)(B)(iii)) However, EPCA does not define the term ''colored fluorescent lamp.'' In order to fully define the scope of EPCA's definition of GSFL, DOE currently defines ''colored fluorescent lamp'' as follows:

> ''Colored fluorescent lamp'' means a fluorescent lamp designated and marketed as a colored lamp, and with either of the following characteristics: a CRI less than 40, as determined according to the method given in CIE Publication 13.2 (10 CFR 430.3), or a correlated color temperature less than 2,500K or greater than 6,600K.

10 CFR 430.2. Because these lamps are not GSFL under EPCA, they are not covered by the standards applicable to GSFL.

The central element of EPCA's definition of ''general service fluorescent lamp'' is that they are fluorescent lamps ''which can be used to satisfy the majority of lighting applications.'' (42 U.S.C. 6291(30)(B)) The exclusions, such as the one for colored lamps, are for lamps designed and marketed for ''non-general lighting applications.'' *Id.* As detailed in the March 2008 ANOPR, DOE became aware of a lamp on the European market that meets the above definition of ''colored fluorescent lamp'' and that is intended for general illumination applications. 73 FR 13620, 13634 (March 13, 2008). Although DOE is unaware of any similar general purpose fluorescent lamps being introduced into the U.S. market, the availability of the European lamp demonstrates the potential for DOE's definition of ''colored fluorescent lamp'' to exclude new products with general service applications from the definition of ''general service fluorescent lamp,'' and thereby from the coverage of standards applicable to GSFL. For this reason, in the March 2008 ANOPR, DOE proposed to revise its definition of ''colored fluorescent lamp'' by adding the following phrase after the words ''colored lamp'': ''and not designed or marketed for general illumination applications.'' *Id.*

In submitted written comments on the ANOPR, NEMA agreed with the proposed revised definition of ''colored fluorescent lamp,'' while noting that DOE will need to give additional consideration to general illumination fluorescent lamps with higher color temperatures. NEMA cited an example of a lamp with a CCT of 8,000K that could be used for both general illumination and specialty applications (NEMA, No. 22 at p. 9). NEMA requested a meeting to discuss this matter in greater detail, since it was performing research related to this topic. (DOE, No. 27) This meeting is subsequently discussed in section II.C.2 of this NOPR.

At the June 2008 NEMA meeting and in its written comments, NEMA recommended that the range of GSFL affected by standards should be increased to 7,000K from the current coverage, which extends to only 6,600K. NEMA believes that lamps with a CCT between 4,500K and 7,000K are growing in popularity and, therefore, energy conservation standards within that range are justifiable (NEMA, No. 26 at pp. 3–4).

NEMA also stated that an efficacy standard would be inappropriate for GSFL with a CCT greater than 7,000K. Because very few GSFL with a CCT greater than 7,000K are commercially available, NEMA argued that it would be impossible to determine whether there would be an appropriate efficacy standard for these lamps that would be technologically feasible. (NEMA, No. 26 at pp. 5–6) NEMA also stated that it is unlikely that exempting these high CCT lamps would increase their sales after a standard, as these lamps are often too ''blue'' for typical consumers. Therefore, NEMA urged DOE to exempt all lamps with a CCT greater than 7,000K from energy conservation standards (NEMA, No. 26 at pp. 3–4).

DOE considered NEMA's input and agrees that because so few of these products with a CCT greater than 7,000K exist in the market, there is not enough information to reliably analyze the performance of currently-available products or the expected performance of emerging products. Manufacturing lamps with CCTs greater than 7,000K would likely require the use of new materials not currently utilized in commonly sold lamps today. In addition, manufacturers may encounter different design trade-offs when developing their products Therefore, DOE is unable to determine whether a particular standard level would be technologically feasible for these lamps.

DOE also agrees that it is appropriate to raise the 6,600K limit to 7,000K in the definition of ''colored fluorescent lamp.'' DOE believes that this amendment would further the statutory objective of maintaining the coverage of GSFL serving general application purposes under DOE's energy conservation standards. Although lamps with CCTs greater than 6,600K and less than 7,000K are not prevalent in the market, DOE's research[14] indicates that manufacturers would likely be able to produce a lamp at 7,000K using the same materials as a 6,500K lamp (a commonly sold lamp). In consideration of the technological similarity between 6,500K and 7,000K lamps, DOE believes that it would be possible to establish technologically feasible efficacy levels for 7,000K lamps.

Therefore, DOE proposes to modify the definition of ''colored fluorescent lamp'' so as to include lamps with CCT less than or equal to 7,000K exclude all lamps with a CCT greater than 7,000K from energy conservation standards. However, DOE notes that NEMA has offered to track the sales of GSFL with a CCT greater than 7,000K in order to determine in the future if energy conservation standards are necessary for these products. (NEMA, No. 26 at p. 4) If these lamp sales show significant growth, and thus the potential for significant energy savings, DOE may consider amending the definition of ''colored fluorescent lamp'' to provide for coverage of these lamps and setting an appropriate energy conservation standard for them in a future rulemaking.

[14] *Ex parte* communication with Edward Yandek of General Electric Company (Dec. 8, 2008) (DOE, No. 29).

As discussed in the March 2008 ANOPR, the discovery of a fluorescent lamp in the European market with a CCT of 17,000K being marketed for general illumination applications prompted DOE to consider actions to prevent such lamps from becoming a potential loophole to the GSFL energy conservation standard. However, the inherently ''blue'' color of these lamps may prevent widespread adoption as substitutes for standard CCT lamps (*e.g.,* 4,100K). Therefore, DOE no longer considers these lamps to be a potential loophole to standards set forth by this rulemaking. For this reason and because DOE is unable to determine a technologically feasible standard for these lamps, DOE believes that the addition of the phrase ''and not designed or marketed for general illumination applications'' with respect lamps with a CCT greater than 7,000K is no longer necessary.

After incorporating the changes discussed above, DOE proposes the following definition of ''colored fluorescent lamp'' for this notice:

Colored fluorescent lamp means either: (1) A fluorescent lamp designated and marketed as a colored lamp with a CRI less than 40, as determined according to the method set forth in CIE Publication 13.2 (10 CFR 430.3); (2) a fluorescent lamp designed and marketed as a colored lamp with a correlated color temperature (CCT) less than 2,500K; or (3) a fluorescent lamp with a CCT greater than 7,000K.

D. Off Mode and Standby Mode Energy Consumption Standards

Section 310(3) of EISA 2007 amended EPCA to require future energy conservation standards to address standby mode and off mode energy use. Specifically, EPCA, as amended, now requires that, when DOE adopts standards for a covered product after July 1, 2010, DOE must, if justified by the criteria for adoption of standards in 42 U.S.C. 6295(o), incorporate standby mode and off mode energy use into the standard, if feasible, or adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)) DOE notes that although the final rule in this standards rulemaking is scheduled for publication by June 2009 (*i.e.,* before the statutory deadline above), DOE nonetheless undertook a preliminary analysis of the potential for energy savings associated with the regulation of standby mode and off mode in covered lamps. DOE has tentatively determined that current technologies for the GSFL and IRL that are the subjects of this rulemaking do not use a standby mode or off mode, so a determination of the energy consumption of such features is inapplicable.

Given EISA 2007's definitions of ''active mode,'' ''off mode,'' and ''standby mode'' applicable to both GSFL and IRL, in order to meet the definition of ''off-mode'' or ''standby mode,'' the lamp must not be providing any active mode function (*i.e.,* emit light). However, to reach such a state, the lamp must be entirely disconnected from the main power source (*i.e.,* the lamp is switched off), thereby not satisfying the requirements of operating in off mode. In addition, DOE believes that all covered products that meet the definitions of ''general service fluorescent lamp'' and ''incandescent reflector lamp'' are single-function products and do not offer any secondary user-oriented or protective functions. Thus, GSFL and IRL do not satisfy the definition for ''standby mode.'' DOE received comments from NEMA in response to the March 2008 ANOPR supporting this characterization of off mode and standby mode energy consumption for these products. (NEMA, No. 22 at p. 1) Therefore, DOE maintains that it is not feasible to incorporate off mode or standby mode energy use into the energy conservation standards for GSFL and IRL and is not proposing amendments to the standard to address lamp operation in such modes. The March 2008 ANOPR provides additional details that support this conclusion. 73 FR 13620, 13627 (March 13, 2008).

E. Color Rendering Index Standards for General Service Fluorescent Lamps

Existing EPCA standards specify both lumens per watt and CRI levels that products must comply with before entering the market. (42 U.S.C. 6295(i)(1)) At the public meeting and in written comments, NEMA and the Joint Comment suggested that it may be necessary to amend the minimum CRI requirements to prevent the possible emergence of loopholes in the product classes structure and standards levels considered in the March 2008 ANOPR. (Public Meeting Transcript, No. 21 at pp. 82–84, 92, 94; Joint Comment, No. 23 at p. 6; NEMA, No. 22 at p. 4–5)

However, because CRI is not a measure of energy consumption or efficacy, but rather a measure of the color quality of the light, DOE has concluded that it does not have the authority to change the CRI standard, for the reasons that follow. According to 42 U.S.C. 6291(6), ''energy conservation standard'' means either: (1) A performance standard which prescribes a minimum level of energy efficiency or a maximum quantity of energy use; or (2) a design requirement (only for specifically enumerated products). Although CRI is a performance requirement, it is not an energy performance requirement within the meaning of the term ''energy conservation standard.'' Because, in the case of GSFL, DOE has the authority to regulate only energy conservation standards (*i.e.,* energy performance requirements), DOE is not proposing to amend the existing minimum CRI requirements.

IV. General Discussion

A. Test Procedures

DOE's test procedures for fluorescent and incandescent lamps are set forth at 10 CFR part 430, subpart B, appendix R.[15] These test procedures provide detailed instructions for measuring GSFL and IRL performance, as well as performance attributes of GSIL, largely by incorporating several industry standards. Prompted by an earlier NEMA comment (NEMA, No. 12, pp. 2–4) at the Framework stage of the energy conservation standards rulemaking, DOE examined these test procedures and decided to initiate a rulemaking, in parallel with this standards rulemaking, to revise its test procedures for GSFL, IRL, and GSIL (even though, as explained above, GSIL are no longer part of this standards rulemaking). These revisions consist largely of: (1) Referencing the most current versions of several lighting industry standards incorporated by reference; (2) adopting certain technical changes and clarifications; (3) expanding the test procedures to accommodate new classes of lamps subject to extended coverage by either EISA 2007 or this energy conservation standards rulemaking; and (4) addressing standby mode and off mode energy consumption (which were found not to apply to GSFL and IRL), as mandated by EISA 2007.

To this end, DOE published a NOPR that proposed to update the current test procedure's references to industry standards for fluorescent and incandescent lamps. 73 FR 13465 (March 13, 2008) (the test procedure NOPR). The test procedure NOPR also proposed the following: (1) A small number of definitional and procedural modifications to the test procedure to accommodate technological migrations in the GSFL market and approaches DOE is considering in this standards rulemaking (73 FR 13465, 13472–73 (March 13, 2008)); (2) revision of the reporting requirements for GSFL, such that all covered lamp efficacies would be reported with an accuracy to the tenths decimal place (73 FR 13465, 13473 (March 13, 2008)); and (3) adoption of a testing and calculation method for measuring the CCT of fluorescent and incandescent lamps (73 FR 13465, 13473–74 (March 13, 2008)). Please see the March 2008 ANOPR (73 FR 13620, 13627–28 (March 13, 2008)) and the March 2008 test procedure NOPR (73 FR 13465, 13472–74 (March 13, 2008)) for a detailed discussion of these proposals and related matters.

The public meeting for the March 2008 ANOPR also served as a public meeting to present and receive comments on the test procedure NOPR. DOE later received written remarks from NEMA responding to the proposals contained in the test procedure NOPR. (NEMA, No. 16)[16] DOE is considering these comments, and will be publishing a final rule in the near future.

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis, which it bases on information it has gathered on all current technology options and prototype designs that could improve the efficiency of the product or equipment that is the subject of the rulemaking. DOE considers a design option to be ''technologically feasible''[17] if it is in the marketplace or if research has progressed to the development of a working prototype.

In consultation with manufacturers, design engineers, and other interested parties, DOE develops a list of design options for consideration in the rulemaking. In the context of the present rulemaking, when determining

[15] ''Uniform Test Method for Measuring Average Lamp Efficiency (LE) and Color Rendering Index (CRI) of Electric Lamps.''

[16] This written comment was submitted to the docket of the test procedure rulemaking (Docket No. EERE–2007–BT–TP–0013; RIN number 1904–AB72).

[17] DOE's regulations set forth the following definition of ''technological feasibility'': ''Technologies incorporated in commercially available products or in working prototypes will be considered technologically feasible.'' 10 CFR 430, subpart C, appendix A, section 4(a)(4)(i).

proposed efficacy levels for GSFL, DOE only considered commercially-available products that can meet or exceed each level. For IRL, trial standard levels 2, 3, 4, and 5 are based on commercially-available products. Although TSL1 is not based on product currently sold in the marketplace, DOE has used a design option (*i.e.*, higher-efficiency gas fills) to model the performance of a higher-efficacy lamp that meets TSL1. DOE received input from manufacturers during interviews to verify that such a design option is technologically feasible. Therefore, DOE has concluded that the all design options to achieve the proposed efficacy levels are technologically feasible.

Once DOE has determined that particular design options are technologically feasible, it evaluates each design option in light of the following criteria: (1) Practicability to manufacture, install, or service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. Chapter 4 of the TSD accompanying this notice contains a description of the screening analysis for this rulemaking. Also, see section 0 of this notice for a discussion of the design options DOE considered.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt or to decline to adopt an amended or new standard for a type (or class) of covered product, as part of the rulemaking process, DOE must ''determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible'' for the product. (42 U.S.C. 6295(p)(1)) In response to the ANOPR, stakeholders commented that 42 U.S.C. 6295(o) requires that DOE evaluate the maximum technologically feasible, or ''max-tech,'' potential standard efficiency levels. They assert that because DOE has gathered only technical information based on products available on the market today, it may not have considered those products that are technically feasible but not yet marketed. If such options are available, stakeholders believe DOE should model them as the max-tech efficiency levels. (Joint Comment, No. 23 at p. 19)

DOE researched whether any technologies could improve the efficacy of GSFL lamps currently marketed. DOE found that higher efficacy GSFL could be achieved but require the use of a higher efficiency fill gas composition. More efficient fill gases often include higher molecular weight gases (*e.g.*, krypton) to increase ultraviolet light output, and, thus, visible light output. However, the use of these heavier gases can cause lamp instability, resulting in striations or flickering. Evidence of this effect can be seen with reduced-wattage lamps, which generally incorporate a mixture of krypton and argon gases, versus full-wattage lamps which primarily use only argon. Reduced-wattage lamps are often marketed with several application-limiting performance notes. For example, NEMA stated reduced-wattage lamps can have performance issues in low-temperature applications or when operated on rapid start or dimming ballasts. (NEMA, No. 21 at p. 10) Therefore, DOE did not consider efficacy levels for GSFL that would require the use of higher-efficiency fill gases that would result in reduced utility. DOE was unable to find any higher-efficacy prototypes or commercially-available lamps that provide the same utility and performance required of GSFL. Therefore, DOE has concluded that TSL5 was the maximum technologically feasible level for GSFL.

For IRL, DOE determined that the maximum technologically feasible efficacy level incorporates the highest technologically feasible efficiency reflector, halogen infrared coating, and filament design. From its research, DOE believes that the highest efficiency reflector employs silver, a technology that DOE understands to be proprietary. From discussions with developers of IR coating technology, DOE understands that by modifying the coating pattern and materials used, varying degrees of IR coating efficiencies can be achieved. Finally, altering filament design to obtain the highest temperature filament operation, while maintaining a lifetime similar to the baseline lamp (3,000 hours), would result in the most efficacious filament. Combining all three of these highest efficiency technologies simultaneously results in the maximum technologically feasible level; however, this level is dependent on the use of a proprietary technology (the silver reflector). Because DOE is unaware of any alternate technology pathways to achieve this efficacy level, DOE did not consider it in its analysis. Instead, DOE based the highest efficacy level analyzed for IRL on a commercially-available IRL which employs a silver reflector, an improved (but not most efficient) IR coating, and a filament design that results in a lifetime of 4,200 hours. Although, this commercially-available lamp uses silver technology, DOE believes that there are alternate pathways to achieve this level. A combination of redesigning the filament to achieve higher temperature operation (and thus reducing lifetime to 3,000 hours), employing other non-proprietary high-efficiency reflectors, or applying higher-efficiency IR coatings has the potential to result in an IRL that meets an equivalent efficacy level. For more information regarding these technologies, see chapter 3 of the TSD. Therefore, DOE has concluded that TSL5 is the maximum technologically feasible level for IRL that is not dependent on the use of a proprietary technology.

Table IV.1 and Table IV.2 list the max-tech levels (TSL5 for GSFL and TSL5 for IRL) that DOE determined for this rulemaking.[18]

TABLE IV.1—MAX-TECH LEVELS FOR GSFL

Lamp type	CCT	Max-tech efficiency lm/W
4-Foot Medium Bipin	≤ 4,500K	94
8-Foot Single Pin Slimline	≤ 4,500K	100
8-Foot RDC HO	≤ 4,500K	95
4-Foot T5 SO	≤ 4,500K	108
4-Foot T5 HO	≤ 4,500K	92

[18] As discussed in section V.C, due to scheduling and resource constraints, DOE did not analyze all GSFL and IRL product classes. Instead, DOE chose representative product classes to directly analyze and scaled analytical results to the remaining product classes. Table IV.1 and Table IV.2 present max-tech levels for only analyzed product classes. Classes not analyzed include the 2-foot U-shaped and high-CCT product classes (for GSFL) and the modified spectrum, ≥ 125 volts, and ≤ 2.5 inches diameter product classes (for IRL).

TABLE IV.2—MAX-TECH LEVEL FOR IRL

Lamp type	Diameter	Voltage	Max-tech efficiency lm/W
Standard Spectrum	> 2.5 inches	< 125	$6.9P^{0.27}$ *

* Where P is the rated wattage.

C. Energy Savings

1. Determination of Savings

DOE used its NIA spreadsheets to estimate energy savings from amended standards for the lamps currently covered by standards and from new standards for the remaining additional lamps that are the subject of this rulemaking. (The NIA spreadsheet models are described in section V.E of this notice and in chapter 11 of the TSD.) DOE forecasted energy savings over the period of analysis (beginning in 2012, the year that amended standards would go into effect, and ending in 2042) for each TSL. It quantified the energy savings attributable to amended and new energy conservation standards (*i.e.,* to each TSL) as the difference in energy consumption between the standards case and the base case. The base case represents the forecast of energy consumption in the absence of amended and new mandatory energy conservation standards. The base case considers market demand for more-efficient products. For example, for both GSFL and IRL, DOE models a shift in the base case from covered GSFL and IRL toward emerging technologies such as light emitting diodes (LED). In addition, consistent with current GSFL market trends, DOE models a shift from T12 lamps to higher-efficacy T8 and T5 lamps. For IRL in the commercial sector, the base-case shipments forecast also considers a migration from halogen IRL to higher-efficacy halogen infrared (HIR) lamps. See section 0 of this notice and chapter 10 of the TSD for details.

The NIA spreadsheet models calculate the energy savings in site energy expressed in kilowatt-hours (kWh). Site energy is the energy directly consumed at building sites by GSFL or IRL. DOE reports national energy savings in terms of the source energy savings, which is the savings in the energy that is used to generate and transmit the energy consumed at the site. To convert site energy to source energy, DOE uses annual site-to-source conversion factors based on the version of the National Energy Modeling System (NEMS) that corresponds to Annual Energy Outlook 2008 (*AEO2008).* The conversion factors vary over time because of projected changes in the nation's portfolio of generation sources. DOE estimated that conversion factors remain constant at 2030 values throughout the remainder of the forecast. See chapter 11 of the TSD for details.

2. Significance of Savings

Section 325 of EPCA prohibits DOE from adopting a standard for a covered product if that standard would not result in "significant" energy savings. (42 U.S.C. 6295(o)(3)(B)) While the term "significant" is not defined in EPCA, the U.S. Court of Appeals, in *Natural Resources Defense Council* v. *Herrington*, 768 F.2d 1355, 1373 (DC Cir. 1985), indicated that Congress intended "significant" energy savings in this context to be savings that were not "genuinely trivial." The energy savings for all of the TSLs considered in this rulemaking are nontrivial, and therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

D. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

To determine the quantitative impacts of a new or amended standard on manufacturers, the economic impact analysis is based on an annual-cash-flow approach. This includes both a short-term assessment—based on the cost and capital requirements during the period between the announcement of a regulation and the regulation's effective start date—and a long-term assessment. The impacts analyzed include INPV (which values the industry on the basis of expected future cash flows), cash flows by year, changes in revenue and income, and other appropriate measures of impact. Second, DOE analyzes and reports the impacts on different types of manufacturers, with particular attention to impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment, manufacturing capacity, plant closures, and loss of capital investment. Finally, DOE takes into account cumulative impacts of different DOE and other regulations on manufacturers.

For consumers, measures of economic impact include the changes in price, LCC, and payback period for each trial standard level. The LCC is one of the seven factors to be considered in determining the economic justification for a new or amended standard. (42 U.S.C. 6295(o)(2)(B)(i)(II))

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy and maintenance expenditures) discounted over the lifetime of the product. For each GSFL and IRL product class, DOE calculated both LCC and LCC savings for various efficacy levels. The LCC analysis required a variety of inputs, such as product prices, installation labor costs, electricity prices, annual operating hours, product energy consumption rates, and discount rates.

To characterize variability in electricity pricing, DOE established regional differences in electricity prices. To account for uncertainty and variability in other inputs, such as annual operating hours and discount rates, DOE used a distribution of values with probabilities assigned to each value. Then for each consumer, DOE sampled the values of these inputs from the probability distributions. The analysis produced a range of LCCs. A distinct advantage of this approach is that DOE can identify the percentage of consumers achieving LCC savings due to an increased energy conservation standard, in addition to the average LCC savings. DOE presents only average LCC savings in this NOPR; however, additional details showing the distribution of results can be found in chapter 8 and appendix 8B of the TSD.

In the LCC analysis, DOE also considered several events that would prompt a consumer to purchase a lamp. For GSFL, DOE calculated LCCs for five lamp purchasing events: (1) Lamp failure; (2) standards-induced retrofit;

(3) ballast failure; (4) ballast retrofit; and (5) new construction/renovation. For IRL, DOE calculated LCCs for the lamp failure and new construction/renovation events, as these were the only lamp purchase events deemed applicable to this product type. Because each event may present the consumer with different lamp (or lamp-and-ballast) options and economics, DOE presents the LCC results for several events for each product class in this NOPR. DOE assumed that the consumer purchases the product in 2012 (the effective start date of the standard). For further detail regarding lamp purchasing events and related LCC calculations, see section V.D and chapter 8 of the TSD.

c. Energy Savings

While significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) DOE used the NES spreadsheet results in its consideration of total projected savings.

d. Lessening of Utility or Performance of Products

In establishing classes of products, and in evaluating design options and the impact of potential standard levels, DOE aimed to develop standards for GSFL and IRL that would not lessen the utility or performance of these products. None of the considered trial standard levels would reduce the utility or performance of the GSFL and IRL under consideration in the rulemaking. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

Since all standard levels for GSFL use full-wattage lamps, rather than requiring a shift to higher-efficacy reduced-wattage lamps (which may have application restrictions), no GSFL efficacy levels reduce the utility or performance of the covered products. For IRL, for all standard levels, there are commercially available IRL with the same utility and performance as the baseline lamps. Therefore, DOE believes that none of the considered trial standard levels would reduce the utility or performance of the IRL under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition likely to result from standards. It directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary no later than 60 days after the publication of a proposed rule, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) DOE has transmitted a copy of today's proposed rule to the Attorney General and has requested that the Department of Justice (DOJ) provide its determination on this issue. DOE will address the Attorney General's determination in the final rule.

f. Need of the Nation To Conserve Energy

The non-monetary benefits of the proposed standard are likely to be reflected in improvements to the security and reliability of the Nation's energy system—namely, reductions in the overall demand for energy will result in reduced costs for maintaining the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity. This analysis captures the effects of efficiency improvements on electricity consumption by the covered products that are the subject of this rulemaking.

The proposed standard also is likely to result in improvements to the environment. In quantifying these improvements, DOE has defined a range of primary energy conversion factors and associated emission reductions based on the estimated level of power generation displaced by energy conservation standards. DOE reports the environmental effects from each TSL for this equipment in the environmental assessment in the TSD. (42. U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a))

g. Other Factors

EPCA allows the Secretary of Energy, in determining whether a standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) Under this provision, DOE considered subgroups of consumers that may be adversely affected by the standards proposed in this rule. Specifically, DOE assessed the impact of standards on low-income consumers, institutions of religious worship, historical facilities, and institutions that serve low-income populations. In considering these subgroups, DOE analyzed variations on electricity prices, operating hours, discount rates, and baseline lamps. See section 0 of this notice for further detail.

2. Rebuttable Presumption

As set forth in section 325(o)(2)(B)(iii) of EPCA, there is a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard level is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. (42 U.S.C. 6295(o)(2)(B)(iii) and 42 U.S.C. 6316(e)(1)) 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 discussed above. 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) and 42 U.S.C. 6316(e)(1)). The results of this analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). Section 0 of this notice addresses the rebuttable-presumption payback calculation.

V. Methodology and Discussion of Comments

A. Product Classes

In general, in evaluating and establishing energy conservation standards, DOE divides covered products into classes by the type of energy used, capacity, or other performance-related features that affect efficiency, and factors such as the utility of the product to users. (42 U.S.C. 6295(q)) DOE normally establishes different energy conservation standards for different product classes based on these criteria.

1. General Service Fluorescent Lamps

In the March 2008 ANOPR, DOE proposed to establish product classes for GSFL based on the following three attributes that have differential utility and affect efficacy: (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. 73 FR 13620, 13636 (March 13, 2008). The following sections summarize and address comments DOE received in response to the GSFL product classes it considered for the March 2008 ANOPR.

DOE received comments related to product classes on three major topics: T12 and T8 lamps, T5 lamps, and correlated color temperature.

a. T12 and T8 Lamps

The physical constraints of the lamp relate to the shape of the lamp (*e.g.*, U-shaped versus linear) and the fact that these lamps could not be substitutes for each other, unless the entire fixture is changed. The lamp shapes provide unique utility because the shapes of these lamps prevent them from being used as replacements, even with a ballast replacement, in a given fixture. However, the shape and geometry of a lamp also impact its efficacy. In the March 2008 ANOPR, DOE acknowledged that a lamp's diameter can affect its efficacy. However, because the utility provided to the end-user is a function of the light output in lumens (which is comparable between T12 and T8 lamps) and not diameter of the bulb, DOE decided not to establish separate product classes for T12 and T8 lamps.

At the public meeting and in its written comments, NEMA stated that separate product classes might be necessary for T8 and T12 lamps. Both NEMA and General Electric (GE) noted that DOE used the 10-percent efficacy differential between 8-foot slimline and 8-foot high output lamps as one reason for establishing their separate product classes. They reasoned that because T8 lamps are at least 10 percent more efficient that T12 lamps, DOE should also split T8 and T12 lamps into separate classes. (Public Meeting Transcript, No. 21 at pp. 82–86; NEMA, No. 22 at p. 5) GE emphasized that because T8 and T12 lamps require different ballasts and because a growing number of new T8 fixtures will not fit T12 lamps, the two are not always suitable replacements and should therefore have separate product classes. GE also expressed concern that it would be impossible to set a single efficacy standard using a lumen-per-watt metric that would be suitable for both T8 and T12 lamps. (Public Meeting Transcript, No. 21 at pp. 88–89)

Conversely, the Joint Comment strongly supported combining T8 and T12 lamps under one product class because the lamps are the same length, use the same lamp holders, and provide the same utility (as measured by lumen package). At the public meeting, ACEEE emphasized that the two lamps compete directly in the marketplace because of their similar performance features. ACEEE also expressed concern that setting product classes based on efficacy could lead to separate standards for any inefficient product. (ACEEE, No. 22 at p. 91) The Joint Comment also stated that the fact that the two lamps use different ballasts is an economic issue, not a utility issue. The Joint Comment noted that large energy savings would be lost if DOE used separate classes because consumers would not migrate to the more efficient T8 lamps—a factor DOE must consider, given its obligation to set standards at the ''maximum improvement in energy efficiency'' that is ''technologically feasible and economically justified.'' (Joint Comment, No. 23 at pp. 4–5)

DOE research shows that T8 lamps are commonly used to replace T12 lamps; this implies that, in this case, lamp diameter does not significantly affect lamp utility. It also illustrates that the lamps share performance features and compete directly in the market. While DOE recognizes that lamp diameter can affect efficacy, lamp efficacy alone is not a criterion DOE uses to establish product classes; to warrant a separate product class, a unique utility feature must be present. As DOE has not identified a unique utility feature of T12 lamps, DOE has decided to combine both T8 and T12 lamps into one product class for each lamp type. However, in response to GE's comment, DOE recognizes that T8 and T12 lamps usually operate on different ballasts. Thus, DOE has structured its analytical tools to consider the impact of standards on consumers of both lamp types. That is, DOE takes the economics of purchasing another ballast into account in its LCC and NIA analyses.

b. T5 Lamps

The Joint Comment stated that T5 lamps (in this rulemaking, referred to as 4-foot miniature bipin lamps) should probably be in the same product class as T8 and T12 lamps because they compete against them in the market. The advocates noted the existence of retrofitting kits for installing T5 lamps into T8 and T12 fixtures, but acknowledged T5 lamps require different lamp holders and are ''too bright to use in direct lighting fixtures.'' The Joint Comment asked DOE to research the pros and cons of including T5 lamps with T8 and T12 lamps. (Joint Comment, No. 23 at p. 5)

Based on its research and consideration of the above comments, DOE has decided to establish a separate product class for 4-foot miniature bipin lamps because their physical constraints prevent them from being used as direct replacements for T8 and T12 lamps in many applications. For example, applications in which consumers cannot change the lamp fixture (from a 4-foot MBP to a 4-foot MiniBP) may not be appropriate for retrofitting to the 4-foot MiniBP system type. As the Joint Comment noted, these lamps require different lamp holders (due to differences in length and base type), and thereby qualify for a separate product class under the previously established ''physical constraints of lamps'' class-setting criteria.

In addition, a lamp's lumen package may result in certain application constraints. Because 4-foot T5 MiniBP lamps have similar total lumen output as 4-foot T8 and T12 MBP lamps over a significantly smaller surface area, T5 lamps are often marketed as too bright for use in direct lighting fixtures. If 4-foot T5 MiniBP lamps were regulated in the same product class as 4-foot MBP lamps, the standard could effectively mandate the use of T5 lamps. To prevent eliminating lamps appropriate for direct lighting applications, DOE believes that 4-foot miniature bipin lamps (T5 lamps) warrant a separate product class from 4-foot medium bipin lamps (primarily T8 and T12 lamps).

In researching these lamp types, DOE found that the high output lamp is rated to emit more than one and a half times the number of lumens as the standard output lamp, also potentially affecting utility. In general, lamps that have high lumen output may be installed in certain high-ceiling or outdoor installations, where large quantities of light are needed. Lamps that have standard levels of light output might be installed in lower-ceiling installations such as offices or hospitals, where distance between the light source and the illuminated surfaces is not as large. DOE also found that this significant lumen output differential in standard output and high output T5 lamps is accompanied by an efficacy difference. Considering the differences in utility (light output and their applicability in direct lighting fixtures) and efficacy, and consistent with DOE's approach in the March 2008 ANOPR, DOE is proposing separate product classes for standard output 4-foot miniature bipin lamps and high output 4-foot miniature bipin lamps.

c. Correlated Color Temperature

Correlated color temperature is a measure of the perceived color of the white light emitted from a lamp, which DOE believes affects lamp utility. Generally, as CCT increases, efficacy of the bulb decreases. The measured efficacy of lamps with different CCT is different because efficacy is measured in lumens per watt, and light emitted across the visible spectrum is not given equal weighting under this metric. Lumens are determined using the human eye's sensitivity function, and due to the fact that the human eye is less responsive to blue light, those fluorescent lamps that shift their spectral emission profiles to contain more blue light will have lower efficacies. In the March 2008 ANOPR, DOE established two product classes for GSFL based on CCT: one for high-color-temperature lamps greater than 4,500K, and another for lamps less than 4,500K.

At the public meeting and in its written comments, NEMA agreed with DOE's decision to establish two product classes based on CCT. However, at the public meeting NEMA noted additional divisions may be necessary at higher CCT levels because these lamps—NEMA specifically noted an 8,000K lamp—are capturing an increasing market share of general service applications. (Public Meeting Transcript, No. 21 at pp. 95–97) Industrial Ecology stated that lamps around 6,500K, which were once reserved for specialty applications, are increasingly being used in general service applications. Industrial Ecology argued that such a trend supports the idea of another product class above the 4,500K division. (Public Meeting Transcript, No. 21 at pp. 97–98).

At the June 2008 NEMA meeting and in a written comment, NEMA commented that growth in higher CCT lamps would likely come at the 5,000K level, although they would remain a relatively small portion of the general service market for the foreseeable future. Lamps with CCTs greater than 7,000K represent a very small portion of the general service market because most consumers consider their light to be too blue. Given the small market for lamps above 7,000K, NEMA stated it had very little practical production data related to efficacies and costs. Therefore, NEMA argued, lamps above 7,000K should be exempt from standards, especially considering that the current energy savings potential from their coverage is very small and unlikely to grow anytime soon. (NEMA, No. 26 at pp. 3–4)

NEMA also commented that an equation using a continuous function (without discontinuities) is inappropriate when developing an efficacy standard for GSFL based on CCT. According to NEMA, practical lamp designs used to develop higher CCT lamps—such as phosphor design, weight and coating formulation, and coating adherence—do not provide for a general physical equation that yields an optimum lumens-per-watt standard. Instead, NEMA stated that successive step function factors need to be applied as CCT continues to increase. (NEMA, No. 26 at p. 5) The Joint Comment said that DOE should design CCT product class divisions carefully to prevent "gaming." The advocates preferred a continuous function to multiple product class divisions because the latter would encourage products to migrate to the lowest CCT value in each product class. If a continuous function were not possible, the Joint Comment strongly recommended raising the 4,500K division to 4,900K. Additionally, the Joint Comment stated, if DOE does set a product class aimed at regulating the 8,000K lamps, the boundary should be approximately 7,900K. (Joint Comment, No. 23 at pp. 5–6)

As noted above, DOE believes CCT affects consumer utility. For example, a lighting designer would likely consider the bluish color of higher color temperature lamps when specifying a luminaire for a particular application. In addition, as NEMA stated, higher CCT lamps are sometimes used for spectrally-enhanced lighting (SEL).[19] Advocates of spectrally-enhanced lighting believe that lamps with a higher CCT can help save energy and may also have health benefits. (NEMA, No. 26 at pp. 2–3) However, DOE notes that although spectrally-enhanced lighting has benefits, higher CCT lamps do emit a different color light that may not be appropriate for all applications. Given the effect on utility and the fact that lamp efficacy usually decreases with higher color temperatures, it is appropriate to establish different product classes based on CCT.

DOE agrees that a continuous function is not possible because increasing the CCT does not lead to proportional reductions in lumens per watt. This occurs because design factors that do not have a linear relationship with lumens per watt, such as rare earth phosphor mix and reformulation, must be employed to maintain efficacy, particularly as CCT increases.

DOE disagrees that a 4,900K division should be used rather than the proposed 4,500K division. If DOE were to use a 4,900K division and manufacturers introduced a 4,850K lamp to the market, it would be subject to standards based on the performance of a 4,100k lamp, which might be difficult to meet, as 4,100K lamps are generally more efficacious than their higher CCT counterparts. Likewise, if DOE used a 4,200K division and manufacturers developed a 4,300K lamp for commercial use, it would be subject to potentially lower standards based on the performance of a 5,000k lamp. This may result in a significant loss in potential energy savings. Instead, DOE proposes to use a 4,500K division, which effectively represents the midpoint between the most common commercially available "warmer" and "cooler" lamps at 4,100K and 5,000K, respectively. By establishing the product class division at the midpoint, DOE ensures that it is establishing a structure that will not subject lamps to inappropriately high standards and also not result in the loss of potential energy savings.

DOE also disagrees with the Joint Comment's argument for a third product class division around 7,900K aimed at 8,000K lamps. As discussed in section III.C.2, DOE is amending its definition of "colored fluorescent lamp," such that these lamps above 7,000K would be excluded from coverage by energy conservation standards. In consideration of this exclusion, DOE feels that is unnecessary to establish a third product class for lamps with a CCT greater than 7,900K.

2. Incandescent Reflector Lamps

In the March 2008 ANOPR, DOE considered product classes for IRL based on the standard-spectrum and modified-spectrum of the lamp. DOE received numerous comments regarding establishing separate product classes for: (1) Modified-spectrum lamps; (2) long-life lamps; (3) lamp diameter; and (4) voltage. The following sections summarize and address these comments.

a. Modified-Spectrum Lamps

Modified-spectrum lamps provide a unique performance-related feature 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. These lamps offer the same benefits as fluorescent lamps with "cooler" CCTs, in that they may ensure better color discrimination and often appear more similar to natural daylight, possibly resulting in psychological benefits.[20] In addition to providing a unique performance feature, DOE also understands that the technologies that modify the spectral emission from these lamps also decrease their efficacy because a portion of the light emission

[19] DOE has conducted several studies on SEL examining whether a significant amount of energy can be saved by using lamps that have less light output, but higher CCT. Lamps with higher CCT appear brighter than those with lower CCT, so the actual light output of higher-CCT lamps can be decreased, while maintaining equivalent perceived brightness and visual acuity. More information on spectrally enhanced lighting is available at: *http://www1.eere.energy.gov/buildings/spectrally_enhanced.html*.

[20] "Full Spectrum Q&A," National Lighting Product Information Program, Vol. 7 Issue 5 (March 2005). Available at: *http://www.lrc.rpi.edu/programs/nlpip/lightingAnswers/fullSpectrum*.

is absorbed by the coating. NEMA and GE supported establishing separate product classes for modified-spectrum lamps. (Public Meeting Transcript, No. 21 at p. 105; NEMA, No. 22 at p. 6).

However, the Joint Comment stated that separate product classes are unnecessary because modified-spectrum products which meet all efficacy levels DOE considered in the ANOPR already exist in the market place. The Joint Comment further argued that additive methods, used for some non-IRL technologies, boost particular visible wavelengths of light to achieve a modified spectrum. These methods represent a more efficient way to achieve a modified spectrum than subtractive methods commonly used for IRL, which filter particular visible wavelengths of light. Therefore, according to the Joint Comment, establishing a separate product class could reduce energy savings because modified-spectrum technology would be subject to a needlessly lower standard. The Joint Comment contended that such a situation would run counter to the rulemaking's goals. (Joint Comment, No. 23 at pp. 14–15) At the public meeting, ACEEE and PG&E questioned whether consumers receive additional utility from modified-spectrum lamps, and, if they do, whether it is sufficient to warrant a separate product class. ACEEE and PG&E suggested DOE analyze the energy savings that could be lost with a separate product class. PG&E further noted that consumers could obtain any additional utility that modified-spectrum lamps provide from other available light sources. (Public Meeting Transcript, No. 21 at pp. 101–103) PG&E commented that modified-spectrum lamps occupy significant retail shelf space, which suggests they have a significant market share, and therefore, present a significant energy savings opportunity. (Public Meeting Transcript, No. 21 at p. 104)

DOE maintains that modified-spectrum lamps provide a unique performance-related feature (a different spectrum of light from the typical incandescent lamp) that standard spectrum lamps do not provide. However, the coatings used for modified-spectrum IRL absorb light output, thus reducing the lamps' efficacies. Given the reduction in efficacy, DOE believes that some modified-spectrum lamps may not be able to meet standards if subjected to the same levels as standard-spectrum lamps. That, in turn, could cause the unavailability of such products, thereby eliminating this performance-related feature from the IRL market. DOE notes that the statute directs DOE to maintain performance-related features for a covered product type. (42 U.S.C. 6295(o)(4))

Regarding the Joint Comment's argument that higher-efficiency, additive technologies may be substituted for subtractive technologies currently used in modified-spectrum IRL lamps, DOE is unaware of any commercially-available IRL or working IRL prototype that employs these additive technologies. Although modified-spectrum LED products may be available, because DOE has determined that modified-spectrum lamps provide a unique performance-related feature, it is unable to subject them to standards that would result in the elimination of such IRL products from the market. Thus, DOE believes it is appropriate to establish a separate product class for modified-spectrum lamps based on their unique performance feature and the impact of this performance feature on product efficacy.

b. Long-Life Lamps

DOE received several comments regarding IRL with long lifetimes. At the public meeting, NEMA commented that lamp life is a top consideration for the lighting industry's customers, particularly large retailers. NEMA stated in its written comments that the current long-life lamps on the market might be jeopardized by the proposed standard levels, which could cause manufacturers to reduce lamp life to increase efficacy—a scenario not necessarily in the market's interest. (Public Meeting Transcript, No. 21 at pp. 177–178; NEMA, No. 22 at p. 17) Although NEMA did not explicitly request a separate product class, the Joint Comment argued that DOE should not establish a separate product class for long-life lamps, noting that other existing lamp types, including halogen infrared reflector lamps and CFLs, could adequately serve long-life applications. In support of their position, the advocates stated further that Congress did not establish a separate class for ''long life'' general service incandescent lamps. (Joint Comment, No. 23 at p. 15)

DOE considers lifetime an economic issue rather than a utility issue, and accounts for lifetime in its LCC and NPV calculations. Lifetime is not considered a utility issue because it does not change the light output of the lamp. As such, DOE did not establish a separate product class based on lamp lifetime. For more details, see the engineering analysis in section V.C.4.b and chapter 5 of the TSD.

c. Lamp Diameter

In its written comments, NEMA noted that smaller diameter lamps—specifically, PAR20 lamps—are inherently less efficient than larger diameter IRL. Manufacturing PAR20 lamps to be compliant with the same efficacy standards as larger lamps would be very difficult. NEMA also commented that the technology options available to larger lamps are not necessarily applicable to PAR20 lamps. For example, the most efficient double-ended infrared halogen burner is difficult to use in PAR20 lamps because of mounting considerations. (NEMA, No. 22 at p. 17)

In response, DOE believes that the IRL diameter provides a distinct utility to the consumer (such as the ability of reduced diameter lamps to be installed in smaller fixtures) and recognizes that efficacy declines with a smaller lamp diameter. A smaller diameter lamp has an inherently lower optical efficiency than a larger diameter lamp given a similar filament size. Therefore, DOE is proposing to establish separate product classes for lamps with a diameter of 2.5 inches or less and lamps with a diameter greater than 2.5 inches.

d. Voltage

In its written comments, NEMA mentioned that DOE's proposed product classes and standards do not address how the market actually uses 130 volt (V) lamps, which represent a sizable portion of standard halogen product sales. NEMA stated that customers almost always operate these 130V lamps at 120V (normal line voltage), which doubles their lifetime but reduces their efficacy below standard levels. (NEMA, No. 22 at p. 16)

DOE agrees with NEMA and is concerned that the operation of 130V lamps at 120V has the potential to significantly affect energy savings. When operated under 120V conditions, lamps rated at 130V in compliance with existing IRL efficacy standards are generally less efficacious than lamps using equivalent technology rated at 120V. Because of this inherent difference in efficacy, it may be less costly to manufacture a lamp rated at 130V and tested at 130V that complies with a standard than a similar 120V lamp complying with the same standard. For example, if DOE were to adopt a minimum efficacy requirement that would effectively require HIR technology for 120V lamps, due to differences in the test procedures for lamps rated at 130V, a 130V lamp may only need to employ an improved halogen technology, which would be less costly. If DOE does not establish a separate standard for lamps rated at 130V, more consumers may purchase 130V lamps because they are less expensive. When consumers operate these lamps at 120V, in order to obtain sufficient light output, they may use more energy than standards-compliant 120V lamps. This practice would increase energy consumption and result in lamps operating with a lower efficacy than any cost-justified standard level. Therefore, to preserve the energy savings intended by these standards, DOE is proposing to establish two separate product classes: (1) Lamps with a rated voltage less than 125V, and (2) lamps with a rated voltage greater than or equal to 125V.

DOE recognizes that there are other possible approaches for addressing this issue of the operational efficacy of 130V lamps. One alternative approach would be that DOE could require all IRL to be tested at 120V, the most common application voltage in the market. DOE requests comment on this issue.

B. Screening Analysis

DOE uses the following four screening criteria to determine which design options are unsuitable for further consideration in the rulemaking:

(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 comes into effect, then DOE will consider that technology practicable to manufacture, install, and service.

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

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

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

Considering these criteria, DOE compiled a list of design options in the March 2008 ANOPR that could be used to increase the efficacy of GSFL and IRL lamps (Table V.1). 73 FR 13620, 13644 (March 13, 2008).

TABLE V.1—GSFL AND IRL DESIGN OPTIONS

GSFL design options	IRL design options
Highly emissive electrode coatings	Higher temperature operation.
Higher efficiency lamp fill gas composition	Thinner filaments.
Higher efficiency phosphors	Efficient filament coiling.
Glass coatings	Efficient filament orientation.
Higher efficiency lamp diameter	Higher efficiency inert fill gas.
	Tungsten-halogen lamps.
	Higher pressure tungsten-halogen lamps.
	Infrared glass coatings.
	Higher efficiency reflector coatings.
	Efficient filament placement.

DOE received a number of comments in response to its list of proposed design options, as discussed below.

1. General Service Fluorescent Lamps

NEMA generally agreed with the list of design options, but mentioned that for GSFL, further efficacy improvement will likely come from improved system (lamp-ballast-luminaire) combinations, and urged DOE to aim in future rulemakings to improve overall systems. (NEMA, No. 22 at p. 9; Public Meeting Transcript, No. 21 at pp. 108–109)

DOE understands that the fluorescent lamp is only one part of a fluorescent lamp system, which also includes ballasts and fixtures. However, DOE does not have the authority to regulate a fluorescent lamp system. EPCA prescribes energy conservation standards for certain GSFL (42 U.S.C. 6295(i)(1)(B)) and fluorescent lamp ballasts. (42 U.S.C. 6295(g)(7)) EPCA does not contain any standards for fluorescent lamp systems. Since EPCA directs DOE to amend only the existing standards for GSFL and fluorescent lamp ballasts, DOE has concluded that it does not have the authority to set energy conservation standards for fluorescent lamp systems. DOE believes other approaches, such as building codes, are more appropriate for regulating a fluorescent lamp system.

a. Higher-Efficiency Lamp Fill Gas Composition

NEMA commented that fill gas mixes are already in use in both T12 and T8 reduced-wattage energy savings lamps. NEMA stated that lamps could be manufactured using even higher efficiency fill gas compositions; however, the actual achieved lumen levels may be unacceptable to the market. NEMA also commented that most manufacturers identify several application-limiting issues for both T8 and T12 reduced-wattage energy saving lamps. (NEMA, No. 22 at pp. 7, 11–12)

DOE agrees that using fill gas composition in reduced-wattage lamps can lead to lamps with limited utility. For example, when marketed, many reduced wattage lamps are not recommended to be used under low lamp ambient temperatures or in drafty locations and on dimming ballasts. These situations could result in lamp starting or stabilization problems, striation (alternating light and dark bands), pulsing or a reduction in light output. Therefore, although DOE incorporates reduced-wattage lamps into the LCC and NIA (as they are viable and likely choices for most GSFL applications), DOE does not consider any efficacy level that would force consumers to purchase these lamps. See section V.C.4.a for details.

b. Higher-Efficiency Phosphors

NEMA commented that rare earth phosphors are already at nearly 100 percent quantum efficiency.[21] While slight improvements in efficacy are

[21] ''Quantum efficiency,'' in this context, is used to quantify the percentage of ultraviolet photons absorbed by the phosphor that are then reemitted as visible photons.

possible with a thicker phosphor coating, NEMA argued that using this option will disproportionately increase lamp costs vis-à-vis the performance improvement. NEMA stated that the opportunities for performance improvement using phosphors ''lie in tailoring phosphor blends and color temperatures to optimize appropriate light sources for specific applications.'' (NEMA, No. 22 at p. 7)

While DOE agrees that thicker phosphor coats may increase cost, DOE does not consider increased costs in the screening analysis. DOE considers potential cost increases in its economic analyses. In addition, many higher-efficiency GSFL incorporate varying thicknesses of rare earth phosphors, or blends of halophosphors and rare earth phosphors. These lamps, more efficacious than their pure halophosphor counterparts, show that using higher-efficiency phosphors is a valid design option that meets all of the screening criteria. Therefore, DOE believes there is room for significant efficacy improvement potential with this design option and, thus, continued to carry it forward in its analyses.

c. Glass Coating

NEMA commented that higher-efficiency lamps already use glass coatings. NEMA also stated that while opportunities exist to improve this technology, manufacturers need to balance costs and performance. (NEMA, No. 22 at p. 7) DOE recognizes that costs may increase with this technology option, but as stated earlier, DOE does not consider the impacts of cost in its screening analysis. Therefore, DOE has included glass coatings as a design option for GSFL, where prototypes or commercially-available products exist.

d. Lamp Diameter

NEMA commented that lamp diameter is already used to optimize luminaire optics and system efficacy, but not to improve lamp efficacy. According to NEMA, further improvements in performance can come from new luminaire designs based on different diameter lamps, but will be limited by lumen packages and the distance between the light source and the luminaire surfaces. (NEMA, No. 22 at p. 7)

In response to this comment, DOE only considered lamp diameter as a design option in the migration from T12 to T8 lamps. DOE's research indicates that T8 lamps are common replacements for T12 lamps. Although the total lumen output of T8 lamps is often lower than that of T12 lamps, these differences in lumen outputs (on the order of 10 percent) do not seem to be significant enough to affect consumer utility. Conversely, although the total lumen output of 4-foot T5 MiniBP lamps can be similar to 4-foot T8 MBP and 4-foot T12 MBP lamps, the lumen output is emitted from a more concentrated light source. DOE's research indicates that T5 lamps' higher light concentrations (and therefore brightness) may require greater distances between the light source and illuminated surfaces. Due to this limitation in utility, DOE did not consider migration to a lamp diameter associated with T5 lamps to be a design option to improve the efficacy of T8 and T12 lamps.

e. Multi-Photon Phosphors

NEMA commented that although commercial multi-photon phosphors are theoretically possible, they have yet to be developed, despite 30 to 40 years of research. (NEMA, No. 22 at p. 7) As explained in chapter 3 of the TSD, because multi-photon phosphors emit more than one visible photon for each incident ultraviolet photon, a lamp would be able to emit more light for the same amount of power, thereby increasing efficacy. DOE agrees that this technology is not sufficiently mature as to warrant further analysis, so DOE has screened out this technology option in the March 2008 ANOPR.

2. Incandescent Reflector Lamps

NEMA does not believe that xenon, a higher-efficiency inert fill gas, should be considered a design option because there is a limited supply of this gas and prices are increasing rapidly. (NEMA, No. 22 at p. 8; Public Meeting Transcript, No. 21 at pp. 108–109)

Although price is not considered in the screening criteria, DOE did conduct an in-depth market assessment of the supply of xenon, and the potential impact of xenon supply limitations on IRL standard levels. DOE determined that although xenon is a rare gas, its supply is sufficiently large to incorporate into all IRL and that the xenon supply would not affect IRL product availability. A more detailed analysis of xenon and its availability can be found in appendix 3B of the TSD.

C. Engineering Analysis

For each product class, the engineering analysis identifies potential, increasing efficacy levels above the level of the baseline model. Those technologies not eliminated in the screening analysis (design options) are inputs to this process. Design options consist of discrete technologies (*e.g.,* infrared reflective coatings, rare-earth phosphor mixes). As detailed in the March 2008 ANOPR, to ensure that efficacy levels analyzed are technologically feasible, DOE concentrated its efforts on developing product efficacy levels associated with ''lamp designs,'' based upon commercially-available lamps that incorporate a range of design options in the engineering analysis. 73 FR 13620, 13645 (March 13, 2008). However, when necessary, DOE supplemented commercially available product information with an examination of the improved performance attributable to discrete technologies so that a substitute lamp at each efficacy level would be available for each baseline lamp.

In energy conservation standard rulemakings for other products, DOE often develops cost-efficiency relationships in the engineering analysis. However, for this lamps rulemaking, DOE derived 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 derived typical inputs for use in the LCC and NIA. See the chapter 7 of the TSD for further details on the product price determination.

1. Approach

For the NOPR, DOE is using the same methodology for the engineering analysis that was detailed in the March 2008 ANOPR. 73 FR 13620, 13645–46 (March 13, 2008). The following is a summary of the steps taken in the engineering analysis:

- Step 1: Select Representative Product Classes
- Step 2: Select Baseline Lamps
- Step 3: Identify Lamp or Lamp-and-Ballast Designs
- Step 4: Develop Efficiency Levels.

A more detailed discussion of the methodology DOE followed to perform the engineering analysis can be found in the engineering analysis chapter of the TSD (chapter 5).

2. Representative Product Classes

As discussed in section 0 of this notice, DOE proposes establishing several product classes for GSFL and IRL. DOE proposes eight product classes across the range of covered GSFL based on utility and performance features, such as: (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. For IRL, DOE proposes eight product classes based on spectrum, lamp diameter, and rated voltage. As detailed in the March 2008 ANOPR, due to scheduling and resource constraints, DOE was not able to analyze each and every product class. 73 FR 13620, 13646 (March 13, 2008). Instead, DOE carefully selected certain product classes to analyze, and then scaled its analytical findings for those representative product classes to other product classes that were not analyzed. 73 FR 13620, 13652 (March 13, 2008). While DOE received several stakeholder comments regarding methods of scaling to product classes not analyzed (discussed in section V.C.7), DOE did not receive objections to the decision to scale to certain product classes and the representative product classes chosen in the March 2008 ANOPR.

For the NOPR, similar to its approach in the March 2008 ANOPR, DOE continued to analyze 4-foot medium bipin, 8-foot single pin slimline, and 8-foot recessed double-contact high output GSFL product classes with CCTs less than or equal to 4,500K. DOE did not explicitly analyze U-shaped lamps, but instead scaled the results of the 4-foot medium bipin class analysis. In addition, DOE has decided to analyze 4-foot T5 miniature bipin standard output lamps and 4-foot T5 miniature bipin high output lamps with CCTs less than or equal to 4,500K as representative product classes.

As discussed in section A.2, DOE chose to subdivide IRL into eight product classes with three subdivisions: (1) High versus low voltage; (2) large versus small diameter lamps; and (3) modified spectrum versus standard spectrum. As detailed in the March 2008 ANOPR, DOE chose to analyze the standard-spectrum incandescent reflector product class because standard-spectrum lamps are more common than modified-spectrum lamps. 73 FR 13620, 13648 (March 13, 2008). After analyzing catalog data and talking to industry experts, DOE found that lamps with a diameter greater than 2.5 inches are more common than lamps of smaller diameters. Lamps with voltage ratings less than 125V also are more common than lamps with higher voltage ratings. Therefore, for the NOPR, DOE proposes to analyze the product class characterized by standard spectrum, voltage less than 125V, and diameter greater than 2.5 inches. For further information on representative product classes, see chapter 5 of the TSD.

3. Baseline Lamps and Systems

Once DOE identified the representative product classes for analysis, DOE selected the representative units for analysis (*i.e.,* baseline lamps) from within each product class. These representative units are generally what DOE believes to be the most common, least efficacious lamps in their respective product classes. DOE chose multiple baseline lamps because DOE found that the market for each product class is segmented into multiple submarkets for lamps with slightly different consumer utilities. For example, the 40W T12, 34W T12, and 32W T8 lamps are the most common lamps in the commercial four-foot medium bipin product class. The 34W T12 is a reduced wattage lamp that is not as versatile as the 40W T12, however, and consumers switching from a T12 to a T8 lamp must purchase a new ballast. Thus, these lamps are not entirely substitutable, so DOE has chosen to analyze them as separate baselines. DOE's selection of baseline lamps is discussed in further detail below.

a. General Service Fluorescent Lamps

As described in the March 2008 ANOPR, DOE took a systems approach to its GSFL analysis. 73 FR 13620, 13649 (March 13, 2008). In this approach, DOE selected typical ballasts (which provide current to the lamps) to pair with each baseline lamp and higher-efficacy lamp. Though DOE did not consider the ballast as directly affecting lamp efficacy, the ballast selection does affect the overall system efficacy (system input power and total lumen output), thereby having a significant impact on LCC and NIA results. For this reason, DOE considered a variety of ballast types (*e.g.,* electronic and magnetic) and ballast factors in its analysis.

In the March 2008 ANOPR, DOE chose three baseline lamps for 4-foot medium bipins less than or equal to 4,500K (installed on T8 electronic and T12 magnetic ballasts), three baseline lamps for 8-foot single pin slimlines less than or equal to 4,500K (installed on T8 electronic and T12 magnetic ballasts), and two baseline lamps for 8-foot recessed double-contact HOs less than or equal to 4,500K (installed on T8 magnetic and T12 magnetic ballasts). 73 FR 13620, 13647 (March 13, 2008). DOE did not receive any comments on baseline lamps for the commercial and industrial sectors and thus has retained all baseline lamps from the March 2008 ANOPR. However, as discussed below, DOE did receive comments regarding additional sectors to analyze and the ballast selected to pair with the 8-foot RDC HO baseline lamps. In addition, DOE developed baseline lamp-and-ballast systems for the 4-foot T5 MiniBP SO and HO product classes.

Regarding GSFL operating in the residential sector, several stakeholders commented that residential T12 ballasts will continue to be sold past 2009 and that the residential applications of these ballasts represent a large portion of the remaining market for these lamps. (NEMA, No. 22 at pp. 20, 25; Public Meeting Transcript, No. 21 at pp. 276–277) PG&E stated that T12 lamps on magnetic ballasts continue to exist in the residential sector in California. (Public Meeting Transcript, No. 21 at p. 279) The Joint Comment also stated that residential applications need to be factored into the analysis, but because the same lamps can be used in all sectors, a separate analysis is not needed for the residential sector. (Joint Comment, No. 23 at p. 10)

In response, in this NOPR, DOE has analyzed GSFL in the residential sector. In interviews with manufacturers and by reviewing manufacturer product catalogs, DOE found that a significant portion of T12 4-foot medium bipin lamps operate in the residential sector. DOE is maintaining the same standards case lamps used in the commercial and industrial sectors for 4-foot medium bipins in the residential sector because, as the Joint Comment stated, the same lamps can be used in all sectors. However, DOE is choosing a separate baseline lamp for the residential 4-foot medium bipin analysis. Conversations with industry experts and a published study prepared for PG&E [22] have revealed that residential consumers are more likely to buy 40W T12 lamps because 32W T8 lamps and 34W T12 lamps are less common. Therefore, in the residential sector, DOE is only analyzing the 40W T12 lamp as a baseline lamp. In addition, reviewing available catalog information, DOE has found that the most common 40W T12 lamp sold in the residential sector is different from the 40W T12 baseline lamp presented in the March 2008 ANOPR for the commercial and industrial sectors. 73 FR 13620, 13647 (March 13, 2008). Therefore, in the NOPR, DOE has chosen a 40W T12 baseline lamp for the residential sector that has a slightly lower efficacy (76.8 lm/W) and shorter lifetime (15,000 hours) than the typical 40W T12 lamp sold in the commercial sector.

[22] ''Codes and Standards Enhancement (CASE) Initiative for PY2008: Title 20 Standards Development,'' *Analysis of Standards Options for Linear Fluorescent Fixtures* (Prepared for PG&E by ACEEE, Lighting Wizards, and Energy Solutions). (Last modified May 14, 2008) Available at: *http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-05-15_workshop/other/PGE_CASE_Study_-_Linear_Fluorescent_Fixtures.pdf.*

After reviewing manufacturer literature and the study prepared for PG&E on fixtures in the residential sector,[23] DOE found that the most common residential sector ballast is a low-power-factor 2-lamp magnetic T12 system with a ballast factor of 0.68. Therefore, for the NOPR, DOE paired the baseline lamp with this ballast for the residential sector analysis.

Because DOE has decided to cover and analyze 4-foot T5 miniature bipin standard output and 4-foot T5 miniature bipin high output lamps in this rulemaking (section 0 of this notice), DOE established baseline lamps for these two product classes. NEMA and the Joint Comment both stated that if DOE does not cover T5 lamps, then less efficient, halophosphor T5 lamps may enter the market place. (Public Meeting Transcript, No. 21 at pp. 71–72; Joint Comment, No. 23 at p. 3) Because these less efficient halophosphor T5 lamps are not on the market today, DOE developed model T5 halophosphor lamps in its engineering analysis. To create these model T5 lamps, DOE used efficacy data from short halophosphor fluorescent T5 lamps currently available and developed a relationship between length and efficacy. DOE validated this relationship by comparing it to previous industry research. DOE then used this relationship to determine the efficacies of a halophosphor 4-foot T5 miniature bipin standard output lamp and a halophosphor 4-foot halophosphor T5 miniature bipin HO lamps. Specifically, the baseline 4-foot miniature bipin standard output lamp is 28W with an efficacy of 86 lm/W and a lifetime of 20,000 hours. The baseline 4-foot miniature bipin high output lamp is 54W with an efficacy of 77 lm/W and a lifetime of 20,000 hours. DOE used these lamps as baseline lamps to establish the economic impacts of a standard that would eliminate such lamps. For more information about these and other baseline lamps, see chapter 5 and appendix 5B of the TSD.

In its review of manufacturer literature, DOE found that a range of ballast factors are available for the 4-foot T5 product classes, and the most common ballast is a 2-lamp electronic ballast. DOE attempts to compare lamp-and-ballast systems with similar light output so that consumers switching to more efficient systems will be able to preserve lumen output. In order for the halophosphor baseline T5 lamps to produce light output similar to the standards-case T5 lamps, they must be paired with the highest ballast factor ballasts available on the market today. Therefore, in the NOPR, DOE is pairing its baseline 4-foot T5 SO miniature bipin lamp with a 1.15 ballast factor ballast, and its baseline 4-foot T5 miniature bipin HO lamp with a 1.0 ballast factor ballast. For further detail on the baseline lamps and ballasts selected for the 4-foot T5 product classes, see chapter 5 of the TSD.

DOE proposed in the March 2008 ANOPR that the most common ballast in use for the 8-foot T12 recessed double-contact, high-output product class is an electronic rapid-start ballast. (March 2008 ANOPR TSD chapter 5). Several stakeholders commented at the public meeting that the majority of 8-foot T12 high-output ballasts installed today are magnetic. (Public Meeting Transcript, No. 21 at pp. 124–125; Public Meeting Transcript, No. 21 at p. 126) NEMA and the Joint Comment also commented that magnetic T12 high-output ballasts are allowed under current regulations and, therefore, will continue to be sold past 2009. (Joint Comment, No. 23 at p. 7; NEMA, No. 22 at p. 25) Because the majority of the installed base is magnetic, DOE is revising its baseline T12 high-output ballast to be magnetic for the life-cycle cost analysis. However, DOE recognizes that historical shipments from the 2000 rulemaking on GSFL ballasts (hereafter ''2000 Ballast Rule'') (62 FR 56740 (Sept. 19, 2000)) indicate that T12 electronic high-output ballasts are also increasingly being shipped.[24] Therefore, in the national impacts analysis, DOE modeled the installed base on magnetic ballasts, and forecasted shipments of T12 high-output lamps operating on both electronic and magnetic ballasts in the national impacts analysis. For further detail regarding the revised baseline lamps and systems for the 8-foot RDC HO product class, see chapter 5 of the TSD.

DOE reviewed the remaining baseline lamp-and-ballast systems discussed in the March 2008 ANOPR and believes they are still appropriate, as DOE received no comments concerning these systems. Therefore, DOE maintained the same number of lamps per system and ballasts discussed in the March 2008 ANOPR for the 4-foot medium bipin and 8-foot single pin slimline product classes analyzed in the commercial and industrial sectors. 73 FR 13620, 13647 (March 13, 2008).

b. Incandescent Reflector Lamps

In the March 2008 ANOPR, DOE proposed three baseline lamps for the IRL representative product class. 73 FR 13620, 13648 (March 13, 2008). These baseline lamps, all parabolic reflector (PAR) halogen baseline lamps, are regulated by EPCA and meet the EPCA standard. (42 U.S.C. 6295(i)(1)) NEMA commented that because BR lamps remain on the market due to a Federal exemption and because they are commonly used in consumer applications, the BR lamp should be the baseline lamp instead of the halogen PAR. (Public Meeting Transcript, No. 21 at p. 162; NEMA, No. 22 at pp. 10, 16, and 18) NEMA also contends that because DOE selected halogen PAR lamps as the baseline, DOE is losing the opportunity to show additional energy savings. (NEMA, No. 22 at p. 16)

In response, although BR lamps are a common incandescent reflector lamp on the market today, DOE believes they should not be selected as baseline lamps in the engineering analysis of this rulemaking for the reasons that follow. The baseline lamp should be typical of *covered* lamps within a certain product class. The most common BR lamp is the 65W BR lamp, which remains on the market due to Federal exemptions. Because the 65W BR lamp is not covered in this rulemaking, it cannot be a baseline lamp. In addition, consumers purchasing the 65W BR lamp would not be affected by the amended standards proposed in this NOPR. Therefore, DOE would not be able to demonstrate additional energy savings for those consumers purchasing the 65W BR lamp even if it were able to select that lamp as a baseline lamp.

Although certain BR lamps are covered in this rulemaking, DOE predicts that the most typical lamp sold on the market in 2012 will continue to be the halogen PAR lamp. EISA 2007 required that all non-exempted BR lamps meet EPCA standards by January 1, 2008. Because these lamps are similar in efficacy and price to the halogen PAR, the most common reflector lamps meeting the EPCA standard in 2007, DOE is continuing to choose halogen PAR lamps as the baseline lamp for the NOPR.

NEMA commented that current PAR baseline lamps have higher efficacy than the lamps sold in 1992 (when EPACT 1992 prescribed IRL standards), due to optical improvements. (NEMA, No. 22 at p. 16) However, because DOE prefers that the baseline lamp be typical of lamps sold on the market today, DOE is maintaining the same 90W PAR baseline lamp and 75W PAR baseline lamp used

[23] *Id.*

[24] U.S. Department of Energy—Energy Efficiency and Renewable Energy Office of Building Research and Standards, *Technical Support Document: Energy Efficiency Standards for Consumer Products: Fluorescent Lamp Ballast Proposed Rule* (Jan. 2000). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/gs_fluorescent_0100_r.html.*

in the March 2008 ANOPR. 73 FR 13620, 13648 (March 13, 2008). DOE now believes that the 50W PAR30 baseline lamp with a lifetime of 3,000 hours and an efficacy of 11.6 lm/W presented in the March 2008 ANOPR is not typical of lamps sold on the market today. 73 FR 13620, 13648 (March 13, 2008). Therefore, for this notice, DOE is choosing a 50W PAR30 lamp with an efficacy of 14.2 lm/W and a lifetime of 3,000 hours. Based on an examination of manufacturer product catalogs, DOE believes that this lamp is a higher-volume product than the baseline lamp presented in the March 2008 ANOPR. The lamp choice is consistent with advice DOE received from GE to use lamps from major manufacturers in the IRL analysis for modified-spectrum lamps. (Public Meeting Transcript, No. 21 at p. 170) For further detail on IRL baseline lamps, see chapter 5 of the TSD.

4. Lamp and Lamp-and-Ballast Designs

As described in the March 2008 ANOPR, in the engineering analysis, DOE considered only ''design options''—technology options used to improve lamp efficacy that were not eliminated in the screening analysis. 73 FR 13620, 13644 (March 13, 2008). DOE's selection of design options guided its selection of lamp and lamp-and-ballast designs and efficacy levels. For example, for GSFL, DOE noted groupings around the types of phosphor used and the wall thickness of those phosphors. Regarding IRL, DOE identified natural ''technology-based'' divisions in the market around the type of incandescent technology (*i.e.*, halogen or HIR) used. DOE also identified certain technology options and created model lamps to represent the efficacy those technology options could achieve.

As described in the March 2008 ANOPR, DOE also accounted for lumen output when DOE established lamp designs for its analyses. 73 FR 13620, 13648 (March 13, 2008). For the LCC analysis, DOE considered those lamps (or lamp-and-ballast systems) that: (1) Emit lumens equal to the lumen output of the baseline lamp or lamp-and-ballast system, or below that lamp by no more than 10 percent; and (2) result in energy savings. DOE took this approach in order to accurately characterize the cost-effectiveness of a particular efficacy level if a consumer makes an informed decision that maintains light output. However, as DOE recognizes that all consumers may not make such decisions, lamp or lamp-and-ballast designs that under-illuminate, over-illuminate, or do not result in energy savings are considered in the NIA.

a. General Service Fluorescent Lamps

As described in the March 2008 ANOPR, DOE used a systems approach for the fluorescent lamp analysis, because DOE recognizes that both lamps and ballasts determine a system's energy use and the overall system lumen output. 73 FR 13620, 13649 (March 13, 2008). This approach allows DOE to select a variety of lamp-and-ballast designs that meet a given efficacy level. Generally, DOE chose its potential design options by selecting commercially-available fluorescent lamps at higher efficacies than the baseline lamps. These higher efficacies are achieved through the design options described in the screening analysis. After selecting these higher-efficacy lamps, DOE selected lamp-and-ballast combinations for the LCC that both save energy and maintain comparable lumen output. For instances when the consumer is replacing only the lamp, DOE selected a reduced-wattage, higher-efficacy lamp for use on the existing ballast. For instances when the consumer is replacing both the lamp and the ballast, DOE was able to obtain energy savings and maintain comparable lumen output using a variety of lamp-and-ballast combinations.

In the March 2008 ANOPR, DOE stated that it was not able to identify any application restrictions on using reduced-wattage fluorescent lamps, so therefore, DOE included reduced-wattage lamps as design options in the ANOPR. 73 FR 13620, 13650 (March 13, 2008). NEMA responded that most manufacturers identify several application issues for these lamps. For example, NEMA stated that reduced-wattage T8 lamps cannot be used with certain rapid-start circuits, at temperatures below 60 degrees Fahrenheit (°F) (or 70 °F for the 25W lamp), in drafty locations, in air-handling fixtures, on low-power-factor ballasts, on dimming ballasts, or on an inverter-operated emergency lighting system, unless the equipment is specifically listed for use with the reduced-wattage lamp in question. (NEMA, No. 22 at p. 10) NEMA also stated that reduced-wattage T12 lamps cannot be used at temperatures below 60 °F, in drafty locations, on low-power-factor ballasts, on reduced-light-output ballasts, on dimming ballasts, or on inverter-operated emergency lighting systems unless the equipment is specifically listed for use with the reduced-wattage lamp in question. (NEMA, No. 22 at p. 11)

In response, DOE recognizes that reduced-wattage lamps cannot be used in certain applications and that consumers should not be subject to any decrease in utility and performance due to an amended energy conservation standard. However, because consumers have the opportunity to purchase at least one full-wattage T12 or T8 lamp at each efficacy level, consumer utility will not be reduced by amending the existing energy conservation standard.

There are many applications where reduced-wattage lamps are appropriate. Therefore, DOE is modeling reduced-wattage lamps in the engineering analysis. In the NIA, DOE did not shift all consumers to reduced-wattage lamps in response to an energy conservation standard, because reduced-wattage lamps cannot be used in certain applications. Specifically, the majority of residential consumers have low-power-factor ballasts not designed to operate 34W T12 lamps. These assumptions are displayed in the NIA market-share matrices described in chapter 10 of the TSD.

b. Incandescent Reflector Lamps

In the March 2008 ANOPR, DOE selected lamp designs and candidate standard levels (CSLs) by observing natural efficacy divisions in the marketplace that correspond to the use of technologies (*e.g.*, halogen capsules, HIR technology, and improved reflector coatings) to increase lamp efficacy. 73 FR 13620, 13650 (March 13, 2008). CSL1, as set forth in the March 2008 ANOPR, could be met with a halogen lamp using a silverized reflector coating. CSL2 could be met with a 3,000-hour halogen infrared (IR) lamp. CSL3 could be met with an improved 4,000-hour halogen infrared lamp. CSL3 could also be achieved by using design options like a silverized reflector coating with a halogen infrared burner, or improved filament placement and higher efficiency inert fill gases in conjunction with a halogen infrared burner.

At the public meeting and through written comments, NEMA proposed several changes to the lamp designs and efficacy levels DOE identified for the IRL engineering analysis. NEMA suggested that DOE should analyze four efficacy levels, beginning with one slightly above EPCA and ending with the max-tech candidate standard level analyzed in the March 2008 ANOPR. (NEMA, No. 22 at p. 17) However, the efficacies of the baseline lamps chosen in the engineering analysis are above the lowest NEMA-proposed efficacy level. Therefore, because NEMA's lowest proposed efficacy level would not raise the efficacies of the most common reflector lamps on the market today, DOE did not consider it in this NOPR.

NEMA commented that DOE should also consider in its NOPR an efficacy level that can be met with non-standard halogen or infrared halogen lamps. (NEMA, No. 22 at p. 18) This standard level would lie between the first efficacy level proposed by NEMA and the first candidate standard level (CSL1) proposed by DOE in the March 2008 ANOPR. 73 FR 13620, 13651 (March 13, 2008). To model the technologies that meet this efficacy level, DOE modeled an improved halogen lamp that uses xenon, a higher efficiency inert fill gas.

NEMA commented that DOE should not analyze CSL1 presented in the March 2008 ANOPR because that level is based on the silverized reflector coating, a patented technology.[25] (NEMA, No. 22 at pp. 16–17; Public Meeting Transcript, No. 21 at pp. 157–158) Other stakeholders commented that DOE should research when the patent on the silver technology expires, because the standard does not go into effect until 2012. (Joint Comment, No. 23 at p. 15) The Joint Comment stated that DOE should research viable alternatives that can be used to reach the first CSL if the silverized reflector coating is indeed patented. (Joint Comment, No. 23 at p. 15)

In response to these stakeholder comments, DOE researched the silverized reflector technology and found that the patent for that technology expires in December 2019.[26] Therefore, for the purpose of this rulemaking, DOE considers the silverized reflector coating a proprietary technology. As discussed during the Framework stage of this rulemaking, DOE only considers proprietary designs in its engineering analysis if there are other technology pathways to meet that efficacy level. DOE researched possible lamp designs for the March 2008 ANOPR's first CSL and found that a halogen lamp with a silverized reflector coating is the only improved halogen technology that can meet the March 2008 ANOPR CSL1. However, a slightly lower level can be achieved with an HIR lamp that has a 6,000-hour lifetime. Therefore, DOE is considering a slightly lower level that can be met by both long-life HIR lamp designs and silverized reflector coating lamp designs in the NOPR. In its analysis of this level, DOE considers both lamp designs as viable consumer options.

NEMA commented that DOE should lower CSL2, because longer life lamps would be in jeopardy of being eliminated from the marketplace. Because longer life products typically have lower efficacies, manufacturers may need to reduce lamp life to meet a particular efficacy level. (Public Meeting Transcript, No. 21 at pp. 177–178; NEMA, No. 22 at p. 16; Joint Comment, No. 23 at p. 15) Although increased lifetime reduces a lamp's efficacy, DOE believes that lifetime is a consumer economic issue rather than a utility issue. In addition, the IRL at each standard level can be manufactured with lifetimes equal to or greater than the lifetimes of the baseline lamp. Therefore, consumers who are purchasing the baseline lamp will continue to be able to purchase a lamp with a similar lifetime in the standards case. Finally, DOE has conducted an analysis to assess the impact of standards on longer lifetime lamps. Based on this analysis, documented in appendix 5D of the TSD, DOE is reasonably certain that even under the highest efficacy level analyzed in this NOPR, 6,000 hour lifetime lamps are technologically feasible. For all of these reasons, DOE maintained the lamp designs and efficacy level for CSL2 described in the March 2008 ANOPR.

Similar to its comments related to CSL1, NEMA commented that CSL3 is problematic because it is also based on the silverized reflector coating, a patented technology. (NEMA, No. 22 at p. 17; Public Meeting Transcript, No. 21 at pp. 157–158)

In its conversations with manufacturers and review of manufacturer catalogs, DOE found that CSL3 is achievable using technologies other than a silverized reflector coating. For example, other non-patented types of improved reflectors and higher-efficiency IR coatings can be used to reach this level. In fact, all major manufacturers produce two or more lamps that exceed this level, some of which are not dependent on the proprietary silverized reflector. Therefore, because there are alternate technology pathways to this level, DOE maintained the March 2008 ANOPR CSL3 as efficacy level 4 in the NOPR. This efficacy level is consistent with CSL4 proposed by NEMA in its comment. (NEMA, No. 22 at p. 17)

Finally, DOE conducted additional market research and discovered that IRL with efficacies significantly higher than the ANOPR CSL3 (or NOPR EL4) are being sold by one major manufacturer. These IRL are marketed as halogen infrared lamps with a silverized reflector, improved IR coating, and a lifetime of 4,200 hours. Therefore, in order to meet the requirement to analyze the highest technologically feasible level, for the NOPR, DOE has added a fifth efficacy level (EL5) based on these high-efficacy lamps. Although, to DOE's knowledge, there are no commercially-available IRL that do not use the patented silverized reflector and are equivalent in efficacy, DOE's research indicates that that are alternate, non-proprietary technology pathways to meet this efficacy level. In particular, DOE has extensively researched one particular advanced IR coating technology. Through interviews with manufacturers of this technology and through independent testing, DOE has preliminarily concluded that by using this advanced IR coating technology with a standard aluminum reflector, manufacturers can produce an IRL with an efficacy that exceeds EL5. For further detail on DOE's research on this technology, see appendix 5D of the TSD.

In summary, EL1 is based on an improved halogen lamp that uses xenon, a higher-efficiency inert fill gas. EL2 is based on a halogen infrared lamp with a lifetime of 6,000 hours; a halogen lamp using a silverized reflector coating could also meet this EL. EL3 is associated with a 3,000-hour halogen infrared lamp; this EL is more efficient than EL2 due to higher temperature operation of the filament. EL4 is based on a 4,000-hour improved halogen infrared lamp; improvements in the halogen infrared lamp could be made by using a double-ended halogen infrared burner, higher-efficiency inert fill gases, and efficient filament orientation. EL5 is based on a 4,200-hour halogen infrared lamps (even further improved); these further improvements include an improved reflector, IR coating, or filament design that produces higher-temperature operation (and may reduce lifetime to 3,000 hours).

5. Efficiency Levels

a. General Service Fluorescent Lamps

i. Revisions to ANOPR Efficiency Levels

For the March 2008 ANOPR, DOE developed CSLs for GSFL by dividing initial lumen output by the ANSI rated wattages of commercially-available lamps, resulting in rated lamp efficacies. In response to the potential GSFL efficacy levels presented in the March 2008 ANOPR, NEMA commented on several reasons why the association

[25] DOE notes that it would clearly be technologically feasible for manufacturers to adopt a product design that surpasses the levels specified in CSL1 (*e.g.*, using technologies that meet CSL2) and also avoids use of the proprietary technology in question. However, if DOE were to adopt CSL1, as presented in the March 2008 ANOPR, such manufacturers would be at a competitive disadvantage as compared to manufacturers who are able to access the patented technology.

[26] Zhao, Tianji *et al.*, ''Protected Coating for Energy Efficient Lamp,'' U.S. Patent 6,773,141 (August 10, 2004).

believes that the efficacy levels need to be revised. NEMA's comments regarding the efficacy levels considered in the March 2008 ANOPR can be divided into five categories: (1) The appropriateness of using ANSI rated wattages in the calculation of lumens per watt; (2) consideration of variability in production of GSFL; (3) manufacturing process limitations related to specialty products; (4) consideration of adjustments to photometry calibrations; and (5) the appropriateness of establishing efficacy levels to the nearest tenth of a lumen per watt. (NEMA, No. 22 at p. 13–14) In consideration of the above issues, NEMA suggested revised efficacy levels that could achieve the same results as the efficacy levels considered in the March 2008 ANOPR.

First, in support of lowering the March 2008 ANOPR efficacy levels, NEMA argued that ANSI rated wattages of GSFL are not necessarily representative of long-term reference watts. NEMA further stated that in many cases the actual lamp reference watts are greater than the ANSI designated value. (NEMA, No. 22 at p. 14) Second, NEMA commented on production variability and its impact on the resulting measured lamp efficacies. NEMA stated that DOE should not use nominal catalog initial lumen values when developing efficacy levels, as they do not reflect statistical lot-to-lot production variation. It also argued that as lamp lumens per watt is not a controlled process element in production or a product rating, larger tolerances may be required. NEMA further stated that lumens per watt is actually a calculation based on two primary process control elements: (1) Watts and (2) lumens. When practical production variation in lamp wattage (above ANSI-designated values) and lamp lumens (below catalog initial lumens) combine, the resulting variation in lumens per watt may be larger than expected. NEMA stated that DOE's proposed efficacy levels should be lowered to account for these tolerances. (NEMA, No. 22 at p. 14)

In consultation with the National Institute of Standards and Technology (NIST), DOE has investigated this issue thoroughly, and DOE agrees with NEMA on several points. By analyzing manufacturer compliance reports (submitted to DOE for existing GSFL energy conservation standards), DOE found that efficacies of lamps when reported for the purpose of compliance often vary from catalog-rated values. Specifically, DOE agrees that ANSI designated rated wattages may not be appropriate in calculating efficacy. In fact, the test procedures for GSFL incorporate a tolerance factor comparing measured lamp wattage to ANSI-rated wattage. DOE acknowledges that this tolerance factor could in fact significantly alter the measured efficacy of the lamps from the rated efficacy. In addition, DOE agrees that using rated lamp efficacy does not sufficiently account for lot-to-lot production variability. For this reason, to establish revised GSFL efficacy levels, DOE proposes to use lamp efficacy values submitted to DOE over the past 10 years for the purpose of compliance with existing energy conservation standards. Using compliance reports as a basis for efficacy standards should ensure that DOE is accurately characterizing the tested performance of GSFL, accounting for the measured wattage effects and wattage and lumen output variability as discussed above.

Further remarking on the effects of production variability, NEMA argued that it is inappropriate to use a small number of test samples to calculate a lumen-per-watt efficacy level. NEMA stated that its suggested levels incorporate a safety factor to take into account manufacturer process variations. (NEMA, No. 22 at p. 14) While DOE appreciates NEMA's input, it disagrees that the sample size is inappropriate. At NEMA's suggestion, a sample size of 21 lamps was originally established for reporting requirements in the 1997 test procedure rulemaking. 62 FR 29222, 29229 (May 29, 1997). The reported efficacy values are obtained by testing at least three lamps manufactured each month for at least 7 months out of a 12-month period. Upon receiving NEMA's comment, DOE consulted with NIST and has tentatively concluded that the minimum of 21 samples is sufficiently large sample size, assuming a normal distribution. In addition, by using the compliance report efficacies, DOE believes that it is accounting for statistical variations due to differences in production. The efficacy reported for compliance is related to the lower limit of the 95-percent confidence interval. This interval represents variation over the whole population of production, not only the sample size. 62 FR 29222, 29230 (May 29, 1997).

Third, NEMA commented that the proposed efficacy levels should be lowered to account for realistic production and manufacturing process limitations. NEMA argued that it may not be possible to apply the highest efficacy levels to some specialty products because they do not use high-speed production methods. (NEMA, No. 22 at p. 14) DOE is unaware of specialty products that meet the definition of GSFL and would be unable to meet the proposed standards. Therefore, DOE cannot appropriately quantify the reduction in efficacy level necessary if such situation in fact exists. DOE requests further comment and detail on this topic.

Fourth, NEMA claims that because the National Voluntary Laboratory Accreditation Program (NVLAP) has made adjustments to photometry calibrations since 1997, the lumens for some products have actually been reduced. These adjustments would thereby merit a reduction in DOE's GSFL efficacy levels. (NEMA, No. 22 at p. 14) In response, DOE consulted with NIST, which is unaware of any such adjustments in photometry calibrations since 1997. The lumen scale has not changed more than 0.2 percent as a result of changes to calibration systems. Furthermore, the formula used in the compliance reports contains a 2-percent de-rate factor to allow for testing variations. Therefore, DOE disagrees with NEMA's assertion that the efficacy levels should be further lowered to account for these adjustments.

Finally, NEMA maintained that if DOE uses lumens per watt as the efficacy level measurement, then the numbers should be rounded to the nearest whole number, rather than carried out to the tenths decimal place. In the March 2008 ANOPR, DOE considered efficacy levels that were specified to the nearest tenths lumen per watt. NEMA asserts that lamp testing and production variation does not allow for establishing minimum lumens per watt levels to the tenth place. (NEMA, No. 22 at p. 12) While DOE appreciates NEMA's comment, after consulting with NIST, DOE disagrees that lamp production variation would prohibit the regulation of GSFL to the nearest tenth decimal place of lumens per watt. If DOE were able to set minimum efficacy requirements to the nearest tenth of a decimal place, the higher-accuracy measurements and compliance could result in increased energy savings. However, in consideration of DOE's approach to establish efficacy levels and conduct subsequent analyses based on certification and compliance reports submitted by manufacturers, DOE now believes that maintaining the current rounding procedure (*i.e.*, to the nearest whole lumen per watt) is more appropriate. Because manufacturer compliance reports round numbers to the nearest lumen per watt, DOE believes that the data would not support establishment of an energy conservation standard for GSFL to the nearest tenth of a lumen per watt. Therefore, in this NOPR, DOE is proposing to establish efficacy levels as whole lumen per watt numbers.

DOE presents revised GSFL efficacy levels in section VI.A.1 of this NOPR.

ii. Four-Foot T5 Miniature Bipin Efficiency Levels

Because DOE proposes to cover 4-foot T5 miniature bipin lamps and 4-foot T5 miniature bipin HO lamps, DOE developed efficacy levels for these two product classes. In its review of manufacturer literature, DOE identified the most common 4-foot T5 miniature bipin standard output lamps on the market (which based on product catalogs, DOE believes accounts for the majority of the 4-foot T5 SO market). The first efficacy level for this product class is based on these lamps, which use 800-series phosphors and have a rated catalog efficacy (initial lamp lumens divided by ANSI rated wattage) of 104 lm/W. In its research, DOE also noted higher efficacy 4-foot T5 miniature bipin standard output lamps that use improved 800-series phosphors. Specifically, there is a reduced-wattage (26W) 4-foot T5 miniature bipin lamp (with a rated efficacy of 112 lm/w) and a full-wattage (28W) lamp (with a rated efficacy of 110 lm/w). EL2, the second efficacy level for this product class, is based on these higher-efficacy lamps. Therefore, DOE analyzed two efficacy levels for this product class. The first efficacy level prevents the introduction of less-efficacious halophosphor lamps on the market, while the second efficacy level raises the efficacy of the current highest volume 4-foot T5 miniature bipin lamps on the market. In order to account for manufacturer variation, DOE used the average reductions in efficacy values due to manufacturer variation calculated for the highest efficacy 4-foot T8 medium bipin lamps, and applied those same reductions to the 4-foot miniature bipin rated efficacy values.

For the 4-foot T5 miniature bipin HO product class, DOE found that higher-efficacy full-wattage lamps do not exist on the market today. DOE did identify a higher-efficacy reduced-wattage lamp for this product class. However, because reduced-wattage lamps have a limited utility, DOE is choosing to base its efficacy levels on full-wattage lamps. In this way, consumers are not forced to purchase a lamp with limited utility under energy conservation standards. Therefore, for this product class, DOE is analyzing one efficacy level, which prevents the introduction of less-efficacious halophosphor lamps on the market. For more information on GSFL efficacy levels, see chapter 5 of the TSD.

b. Incandescent Reflector Lamps

As wattage increases for incandescent lamps, efficacy generally increases. Therefore, so that the efficacy levels reflected the performance of these lamps, DOE proposed in the ANOPR that the efficacy requirement for IRL vary according to the following equation: $a*P^{0.27}$, where ''a'' is a constant specifying the technology level and ''P'' is the wattage of the lamp. 73 FR 13620, 13645 (March 13, 2008). At the public meeting, NEMA commented that the smooth form of the candidate standard levels for IRL was appropriate. (Public Meeting Transcript, No. 21 at pp. 100–101, 156) Several other stakeholders also commented that they support the continuous function for IRL. These stakeholders noted that continuous functions more closely follow theoretical equations predicting the level of efficacy possible for any given desired level of light output and thus maximize energy savings. (Joint Comment, No. 23 at p. 15) DOE agrees with these comments and is proposing to maintain the continuous function for IRL in the same equation form proposed in the ANOPR.

As described in section V.C.4.b, DOE is proposing five efficacy levels in this NOPR. EL1 is based on an improved halogen lamp that uses xenon, a higher-efficiency inert fill gas. EL2 is based on a halogen infrared lamp with a lifetime of 6,000 hours. A halogen lamp using a silverized reflector coating also meets this EL. EL3 is based on the 3,000-hour HIR lamp. EL4 is based on a 4,000-hour improved HIR lamp. EL5 is based on a 4,200-hour improved HIR lamp.

6. Engineering Analysis Results

a. General Service Fluorescent Lamps

In chapter 5 of the March 2008 ANOPR TSD, DOE presented lifetime, rated wattage, and rated efficacy results for all lamp-and-ballast designs. NEMA commented that the lifetime rating for the reduced-wattage 30W T8 lamp should be 20,000 hours instead of 18,000 hours. (NEMA, No. 22 at p. 18) DOE reviewed catalog data and agrees that 20,000 hours is the appropriate lifetime for the 30W T8 lamp. DOE also reviewed catalog data for other reduced-wattage lamps. DOE found several 25W T8 lamps that were introduced on the market after it completed the ANOPR GSFL engineering analysis. Therefore, DOE updated the 25W T8 reduced-wattage lamp to have a slightly higher lumen output and longer lifetime to reflect the more common 25W T8 lamps sold on the market today.

Through interviews with lamp manufacturers, DOE found that several of the rated wattages DOE used in its ANOPR for the 4-foot medium bipin product class were not accurate. For the NOPR, DOE updated the rated wattage of the nominally 40W T12 from 40 to 41 watts. DOE also updated the rated wattage of the 30W T8, 28W T8, and 25W T8 lamp from 30 to 30.4 watts, 28 to 28.4 watts, and 25 to 26.6 watts, respectively. Due to these updates (and because the rated wattage affects the rated lamp efficacy), two 40W T12 lamps and the 25W T8 lamp have lower efficiencies than as they were analyzed in the March 2008 ANOPR. For further detail associated with these revisions, see chapter 5 of the TSD.

In addition to updating lamp efficacy, DOE revised the 8-foot T12 high output engineering analysis to reflect the purchase of a magnetic ballast in both the base case and standards case. As discussed in section V.C.4.a of this notice, DOE recognizes that a typical 8-foot T12 high output system uses a magnetic ballast. In addition, as the 2000 ballast rule does not require that these systems be electronic, consumers will be able to purchase a magnetic 8-foot T12 high output system in the future.

DOE also created a separate residential engineering analysis. In this engineering analysis, DOE assumes that the most typical installed fluorescent system in a residential household is a 40W T12 magnetic system. However, DOE recognizes that T8 systems are gaining in market share in the residential market. Therefore, DOE assumes that the majority of fluorescent systems installed for new construction and renovation in the residential sector are T8 systems. DOE discusses this assumption further in section V.D and V.E, as it primarily affects the LCC and NIA.

In the March 2008 ANOPR, DOE considered using two low ballast factor (BF) ballasts for 4-foot T8s, a 0.75 BF and a 0.78 BF. ACEEE stated that manufacturers are now selling ballasts for 4-foot T8 lamps with a ballast factor between 0.68–0.7 and that DOE should consider this ballast in the engineering analysis. (Public Meeting Transcript, No. 21 at p. 262) After reviewing catalog data for fluorescent lamp ballasts, DOE decided to add a ballast with a 0.71 BF in its engineering analysis as a system option that attains energy savings while maintaining light output. By including this low-BF ballast, DOE is able to more thoroughly characterize all consumer purchase options in the LCC and NIA.

b. Incandescent Reflector Lamps

In the March 2008 ANOPR, DOE also presented engineering analysis results for IRL. NEMA generally agreed with the efficacy values in the table. (NEMA, No. 22 at p. 18) Thus, DOE is maintaining this approach with one exception. Specifically, DOE is revising the efficacy values it used for the 50W PAR30 baseline lamps and is creating several additional model lamps for the efficacy levels not analyzed in the March 2008 ANOPR. Because the revised baseline model exhibits a slightly different lumen package than the baseline model analyzed in the March 2008 ANOPR, DOE has created several additional model lamps in order to match the lumen package of the baseline lamp. For more information on the revised baseline model, see section V.C.3.b. For more information about lamp designs used in the IRL engineering analysis, see chapter 5 of the TSD.

7. Scaling to Product Classes Not Analyzed

As discussed above, DOE identified and selected certain product classes as ''representative'' product classes where DOE would concentrate its analytical effort. DOE chose these representative product classes primarily because of their high market volumes. The following section discusses how DOE scaled efficacy standards from those product classes it analyzed to those it did not.

a. General Service Fluorescent Lamps

In the engineering analysis for GSFL, DOE decided not to analyze the 2-foot U-shaped product class and the product classes with a CCT greater than 4,500K, due to the small market share of these classes. Instead, DOE is scaling the efficacy standards for the product classes analyzed to these product classes. The following sections discuss DOE's approaches to scaling to product classes not directly analyzed.

i. Correlated Color Temperature

Regarding the CCT product class division, DOE found in the March 2008 ANOPR that the reduction in efficacy between 4,100K and 6,500K lamps was between 4 percent and 7 percent. To avoid subjecting certain products to inappropriately high standards, DOE considered a single 7-percent reduction (from the efficacy levels for lamps with CCT less than or equal to 4,500K (low CCT)) for product classes greater than 4,500K (high CCT). 73 FR 13620, 13653 (March 13, 2008).

NEMA disagreed with DOE's use of a single 7-percent reduction for all GSFL lamps with a CCT greater than 4,500K. (NEMA, No. 22 at p. 18) NEMA submitted a written comment recommending an individualized reduction for each efficacy level and each product class for products with a CCT between 4,500K and 7,000K. NEMA's reductions ranged from 2.6 percent to 7.2 percent, depending on the efficacy level and product class. (NEMA, No. 26 at pp. 4, 6–7)

The Joint Comment also disagreed with the 7-percent reduction DOE employed. Looking at catalog data for the greater-than-4,500K product classes, the Joint Comment noted that the reduction in efficacy when moving from low-CCT to high-CCT lamps or from 4-foot MBP to 2-foot U-shaped lamps varies by efficacy level. For example, at CSL1 in the 4-foot medium bipin product class, the Joint Comment found that no reduction in the efficacy standard was necessary because high-CCT and 2-foot U-shaped T8 lamps are able to meet that level. At CSL3, the Joint Comment found a 5-percent reduction was appropriate; at CSL4 and CSL5, the Joint Comment found a 3-percent reduction was appropriate. Based on this data, the Joint Comment stated that the commenters would accept a 5-percent reduction for both the 2-foot U-shaped and greater-than-4,500K product classes. (Joint Comment, No. 23 at pp. 9–10)

Through an examination of the comments and a further inspection of manufacturer catalog data, DOE now recognizes that a single efficacy reduction of 7 percent for each efficacy level and each product class is not always appropriate when trying to establish efficacy levels for lamps with greater than 4,500K CCT. Therefore, for this NOPR, DOE proposes to establish a separate scaling factor for each EL and product class. DOE's intention in developing scaling factors for this NOPR was to establish high-CCT efficacy levels that mimic the same technological effects as the low-CCT efficacy levels. For example, if EL3 for the low-CCT 4-foot MBP product class eliminates all but the highest-efficacy, low-CCT T12 lamps, DOE established a high-CCT EL3 that attempted to eliminate all but the highest-efficacy, high-CCT, T12 lamps as well. Because the NEMA technical committee analyzed all efficacy levels for all product classes with a similar intention and because DOE found that this range is consistent with the range of reductions found in manufacturer literature, DOE proposes to adopt the percentage reduction for each EL suggested by NEMA. In order to establish efficacy levels for high CCT lamps, DOE then applied these percentage reductions to the efficacy levels (discussed in sectionV.C.5.a) for the representative product classes. For more information on the efficacy levels for product classes with a CCT greater than 4,500K, see chapter 5 of the TSD.

ii. U-Shaped Lamps

Regarding the 2-foot U-shaped product classes, in March 2008 ANOPR, DOE found that when comparing catalog efficacies of 2-foot U-shaped lamps to 4-foot MBP lamps, efficacy scaling factors varied depending on whether one was comparing T12 lamps or T8 lamps. Specifically, DOE had initially determined that a 3-percent reduction was appropriate for T8 lamps, and a 6-percent reduction was appropriate for T12 lamps. To avoid subjecting certain products to inappropriately high standards, DOE stated that it was considering to apply a single 6-percent reduction from the five 4-foot medium bipin efficacy levels to obtain five 2-foot U-shaped efficacy levels. 73 FR 13620, 13653 (March 13, 2008).

In response to the ANOPR, NEMA commented that only three ELs for the 2-foot U-shaped product class were appropriate. These ELs recommended by NEMA were based on the same technology options for the 4-foot medium bipin product class: (1) NEMA's EL1 would remove all halophosphor T12 lamps; (2) NEMA's EL2 would remove all 700-series T12 U-lamps; and (3) NEMA's EL3 would remove all T12 U-lamps. (NEMA, No. 22 at p. 15) Each EL recommended by NEMA represented an approximately 9-percent to 10-percent reduction from ELs in the 4-foot medium bipin product class. As discussed above, the Joint Comment recommended that DOE use a single 5-percent reduction when scaling from the 4-foot medium bipin product class to the 2-foot U-shaped product class. However, the Joint Comment also found that the reduction varied by CSL. (Joint Comment, No. 23 at pp. 9–10)

Similar to its analysis regarding scaling to high-CCT product classes, DOE recognizes that a single reduction in efficacy may not be appropriate for all efficacy levels for the U-shaped product classes. Therefore, similar to NEMA's suggestion, DOE is proposing a separate reduction for each efficacy level based on similar technology steps seen for the 4-foot medium bipin product class. However, after examining commercially-available product DOE believes that five, not three, efficacy levels are appropriate for the 2-foot U-shaped product class. DOE assessed manufacturer catalogs containing commercially-available U-shaped lamps to develop standard levels with a similar technology impact at each EL as 4-foot linear medium bipin lamps. DOE supplemented this analysis with compliance report data for U-shaped lamps to verify that the established efficacy levels coincide with the technological goals and actual performance of products on the market. For specific scaling factors for the proposed 2-foot U-shaped efficacy levels and a more detailed discussion of DOE's methodology, see chapter 5 of the TSD.

b. Incandescent Reflector Lamps

i. Modified-Spectrum IRL

At the ANOPR public meeting, DOE stated that the average reduction in efficacy of modified-spectrum lamps (as compared to standard spectrum lamps) was between 2 percent and 25 percent, with an average reduction of 15 percent. DOE acknowledged the range of spectrum modification and its effects on utility, and aimed to establish a standard that would not eliminate modified-spectrum lamps. Therefore, in the March 2008 ANOPR, DOE considered a minimum efficacy requirement for each modified-spectrum lamp that would be dependent on the testing of a equivalent standard-spectrum lamp. More specifically, the efficacy requirement for the modified-spectrum lamp would be determined on a per-lamp basis by measuring the lumen output of both the modified-spectrum lamp and the equivalent standard-spectrum reference lamp; manufacturers would then multiply the ratio of lumen outputs (*i.e.,* the lumen output of the modified-spectrum lamp divided by the lumen output of the standard-spectrum reference lamp) by the efficacy requirement for the standard-spectrum reference lamp to obtain the efficacy requirement for that modified-spectrum lamp. 73 FR 13620,13653 (March 13, 2008).

GE commented that this approach may be reasonable as long as DOE gave this reduction to true modified-spectrum lamps, rather than lamps marketed as having modified spectrums, but which in fact do not meet the requirements of that term. (Public Meeting Transcript, No. 21 at p. 168) NEMA commented that DOE's proposal for establishing an efficacy standard for modified-spectrum IRL is complicated, difficult to enforce, and non-verifiable. (NEMA, No. 22 at p. 19) In addition, NEMA expressed concern that the responsibility of establishing the efficacy for the equivalent standard-spectrum lamp would fall on the manufacturer. (Public Meeting Transcript, No. 21 at pp. 100–101) Also, the Joint Comment disagreed with an approach that would allow modified-spectrum technologies a variable reduction in efficacy (depending on their degree of spectrum modification and the method with which it is reached). (Joint Comment, No. 23 at p. 16) In response to those comments, DOE recognizes the drawbacks to the approach considered in the ANOPR and instead in the NOPR is proposing a single efficacy requirement (irrespective of the degree or method of spectrum modification) for each modified-spectrum IRL product class.

GE and NEMA suggested that the 25-percent reduction for A-line modified-spectrum lamps enacted by EISA 2007 standards for general service incandescent lamps (GSIL) and modified-spectrum GSIL may be appropriate for modified-spectrum IRL. (Public Meeting Transcript, No. 21 at pp. 169–170; NEMA, No. 22 at p. 19) The Joint Comment expressed an opposing viewpoint, arguing that the 25-percent reduction specified in EISA 2007 was based on a political compromise, not technical research. The Joint Comment also mentions that Ecos Consulting, on behalf of PG&E, tested a variety of modified-spectrum general service incandescent lamps. Their researchers estimated a total light output reduction of 11 to 18 percent due to the modified spectrum. (Joint Comment, No. 23 at p. 16)

DOE agrees with the Joint Comment that the reduction in efficacy for general service incandescent lamps used in EISA 2007 may not be appropriate for IRL. Instead, DOE based its reduction for the modified-spectrum product classes on independent testing and research of commercially-available modified-spectrum and standard-spectrum IRL.

Several stakeholders commented that the range of lumen reduction (2 percent to 29 percent) found among commercially-available modified-spectrum IRL may be attributable to lamps that do not meet the statutory definition of ''modified spectrum,'' which would make the stated average too high. (NEMA, No. 22 at p. 19; Public Meeting Transcript, No. 21 at pp. 164–167) These stakeholders suggested that DOE should only use lamps that meet the definition of ''modified spectrum'' when determining an appropriate scaling factor. (Public Meeting Transcript, No. 21 at p. 167–168) GE suggested that lamps sold by major manufacturers will meet the statutory definition of ''modified spectrum'' because NEMA manufacturers offered input into the legislative process that created this definition. (Public Meeting Transcript, No. 21 at p. 171)

In addition, the Joint Comment noted that when determining the modified-spectrum scaling factor, DOE should base its analysis on HIR IRL sources rather than conventional incandescent or conventional halogen IRL. The Joint Comment further stated that the spectral distribution of the HIR sources have reduced output in the red region of the spectrum compared to conventional incandescent lamp. The comment argued because this red region is the portion of the spectrum modified-spectrum lamps are often trying to suppress, a lower and more accurate scaling factor could be calculated by considering only HIR lamps. (Joint Comment, No. 23 at p. 16)

DOE agrees with stakeholders regarding the need to determine appropriate scaling factors and tested several modified-spectrum lamps from major manufacturers to determine whether they qualify as modified spectrum under the statutory definition. DOE only used the IRL that qualify as modified spectrum under the statutory definition to determine an appropriate scaling factor. In addition, DOE acknowledges that the spectral power distributions of incandescent (non-halogen), halogen, and HIR IRL are different over the electromagnetic spectrum. However, DOE does not believe that the reduced light output in the red region of the spectrum of HIR sources significantly affects the resulting scaling factor. This high wavelength red region of the spectrum is not weighted heavily when calculating the lumens emitted by the lamp. Therefore, any spectral differences in the infrared regions between the halogen IRL compared to the halogen infrared IRL would produce only minor differences in the reduction in efficacy for modified-spectrum lamps. Therefore, DOE tested both HIR and conventional halogen lamps in determining an appropriate scaling factor for modified spectrum.

However, as non-halogen (or conventional incandescent) IRL have significantly different radiation spectra over wavelengths contributing to the calculation of lumens (in general their light outputs are shifted toward lower wavelengths), it is likely that the resulting scaling factor based on these lamps would be significantly different than for halogen sources. Because non-halogen IRL (representing the IRL lamp types exempted from standards) are not regulated in this rulemaking, DOE believes that it would be inappropriate to include such lamps in its scaling factor analysis. Therefore, DOE considered only halogen and HIR IRL for the computation of the modified-spectrum IRL scaling factor.

To determine the scaling factor, DOE tested seven pairs (each pair consisting of one standard-spectrum lamp and one lamp marketed as modified-spectrum or a similar designation) of halogen IRL and one pair of HIR IRL made by major manufacturers. Though many of the lamps did not qualify as modified-spectrum under the statutory definition, for those that did qualify, DOE determined that the difference in light output and efficacy due to the modified-spectrum coating was 19 percent for both the halogen and IR halogen lamps. Therefore, DOE proposes to use a 19 percent reduction as the scaling factor for modified-spectrum IRL. For further details on scaling to modified-spectrum lamps, see chapter 5 and appendix 5C of the TSD.

ii. Lamp Diameter

As discussed in section V.A.2.c, in this NOPR, DOE has established separate product classes for IRL with a diameter of 2.5 inches or less based on their decreased efficacy associated with the unique utility that they provide (*e.g.*, ability of reduced diameter lamps to be installed in smaller fixtures). NEMA commented that a percentage reduction should be applied to the PAR30/PAR38 CSL so as not to eliminate PAR20 lamps (with diameters of 2.5 inches) at the highest CSLs set forth in the ANOPR. (Public Meeting Transcript, No. 21 at pp. 158–159) NEMA explained that the PAR20 lamp optical system is inherently less efficient than the PAR30 and PAR38 optical systems. In addition, it is difficult to implement the most efficient double-ended HIR burner in the PAR20 lamps. Therefore, NEMA suggests a reduction in the lumen per watt standards by 12 percent. (NEMA, No. 22 at pp. 17–18) In the Joint Comment, stakeholders stated that they were not opposed to a reduction in the efficacy standard as long as data supports manufacturer claims. (Joint Comment, No. 23 at p. 15–16)

DOE understands that PAR20 lamps are inherently less efficient than PAR30 and PAR38 lamps. To determine an appropriate scaling factor, DOE examined the inherent efficacy differences between the PAR20 lamp and its PAR30 or PAR38 counterpart by comparing catalog efficacy data of each lamp type from several lamp manufacturers. In general, DOE's analysis is consistent with NEMA's suggestion. Therefore, DOE proposes applying a 12-percent reduction from the efficacy requirement of the PAR30/PAR38 product class to determine the efficacy requirement for the PAR20 product class. For further details regarding the scaling to smaller lamp diameters, see chapter 5 of the TSD.

iii. Voltage

DOE also conducted an analysis to determine how to scale from the less than 125 volt product class to the greater or equal to 125 volt product class. NEMA commented that lamps rated at 130V are almost always used by customers to achieve ''double life'' by operating them at 120V, which results in performance below EPACT 1992 efficacy levels. (NEMA, No. 22 at p. 16) In consideration of the different test procedures for IRL rated at 130V than those rated at 120V, and by using equations from the *IESNA Lighting Handbook*,[27] DOE derived an efficacy scaling factor which would result in equivalent performance of both classes of IRL when operating under the same voltage conditions (as NEMA suggests they most often are). DOE determined that a higher standard for lamps equal to or greater than 125V would result in similar technological requirements and operational efficacies for lamps rated at all voltages. Using published manufacturer literature and the *IESNA Lighting Handbook*, DOE determined that there should be a 15-percent increase in the efficacy standard for lamps rated at 125V or greater. See chapter 5 of the TSD for details of the results and methodology used in the scaling analysis and other aspects of the engineering analysis.

D. Life-Cycle Cost and Payback Period Analyses

This section describes the LCC and payback period analyses and the spreadsheet model DOE used for analyzing the economic impacts of possible standards on individual consumers. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 and appendix 8A of the TSD. DOE conducted the LCC and PBP analyses using a spreadsheet model developed in Microsoft Excel. When combined with Crystal Ball (a commercially-available software program), the LCC and PBP model generates a Monte Carlo simulation [28] to perform the analysis by incorporating uncertainty and variability considerations.

The LCC analysis estimates the impact of a standard on consumers by calculating the net cost of a lamp (or lamp-and-ballast system) under a base-case scenario (in which no new energy conservation standard is in effect) and under a standards-case scenario (in which the proposed energy conservation regulation is applied). As detailed in the March 2008 ANOPR, 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. 73 FR 13620, 13659 (March 13, 2008). As noted in the March 2008 ANOPR, DOE also incorporated a residual value calculation to account for any remaining lifetime of lamps (or ballasts) at the end of the analysis period. 73 FR 13620, 13659 (March 13, 2008). The residual value is an estimate of the product's value to the consumer at the end of the life-cycle cost analysis period. In addition, this residual value must recognize that a lamp system continues 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*.[29]

The payback period is the change in purchase expense due to an increased energy conservation standard, divided by the change in annual operating cost that results from the standard. Stated more simply, the payback period is the time period it takes to recoup the increased purchase cost (including installation) of a more-efficient product through energy savings. DOE expresses this period in years.

The Joint Comment stated that given the inherent uncertainty in the LCC methodology, DOE should recognize that LCC results within a certain range can be considered essentially equivalent. The Joint Comment emphasized that recognizing this uncertainty is especially important if other aspects of the analysis (*e.g.*, energy savings) show large differences for standard levels with LCC results that, given uncertainty in the analysis, are essentially the same. (Joint Comment, No. 23 at p. 22) DOE agrees that there are inherent sources of uncertainty in

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

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

[29] 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: *http://fire.nist.gov/fire/firedocs/build96/PDF/b96121.pdf.*

the results of the LCC analysis due to the need to forecast certain inputs (*e.g.*, future electricity prices). In addition, DOE recognizes that inputs such as sales tax, operating hours, and discount rates may introduce variability in LCC results. However, as explained below, DOE's analyses are structured so as to address such uncertainties. As stated earlier, to properly characterize the LCC results, DOE performed probability analyses via Monte Carlo simulations by utilizing Microsoft Excel in combination with Crystal Ball. The Monte Carlo approach allowed DOE to determine average LCC savings and payback periods, as well as the proportion of lamp installations achieving LCC savings or attaining certain payback values. To fully consider the range of LCC results that may occur due to a standard, DOE also performed several sensitivity analyses on inputs such as operating hours, electricity price forecasts, and product prices. Based on these analyses, DOE believes that it can characterize the LCC and PBP for these products with a reasonable degree of certainty. See the TSD appendix 8B for further details, where probable ranges of LCC results are presented.

Table V.2 summarizes the approach and data that DOE used to derive the inputs to the LCC and PBP calculations for the March 2008 ANOPR and the changes made for today's proposed rule. The following sections discuss these inputs and comments DOE received regarding its presentation of the LCC and PBP analyses in the March 2008 ANOPR, as well as DOE's responses thereto.

TABLE V.2—SUMMARY OF INPUTS AND KEY ASSUMPTIONS USED IN THE ANOPR AND NOPR LCC ANALYSES

Inputs	March 2008 ANOPR	Changes for the Proposed Rule
Consumer Product Price	Applied 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.	Used same methodology from March 2008 ANOPR to derive additional prices for new lamps and ballasts incorporated into the engineering analysis.
Sales Tax	Derived weighted-average tax values for each Census division and large State from data provided by the Sales Tax Clearinghouse.[1]	Updated the sales tax using the latest information from the Sales Tax Clearinghouse.[2]
Installation Cost	Derived costs using the RS Means Electrical Cost Data, 2007[3] to obtain average labor times for installation, as well as labor rates for electricians and helpers based on wage rates, benefits, and training costs.	IRL and GSFL: Updated lamp replacement and lamp and ballast replacement labor rates from 2006$ to 2007$. GSFL: Added 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	Not included	GSFL: Included a recycling cost of 10 cents per linear foot in the commercial and industrial sectors. IRL: No change.
Annual Operating Hours	Determined operating hours by associating building-type-specific operating hours data with regional distributions of various building types using the 2002 U.S. Lighting Market Characterization[4] and the Energy Information Administration's (EIA) 2003 Commercial Building Energy Consumption Survey (CBECS),[5] 2001 Residential Energy Consumption Survey,[6] and 2002 Manufacturing Energy Consumption Survey.[7]	GSFL: Added residential GSFL to LCC analysis and used methodology developed in the March 2008 ANOPR to derive residential operating hours for GSFL based on data in the 2002 U.S. Lighting Market Characterization and the EIA's 2001 Residential Energy Consumption Survey. IRL: Removed industrial sector analysis due to the low prevalence of IRL in that sector.
Product Energy Consumption Rate.	Determined lamp input power (or lamp-and-ballast system input power for GSFL) based on published manufacturer literature. Used a linear fit of GSFL system power on several different ballasts with varying ballast factors in order to derive GSFL system power for all of the ballasts used in the analysis.	Updated 4-foot T8 lamp-and-ballast system input power based on additional published manufacturer literature. Developed new system input powers for 8-foot T12 HO systems, 4-foot T12 residential systems, and 4-foot T5 systems.
Electricity Prices	Price: Based on EIA's 2005 Form EIA–861 data Variability: Regional energy prices determined for 13 regions.	Price: Updated using EIA's 2006 Form EIA 861 data.[8] Variability: No change.
Electricity Price Trends	Forecasted with EIA's Annual Energy Outlook (*AEO) 2007*.[9]	Updated with EIA's *AEO2008*.[10]
Lifetime	Ballast lifetime based on average ballast life of 49,054 from 2000 Ballast Rule.[11] Lamp lifetime based on published manufacturer literature where available. DOE assumed a lamp operating time of 3 hours per start. Where manufacturer literature was not available, DOE derived lamp lifetimes as part of the engineering analysis.	Ballasts: No change in commercial and industrial sector. Developed separate ballast lifetime estimate for the residential sector. Residential GSFL: 4-foot medium bipin lamp lifetime is dependent on the fixture lifetime (*i.e.,* the fixture reaches end of life before the lamp reaches end of life.). Commercial and industrial GSFL: No change. IRL: No change.

TABLE V.2—SUMMARY OF INPUTS AND KEY ASSUMPTIONS USED IN THE ANOPR AND NOPR LCC ANALYSES—Continued

Inputs	March 2008 ANOPR	Changes for the Proposed Rule
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[12] for 1989, 1992, 1995, 1998, 2001, and 2004. Commercial and industrial: Derived discount rates using the cost of capital of publicly-traded firms in the sectors that purchase lamps, based on data in the 2003 CBECS,[13] Damodaran Online,[14] Ibbotson's Associates,[15] the 2007 Value Line Investment survey,[16] Office of Management and Budget (OMB) Circular No. A–94,[17] 2008 State and local bond interest rates,[18] and the U.S. Bureau of Economic Analysis.[19]	DOE updated the commercial and industrial discount rates using the latest versions of the sources used in the March 2008 ANOPR.
Analysis Period	Based on the longest baseline lamp life in a product class divided by the annual operating hours of that lamp.	Commercial and industrial GSFL: No Change. Residential GSFL: Analysis period is based on the useful lifetime of the baseline lamp. IRL: No Change.
Lamp Purchasing Events	DOE assessed five events: Lamp failure, standards-induced retrofit, ballast failure (GSFL only), ballast retrofit (GSFL only), and new construction/renovation.	GSFL: DOE assumed that HO lamps used magnetic ballasts in the base case. DOE added lamp failure, ballast failure/fixture failure, and new construction events for 4-foot medium bipin systems in the residential sector, where DOE also assumed the usage of magnetic ballasts in the base case. IRL: No change.

[1] The four large States are New York, California, Texas, and Florida.

[2] Sales Tax Clearinghouse, Aggregate State Tax Rates (2008)(Last accessed May 30, 2008). Available at: *http://thestc.com/STrates.stm*. The May 30, 2008 material from this Web site is available in Docket # EE–2006–STD–0131. For more information, contact Brenda Edwards at (202) 586–2945.

[3] R. S. Means Company, Inc., 2007 RS Means Electrical Cost Data (2007).

[4] 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: *http://www.eere.energy.gov/buildings/info/documents/pdfs/lmc_vol1_final.pdf*.

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

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

[7] 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: *http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/shelltables.html.*

[8] U.S. Department of Energy, Energy Information Administration, Form EIA–861 for 2006 (2006). Available at: *http://www.eia.doe.gov/cneaf/electricity/page/eia861.html.*

[9] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2007 with Projections to 2030* (Feb. 2007). Available at: *http://www.eia.doe.gov/oiaf/aeo/index.html.*

[10] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2008 with Projections to 2030* (June 2008). Available at: *http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_3.xls*.

[11] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Office of Building Research and Standards, Technical Support Document: Energy Efficiency Standards for Consumer Products: Fluorescent Lamps Ballast Final Rule (Sept. 2000). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/gs_fluorescent_0100_r.html*.

[12] The Federal Reserve Board, Survey of Consumer Finances. Available at: *http://www.federalreserve.gov/PUBS/oss/oss2/scfindex.html.*

[13] U.S. Department of Energy, Energy Information Administration, Commercial Building Energy Consumption Survey (2003). Available at: *http://www.eia.doe.gov/emeu/cbecs/*.

[14] Damodaran Online, *The Data Page: Historical Returns on Stocks, Bonds, and Bills—United States* (2006). Available at: *http://pages.stern.nyu.edu/adamodar*. (Last accessed Sept. 12, 2007.) The September 12, 2007 material from this Web site is available in Docket # EE–2006–STD–0131. For more information, contact Brenda Edwards at (202) 586–2945.

[15] Ibbotson's Associates, Stocks, Bonds, Bills, and Inflation, Valuation Edition, 2001 Yearbook (2001).

[16] Value Line, Value Line Investment Survey (2007). Available at: *http://www.valueline.com.*

[17] U.S. Office of Management and Budget, Circular No. A–94 Appendix C (2008). Available at: *http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html*.

[18] Federal Reserve Board, Statistics: Releases and Historical Data—Selected Interest Rates—State and Local Bonds (2008). Available at: *http://www.federalreserve.gov/releases/h15/data/Monthly/H15_SL_Y20.txt*.

[19] U.S. Department of Commerce, Bureau of Economic Analysis, Table 1.1.9 Implicit Price Deflators for Gross Domestic Product (2008). Available at: *http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N.*

1. Consumer Product Price

As in the March 2008 ANOPR, DOE used a variety of sources to develop consumer equipment prices, including lamp and ballast prices in manufacturers' suggested retail price lists (''blue books''), State procurement contracts, large electrical supply distributors, hardware and home improvement stores, Internet retailers, and other similar sources. DOE then developed low, medium, and high prices based on its findings.

For the NOPR, DOE added several new lamps and ballasts to its analyses. Accordingly, DOE developed prices for 4-foot medium bipin GSFL systems in the residential sector, the 8-foot HO magnetic ballast, and commercially-available 4-foot T5 miniature bipin standard output and high-output lamps and ballasts using the same methodology applied in the March 2008 ANOPR. However, not all lamps assessed for this rulemaking are commercially available. In particular, DOE developed model halophosphor T5 standard-output and high-output lamps as baselines for these product classes. To establish prices for these baseline lamps, DOE calculated the price differential between a halophosphor 4-foot MBP lamp and the highest-efficacy 32W 4-foot MBP lamp. DOE then used this relationship to scale prices from the commercially-available T5 standard-output and high-output lamps to establish the halophosphor lamp prices.

DOE also developed a model IRL for EL1 based on the incorporation of xenon gas into the lamps. To determine the price of these lamps, DOE interviewed manufacturers and conducted its own research on the cost of xenon [30] to develop a manufacturer cost increase over the baseline lamp in a product class, and then applied a markup to represent consumer prices. See the engineering analysis in section V.C.4.b for further information on the model IRL lamp.

DOE also developed a price for the 6,000-hour HIR IRL for the NOPR. After reviewing data in manufacturer catalogs and interviewing manufacturers, DOE determined that the manufacturing costs for the 6,000-hour HIR lamp are the same as the manufacturing costs for the 3,000-hour HIR lamps that meet EL3. Therefore, for the NOPR, the commoditized retail prices for the long-life HIR lamps are the same as for the IRL that meet EL3.

Lastly, because DOE did not have manufacturer suggested retail price list data for the EL5 (HIR Plus) IRL, DOE used prices offered by Internet retailers to establish prices for these lamps. Specifically, DOE calculated individual retailers' discounts on blue book prices for EL4 (Improved HIR) lamps. DOE applied these same discounts to establish average blue book prices for EL5 lamps across all Internet retailers found to sell both EL4 and EL5 lamps. Using these approximate blue-book prices, DOE then followed the same methodology applied in the March 2008 ANOPR to establish low, medium and high lamp prices.

[30] DOE used the information in the following article to obtain the price of xenon: Betzendahl, Richard, ''The Rare Gets More Rare: The Rare Gases Market Update,'' CryoGas International (June 2008) 26.

2. Sales Tax

As in the March 2008 ANOPR, DOE obtained State and local sales tax data from the Sales Tax Clearinghouse. (March 2008 ANOPR TSD chapter 7) The data represented weighted averages that include county and city rates. DOE used the data to compute population-weighted average tax values for each Census division and four large States (New York, California, Texas, and Florida). For the NOPR, DOE retained this methodology and used updated sales tax data from the Sales Tax Clearinghouse [31] and updated population estimates from the U.S. Census Bureau.[32]

3. Installation Costs

As detailed in the ANOPR, DOE considered the total installed cost of a lamp or lamp-and-ballast system to be the consumer product price (including sales taxes) plus the installation cost. 73 FR 13620, 13660 (March 13, 2008). For the commercial and industrial sectors, DOE assumed an installation cost that was the product of the average labor rate and the time needed to install a lamp or lamp and ballast. In the residential sector, DOE assumed that consumers must pay for the installation of a lamp and ballast system. Therefore, the installation cost assumed was the product of the average labor rate and the time needed to install the lamp and ballast system. However, DOE assumed that consumers would install their own replacement lamps and, thus, would incur no installation cost when replacing their own lamp.

DOE received multiple comments on the average labor rates DOE used in the March 2008 ANOPR: $65.35 per hour for an electrician and $42.40 per hour for an electrician's helper. (March 2008 ANOPR TSD chapter 8). DOE assumed that the lamp-and-ballast hourly labor rate is 50 percent of an electrician's rate and 50 percent of the helper's rate, for a total labor rate of $53.88 based on ''RS Means Electrical Cost Data, 2007'' (RS Means).[33] NEMA commented that $53.88 per hour is approximately 10 percent lower than the current labor rate including benefits, while the Joint Comment stated that $54 per hour for ballast change-outs is reasonable only for residential and small commercial customers, and is too high for large commercial customers, who will have a full-time electrician or non-electrician maintenance person on staff for installations. (NEMA, No. 22 at p. 22; Joint Comment, No. 23 at p. 10) ACEEE also commented that large companies may have electricians on staff and encouraged DOE to research labor rates for these workers. (Public Meeting Transcript, No. 21 at pp. 216–217)

[31] Sales Tax Clearinghouse, ''Aggregate State Tax Rates'' (2007) (Last accessed May 30, 2008). Available at: *http://thestc.com/STrates.stm*. The May 30, 2008, material from this Web site is available in Docket #EE–2006–STD–0131. For more information, contact Brenda Edwards at (202) 586–2945.

[32] U.S. Census Bureau, ''Population Change: April 1, 2000 to July 1, 2007'' (July 2007). Available at: *http://www.census.gov/popest/states/files/NST-EST2007-popchg2000-2007.csv*.

[33] R. S. Means Company, Inc., *2007 RS Means Electrical Cost Data* (2007).

DOE understands that there may be a range of labor rates in the market for installations and also clarifies that the March 2008 ANOPR labor rate of $53.88 per hour is for the installation of lamps and ballasts, not only ballasts, as stated in the Joint Comment. ACEEE and the Joint Comment requested that DOE lower the labor rate, while NEMA commented that DOE should raise the labor rate; none of the comments provided DOE with supporting references. 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. Productivity data in RS Means represents an extended period of observations. For this reason, DOE chose to retain for the NOPR the RS Means methodology used for the March 2008 ANOPR. Based on inflation estimates derived from consumer price index data from the U.S. Bureau of Labor Statistics, DOE estimated that this rate in 2007 dollars is $55.41 per hour. DOE also updated the lamp replacement labor rate to be $15.94 per hour in 2007 dollars.

In the March 2008 ANOPR, DOE used several installation times for lamps and ballasts in the commercial and industrial sector analyses, such as the lower bound installation time of 30 minutes for 2-lamp 4-foot medium bipin fixtures, and the upper bound installation time of 60 minutes for 2-lamp 8-foot recessed double contact high-output fixtures. (March 2008 ANOPR TSD chapter 8) These times were obtained from the 2000 Ballast Rule TSD.[34]

DOE received several comments addressing these installation times. GE commented that the 2005 National Electric Code requirements for disconnecting luminaires before they are serviced for lamp or ballast

[34] U.S. Department of Energy, ''Appendix A: Engineering Analysis Support Documentation, 2000 Ballast Rule'' (2000) (Last accessed June 20, 2008). Available at: *http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/appendix_a.pdf*.

replacements and installing luminaire disconnects for new construction or major retrofits will necessitate additional labor time. (Public Meeting Transcript, No. 21 at pp. 218–219; NEMA, No. 22 at p. 22) NEMA recommended that DOE use an installation time of approximately 2 to 3 minutes for luminaire disconnects. Industrial Ecology commented on average installation times during the recent relamping of a school in Atlantic City, NJ, in which an electrician changed ballasts and lamps for 4-lamp and 2-lamp fixtures at the rate of approximately 3 fixtures per hour. (Public Meeting Transcript, No. 21 at p. 220)

DOE agrees that extra time will be needed when a luminaire disconnect must be installed. Because DOE has not received detailed data on other installation times apart from the ones used in the 2000 Ballast Rule, DOE revised the ANOPR installation times specifically to address the time added by the installation of luminaire disconnects. For the NOPR analysis, DOE added 2.5 minutes to the ANOPR installation times for new construction, major retrofits, and renovation, events in which DOE assumed that a luminaire disconnect must be installed. Additional details on installation costs are available in chapter 8 of the NOPR TSD.

4. Disposal Costs

DOE did not consider disposal costs in the March 2008 ANOPR. Industrial Ecology commented that recycling costs should be considered in the LCC analysis for GSFL and that such costs range from 5 cents to 10 cents per foot. (Public Meeting Transcript, No. 21 at p. 212) In response, DOE researched recycling costs for GSFL and found an average cost of 10 cents per linear foot.[35] DOE also explored the prevalence of recycling in the commercial, industrial, and residential sectors. A report released by the Association of Lighting and Mercury Recyclers in 2004 noted that approximately 30 percent of lamps used by businesses and 2 percent of lamps in the residential sector are recycled nationwide.[36] DOE considers the 30 percent commercial and industrial recycling rate to be significant and, thus, incorporates recycling costs into its main analysis. DOE applied a cost of 10 cents per linear foot in the commercial and industrial sectors every time a lamp is replaced during the LCC analysis period. Due to discounting, the inclusion of recycling costs affects the LCC savings of lamps with different lifetimes than the baseline lamps that they are compared to. The recycling cost also affects the residual value of lamps that operate beyond the end of the analysis period. In the Monte Carlo analysis, DOE assumes that commercial and industrial consumers pay recycling costs in approximately 30 percent of lamp failures. DOE does not expect the 2 percent residential recycling rate to affect the residential sector LCC substantially, however, and thus did not apply the recycling costs to this sector.

5. Annual Operating Hours

DOE developed annual operating hours for IRL and GSFL in the March 2008 ANOPR by combining building type-specific operating hours data in the 2002 U.S. Lighting Market Characterization (LMC)[37] with data in the 2003 Commercial Building Energy Consumption Survey (CBECS),[38] the 2001 Residential Energy Consumption Survey (RECS),[39] and the 2002 Manufacturing Energy Consumption Survey (MECS),[40] which describe the probability that a particular building type exists in a particular region. (March 2008 ANOPR TSD chapter 6) DOE received comments on three areas related to the operating hours used for the LCC analysis: (1) Sectors analyzed; (2) regional variations; and (3) building types. These comments are discussed below. For further details regarding the annual operating hours used in the analyses, see chapter 6 of the TSD.

a. Sectors Analyzed

In the March 2008 ANOPR, DOE analyzed GSFL in the commercial and industrial sectors; DOE did not analyze the usage of GSFL in the residential sector because it believed it was a relatively small portion of GSFL sales. The Joint Comment requested that DOE perform an LCC analysis of GSFL in the residential sector, because lamps in the residential sector are replaced infrequently due to lower operating hours compared to the commercial and industrial sectors. (Joint Comment, No. 23 at p. 10) Similarly, NEMA commented that DOE should assess GSFL in the residential sector, because certain ELs may eliminate T12 lamp types, requiring many residential consumers to install new lamp fixtures. (NEMA, No. 22 at p. 32)

In response, DOE assessed the installed stock of lamps using the LMC, which stated that approximately 25 percent of linear fluorescent lamps exist in the residential sector. DOE considers this proportion to be significant and, thus, supports the recommendation to perform a residential LCC analysis of GSFL. DOE developed residential operating hours for GSFL by using data in the 2002 LMC and the 2001 RECS. However, DOE only performed an LCC analysis of 4-foot medium bipin lamps in the residential sector, because marketing literature indicates that 8-foot single pin slimline lamps and 8-foot recessed double contact HO lamps are not prevalent in residential settings.

In the March 2008 ANOPR, DOE analyzed IRL in the commercial, residential, and industrial sectors. (March 2008 ANOPR TSD chapter 6) NEMA commented that IRL should be removed from the industrial sector LCC analysis because they are rarely used in industrial settings. The Joint Comment emphasized the importance of analyzing IRL in the residential sector due to lower operating hours and higher electricity prices for residences compared to prices in the commercial sector. (NEMA, No. 22 at p. 20; Joint Comment, No. 23 at p. 17)

The LMC indicates that less than 1 percent of IRL were found in the industrial sector. Based on this data, DOE agrees with both comments and has removed IRL from the industrial sector in terms of its analyses. Consistent with the March 2008 ANORP LCC analysis, DOE also continued to perform a residential sector LCC analysis of IRL for the NOPR.

b. Regional Variation

At the public meeting for the March 2008 ANOPR, the Alliance to Save

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[35] Environmental Health and Safety Online's fluorescent lights and lighting disposal and recycling Web page—Recycling Costs. Available at: *http://www.ehso.com/fluoresc.php* (Last accessed Dec. 8, 2008).

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

[37] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, ''U.S. Lighting Market Characterization. Volume I: National Lighting Inventory and Energy Consumption Estimate (2002).'' Available at: *http://www.netl.doe.gov/ssl/PDFs/lmc_vol1_final.pdf*.

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

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

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

Energy commented that the LMC, which DOE used during the LCC analysis, may underestimate energy usage in the residential sector because operating hours may vary regionally (*e.g.*, by latitude), even for the same building types. (Public Meeting Transcript, No. 21 at pp. 197–198) In contrast, the Northwest Power and Conservation Council responded that there was a variation of a tenth of an hour per day in operating hours between a study completed in Tacoma, Washington, and a study of California. Therefore, the Council suggested that differences in latitude and weather do not significantly affect operating hours. (Public Meeting Transcript, No. 21 at p. 199)

DOE found no conclusive evidence that would suggest that geographic location has a significant impact on operating hours for a given building type. However, DOE found evidence of regional differences in the proportions of different building types (*e.g.*, number of mobile homes versus number of multi-family dwellings) as the probable source of regional variation in operating hours.[41] As detailed in the March 2008 ANOPR, DOE captured this regional variation by using the RECS, CBECS, and MECS to determine the probability that a particular building type exists in a particular region. 73 FR 13620, 13654 (March 13, 2008). For this reason, DOE has not revised its analysis for the NOPR to specifically address latitude, weather, or other regional factors apart from building type proportions.

c. Building Type

NEMA requested a confirmation that DOE has included retail facilities in its consideration of operating hours, because retail facilities have more operating hours compared to other commercial facilities. (NEMA, No. 22 at p. 20) DOE is aware that different commercial building types have different average operating hours and, thus, considered a variety of commercial building types, including retail facilities, in its analysis. Operating hours were determined using the LMC study. DOE assessed the operating hours for retail facilities for the March 2008 ANOPR (ANOPR chapter 6 of the TSD) and retained the assessment of commercial retail facility operating hours for the NOPR analysis.

[41] E. Vine, D. Fielding, ''An Evaluation of Residential CFL Hours-of-Use Methodologies and Estimates: Recommendations for Evaluators and Program Managers,'' *Energy and Buildings* 38 (2006), 1388–1394.

6. Product Energy Consumption Rate

As in the March 2008 ANOPR, DOE determined lamp input power (or lamp-and-ballast system input power for GSFL) based on published manufacturer literature. (March 2008 ANOPR TSD chapter 5) For GSFL, DOE assessed a variety of lamp-and-ballast combinations by establishing a correlation between ballast factor and system input power. This allowed DOE to derive GSFL system power (in watts) for all of the lamp and ballast combinations used in the analysis. The rated system power was then multiplied by the annual operating hours of the system to determine the annual energy consumption. DOE retained this methodology for this notice.

For this NOPR, DOE updated system input power ratings for certain lamp-and-ballast combinations, and developed new system-input powers for other lamp-and-ballast combinations not considered in the March 2008 ANOPR. Specifically, DOE obtained additional system power ratings for 4-foot T8 ballasts from recently released manufacturer literature and updated these system input power ratings for the NOPR. DOE also developed new system input power ratings for magnetic residential 4-foot T12 systems, magnetic 8-foot HO systems, 4-foot T5 miniature bipin systems, and 4-foot T5 miniature bipin HO systems.

7. Electricity Prices

DOE determined 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. The derivation of prices was based on data in EIA's Form EIA–861. DOE received three comments on the regional electricity prices that it used for the ANOPR LCC. PG&E commented that the California residential electricity price of 9.9 cents per kWh (ANOPR TSD chapter 8) was lower than what appears to be an average of 14 cents per kWh in the State. ACEEE and the Joint Comment recommended that DOE use EIA's publication ''Electric Power Monthly''—as a source of recent electricity prices instead of Form EIA–861. (Public Meeting Transcript, No. 21 at pp. 223–224; Joint Comment, No. 23 at p. 18)

In response, DOE notes that it uses Form EIA–861 for two reasons. First, it allows for the creation of regional average electricity prices weighted by the number of customers each electric utility serves. DOE prefers to use customer-weighted average electricity prices so that prices are not skewed by utilities serving small numbers of very large electricity consumers. Electricity sales are not well correlated with the number of consumers in the commercial sector, and the usage of customer-weighted averages more heavily weights the utilities that serve larger numbers of consumers. Second, ''Electric Power Monthly'' does not report customer-weighted prices. DOE appreciates the comments related to electricity prices, and for the NOPR analysis, DOE updated its electricity prices by using the latest version of Form EIA–861 (2006).[42] DOE notes that the latest Form's updated residential electricity price for California is 14.7 cents per kWh which is consistent with PG&E's assessment that the average residential electricity price in California is around 14 cents per kWh.

8. Electricity Price Trends

To project electricity prices to the end of the LCC analysis period in the March 2008 ANOPR, DOE used the reference, low-economic-growth, and high-economic-growth projections in EIA's *AEO2007*.[43] 73 FR 13620, 13660 (March 13, 2008). DOE received several comments on the resulting electricity price trends that it used in the LCC calculation. PG&E commented that DOE's forecasted electricity prices do not increase in real terms in the next 20 years, which the commenter argued is unrealistic. ACEEE and the Joint Comment both stated that DOE should use the most recent *AEO* forecasts along with a collection of other electricity price forecasts. (Public Meeting Transcript, No. 21 at pp. 224–225; Joint Comment, No. 23 at p. 18)

DOE supports the suggestion that it should use the most recent electricity price forecasts. DOE uses EIA's *AEO* because it is publicly available and has been widely reviewed. The latest *AEO* contains a table of comparisons to three other electricity forecasts; the only forecast that included prices (from Global Insight, Inc.) showed electricity prices very similar to the prices in the *AEO2008* reference case. Also, a conversion of the *AEO2008* forecast into real dollars reveals that *AEO*'s forecasted electricity prices do increase in real terms. For these reasons, DOE chose to continue using the *AEO* and

[42] Energy Information Administration, *Form EIA–861 Final Data File for 2006* (2006) (Last accessed June 20, 2008). Available at: *http://www.eia.doe.gov/cneaf/electricity/page/eia861.html.*

[43] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2007 with Projections to 2030* (Feb. 2007). Available at: *http://www.eia.doe.gov/oiaf/archive/aeo07/index.html.*

the reference case in *AEO2008*.[44] DOE also presents LCC and PBP results for the low-economic-growth and high-economic-growth scenarios from *AEO2008* in appendix 8B of the TSD.

9. Lifetime

a. Ballast Lifetime

In chapter 8 of the March 2008 ANOPR TSD, DOE stated that it used 49,054 hours as the estimated ballast lifetime based on findings in the 2000 Ballast Rule. The Joint Comment suggested three reasons why ballast lifetimes are actually longer than the lifetime used in the 2000 Ballast Rule. The Joint Comment stated that, on average, ballasts operate below their life rating temperature. In addition, manufacturer estimates exceed the DOE lifetime even at rated conditions. The commenter also argued that market data of historical shipments of ballasts sold to new construction versus retrofit and replacement suggest that the average ballast life is longer than suggested. The Joint Comment contends that, in addition to considering the above points generally, DOE should specifically study these shipments to establish ballast lifetime. (Joint Comment, No. 23 at pp. 7–9)

Based on the Joint Comment's suggestions, DOE investigated several different ways of measuring a ballast's useful lifetime in commercial and residential buildings. DOE does not believe that using the rated temperature of ballasts is an appropriate way to measure a ballast's lifetime. For example, a building renovation or a lighting retrofit may cause buildings or homeowners to replace a ballast before it fails. DOE also believes that examining historical sales data of ballasts sold to new construction versus replacement and retrofit to estimate ballast lifetime would involve too many assumptions to provide a useful measure of lifetime. For example, DOE would need to estimate an appropriate distribution of ballast lifetimes in the field because ballasts are replaced at various points in their useful life due to different operating hours, failure rates, and time periods between initial building construction and the first lighting retrofit.

In its investigation of ballast lifetime, DOE encountered several studies that establish the ''measure life'' (*i.e.,* the true service life of a ballast in the field) of ballasts in both the commercial and residential sectors. One study comparing the results of several ''measure life'' reports found that the average ballast lifetime after a retrofit in the commercial sector is 13 years, and the average ballast lifetime after new construction is 15 years.[45] Using DOE's estimate of 49,054 hours and average operating hours for GSFL in the commercial sector, the lifetime of an average ballast is approximately 14.2 years. Because this lifetime is consistent with several measure life reports, DOE maintains the same ballast lifetime of 49,054 hours in its NOPR analysis. DOE also found in a separate measure life report that the average fixture and ballast in the residential sector lasts for 15 years. Therefore, in its residential sector analysis for GSFL, DOE established 15 years as the average ballast lifetime in the residential sector,[46] and an average annual operating lifetime of 789 hours. The ballast's average hours of operation over its service lifetime is therefore 11,835 hours in the residential sector.

b. Lamp Lifetime

When possible, DOE used manufacturer literature to measure lamp lifetimes, as in the March 2008 ANOPR. 73 FR 13620, 13662 (March 13, 2008). When published manufacturer literature was not available (as for some IRL), DOE derived lamp lifetimes as part of the engineering analysis (section V.C.4.b). DOE based its calculations of GSFL lifetime for the base and standards cases on lamp operating times of 3 hours per start in the March 2008 ANOPR LCC analysis. 73 FR 13620, 13662 (March 13, 2008). In comments, NEMA supported the 3 hours per start operating time for both the base and standards cases, but also argued that while lamps are started every 12 hours in commercial and industrial applications, the increasing use of occupancy sensors is leading to shorter start cycles. (NEMA, No. 22 at p. 23) DOE did not receive any other comments about using a GSFL operating time of 3 hours per start. Therefore, DOE retained the assumption of 3 hours per start in the NOPR LCC analysis for both the base and standards cases. In addition, DOE researched the impact of occupancy sensors on start cycle lengths. However, DOE was unable to obtain significant information with which it could quantify this effect.

As in the March 2008 ANOPR, DOE also considered in the NOPR analysis the impact of group re-lamping practices on GSFL lifetime in the commercial and industrial sectors. 73 FR 13620, 13662 (March 13, 2008). DOE assumed that a lamp subject to group re-lamping operates for 75 percent of its rated lifetime, an estimate obtained from the 2000 Ballast Rule.[47] By considering lamp rated lifetimes and the prevalence of group versus spot re-lamping practices, DOE derived an average lifetime for a GSFL. This ranged from 91 percent of rated lifetime for 8-foot single pin slimline lamps to 94 percent of rated lifetime for 4-foot medium bipin lamps. See chapter 8 of the TSD for further details.

As stated above, DOE is using 15 years as the estimated fixture and ballast lifetime in the residential sector for purposes of its analyses. If one calculates the lifetime of the baseline GSFL lamp in the residential sector by dividing the life in hours by the average operating hours of a GSFL in the residential sector (789 hours), one finds that the baseline lamp should live for 19 years. Because the lifetime of the baseline lamp is longer than the average lifetime of a fixture and ballast, DOE assumes that the ballast or fixture lifetime limits the lifetime of an average lamp in the residential sector. DOE is aware that there are certain rooms in residential buildings where GSFL are operated for much longer than 789 hours per year; in particular, GSFL are operated for approximately 1,210 hours per year in kitchens of single-family detached households. Therefore, DOE has conducted the residential sector analysis under average operating hours and high operating hours. Under average operating hours (789 hours per year), DOE assumes that lamp lifetime of the baseline-case and standards-case lamps is limited to 11,835 hours or 15 years, due to a ballast or fixture failure. Thus, in this situation, the lamp failure event does not occur; only the ballast failure event occurs. See section V.D.14 for a description of lamp purchase events.

DOE recognizes that although some consumers do not experience a lamp failure in the residential sector, consumers whose operating hours yield a lamp lifetime that is shorter than that of the fixture or ballast do need to replace their lamp occasionally. DOE

[44] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2008 with Projections to 2030* (June 2008). Available at: *http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_3.xls.*

[45] GDS Associates, Inc., Engineers and Consultants, *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures* (The New England State Program Working Group) (2007).

[46] Economic Research Associates, Inc., and Quantec, LLC., *Revised/Updated EULs Based on Retention and Persistence Studies Results* (Southern California Edison) (2005).

[47] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, ''Energy Conservation Program for Consumer Products: Technical Support Document: Energy Efficiency Standards for Consumer Products: Fluorescent Lamp Ballast Proposed Rule: Appendix A'' (Jan. 2000) A–19.

assumes the shortest lifetime of the baseline lamp, using the highest operating hours for GSFL in the LMC of 1,210 hours per year (as in kitchens), is approximately 12.5 years. When a baseline lamp is replaced at 12.5 years, the fixture and ballast have another 2.5 years of life remaining. DOE assumes that when fixtures or ballasts are discarded, their associated lamps are also discarded at the same time. Therefore, for GSFL in the residential sector, the longest useful life of the baseline replacement lamp would be 2.5 years or 1,972 hours. At the end of this lifetime, the ballast and fixture are replaced. Therefore, for the lamp replacement event for a GSFL in the residential sector in a high operating hours scenario (1,210 hours per year), the lifetime of the baseline lamp is assumed to be 1,972 hours or 2.5 years, and DOE assumes that the ballast failure event does not occur. DOE requests comment on the typical service life of a GSFL in the residential sector.

10. Discount Rates

In the March 2008 ANOPR, DOE derived residential discount rates by identifying all possible debt or asset classes that might be used to purchase replacement products, including household assets that might be affected indirectly. 73 FR 13620, 13663 (March 13, 2008). DOE estimated the average shares of the various debt and equity classes in the average U.S. household equity and debt portfolios using data from the SCFs from 1989 to 2004. DOE used the mean share of each class across the six sample years as a basis for estimating the effective financing rate for replacement equipment. DOE estimated interest or return rates associated with each type of equity and debt using SCF data and other sources. The mean real effective rate across the classes of household debt and equity, weighted by the shares of each class, is 5.6 percent.

For the commercial sector and industrial sector, DOE derived the discount rate from the cost of capital of publicly-traded firms in the sectors that purchase lamps. To obtain an average discount rate value for the commercial sector, DOE used data from CBECS 2003, which provides market-share data by type of owner. Weighting each ownership type by its market share, DOE estimated the average discount rate for the commercial sector to be 6.2 percent. Similarly, the industrial sector discount rate was derived to be 7.5 percent. 73 FR 13620, 13663 (March 13, 2008).

The Joint Comment stated that, in the past, NRDC has argued that a 2 to 3 percent real discount rate should be used in the LCC. (Joint Comment, No. 23 at p. 22) It also stated that ACEEE and others have supported the weighted average cost of capital approach. In general, the Joint Comment stated that if DOE continues with using the weighted cost of capital approach, the agency should make sure its calculations are updated, as current economic conditions will influence agency estimates for discount rates over the analysis period. (Joint Comment, No. 23 at p. 22) In consideration of the above comments (and absent any evidence to the contrary), DOE agrees with ACEEE and others in the Joint Comment that the weighted average cost of capital approach described above is the most accurate way of establishing an appropriate consumer discount rate for the LCC analysis. For this NOPR, DOE was not able to use the most up-to-date information to update the residential discount rate, because the 2007 SCF survey was not available at the time of publication. However, because the rates for various forms of credit carried by households in these years were established over a range of time, DOE believes they are representative of rates that may be in effect in 2012. DOE is not aware of any other nationally representative data source that provides interest rates from a statistically valid sample. Therefore, DOE continued to use the above approach and results for today's proposed rule. According to the Federal Reserve Board Web site, the 2007 SCF survey may be available in the first quarter of 2009.[48] Contingent on this data's release in a timely manner, DOE will attempt to incorporate the 2007 SCF survey in the final rule of this rulemaking.

Despite the limitations associated with its residential analysis, DOE was able to update certain sources used to compute the commercial and industrial sector discount rates. Specifically, DOE applied the 2008 Damodaran Online Data, the 2008 implicit price deflators from the U.S. Department of Commerce, the 2007 Value Line Investment Survey data, information from the 2008 OMB Circular No. A–94, and 2008 State and local bond interest rates. However, DOE continued to use data from CBECS 2003, which provides market-share data by type of owner to obtain an average discount rate value for the commercial sector. DOE is not aware of any other nationally representative data source that provides market-share data by type of owner and, therefore, is continuing to use this source of data in today's proposed rule. DOE computed the new discount rates to be 7.0 percent in the commercial sector and 7.6 percent in the industrial sector. For further details on discount rates, see chapter 8 and appendix 8C of the TSD.

11. Analysis Period

The analysis period is the span of time over which the LCC is calculated. For the March 2008 ANOPR, DOE used the longest baseline lamp life in a product class divided by the annual operating hours of that lamp as the analysis period. 73 FR 13620, 13663 (March 13, 2008). During Monte Carlo simulations for the LCC analysis, DOE selected the analysis period based on the longest baseline lamp life divided by the annual operating hours chosen by Crystal Ball. For the NOPR analysis, DOE retained this methodology for IRL and GSFL in the commercial and industrial sectors. However, for GSFL in the residential sector, the analysis period is based on the useful life of the baseline lamp for a specific event. Specifically, for the lamp replacement event, the analysis period is 2.5 years, and for the lamp and ballast replacement and new construction event, the analysis period is 15 years. DOE requests comment on the analysis period used for the residential sector analysis. See section V.D.9.a of this notice for more information on the useful life of the baseline lamp in all residential sector purchase events.

12. Effective Date

For purposes of DOE's analyses, the effective date is the date when a new standard becomes operative. DOE intends to publish the final rule for this rulemaking in June 2009. 73 FR 13620, 13663 (March 13, 2008). In accordance with sections 325(i)(3) and (i)(5) of EPCA, the effective date of any new or amended energy conservation standard for these lamps shall be 3 years after the final rule is published, which would be June 2012 for this rulemaking. (42 U.S.C. 6295(i)(3) and (i)(5)) DOE performed its LCC analysis based upon an assumption that each consumer would purchase a new product in the year that the standard takes effect.

13. Payback Period Inputs

The payback period (PBP) is the amount of time a consumer needs to recover the assumed additional costs of a more-efficient product through lower operating costs. As in the March 2008 ANOPR, DOE used a ''simple'' PBP for the NOPR, because the PBP does not take into account other changes in operating expenses over time or the time value of money. 73 FR 13620, 13663

[48] *http://www.federalreserve.gov/PUBS/oss/oss2/2007/scf2007home_modify.html.*

(March 13, 2008). 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 (2012 in this case) are needed. 73 FR 13620, 13663 (March 13, 2008).

14. Lamp Purchase Events

In the March 2008 ANOPR, DOE described five types of events that would prompt a consumer to purchase a lamp. 73 FR 13620, 13664 (March 13, 2008). These events are described below along with changes for the NOPR analysis. Of particular note, DOE conducted a number of new analyses for the NOPR which assessed lamp failure, ballast failure, and new construction events for residential sector GSFL. In addition, though described primarily in the context of GSFL, lamp purchase events can be applied to IRL as well. However, considering that IRL are generally not used with a ballast the only lamp purchase events applicable are lamp failure (event I) and new construction and renovation (event V).

- *Lamp Failure* (Event I): This event reflects a scenario in which a lamp has failed (spot relamping) or is about to fail (group re-lamping). In the base case, identical lamps are installed as replacements. In the standards case, the consumer installs a standards-compliant lamp that is compatible with the existing ballast. When a standards-compliant lamp for that ballast is not available, the consumer purchases a new lamp and ballast. For the NOPR, DOE added a residential sector GSFL lamp failure event.
- *Standards-Induced Retrofit* (Event II): This event occurs when a consumer realizes that its T12 lamp will fail in the near future and installs a standards-compliant lamp and ballast. In the base case, the consumer would have installed only a new lamp. This event applies only to T12 commercial and industrial users because there are certain lamp standard levels that a T12 cannot meet. This event does not apply to T12 residential users because these users would not proactively replace their T12 system before the T12 lamp fails.
- *Ballast Failure* (Event III): In the March 2008 ANOPR, DOE assumed that failed ballasts would be replaced with electronic ballasts because standards set by the 2000 Ballast Rule and EPACT 2005 ban the sale of magnetic 4-foot medium bipin and 8-foot single pin slimline ballasts beginning in 2010. 73 FR 13620, 13664 (March 13, 2008). NEMA commented that the 2000 Ballast Rule allows the continued sale of residential magnetic ballasts as well as magnetic cold-temperature ballasts, which operate a large portion of the installed base of T12 recessed double contact high-output lamps. (NEMA, No. 22 at p. 20) In response, DOE has assumed that failed magnetic HO ballasts would be replaced with magnetic ballasts in the base case for the NOPR analysis. DOE also assumed that magnetic ballasts would be purchased in the event of a ballast or fixture failure in the residential sector base case for the NOPR analysis because residential systems are commonly T12 magnetic systems currently. In addition, standards established in the 2000 Ballast Rule and the Energy Policy Act of 2005 (EPACT 2005, Pub. L. 109–58) will allow magnetic ballasts to continue to be sold in the residential sector after 2010. See the engineering analysis (section V.C) for further details.
- *Ballast Retrofit* (Event IV): This event applies only to T12 users because, according to industry experts, the majority of ballast retrofits occur for consumers with T12 systems. Consumers retrofitting their ballasts commonly do so to save energy, and T8 systems are generally more efficacious than T12 systems.
- *New Construction and Renovation* (Event V): This event encompasses all fixture installations where the lighting design will be completely new or can be completely changed. The scenario applies only to baseline lamps that are usually used in new construction and renovation (4-foot T8 lamps, 4-foot T12 lamps in the residential sector, 8-foot single pin slimline T8 lamps, and 8-foot recessed double contact HO T12 lamps). For the NOPR analysis, DOE assumed that 4-foot T8 lamps with electronic ballasts would be chosen during the new construction and renovation event for the 4-foot T12 residential baseline.

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

1. General

DOE's NIA assesses the national energy savings (NES) and the national net present value (NPV) of total customer costs and savings that would be expected to result from new standards at specific efficacy levels.

DOE uses the NIA spreadsheets to calculate energy savings and NPV based on the annual energy consumption and total installed cost data employed in the LCC analysis. DOE forecasts the energy savings, energy cost savings, equipment costs, and NPV for each product class from 2012 through 2042. The forecasts provide annual and cumulative values for all four output parameters. DOE also examines impact sensitivities by analyzing various lamp shipment scenarios (such as Roll-up and Shift).

DOE develops a base-case forecast for each analyzed lamp type which characterizes energy use and consumer costs (lamp purchase and operation) in the absence of new or revised energy conservation standards. To evaluate the impacts of such standards on these lamps, DOE compares the estimated base-case projection with projections characterizing the market if DOE did promulgate new or amended standards (*i.e.*, the standards case). In characterizing the base and standards cases, DOE considers historical shipments, the mix of efficacies sold in the absence of any new standards, and how that mix might change over time.

Inputs and issues associated with the NIA are discussed immediately below.

a. Overview of NIA Changes in This Notice

Based on the comments it received on the March 2008 ANOPR, DOE made a number of changes to the NIA. Table V.3 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the March 2008 ANOPR, as well as the changes it made for this notice. Following the table, DOE details those inputs and the changes, and summarizes and responds to each of the NIA-related comments it received. See TSD chapters 10 and 11 for further details.

TABLE V.3—APPROACH AND DATA USED TO DERIVE THE INPUTS TO THE NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE ANALYSES

Inputs	2008 ANOPR description	Changes for the proposed rule
Shipments	Annual shipments from shipments model	See Table V.4 and Table V.5.

TABLE V.3—APPROACH AND DATA USED TO DERIVE THE INPUTS TO THE NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE ANALYSES—Continued

Inputs	2008 ANOPR description	Changes for the proposed rule
Stock of lamps	Established based on the projected 2011 lamp stock, the service life of lamps and/or ballasts, and the annual shipments. The 2011 stock is based on historical shipments and projected shipments from 2006 to 2011. (See ANOPR TSD chapter 10, shipments analysis.).	Established based on 2005 lamp stock, rather than 2011. Considered market penetration of emerging technologies. See Table V.4 and Table V.5 for additional detail.
Effective date of standard	2012	No change.
Analysis period	2012 to 2042	No change.
Unit energy consumption (kWh/yr).	Established in the energy-use characterization, ANOPR TSD chapter 6, by lamp or lamp-and-ballast design and sector.	No change.
Total installed cost	Established in the product price determination, ANOPR TSD chapter 7 and the LCC analysis, ANOPR chapter 8, by lamp-and-ballast designs.	Added costs of retrofit kit and labor for replacing a 8-foot SP slimline system with two 4-foot MBP systems.
Electricity price forecast	*AEO2007* forecasts (to 2030) and extrapolation for beyond 2030. (See ANOPR TSD chapter 8.).	Updated for *AEO2008*.
Energy site-to-source conversion.	Conversion varies yearly and is generated by *AEO2007* forecasts (to 2030) of electricity generation and electricity-related losses. Conversion factors for beyond 2030 are extrapolated.	Conversion varies yearly and is now generated by DOE/EIA's NEMS program (a time-series conversion factor; includes electric generation, transmission, and distribution losses). Conversion factors for beyond 2030 are held constant.
HVAC interaction savings	6.25 percent of total energy savings in the commercial sector.	No change.
Rebound effect	1 percent of total energy savings in the commercial and industrial sectors. 8.5 percent of total energy savings in the residential sector.	No change.
Discount rate	3 and 7 percent real	No change.
Present year	Future costs and savings are discounted to 2007	No change.

2. Shipments Analysis

Lamp shipments are an important input to the NIA. In the March 2008 ANOPR, DOE followed a four-step approach to forecast shipments for GSFL and IRL. 73 FR 13620, 13668 (March 13, 2008). First, DOE used NEMA's historical shipment data from 2001 to 2005 to estimate total historical (NEMA members and non-NEMA members) shipments of each analyzed lamp type in the commercial, industrial, and residential sectors. Second, using these historical shipments, DOE linearly extrapolated shipments to 2011. Then, based on average service lifetimes, DOE estimated a stock of lamps in 2011 for each lamp type. Next, DOE forecasted lamp (and ballast for GSFL) shipments from 2012 to 2042 (the NIA analysis period) based on four market events: (1) New construction; (2) ballast failure (GSFL only); (3) lamp replacement; and (4) standards-induced retrofit (for the standards case). Lastly, because these shipments depend on lamp and lamp-system properties (*e.g.*, lifetime and lumen output), DOE developed base-case and standards-case market-share matrices. These matrices determine the forecasted technology mixes in the lamp stock and shipments.

Table V.4 and Table V.5 summarize the approach and data DOE used for GSFL and IRL, respectively, to derive the inputs to the shipments analysis for the March 2008 ANOPR, as well as the changes DOE made for the NOPR. A discussion of the inputs and the changes follows.

TABLE V.4—APPROACH AND DATA USED TO DERIVE THE INPUTS TO GSFL SHIPMENTS ANALYSIS

Inputs	2008 ANOPR description	Changes for the proposed rule
Historical shipments	2001–2005 shipment data provided publicly by NEMA. Assumed NEMA data represented 90 percent of GSFL shipments.	Calibrated 2006–2007 forecasted shipments based on confidential historical shipment data NEMA provided for those years.
Lamp inventory	Calculated lamp inventory in 2011 by linearly projecting NEMA's 2001–2005 historical shipment data. Then used growth and shipment assumptions to establish lamp inventory from 2012 to 2042.	Did not use linear projections; calculated stock in 2005. Then used growth, emerging technologies, and shipment assumptions to establish lamp inventory from 2006 to 2042.
Growth	Shipment growth driven by lumen demand. Lumen demand projected from historical CBECS commercial floor space growth.	Based commercial and residential growth on *AEO2008* estimates for future floor space growth. For the residential sector, modeled variations in number of lamps per new home. For the industrial sector, projected floor space growth using MECS.
T5 lamps	Not included	Shipments modeled by assuming T5 lamps used in new construction and in conversions from 4-foot medium bipin, 8-foot SP slimline, and 8-foot RDC HO.

TABLE V.4—APPROACH AND DATA USED TO DERIVE THE INPUTS TO GSFL SHIPMENTS ANALYSIS—Continued

Inputs	2008 ANOPR description	Changes for the proposed rule
T12 ballasts	Assumed no T12 magnetic ballasts shipped after 2009 for 8-foot SP slimline and 4-foot MBP lamps. Did not consider T12 electronic ballasts for 8-foot SP slimline and 4-foot MBP lamps.	Assumed no T12 magnetic ballasts shipped after 2010 for commercial 4-foot MBP and 8-foot SP slimline. Also assumed 4-foot MBP and 8-foot SP slimline electronic T12 ballasts shipped through 2042. For 8-foot T12 RDC HO and residential 4-foot T12 MBP, assumed magnetic ballasts are shipped through 2042.
Sectors analyzed	Commercial and industrial	Included residential sector in analysis.
Base-case emerging technologies.	None included	Developed two base-case scenarios, one of which modeled the market penetration of LEDs based on projected payback period.
Market share matrices	Developed product distributions based on interviews and catalog data.	Revised product distributions based on comments, subsequent interviews, and further catalog research.
Standards case scenarios	Shift and Roll-up scenarios analyzed. Assumed all consumers will attempt to maintain lumen output by either moving to lower ballast factors or reduced-wattage lamps in the standards case.	Revised the Shift and Roll-up scenarios. Developed a standards-case scenario (Market Segment-Based Lighting Expertise scenario) to characterize consumers who, based on lighting expertise, will not migrate to lower ballast factors or reduced-wattage lamps to maintain lumen output.

TABLE V.5—APPROACH AND DATA USED TO DERIVE THE INPUTS TO IRL SHIPMENTS ANALYSIS

Inputs	2008 ANOPR description	Changes for the proposed rule
Historical shipments	2001–2005 shipment data provided publicly by NEMA. Assumed NEMA data represented 85 percent of IRL shipments.	Calibrated 2006–2007 projected shipments based on confidential historical shipment data NEMA provided for those years.
Lamp inventory	Calculated stock in 2011 by linearly projecting NEMA's 2001–2005 historical shipment data. Then used growth assumptions to establish lamp inventory from 2012 to 2042.	Did not use linear projections; calculated stock in 2005. Then used growth and emerging technologies assumptions to establish lamp inventory from 2006 to 2042.
Growth	Shipment growth driven by socket growth. Socket growth projected from historical CBECS commercial floor space and RECS residential building growth.	Based growth on *AEO2008* estimates for future commercial floor space and residential buildings. Also accounted for trend of increasing sockets per home.
Sectors analyzed	Commercial and residential	No change.
Base case reflector compact fluorescent lamps (R–CFL) and emerging technologies.	Assumed 0 percent stock penetration in 2012 and 50 percent stock penetration in 2042.	Developed two base-case scenarios modeling the market penetration of LED, CMH, and R–CFL based on projected payback period.
Market share matrices	Considered mix of technologies consumers select in the base case and standards case, as well as each of the scenarios analyzed.	Revised market-share matrices to reflect its changes in the scenarios analyzed and engineering analyses.
Standards-case scenarios	Modeled the Roll-up scenario.	Modeled both Roll-up and Shift scenarios.
	Analyzed two standards-case sensitivity scenarios: One modeling consumer movement to exempted BR lamps and another modeling a 10 percent increase in lumen output. Did not consider additional migration to R–CFL in the standards case.	Revised BR lamp sensitivity scenario, creating two new standards-case scenarios also accounting for additional migration to R–CFL: "Product Substitution" and "No Product Substitution."

a. Lamp Inventory

In the March 2008 ANOPR, DOE linearly extrapolated NEMA's historical lamp shipments from 2005 to 2011 to establish a 2011 installed stock of GSFL and IRL using each lamp's average service lifetime. In its written comments, NEMA argued that DOE's linear extrapolation approach does not account for market dynamics and is vulnerable to certain temporal biases inherent in NEMA's historical data. For example, if a new product was introduced and rapidly gained market share during this historical shipment period, a linear extrapolation based on this data could exaggerate the growth rate of this product in future years. Likewise, any new products introduced would be excluded from the future results. For example, Philips noted at the public meeting that because DOE extrapolated shipment data from 2001 to 2005 to establish its lamp stocks, it may have discounted migration to T5 lamps, which have only started to grow in the last couple of years. Thus, the commenter argued that DOE may have overstated the 2011 stock of some types of lamps (*e.g.*, T8 lamps), while understating others (*e.g.*, T5 lamps). (NEMA, No. 22 at pp. 23–25, 31; Public Meeting Transcript, No. 21 at p. 246)

On the other hand, NEMA suggested that a linear extrapolation is sometimes appropriate for lamps with small and stable market shares, such as 8-foot T8 recessed double contact HO lamps. However, for large and variable product classes, NEMA urged DOE to model lamp types against specific economic factors and technical relationships. (NEMA, No. 22 at p. 24)

DOE agrees that a linear extrapolation may generally be too limited in its application, and that lamp shipment forecasts from 2006 to 2011 should incorporate both market dynamics and macroeconomic factors. Therefore, DOE is no longer using a linear extrapolation from historical data. Instead, for this NOPR, DOE calculated an installed stock of lamps in 2005 and applied growth, replacement rate, and emerging technologies assumptions to develop shipments estimates from 2006 to 2042. In addition, DOE received confidential shipment information from NEMA for 2006 and 2007, and, when possible, calibrated the shipments model to match that information. The assumptions used to develop shipment forecasts are discussed in the following sections.

b. Shipments Growth

To develop the shipments models for both GSFL and IRL, DOE applied several growth rate assumptions. In the March 2008 ANOPR, DOE modeled GSFL shipments from 2012 to 2042 by projecting lumen growth based on lumen demand serviced by each lamp type in the commercial and industrial sectors. For IRL, DOE projected shipments through 2042 based on growth in the number of sockets using IRL in the commercial and residential sectors. DOE based forecasted lumen and socket growth for GSFL and IRL on historical residential building growth from RECS and historical commercial and industrial floor space growth from CBECS and MECS.

DOE received a number of comments in response to its growth rate methodology. The majority of these comments fell into three categories: (1) The limits of basing lamp stock growth on historical floor space growth; (2) the increasing number of lamps per household; and (3) the wider spacing of more-efficient light fixtures. Below is a discussion of those comments. For further details regarding GSFL and IRL growth rate assumptions, see TSD chapter 10.

i. Floor Space and Building Growth

NEMA stated that the commercial and residential growth rates DOE used in the March 2008 ANOPR (based on total floor space from CBECS in RECS) have likely led to an overstatement of lamp shipments and stock, given the deteriorating economy. (NEMA, No. 22 at pp. 23–24) DOE understands NEMA's concerns and no longer establishes its commercial and residential growth from historical floor space growth. Instead, for this NOPR, DOE modeled commercial floor space and residential buildings growth based on *AEO2008*, which estimates year-to-year commercial floor space and residential building growth. Because *AEO2008* takes into account future trends in economic growth, DOE was able to incorporate forecasts of macroeconomic conditions in its growth forecast. However, because *AEO* does not provide industrial floor space forecasts, DOE used historical MECS floor space values to establish a growth rate for the industrial sector.

ii. Lamps per Household

The Joint Comment stated that DOE's growth forecasts omitted an important factor driving IRL sales: a trend toward an increasing number of recessed fixtures per home in new construction and existing home renovation. Because this trend is excluded from DOE's analysis, which assumed growth based on floor space growth, the Joint Comment argued that IRL shipments are likely understated. NEMA also stated that it has seen a trend toward increasing light points per home. To address this development, the Joint Comment recommended DOE obtain additional data on sales trends of these lamps and not assume recessed socket growth was directly proportional to floor space growth. The Joint Comment, PG&E, and ACEEE cited several studies supporting this claim. (Joint Comment, No. 23 at p. 17; Public Meeting Transcript, No. 21 at pp. 287–288; NEMA, No. 22 at p. 31)

DOE agrees with the Joint Comment that the increasing popularity of recessed fixtures in new homes will drive IRL sales growth faster in the residential sector. New homes are likely to install more IRL than those installed in older homes, and older homes may be renovated to include more recessed cans and, thus, more reflector lamps. Therefore, DOE conducted an analysis that estimated the average number of recessed cans in homes between 2005 and 2042. Using California data [49] on recessed cans per home broken out by home age, DOE assumed new homes constructed after 2005 would install the same number of recessed cans as homes constructed between 2001 and 2005. DOE also assumed that half of the homes constructed before 2001 would be renovated by 2042 to have an equal number of recessed cans as newly constructed homes. DOE estimated the distribution of homes by age using U.S. Census data [50] on new building starts in the residential sector. DOE estimated new construction and the number of future homes constructed in each year from *AEO2008*. Using this data, DOE estimated that the average number of recessed cans per home in 2005 was 4.82, and the average number of recessed cans per home in 2042 will be 8.52. As noted above, DOE also agrees with NEMA that growth rates should include forecasts of economic conditions. Therefore, to estimate the growth rate in each year, DOE multiplied the number of recessed cans in homes by the projected stock of homes according to *AEO2008*. Combining these two sources, DOE predicts an average growth rate of sockets of 2.6 percent between 2006 and 2042, compared to the 1.6 percent DOE estimated in the March 2008 ANOPR.

DOE estimated the GSFL growth rate in the residential sector using a methodology similar to that which it employed for IRL in the residential sector. Instead of using the number of recessed cans per home by home age, DOE used the number of T8 and T12 lamps by home age. Again, DOE assumed that the same number of T8 and T12 lamps per home would be installed in new homes as those installed between 2001 and 2005, and that half of homes built before 2001 would be renovated by 2042 to have the same number of T8 and T12 lamps as newly constructed homes. DOE estimated that the average number of T8 and T12 lamps per home in 2005 was 4.5, and the average number in 2042 will be 4.7. Combining this growth estimate with *AEO2008*'s projected growth in the residential home stock yields an average growth rate of 1 percent between 2006 and 2042 for GSFL in the residential sector. Compared to IRL, the lower GSFL growth rate reflects the lower growth rate of T8 and T12 lamps per home versus recessed cans. (In the March 2008 ANOPR, DOE did not consider the residential sector for GSFL.)

iii. Wider Spacing of More-Efficient Fixtures

In its written comments, NEMA suggested that DOE should assume a slower growth rate in the commercial building IRL socket base to account for wider spacing of lighting fixtures and/or greater use of high-output systems. (NEMA, No. 22 at p. 31) While DOE appreciates NEMA's comment, it was unable to find (and the commenter did not provide) any information related to wider spacing between fixtures, and, therefore, DOE did not change growth estimates to account for this potential effect.

[49] RLW Analytics, Inc., ''California Statewide Residential Lighting and Appliance Efficiency Saturation Survey'' (August 2005) (Last accessed on Sept. 29, 2008). Available at: *http://www.calresest.com/docs/2005CLASSREPORT.pdf.*

[50] U.S. Census Bureau, Manufacturing and Construction Division, ''New Privately Owned Housing Unit Starts'' (2008) (Last accessed on Sept. 29, 2008). Available at: *http://www.census.gov/const/startsan.pdf.*

c. Base-Case Scenarios: Emerging Technologies and Existing Technologies

In the March 2008 ANOPR, DOE estimated that by 2042 R–CFL and emerging technologies, (*e.g.*, such as LED lamps, and ceramic metal halide (CMH) lamps) would compose 50 percent of IRL sockets in the installed base. 73 FR 13620, 13670 (March 13, 2008). For IRL, DOE accounted for the impact of emerging technologies by deducting their market share in each year over the analysis period from the installed base of lamps, effectively reducing the size of the market affected by the standards proposed in this rulemaking. In the March 2008 ANOPR, DOE did not account for any penetration of emerging technologies into the GSFL market, and requested comment on if and how it should incorporate their effects into its analyses.

DOE received several comments on its consideration of emerging technologies. NEMA argued that the performance improvements of CMH will drive the technology's market penetration into the GSFL market. NEMA also asserted that LED lamps could displace GSFL shipments to some extent by 2042. (NEMA, No. 22 at pp. 24–26) As for emerging technologies in the IRL market, NEMA commented that LED lamps could also displace shipments of IRL to some extent by 2042, particularly in the residential sector. NEMA stated that the shift from halogen IRL to CMH is already occurring in the retail market. Industrial Ecology stated that an integrated PAR CMH lamp would be expected to replace other IRL PAR lamps in the commercial retail market. (NEMA, No. 22 at pp. 24–26; Public Meeting Transcript, No. 21 at pp. 307–309) NEMA argued that these emerging technologies will significantly affect future lamp shipments and reduce the NPV results of standards for both GSFL and IRL. To more accurately forecast the impact of emerging technologies, NEMA suggested that DOE should examine historical price and performance points of R–CFL, as well as product cycles for other advanced technology equipment. (NEMA, No. 22 at pp. 24–26) Industrial Ecology suggested that DOE should use semiconductor industry data to assess the manufacturing capacity for solid state lamps. (Public Meeting Transcript, No. 21 at p. 311–312)

DOE agrees that emerging technologies could penetrate GSFL and IRL markets and significantly affect shipment forecasts and NIA results. Therefore, for the NOPR, DOE has revised its analysis of emerging technologies within the IRL market and now accounts for emerging technologies within the GSFL market as well. These emerging technologies already are, or eventually will likely be, significantly more efficacious and longer lasting than the lamps they replace. However, to calculate the energy savings and NPV benefits due to the penetration of an emerging technology, DOE must accurately forecast the anticipated price and performance points of the individual technologies—a difficult and highly speculative task. Forecasts related to emerging technologies are inherently uncertain because they depend upon assumptions about future price, efficacy, and utility, none of which can be verified. Therefore, for the NOPR, DOE has chosen to analyze *two* base-case scenarios for both GSFL and IRL: (1) Existing Technologies, and (2) Emerging Technologies. DOE believes evaluating two base-case scenarios more completely characterizes the inherent uncertainty of the market penetration of the technologies and the consequent impact on NPV and NES. Incorporating emerging technologies in the base case does not affect the relative benefits of each TSL and prevents uncertain projections of market share, price, or performance from obscuring the benefits derived from more-efficient GSFL and IRL alone.

For these base-case scenarios, DOE estimated the market penetration of three specific technologies into the projected installed stock: (1) LED lamps; (2) CMH lamps; and (3) reflector CFL. In general, the Existing Technologies scenario only considers the market penetration of technologies that are currently readily available and have reached maturation in terms of price and efficacy. Specifically, DOE considers R–CFL in the Existing Technologies scenario within the IRL market. For GSFL, no technologies other than those covered by this rulemaking were analyzed in the Existing Technologies scenario. (DOE considers the migration to T5 lamps, a covered product, separately, as discussed in section V.E.2.d.)

In the Emerging Technologies scenario, DOE attempts to forecast the market penetration of mature technologies *and* those technologies that are still undergoing significant changes in price and efficacy. Specifically, DOE considered the market penetration of R–CFL, LED lamps, and CMH lamps in the Emerging Technologies scenario.

DOE generally followed a 5-step process for each scenario to estimate the market penetration of the analyzed technologies and account for their impact on NES and NPV. (Sector- and technology-specific aspects of DOE's methodology are described below and in TSD chapter 10.)

First, DOE developed price, performance, and efficacy forecasts for each of the analyzed technologies. DOE's methodology in generating these forecasts for each analyzed technology is described below. Second, using those estimates, DOE calculated the payback period (PBP) of each technology in the relevant sector using the difference between its purchase price, annual electricity cost, and annual lamp replacement cost relative to the lamp it replaces. (See TSD chapter 10 for further details.) Third, DOE used a relationship between PBP and market penetration to predict the market penetration of each technology in the relevant sector in every year from 2006 to 2042. Generally, lower PBP of a given lamp technology results in a greater predicted market penetration of that technology. DOE used a 5-year average of the market penetrations predicted by the relationship as its final market penetration. The 5-year average represents the time DOE assumed it takes products with lower PBPs to penetrate the market. Fourth, when necessary, DOE applied a scaling factor to the predicted market penetration to account for observed market trends. Fifth, DOE reduced the projected installed stock of covered products in each year by the value that corresponded to the highest level of market penetration achieved in each year by one of the analyzed technologies. Thus, the inclusion of R–CFL and other lamps using emerging technologies in the base case have the effect of lowering the energy savings of a potential new standard. For those covered lamps remaining, the cost-effectiveness of LCC savings and, thus, the relative cost effectiveness of each TSL is not affected.

Because the lamps employing emerging technologies are beyond the scope of the rulemaking, they are not considered design options to improving IRL or GSFL efficacy, but rather they may substitutes for the lamps covered in this rulemaking. In the Emerging Technologies base case, DOE uses its prices projections effectively as inputs into its shipments forecasts of its covered products, rather than forecasts of shipments of lamps employing the emerging technologies themselves. In this way, the price projections of the analyzed lamps using emerging technologies indirectly affect the NPV of the present rulemaking, despite not being a direct input into equipment prices. As stated previously, to acknowledge the uncertainty of price forecasts for lamps using emerging technologies, DOE models two base-case scenarios.

i. General Service Fluorescent Lamps

For the Existing Technologies scenario, DOE believes that no mature technologies in the current market show the potential to significantly penetrate the GSFL market. (T5 lamps, previously considered an emerging technology, are now a covered product class.) Therefore, for the Existing Technologies scenario, DOE considered only the fluorescent technologies already covered by this rulemaking. Thus, except for the addition of T5 lamps, the Existing Technologies base case in this NOPR is the same as the base case in the March 2008 ANOPR.

In the GSFL Emerging Technology scenario, however, DOE separately considered the potential market penetration of two technologies: (1) LEDs (into the commercial, residential, and industrial sectors); and (2) CMH (into the commercial and industrial sectors).

For its analysis of LED market penetration, DOE found a commercially-available retrofit kit that included a LED replacement for a 4-foot medium bipin system. DOE used the retrofit kit as a current baseline from which to project future cost, efficacy, and price points. DOE interviewed an integrated circuit manufacturer to develop cost estimates for LED driver circuits. For cost estimates of other components, DOE used prices of existing LED products already on the market, which it modified in accordance with cost data and efficacy projections from DOE's Solid State Lighting Multi-Year Program Plan.[51] Lastly, using markup based on currently-available LED lamps, DOE was able to develop price and efficacy projections for the LED luminaire in the retrofit kit.[52] Following the 5-step process described above, DOE calculated a 41 percent market penetration rate of LED lamps into the 4-foot GSFL commercial sector by 2042. DOE assumed LED lamps penetrated only the new construction, renovation, and fixture replacement markets because these lamps would require their own specific fixtures. In the residential sector, the LED option did not have a low enough payback period to result in any market penetration.

DOE also analyzed the potential penetration of CMH into the GSFL market. DOE first estimated current CMH prices using a methodology similar to the methodology it used to estimate GSFL and IRL prices, as described in the product price determination. (See TSD chapter 7.) Industry experts informed DOE that CMH efficacies and lifetimes would increase over the next several years while prices would remain constant. Applying these lifetime and efficacy projections DOE compared CMH replacements to GSFL systems. As a result, DOE assumed no market penetration of CMH because it found that T5 lamp systems (standard output and high output) would always be less costly and more efficacious than projected CMH replacements. Given this information, DOE believes that it is likely that migration to CMH (from the GSFL market) will be dominated by the migration to standard-output and high-output T5 lamps.

ii. Incandescent Reflector Lamps

As with GSFL, DOE considered two base case scenarios for IRL: Existing Technologies and Emerging Technologies. Because DOE believes that R–CFL is a mature technology with relatively stable price points and efficacies, DOE considered R–CFL penetration into the residential market in the Existing Technologies scenario. In contrast, for the Emerging Technologies scenario, DOE considered the market penetration of R–CFL, LED, and CMH lamps in both the residential and commercial sectors. DOE separately calculated the penetration of each technology into the IRL stock by using the 5-step process described above.

For R–CFL, DOE developed price forecasts based on historical pricing trends of CFL and R–CFL, using a methodology similar to the methodology DOE used to estimate GSFL and IRL prices, as described in the product price determination. (See TSD chapter 7.) DOE assumed no future change in efficacy. Using this data, DOE found the market penetration predicted by the PBP relationship. However, PG&E argued that R–CFL are not always suitable substitutes for IRL because they lack dimming capabilities and their beam width is too broad. (Public Meeting Transcript, No. 21 at pp. 289, 321) Industrial Ecology commented that dimmable R–CFL do in fact exist, while PG&E noted that these lamps have little market share. (Public Meeting Transcript, No. 21 at pp. 291, 321) DOE agrees that R–CFL may not always be appropriate substitutes for IRL, due to differences in form factor, beam spread, color quality, size and dimming capability. DOE observed that the actual market penetration of CFL replacements for A-line incandescent lamps thus far has been approximately 40 percent of the penetration predicted by the PBP-penetration relationship. Therefore, DOE applied these same scaling-factor reductions of 40 percent and 36 percent in calculating the market penetration of R–CFL into the IRL market for the residential and commercial sectors, respectively.

For LED and CMH lamps in the IRL market, DOE developed price and efficacy forecasts using a methodology similar to the one described above for GSFL. DOE did not apply the scaling factor reduction to the predicted LED and CMH market penetration rates that it used for the R–CFL analysis. DOE believes the substitutability problems that arise when R–CFL replace IRL do not apply when LED and CMH replace IRL.

By the methodology described, DOE arrived at market penetration values (and market size reductions) for each base-case scenario. For the Existing Technology scenario, 2042 R–CFL penetration reached 38 percent in the residential sector and 20 percent in the commercial sector. (This was the highest market penetration because it was the only technology analyzed for the scenario.) For the Emerging Technology scenario, LED reached the highest market penetration of any analyzed technology in both the residential sector and the commercial sector. DOE's analysis found LED lamps could penetrate 40 percent and 82 percent of the IRL installed stock by 2042 in the residential and commercial sector, respectively. DOE's results support a comment by Industrial Ecology stating that emerging technologies will enter the commercial market first. (Public Meeting Transcript, No. 21 at p. 308) This effect occurs because there are higher installation and operating costs in the commercial sector relative to the residential sector, resulting in lower PBPs and faster migration to emerging technologies. Again, DOE used these results to effectively reduce the size of the IRL market for its analysis.

d. Fluorescent Market Sectors Analyzed

In the March 2008 ANOPR, DOE modeled both the commercial and industrial market sectors to generate GSFL shipments forecasts. DOE received several comments on its decision not to model the residential sector.

[51] *Multi-Year Program Plan FY'09 to FY'14: Solid-State Lighting Research and Development* (March 2008). Available at: *http://www.netl.doe.gov/ssl/PDFs/SSLMYPP2008_web.pdf.*

[52] Because they are based on an existing LED retrofit kit, DOE's projections did not consider innovations in form factor on OLED tyechnology which could improve the possible payback period for solid-state lighting technologies.

GE commented that DOE should model the residential sector because it makes substantial use of less-efficacious T12 lamps, which could be effectively eliminated by new standards. GE estimated that by 2012, roughly 20 percent of GSFL shipments will be T12 lamps, and more than half of those will go to residential consumers. PG&E stated that California codes only recently required higher-efficacy lamps in new construction; therefore, 4-foot T12 lamps with magnetic ballasts remain a large part of the residential installed stock. (Public Meeting Transcript, No. 21 at pp. 276–279)

The Joint Comment asserted that a separate analysis for the residential sector is unnecessary; however, the Joint Comment recommended that residential applications should be accounted for in DOE's LCC analysis based on the proportion of lamp sales, operating hours, and electric rates. The Joint Comment stated DOE should use caution in apportioning all sales through do-it-yourself (DIY) stores, such as Home Depot and Lowe's, to the residential sector. (Joint Comment, No. 23 at p. 10) PG&E and NEMA commented that approximately 20 percent of DIY business is commercial. (NEMA, No. 22 at p. 30; Public Meeting Transcript, No. 21 at p. 290)

DOE agrees that it should model the residential sector to more accurately capture overall consumer behavior and the market impact of standards. DOE calculated the initial residential stock of 4-foot medium bipin T12 lamps using the lamps sold through the DIY distribution chain, which accounted for approximately 25 percent of NEMA's historical shipments. Next, DOE assumed 20 percent of those DIY sales went to small commercial consumers, with the remaining 80 percent apportioned to the residential sector. As a result, DOE assumed 20 percent of all 4-foot medium bipin shipments went to the residential sector and all of those were T12 lamps.

From those shipments, DOE calculated the residential installed stock and then modeled new construction, renovation, and fixture/ballast replacement in the same manner described in section 0. DOE assumed that in the base case, a portion of consumers will continue to purchase 4-foot T12 magnetic systems, while the remaining consumers will choose to purchase higher-efficacy 4-foot T8 and 4-foot T12 electronic systems. Overall, the number of 4-foot T12 systems installed in the residential sectors is relatively constant over the analysis period. For more details regarding DOE's assumptions in the residential sector, please see chapter 10 of the TSD.

e. GSFL Product Migration

DOE received many comments on its assumptions characterizing how consumers will migrate among different GSFL products. These comments were primarily focused on the movement away from T12 systems and the migration toward T5 systems, topics discussed in detail below.

i. Ballast Rule Effective Start Date

NEMA commented that the 2000 Ballast Rule does not ban T12 magnetic ballasts in the commercial sector until June 2010. This means these ballasts will be available through the end of 2010, and not 2009 as DOE's model had assumed, because some T12s will remain in the distribution chain for a period of months after the rule takes effect. Therefore, NEMA argued, DOE should expect T12 lamps to continue to be shipped beyond 2022, the year DOE projected the lamps will phase out. (NEMA, No. 22 at p. 25, 28) DOE agrees with NEMA that commercial sector magnetic ballasts will continue to be available through 2010 and has revised its model accordingly to better reflect the timing of the 2000 Ballast Rule's effective start date of amended standards. According to the revised model, DOE estimates that the majority of banned magnetic T12 ballasts will be eliminated from the installed stock by 2025. However, as discussed below, the inclusion of T12 electronic ballasts results in T12 lamps being shipped throughout the analysis period.

ii. Four-Foot Medium Bipin T12 Lamp Replacements

In the March 2008 ANOPR, DOE assumed that 100 percent of 4-foot T12 systems would be replaced by 4-foot T8 systems upon ballast failure. This assumption was made in consideration of the 2000 Ballast Rule, which effectively banned most 4-foot T12 medium bipin magnetic ballasts. 10 CFR part 430.32(m)(5) DOE received several comments related to this assumption and the implications for DOE's GSFL shipments analysis.

Stakeholders generally agreed that DOE's base-case assumption was too optimistic in terms of the migration from 4-foot T12 to 4-foot T8 systems. The comments provided two reasons why consumers would be expected to maintain T12 electronic ballasts and not migrate to T8 lamps. First, because the installed stock is dominated by T12 lamps, it is unlikely all consumers would switch to T8 lamps upon repurchase, especially when spot re-ballasting. Some commercial sector consumers would be expected to use another T12 lamp and ballast to maintain visual consistency with other lamps in a room. Second, the Joint Comment noted that residential low-power-factor ballasts are not subject to the 2000 Ballast Rule, meaning legal ballasts compatible with T12 lamps will continue to exist. 10 CFR part 430.32(m)(7)(iii). Similarly, Osram Sylvania made the same point and commented that 4-foot T12 medium bipin magnetic ballast systems are common in the residential sector. Osram Sylvania added that some fixtures include electronic ballasts and are marketed as being capable of operating T12 lamps, which could perpetuate T12 usage. NEMA added that cold temperature ballasts for 8-foot T12 RDC high output lamps are still allowed under the rule as well. (Public Meeting Transcript, No. 21 at pp. 248–251, 276, 281; NEMA, No. at pp. 25, 28; Joint Comment, No. 23 at p. 7)

The stakeholders did differ slightly on the appropriate replacement rates that DOE should assume. The Joint Comment recommended DOE assume 5 to 10 percent of the commercial market and a higher proportion of the residential market will purchase T12 lamp and ballast systems upon ballast failure, with the remainder migrating to T8 systems. (Joint Comment, No. 23 at p. 7) GE estimated that about 20 percent of the currently installed base of T12 lamps will be replaced by T12 lamps, while the other 80 percent will migrate to T8 lamps. (Public Meeting Transcript, No. 21 at pp. 250–252) NEMA suggested that DOE should assume that in 2022, T12 lamps will compose at least 10 percent of the 4-foot lamp market, 40 percent of the 8-foot single pin slimline market, and over 90 percent of the RDC HO market. (NEMA, No. 22 at p. 28)

After careful consideration of these comments, DOE has decided to modify its assumption regarding the rate of migration from T12 to T8 lamps. Accordingly, DOE is using NEMA's estimates to recalibrate its shipment forecasts. DOE now agrees that not all 4-foot T12 lamps would be replaced by T8 systems upon ballast failure. Thus, for this NOPR, DOE assumed 90 percent (down from 100 percent) of 4-foot T12 systems will be replaced with T8 systems and 10 percent with T12 systems. According to DOE's estimates in 2022, T12 lamps will comprise nearly 20 percent of the 4-foot medium bipin market, 25 percent of the 8-foot single pin slimline market, and 93 percent of the 8-foot recessed double contact HO market. (See TSD chapter 10.) DOE notes that these estimates do not exactly align with NEMA's suggestions, because they incorporate several other phenomena in addition to the migration to T12 electronic systems (*e.g.*, growth rate, emerging technologies, T5 penetration, 8-foot SP slimline to 4-foot MBP conversions).

iii. Eight-Foot Single Pin Slimline T12 Lamp Replacements

For its shipments forecasts in the March 2008 ANOPR, DOE assumed that 90 percent of the 8-foot T12 single pin systems would be replaced with two 4-foot T8 systems, and 10 percent would be replaced by 8-foot single pin T8 systems. In its written comments, NEMA generally agreed with DOE's assumption but provided slightly different replacement rate: NEMA suggested that DOE should assume 80 percent of the 8-foot T12 single pin lamps would be replaced by two 4-foot T8 lamps and 20 percent by 8-foot T8 lamps. (NEMA, No. 22 at p. 28) ACEEE and the Joint Comment argued that DOE's assumption that 90 percent of the 8-foot market would switch to 4-foot lamps is much too high, particularly because the current stock is dominated by T12. The Joint Comment also stated that DOE should include some electronic T12 system ballast purchases, as in the case of 4-foot T12 lamps. (Public Meeting Transcript, No. 21 at pp. 254–255; Joint Comment, No. 23 at p. 7)

Based on its consideration of the above comments, DOE revised its estimated conversion rates for 8-foot single pin slimline systems in this NOPR. In line with the Joint Comment and NEMA's recommendations, DOE lowered its conversion rates to 4-foot MBP systems. In addition, consistent with NEMA's suggestion, DOE has included a conversion to electronic 8-foot T12 SP slimline systems. DOE now assumes 80 percent of the 8-foot T12 single pin lamps would be replaced by two 4-foot MBP T8 systems, with the remaining 20 percent split evenly between 8-foot T8 and electronic 8-foot T12 SP slimline systems.

iv. Four-Foot T5 Lamps

In the March 2008 ANOPR, DOE did not analyze 4-foot miniature bipin T5 standard output (SO) and high output (HO) lamps as covered product classes. As discussed in section A.1.b above, for this NOPR, DOE is proposing to cover both T5 SO and T5 HO lamps as additional, distinct product classes. The following describes the methodology DOE used to generate shipments of these lamps.

To establish the 2005 installed stock of T5 lamps, DOE first estimated 2001-to-2005 shipments based on assumptions derived from its market research and supported by manufacturer interviews. Market literature indicated that T5 lamps represented 2 percent of the 2004 GSFL market, a figure DOE assumed for its analysis. DOE's research also indicated that the combined market share of T5 SO and HO lamps was growing as a percentage of the overall GSFL market. Additionally, in interviews, manufacturers provided insight on the proportions of T5 lamp sales that are standard output and high output. Using these assumptions, DOE generated historical shipment estimates for 2001 to 2005, which it used to calculate the initial stock of SO and HO lamps in the same manner it does for all other GSFL product classes. Finally, DOE received confidential aggregated (both SO and HO) T5 lamp shipment data from NEMA for 2001 to 2007. DOE used this data to validate its installed stock estimates.

In general, after establishing the 2005 T5 SO and HO installed stocks, DOE modeled shipment growth based on a migration from other product classes. For T5 SO lamps specifically, DOE's research indicated that shipment growth of these lamps is primarily driven by a migration from the 4-foot MBP market. In addition, because 4-foot T5 MiniBP SO systems require a different fixture than 4-foot MBP systems, T5 systems would be unlikely to penetrate the ballast-only replacement market. Therefore, to establish T5 standard output shipments, DOE allotted a portion of the 4-foot MBP fixture replacement, renovation, and new construction markets to 4-foot T5 MiniBP systems. To do this, DOE first calculated the size of this potential market for new T5 SO systems in each year. DOE then determined the portion of this market that would actually be serviced by T5 SO lamps by calculating the share that resulted in T5 shipments consistent with 2006 and 2007 historical data. DOE held the resulting percentage (approximately 12.5 percent) constant throughout the analysis period. As a result of the inclusion of 4-foot T5 MiniBP lamps eroding part of the 4-foot MBP market, estimates of total 4-foot MBP lamp shipments are lower in the NOPR than in the ANOPR. Using this methodology, in the base case Emerging Technologies scenario, DOE forecasts T5 SO shipments of 15.0 million in 2008, 24.2 million in 2012, and 47.4 million in 2025 (56.2 million in 2025 in the base-case Existing Technologies scenario).[53]

For T5 HO lamps, after establishing the installed stock in 2005 in the same manner as with T5 SO lamps, DOE developed 4-foot T5 MiniBP HO lamp shipments by modeling a migration from two different lighting markets. Marketing literature indicated, similar to 8-foot RDC HO systems, a large portion of 4-foot MiniBP T5 HO systems serve high-bay (ceilings higher than 20-feet high) applications due to their highly-concentrated light output. Historical shipment data for 8-foot RDC HO lamps showed substantial declines in 2006 and 2007, indicating T5 HO lamps may be rapidly displacing them. In addition, DOE's research indicated that a significant portion of 4-foot T5 HO growth can be attributed to a penetration into the high intensity discharge (HID) lamp high-bay and low-bay markets. Therefore, to calculate the growth in 4-foot MiniBP T5 HO lamp shipments, DOE assumed that these systems were penetrating both the 8-foot RDC HO and HID markets. Similar to its analysis for T5 SO systems, DOE established that the fixture replacement, renovation, and new construction market segments represent the available market for T5 HO systems. DOE obtained HID shipment data from the 2004 HID determination,[54] from which DOE calculated the total lumens servicing low-bay and high-bay applications. Then, consistent with historical T5 and 8-foot RDC HO shipments, DOE assumed T5 HO would fully penetrate the 8-foot RDC HO new construction, renovation, and fixture replacement markets, as well as the HID new construction and renovation market. Using this methodology, DOE forecasts T5 HO shipments of 14.0 million in 2008, 23.6 million in 2012, and 46.1 million in 2025.

For further details on shipment forecasts of 4-foot T5 lamps, see chapter 10 of the TSD. DOE seeks public comment on its analysis of the 4-foot T5 SO and HO markets, as well as its shipment results.

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[53] As discussed earlier, DOE models two base-case shipment scenarios: Existing Technologies and Emerging Technologies. Because the Emerging Technologies scenario models the potential substitution of GSFL systems with lamps that incorporate emerging technologies (such as LED), the Emerging Technologies scenario generally results in fewer shipments of GSFL. However, based on price and technology advancement projections, DOE estimated that these emerging technologies will not likely significantly penetrate the GSFL market until after 2012.

[54] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, ''Energy Conservation Program for Commercial and Industrial Equipment: High-Intensity Discharge Lamps Analysis of Potential Energy Savings'' (Dec. 2004). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/hid_energy_savings_report.pdf*.

3. Base-Case Market-Share Matrices

DOE's market-share matrices are another important input into the shipments analysis and NIA. Within each product class, DOE considers the mix of technologies from which consumers can choose. These choices are represented in market-share matrices, which apportion market share for lamp stocks (in 2012) or lamp shipments (after 2012). Because shipments depend on lamp lifetime and system lumen output assumptions, among other inputs, DOE allocated market shares to each of the lamp technologies for the base case and standards case. The matrices enable the shipment model to capture a migration to different lamps, or, for GSFL, lamp-and-ballast designs, over time in both the base and standards cases. Issues related to these market-share matrices are discussed below.

a. General Service Fluorescent Lamps

A ballast factor measures the actual lumen output of a lamp-and-ballast system relative to a reference system. A lower ballast factor will, all else equal, lead to lower lumen output, and proportionally less energy consumption than the reference system. ACEEE commented that the ballast factor of 0.75 that DOE used in the market matrices is fairly uncommon and that manufacturers are now marketing lower ballast factors, including 0.7, 0.69, and 0.68. Therefore, ACEEE expects a bigger jump from normal to low ballast factor than the 0.78–0.75 jump that DOE assumes in its market-share matrices presented in the ANOPR. The Joint Comment noted that 0.71 represents the mid-point of very low ballast factors on the market. (Public Meeting Transcript, No. 21 at pp. 262–263; Joint Comment, No. 21 at p. 10) Consistent with changes incorporated in the engineering analysis, DOE incorporated a 0.71 ballast factor ballast option in the NIA. In sum, DOE attempts to match as closely as possible the lumen output of the retiring system and the replacement system. To the extent that a lower ballast factor can achieve the appropriate lumen output, it is incorporated into the technology choices facing consumers.

Regarding the base-case 4-foot T8 medium bipin market-share matrix, Industrial Ecology commented that DOE was incorrect to assume 0 percent market share for the 25W lamp in 2012. Because thousands of these lamps are being sold in 2008, that estimate should be much greater than zero. (Public Meeting Transcript, No. 21 at p. 261) The Joint Comment stated that 30W lamps are being displaced by 25W and 28W options. Therefore, DOE's 30W market share assumptions—4 percent in 2012 and 15 percent in 2042—are too large. The Joint Comment suggested that DOE should substantially reduce the market share of 30W lamps and split those sales between 25W and 28W lamps. (Joint Comment, No. 23 at p. 10)

NEMA commented on the same market-share matrix, stating that the market share for T8 lamps in the 2042 base case should be less than 30 percent for 32W lamps and greater than 30 percent for 25W lamps, with the rest of the market composed of 28W and 30W lamps. (NEMA, No. 22 at p. 28)

DOE considered the submitted comments and modified its base-case 4-foot T8 medium bipin market-share matrix accordingly. Based on a confidential NEMA survey of market shares of 4-foot medium bipin lamps, in 2012, DOE allocated 4 percent, 4 percent, and 2 percent of the 4-foot T8 market share to 25W, 28W, and 30W lamps, respectively, for the revised NOPR base-case market-share matrices. In 2042, DOE allocated 32 percent, 27 percent, and 14 percent market to 25W, 28W, and 30W lamps, respectively. See chapter 10 of the NOPR TSD for the full market-share matrices in 2012 and 2042.

b. Incandescent Reflector Lamps

In the March 2008 ANOPR, DOE presented market-share matrices for both residential and commercial IRL. For the commercial sector, the base-case IRL market-share matrix apportioned market share of the stock to only halogen and the standard HIR (currently EL2) lamps. Although DOE received no comments from stakeholders, DOE modified these matrices for the NOPR to reflect changes made in the engineering analysis. For the NOPR, the base case market-share matrix for commercial IRL now allocates market share to all currently commercially-available lamp technologies, including improved halogen, long-life HIR, and the silverized reflector technology. DOE believes this revised distribution better reflects product availability and consumer purchasing trends because they include all covered lamp technologies currently being sold.

4. GSFL Standards-Case Shipment Scenarios and Forecasts

In the March 2008 ANOPR, DOE modified its base-case market-share matrices to account for two standards-case scenarios and to generate shipment forecasts. DOE considered a Roll-up scenario and a Shift scenario, described below. DOE also introduced voluntary standards-induced retrofits in the standards case. DOE received several comments on the scenarios it analyzed and its rate of voluntary retrofits. In response to those and related comments, DOE is modifying its Shift and Roll-up scenarios and introducing new standards-case scenarios. These scenarios are discussed in detail below and in TSD chapter 10.

a. Shift/Roll-Up Scenarios

In the March 2008 ANOPR, DOE modeled lower-bound and upper-bound energy conservation scenarios for the GSFL standards-case NIA to characterize the range of energy savings that may result from standards. 73 FR 13620, 13671 (March 13, 2008). In the standards-case NIA for GSFL and commercial IRL, DOE first modeled a lower-bound energy conservation scenario called the Roll-up scenario. 73 FR 13620, 13671 (March 13, 2008). This scenario assumes that consumers owning lamps or systems that do not meet the new standards will ''roll up'' to the lowest first-cost option available (preserving lumen output if possible) when purchasing standards-compliant lamps. (March 2008 ANOPR TSD chapter 9) The Roll-up scenario also assumes that consumers already owning standards-compliant lamps or systems will continue to purchase those lamps or systems.

DOE also modeled a Shift scenario in the March 2008 ANOPR for the GSFL NIA, in which DOE assumed that consumers are driven by both lamps cost and energy savings. In this case, consumers may purchase a variety of lamps or systems that are more efficacious than their base case systems. (73 FR 13620, 13671 (March 13, 2008); March 2008 ANOPR TSD chapter 9) Specifically, consumers who purchase products in the base case at above-minimum standard levels will ''shift up'' to even higher efficacy standard levels in the Shift scenario. DOE used this scenario to illustrate upper-bound energy savings.

The Joint Comment argued that both the Roll-up and Shift scenarios understate standards-case energy savings, but the Roll-up scenario is more unrealistic because standards change the relative economics of more-efficient products. (Joint Comment, No. 23 at p. 11) In other words, standards would eliminate the least-efficacious lamps (which usually have the lowest first costs), thereby reducing the cost premium of high-efficacy lamps relative to the lowest first-cost available lamp. According to the commenter, that would encourage some consumers to purchase lamps above the standards. The Joint Comment also argued that new standards would encourage manufacturers to promote more efficacious products, a market dynamic not sufficiently captured by either scenario. (Joint Comment, No. 23 at p. 11)

The Joint Comment further stated that the Shift scenario reflects a more realistic consumer response to standards than the Roll-up scenario. Historically, for example, some consumers have purchased systems that are more efficacious than minimum standards. Still, the Joint Comment argued, the Shift scenario does not fully capture the spread of efficiencies in a standards-compliant market and fails to characterize manufacturer efforts to hasten development of more-efficient lamps and systems. The Joint Comment argued that DOE's scenarios should anticipate voluntary programs and manufacturer interest in establishing more-efficient product lines in the standards case. (Joint Comment, No. 23 at pp. 11, 22)

Regarding the comment about the relative economics of lamp purchases, DOE agrees that the relative first-costs change in the standards case (*i.e.*, the up-front cost differential between the least-cost, standards-compliant lamp and a more-efficient lamp) is less than in the base case. This effect is one of the reasons DOE models a Shift scenario. Still, DOE does not believe that this effect implies that the Shift scenario is necessarily more viable than the Roll-up scenario. Although the relative up-front economics change between cost and efficacy, they may not change between cost and income, meaning some consumers—particularly those not concerned about energy savings—may focus on the absolute costs at the time of purchase. A consumer's lighting budget, for example, will not necessarily increase simply because there is a smaller cost premium for a more-efficacious lamp. In sum, DOE cannot be certain which scenario is more likely, and, thus, continues to model both scenarios.

However, DOE agrees that revisions to the Shift scenario may better capture the spread of efficiencies in the market. Therefore, DOE revised its Shift scenario for the NOPR to more closely retain the existing (baseline) efficacy distribution in the standards case. (See TSD chapter 11 for the revised Shift scenario efficacy distribution results.) However, as the standard becomes more stringent, DOE has maintained its approach of incrementally accumulating market share of the lamp stock at TSL5 and not projecting some to move beyond what now characterizes the maximum technologically feasible standard level (''max-tech''). It is not possible for DOE to model a spread of efficiencies above max-tech levels. DOE has interviewed manufacturers and concluded it cannot reasonably predict future price and performance points of technologies yet to be developed for the market. DOE seeks comment and supporting data on whether the Roll-up or Shift scenario is more appropriate.

b. Lighting Expertise Scenarios

In its written comments, NEMA stated that it considers the Shift scenario implausible because the scenario assumes consumers will ''aggressively'' migrate to lower-ballast-factor ballasts. NEMA strongly disagreed with DOE's assumption that more-stringent efficacy standards are significantly correlated with lower GSFL ballast factors (particularly at CSLs 3, 4, and 5), and NEMA argued that it had seen no direct and demonstrated causal relationship between them in its experience. Further, NEMA argued that there is no proven correlation between new potential GSFL standards and the future mix of ballast factor values that will occur; therefore, NEMA reasoned that DOE should not apply such a correlation in its standards-case market-share matrices. NEMA also commented that new standards-compliant GSFL and their ballasts would have to be interoperable across manufacturers and with a wide range of existing ballasts and luminaires. Therefore, more-stringent efficacy standards would mostly yield greater lumen output, rather than decreasing lamp wattage. As such, NEMA argued, DOE has overreached in building a case for standards set at higher efficacy levels by inappropriately and arbitrarily assuming a strong correlation between increasing efficacy and decreasing ballast factor views. (NEMA, No. 22 at p. 26, 27)

NEMA also commented that the most direct way to use the efficacy improvements imposed by the standards is to use fewer luminaires to attain the same delivered light level on the work surface while reducing the total wattage. However, NEMA maintains that this is not a practical possibility because, even for new construction or major renovation projects, the spacing of luminaires is dictated by a building and ceiling system grid. Thus, there is no opportunity to take advantage of additional lumens that might result from standards by re-spacing existing luminaires, which must continue to operate on high-volume ballast designs. (NEMA, No. 22 at p. 26) Based on these arguments, NEMA strongly asserted that moving beyond CSL1 and CSL2 for a lamp-only rulemaking is ill-advised. (NEMA, No. 22 at p. 26, 27)

DOE has carefully considered NEMA's comments on DOE's assumption of a general trend toward lower-BF ballasts over the analysis period. In response, DOE undertook an extensive literature review and analysis—discussed below—to better characterize the likelihood of consumers migrating to lower-BF ballast systems if higher efficacy standards are required. DOE assessed the lighting expertise of groups of consumers, described below, who make lighting purchase decisions. DOE assumes that consumers with ''high'' lighting expertise will be sufficiently educated about ballast factors and lamp efficacy to migrate to lower-ballast-factor ballasts when lower wattage lamps are not available in the standards case. That is, these consumers will seek to maintain light output in the replacement purchase.

To analyze this issue, DOE first characterized the lighting market supply chain in the commercial and residential sectors and identified the decision makers within each one (*e.g.*, contractors, homeowners). DOE broke down each sector by the principal events that prompt lamp purchases: (1) Ballast failure; (2) retrofit; (3) fixture replacement; (4) renovation; and (5) new construction. DOE assigned probabilities reflecting each decision maker's likelihood of making the lighting purchase decision given the purchase event. For example, in purchase events driven by new construction, DOE assumed lighting designers, architects, and electrical engineers make 70 percent of the decisions, owners make 20 percent, and electrical contractors make the remaining 10 percent. DOE then analyzed the likelihood of each decision maker choosing to run a lamp on a lower BF ballast if forced by standards to purchase a more-efficacious lamp. DOE described that likelihood with a probability that was based on the technical expertise and motivation of the decision maker. Within each purchase event, DOE multiplied the likelihood of each market actor making the decision by the likelihood of that actor choosing a lower-BF ballast. In this way, DOE derived an estimate for the likelihood of a lower-BF ballast being selected for each event in each sector in the standards case.

DOE assumed the commercial and industrial sectors behave similarly with respect to ballast factor choices, and no distinction was made between them in this analysis. Additionally, decision makers in the large-commercial sector can be different agents making different decisions than those in the small-commercial sector. In the market segments (purchase events) where DOE found consumer behavior to be substantially different between these subsectors, DOE weighted the relative impact of each subsector when characterizing the overall commercial market. Table V.6 presents the results of DOE's analysis for the commercial and residential sectors. The values depict the probability that lamps purchased in each event will be matched with lower-ballast-factor ballasts, if necessary, to maintain lumen output. For example, 78 percent of lamps purchased in new construction in the commercial sector will be paired with lower-ballast-factor ballasts, if no reduced-wattage lamps are available in the standards case,

TABLE V.6—MARKET SEGMENT-BASED LIKELIHOOD OF HIGH LIGHTING EXPERTISE

Lamp purchase event	Probability	
	Commercial (in percent)	Residential (in percent)
Renovation	69	48
New Construction	78	61
Retrofit	92	0
Ballast Replacement	8	0
Fixture Replacement	34	0

In light of NEMA's comments and DOE's analysis, DOE used these results to add a second set of standards-case scenarios to characterize ballast factor migration in the GSFL NIA. DOE now also analyzes a High Lighting Expertise scenario and a Market Segment-Based Lighting Expertise scenario. These scenarios characterize consumers' decisions (or lack thereof) when purchasing a more-efficient lamp to either maintain previous lumen output or accept higher lighting levels. For its part, the High Lighting Expertise scenario uses the same methodology as DOE used in the ANOPR. The High Lighting Expertise scenario generally characterizes more sophisticated lighting decisions in which consistent lighting levels and/or energy savings play a determining role in consumer behavior. In this scenario, consumers are more likely to choose a lower-ballast-factor ballast to pair with higher-efficacy lamps. Conversely, in the Market Segment-Based scenario, DOE assumed consumers often accept higher lighting levels as a consequence of higher-efficacy lamps. As a consequence, these consumers do not achieve the same energy savings as would be possible by migrating to lower-ballast-factor ballasts. DOE used this analysis, and the results shown in Table V.6, to characterize the Market Segment-Based expertise scenario. On the other hand, in the High Lighting Expertise scenario, DOE assumes all consumers (100 percent) migrate to lower-ballast-factor ballasts when appropriate. Please see TSD appendix 10B for more details.

c. Voluntary Retrofits

In the March 2008 ANOPR, DOE assumed that more-stringent efficacy standards would lead to higher T12 lamp prices, and, in turn, higher rates of voluntary retrofits from T12 to more-efficacious T8 lamps. For example, DOE assumed that CSL1 would drive an additional 10 percent of the T12 market to voluntarily migrate to T8 lamps, that CSL2 would drive an additional 20 percent, that CSL3 would drive an additional 30 percent, and so on. These commercial standards-induced retrofits involve consumers voluntarily discarding their functioning T12 ballasts, and purchasing new T8 ballasts in the standards case. In contrast, in the base case, these consumers would have utilized the entirety of their T12 ballast lifetime.

At the public meeting, ACEEE agreed with DOE's assumption that standards will accelerate voluntary retrofits, but argued that DOE's retrofit rate was too aggressive. ACEEE specifically stated that the 50-percent retrofit rate per year at CSL5 was too high and suggested a rate of roughly half that level. (Public Meeting Transcript, No. 21 at p. 282) GE agreed that DOE's retrofit rates were too high, suggesting that 10 percent at CSL1 is an appropriate starting point, but 25 percent should probably be the maximum assumed retrofit rate at CSL5. Using those rates as the minimum and maximum, GE said DOE could scale the rate for the other CSLs. (Public Meeting Transcript, No. 21 at pp. 282–283) In its written comments, NEMA similarly stated that DOE's conversion rate for consumers voluntarily retrofitting from T12 to T8 systems is likely overstated. NEMA suggested that DOE should use a voluntary retrofit rate of 20 to 25 percent for CSL5 and recommended that other rates be adjusted based on that percentage. (NEMA, No. 22 at p. 28)

At the public meeting, Philips also commented that it would expect utilities to be more aggressive with their rebate programs in the standards case than they would be in the base case. PG&E stated that voluntary retrofits are driven by many factors, including attention to global climate change, increased product availability, and other factors, not necessarily utility rebate programs. (Public Meeting Transcript, No. 21 at pp. 273–275)

DOE considered these comments and maintains that these standards-induced retrofits are a likely phenomenon and important to model in the NIA. DOE agrees that its initial retrofit assumptions were likely too high, particularly for the higher efficacy levels. For the NOPR, consistent with comments received, in the commercial sector DOE continued to assume that EL1 would drive an additional 10 percent of the T12 market per year to voluntary retrofit to T8 lamps. DOE also assumed a 25-percent retrofit rate at EL4 and EL5, levels at which all T12 lamps are effectively eliminated from the market. For TSL1, TSL2, and TSL3, DOE changed the standards-induced retrofit rates to 10 percent, 15 percent, and 20 percent, respectively.

Similar to DOE's approach in the commercial sector, DOE also included increased migration of residential consumers from 4-foot medium bipin T12 systems to T8 systems. As discussed in chapter 10 of TSD, DOE assumed in the base case that residential consumers replacing their T12 fixture (either due to fixture failure or ballast failure) would purchase another T12 system. In contrast, in the commercial sector, DOE assumes 90 percent of 4-foot MBP consumer replace their T12 ballasts with T8 ballast upon fixture or ballast failure in the base case. In addition, while in the commercial sector DOE assumed, under amended energy conservation standards, some consumers would retrofit their working T12 ballast systems before end of ballast life, DOE assumed residential consumers never do so. Instead, in the residential sector, DOE incorporated an additional migration to T8 lamps only when the consumer is confronted with a ballast or fixture failure. In such situations DOE assumed that a certain percentage residential consumers, who in the base case would purchase a new T12 system, would instead, in the standards case, elect to purchase a T8 system—despite the availability of T12 options. Specifically, based on manufacturer interviews, DOE shifts 25 percent, 35 percent, and 65 percent of these consumers to T8 systems at TSL1, TSL2, and TSL3, respectively (thereby reflecting increased cost of T12 lamps). At TSL4 and TSL5, all residential consumers migrate to T8 systems because T12 lamps would be effectively eliminated from the market.

5. IRL—Standards-Case Shipment Scenarios and Forecasts

In the March 2008 ANOPR, DOE modified its market-share matrices to account for standards-case scenarios and generate shipment forecasts for IRL. DOE created one main shipment scenario and two sensitivity scenarios to characterize how IRL consumers would be expected to react to standards in the commercial and residential sectors. The sensitivity scenarios were called the ''65W BR Lamp Substitution'' scenario and the ''10-Percent Lumen Increase'' scenario. For all three standards-case scenarios in these sectors, DOE assumed that consumers whose base-case lamp purchase has an efficacy lower than that of the standard would roll up to the least efficacious lamp design available. Any IRL consumer whose base-case lamp purchase meets the efficacy standard would remain unaffected.

In the main shipment scenario, DOE made two assumptions: (1) Consumers who purchase covered IRL technology in the base case continue to purchase covered IRL technology in the standards case (*i.e.*, the total number of installed covered IRL in the base case is the same as that in the standards case throughout the analysis period); and (2) in the standards case, consumers purchase higher-efficacy lamp designs with equivalent lumen output as their base-case lamps.

The remaining sensitivity scenarios modeled two situations—one in which consumers may migrate from regulated IRL toward the exempt 65W BR lamps in the standards case (termed ''65 Watt BR lamp substitution''), and another in which a portion of residential consumers of IRL buy a more-efficacious lamp at the same wattage as in the base case (termed ''10-percent lumen increase''). This sensitivity scenario assumed consumers would, on average, purchase 10 percent more lumens in the standards case. As explained below, DOE received several comments on the March 2008 ANOPR standards-case IRL shipments. In response to those and related comments, DOE is modifying and introducing new standards-case scenarios, discussed in detail below and in TSD chapter 10.

i. Shift/Roll-Up Scenarios

For commercial sector IRL, DOE chose to model a Roll-up scenario in the March 2008 ANOPR. The Joint Comment encouraged DOE to also model a Shift scenario for commercial IRL because of the variety of existing and emerging efficiency options available. The Joint Comment argued a Shift scenario would better capture both the improved cost competitiveness of higher-efficacy options and greater manufacturer investment in developing higher-efficacy products. (Joint Comment, No. 23 at p. 18)

DOE agrees that some commercial consumers may continue to purchase products above the minimum standard level. Therefore, similar to the Shift scenario in GSFL, DOE created a Shift scenario for IRL that captures the same spread of efficiencies in the standards case as in the base case. To model this, DOE compiled a distribution of IRL in the commercial sector with different efficacies using the revised efficacy standard levels for this notice. Based on this distribution, DOE then created a Shift scenario for the NOPR IRL national impact analysis.

In the March 2008 ANOPR, DOE's residential standards-case market-share matrix assumed that the entire residential market purchases the least-cost standards-compliant lamp at each efficacy level. Because all residential consumers purchase baseline lamps, the Shift and Roll-up scenarios lead to equivalent results. For example, at CSL1, DOE assumed the entire residential market would choose improved halogen lamps; at CSL3, the market would choose improved HIR.

NEMA commented that residential consumers do not necessarily purchase lamps that meet only one efficacy level. (NEMA, No. 22 at p. 31) NEMA contended that consumers could opt to buy lamps that meet a higher CSL than the one imposed by DOE.

Based on NEMA's comment, DOE reconsidered its assumption that consumers in the residential market purchase lamps at only the lowest efficacy level. However, DOE believes that its assumption that consumers buy lamps at the lowest first-cost standards-compliant efficacy level correctly characterizes residential consumer behavior in general. For example, although lamps using HIR technology are available today, consumers generally do not buy them because of their high initial cost. DOE does not believe current market behavior will radically change under new or amended standards. Without data suggesting otherwise, DOE believes the most appropriate forecasting assumption should generally reflect the predominant, current consumer behavior. Therefore, DOE maintains its assumption for the NOPR that residential consumers would continue to purchase the lowest-first-cost, standards-compliant lamps. For further detail regarding the Shift and Roll-up scenarios, see chapter 10 of the TSD.

ii. Product-Substitution Scenarios

At the public meeting, ACEEE commented that the deployment of non-IRL emerging technologies will be affected by the efficacy level that DOE selects for this rule. (Public Meeting Transcript, No. 21 at p. 291) While DOE considered the comment, it ultimately did not model additional movement to LED or CMH lamps in response to standards because the efficacy and price projections for such lamps have a significant degree of uncertainty. DOE does not wish to incorporate that level of conjecture into the NPV calculation for this rule.

However, because DOE assumed R–CFL technology was mature, DOE did assess additional movement from IRL to R–CFL in response to standards. For the residential sector, DOE calculated simple payback periods comparing R–CFL to the baseline halogen and R–CFL to the higher-efficacy lamp designs. Using incremental market penetrations based on the payback period calculations, DOE incorporated additional movement to R–CFL in the residential sector standards case. In the commercial sector, DOE assumed that all institutions wishing to convert to R–CFL, despite its shortcomings (such as lower color quality), do so before 2012. Therefore, there is no additional movement to R–CFL in response to standards.

DOE excluded certain IRL (particularly some BR and ER lamps, such as 65W BR30 and ER40 lamps) from the base-case NIA in the March 2008 ANOPR because these IRL were exempted from standards by EISA 2007. (EISA 2007 section 322(b); 42 U.S.C. 6295(i)(1)(C)) In the standards-case sensitivity scenario, DOE modeled the movements to exempted IRL as a reduction in the market size of covered IRL as consumers move from covered to non-covered lamps. DOE received a number of comments on its choice to exclude exempted IRL from the base case and standards case in the NIA.

Several comments recommended that DOE should model movements to exempt IRL in the main base-case and standards-case NIA scenarios instead of only modeling such movements in a sensitivity scenario. ACEEE commented that DOE needs to account for BR lamps in its analysis; by excluding BR lamps from the base case, ACEEE argued DOE was essentially ignoring their presence in the market. The Joint Comment argues that 65W BR lamps should be included in the base case because they represent a potential loophole to standards. (Public Meeting Transcript, No. 21 at pp. 293–294, 313–314; Joint Comment, No. 23 at p. 17)

As stated above, DOE only includes products being regulated in this rulemaking in the base-case shipment forecasts. Since this rulemaking does not cover 65W BR lamps, DOE cannot include them in the base-case NIA. Accordingly, DOE removed exempted IRL from the shipment data used as inputs to the base-case NIA in the ANOPR. (March 2008 ANOPR TSD chapter 9) For the standards-case NIA, DOE created a ''65 Watt BR lamp substitution'' sensitivity scenario to model movements to exempted 65W BR lamps due to the various CSLs. (March 2008 ANOPR TSD appendix 9A) DOE included 65W BR lamps in the standards case because covered products shift to this lamp.

DOE received a number of comments on how it modeled the shift to BR lamps in the standards case. NEMA stressed its significance and agreed that consumers will shift from covered to exempted BR lamps, with the shift increasing as more-stringent standards raise product costs. (NEMA, No. 22 at p. 27) The Joint Comment maintained that 65W BR lamps should be included in the standards case. (Joint Comment, No. 23 at p. 17) However, some attendees of the public meeting suggested that the shift to the 65W BR might be inappropriate because they believed that consumers already purchase exempted BR lamps in most applications where consumers have the option of installing either the exempted BR lamps or higher-efficacy PAR lamps. For example, PG&E commented that the vast majority of IRL in recessed cans are already exempted BR lamps, so it is unlikely that consumers will switch from existing PAR lamps (which are included in coverage) to new BR lamps in those applications. In addition, Industrial Ecology stated that some household recessed can fixtures are not strong enough to hold PAR lamps, which are heavier than BR lamps. Thus, BR lamps would likely maintain their indoor recessed can market share relative to PAR lamps. Regarding outdoor applications in which PAR lamps are often used, Industrial Ecology also commented that BR lamps are generally incompatible with these application, meaning consumers would likely not migrate from PAR lamps to exempted BR lamps for outdoor applications in response to standards. (Public Meeting Transcript, No. 21 at pp. 319, 321)

DOE considered these comments, and agrees that PAR lamps may be more suitable for outdoor applications than the exempted BR lamps. However, based on residential estimates that 40 percent of all residential IRL are PAR lamps,[55] DOE believes that a considerable portion of residential PAR lamps are used in non-outdoor applications which are compatible with both PAR and the exempted BR lamps. Thus, DOE maintains that some residential consumers would likely move to exempted IRL under standards. For the NOPR, DOE revised its estimates of the number of consumers that will shift to exempted IRL by calculating incremental market penetrations for each standard level.

To better account for migration to exempted lamps, DOE has decided to analyze a second set of standards-case scenarios for IRL in this NOPR. DOE now analyzes scenarios called the Product Substitution and No Product Substitution scenarios. The Product Substitution scenario models a shift to both exempted BR lamps and to R–CFL in the standards case. The No Product Substitution scenario does not model any additional shift in the standards case to non-regulated reflector technologies. For more information about the product substitution standards case scenario, see chapter 10 of the TSD.

DOE maintains the 10-percent lumen increase sensitivity scenario from the ANOPR, a scenario in which a portion of consumers purchase the same wattage higher efficacy lamp in the standards case and do not save energy. See appendix 11A for more detail on this sensitivity scenario.

6. Other Inputs

a. Analysis Period

In its written comments, NEMA stated that any market forecast, even over a short period of time, will contain errors. NEMA argued that forecasting market relationships over 30 years will compound any inherent errors to the point where the estimate may no longer be useful. For example, NEMA argued that overstating growth of lamps covered by this standard would overstate the discounted value of potential benefits associated with amended standards. (NEMA, No. 22 at p. 24) DOE recognizes that forecasting over long periods of time can lead to inaccuracies. However, due to the long lifetime of ballasts and lamps in some sectors, the stock of these products can take decades to turn over. Thus, DOE believes the standards impact on energy consumption and energy savings is best quantified and evaluated over a long period of time. Therefore, DOE has decided to maintain an analysis period from 2012 to 2042, consistent with the shipment and national impact analyses of other rulemakings. However, to account for the uncertainties involved in forecasting energy savings and NPV in general, and over long periods of time, DOE has created several base-case and standards-case scenarios. Based on these scenarios, previously discussed in sections V.E.2.c, V.E.4, and V.E.5, DOE believes that it can characterize the NIA results for these products with a sufficient degree of certainty.

b. Total Installed Cost

The total annual installed cost increase is equal to the annual change in the per-unit total installed cost (*i.e.*, the difference between base case and standards case) multiplied by the shipments forecasted in the standards case.

On this topic, GE commented that the cost of migrating from an 8-foot lamp to a 4-foot lamp includes not only the lamp and ballast costs, but also the cost of the retrofit kit and labor, which was not included in DOE's ANOPR NIA. NEMA commented that the retrofits kits would cost $45–$50, not including labor, which would take 20–25 minutes. (NEMA, No. 22 at p. 28; Public Meeting Transcript, No. 21 at pp. 255–256) DOE agrees that the retrofit kit costs should be included in the NIA. Therefore, DOE is including in the NIA the retrofit kit cost of $50 per 8-foot single pin lamp that is replaced by two 4-foot lamps. DOE is also including a total installation time of 25 minutes. See TSD chapter 11 for further detail on retrofit kit costs.

c. Electricity Price Forecast

In the March 2008 ANOPR, DOE projected electricity prices using EIA's *AEO2007* estimates and extrapolated prices beyond 2030. In this notice, DOE

[55] New York State Energy Research and Development Authority, Incandescent Reflector Lamps Study of Proposed Energy Efficiency Standards for New York State (2006). Available at: *http://www.nyserda.org/publications/Report%2006-07-Complete%20report-web.pdf* (Last accessed Oct. 7, 2006).

updated those projections based upon *AEO2008*. DOE received a comment on using electricity price forecasts other than those of *AEO* as sensitivities. See section 0 above for more detail on this comment and DOE's response.

d. Energy Site-to-Source Conversion

The site-to-source conversion factor is the multiplicative factor DOE uses for converting site energy consumption into primary or source energy consumption. In the March 2008 ANOPR, DOE used EIA's *AEO2007* forecasts (to 2030) of electricity generation and electricity-related losses. DOE extrapolated conversion factors beyond 2030. In this notice, however, DOE uses annual site-to-source conversion factors based on the version of the National Energy Modeling System (NEMS) that corresponds to *AEO2008*. The conversion factors vary over time because of projected changes in the Nation's portfolio of generation sources. DOE estimated that conversion factors remain constant at 2030 values throughout the remainder of the forecast.

e. HVAC Interaction Factor

In the March 2008 ANOPR, DOE assumed a 6.25 percent HVAC interaction factor. The HVAC interaction factor measures the reduced cooling loads and increased heating loads that result from their interaction with more-efficacious lighting systems. For example, a 6.25 percent HVAC interaction factor means that one quad of energy savings due to lamps standards results in 1.0625 quads of total energy savings after the interaction with heating, ventilation, and air conditioning systems is taken into account. At the public meeting, PG&E stated that DOE's assumed level for this factor was too low. PG&E argued that if the heat from these products goes directly into the building and it takes one unit of electric energy to remove three units of heat, 6.25 percent was a very conservative number. (Public Meeting Transcript, No. 21 at pp. 333–334) Industrial Ecology agreed that 6.25 percent was on the low end of most estimates and cited the following rule of thumb used in the service industry: One saves a quarter of a watt in HVAC operation for every watt one saves ceiling lighting systems. Industrial Ecology suggested that DOE should look into other studies for more information on the HVAC interaction factor. (Public Meeting Transcript, No. 21 at pp. 333–334)

DOE is unaware of any other national-level studies that may be useful in estimating the HVAC factor specific to lighting over the entire calendar year. Therefore, DOE continues to use the study [56] that originated from the 2000 Ballast Rule. DOE notes that it has updated the study since its original publication and that it is a national-level analysis covering many building types across several climate zones.

f. Rebound Effect

In its analyses, DOE accounted for an anticipated ''rebound effect'' [57] that may occur after the installation of energy efficient lighting equipment. After consulting the literature [58] reporting on this effect, DOE used in the March 2008 ANOPR an 8.5-percent rebound effect for the residential sector and a 1-percent effect in the commercial sector, with every 100 percent increase in energy efficiency. NEMA agreed with DOE's inclusion of the rebound effect, but commented that more research needs to be done to characterize its magnitude. (NEMA, No. 22 at p. 30) DOE is unaware of other data that would affect its current rebound effect assumptions. DOE invites additional comments on this issue and will consider incorporating any relevant data provided.

g. Discount Rates

In its analyses, DOE multiplies monetary values in future years by a discount factor in order to determine their present value. DOE estimated national impacts using both a 3-percent and a 7-percent real discount rate as the average real rate of return on private investment in the U.S. economy. The Joint Comment argued that DOE should use a 2-percent to 3-percent real discount rate, noting other rulemakings and extensive academic research supporting a real societal discount rate in that range. (Joint Comment, No. 23 at p. 22) While DOE acknowledges the comment, the Department notes that it is required to follow guidelines on discount factors set forth by the Office of Management and Budget (OMB). Specifically, DOE uses these discount rates in accordance with guidance that OMB provides to Federal agencies on the development of regulatory analysis (OMB Circular A–4 (Sept.17, 2003), particularly section E, ''Identifying and Measuring Benefits and Costs''). Accordingly, DOE is continuing to use 3-percent and 7-percent real discount rates for the relevant calculations in this NOPR.

F. Consumer Subgroup Analysis

In analyzing the potential impacts of new or amended standards, DOE evaluates the impacts on identifiable subgroups of consumers (*e.g.*, low-income households or small businesses) that may be disproportionately affected by a national standard. In the March 2008 ANOPR, DOE requested comments on subgroups that should be considered for the NOPR analysis. 73 FR 13620, 13682 (March 13, 2008). NEMA commented that DOE should assess the impacts of standards on low-income consumers, as well as houses of worship, historical facilities, and institutions that serve low-income populations. (NEMA, No. 22 at p. 32)

DOE researched the suggested subgroups using the 2001 RECS and 2003 CBECS databases and the 2002 U.S. Lighting Market Characterization. The Residential Furnaces and Boilers NOPR,[59] Central Air Conditioners Supplemental Notice of Proposed Rulemaking,[60] and Clothes Washers Final Rule [61] defined ''low-income consumers'' as residential consumers with incomes at or below the poverty line, as defined by the U.S. Census Bureau. DOE has defined ''low-income consumers'' in the same way for this

[56] U.S. Department of Energy—Energy Efficiency and Renewable Energy Office of Building Research and Standards. *Technical Support Document: Energy Efficiency Standards for Consumer Products: Fluorescent Lamp Ballast Proposed Rule: Appendix B. Marginal Energy Prices and National Energy Savings*. January 2000. Washington, DC. *http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/appendix_b.pdf*.

[57] Under economic theory, ''rebound effect'' refers to the tendency of a consumer to respond to the cost savings associated with more-efficient equipment in a manner that actually leads to marginally greater product usage, thereby diminishing some portion of anticipated energy savings related to improved efficiency.

[58] Greening, L.A., D.L. Greene, and C. Difiglio, ''Energy efficiency and consumption—the rebound effect—a survey,'' 28 *Energy Policy* (2000), pp. 389–401.

[59] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, *Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnaces and Boilers Proposed Rule: Chapter 11* (2006). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/furnaces_boilers/fb_tsd_chapt11_0906.pdf* (Last accessed Dec. 8, 2008).

[60] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, *Technical Support Document: Energy Conservation Program for Consumer Products: Central Air Conditioners and Heat Pumps Energy Conservation Standards Proposed Rule: Chapter 10* (2001). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/chap10_sub-grp.pdf* (Last accessed Dec. 8, 2008).

[61] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, *Technical Support Document: Energy Conservation Program for Consumer Products: Clothes Washer Energy Conservation Standards Final Rule: Chapter 18* (2001). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/chapter_8_consumer_analysis.pdf*. (Last accessed Dec. 8, 2008).

rule. DOE discovered that in 2001, residential low-income consumers faced electricity prices that were 0.1 cents per kWh lower than the prices faced by consumers above the poverty line. Using this information, DOE performed a subgroup analysis of low-income consumers for the NOPR, the key findings of which are presented below and addressed in section VI.B.1.b.

DOE found that houses of worship used their lamps for fewer hours per year than any other building type in the non-mall commercial building sector, according to the 2003 CBECS and LMC. DOE analyzed houses of worship using 1,705 operating hours per year for GSFL (rather than 3,435 hours per year for an average commercial facility) and 1,609 operating hours per year for IRL (rather than 3,450 hours per year for an average commercial facility).

DOE also found that a wide range of sites (from single buildings to entire districts) are classified as ''historical facilities.'' Because historical facilities serve a range of functions, DOE assumed that such facilities also feature the same variety of operating hours, electricity prices, and discount rates as a typical consumer. However, DOE did find that these buildings, on average, have more T12 lamps than the typical commercial or residential building. Therefore, in its subgroup analysis for historical facilities, DOE concentrated on the LCC analysis and results for those consumers with T12 fluorescent lamps.

DOE also found a wide array of nonprofit and for-profit organizations that serve low-income populations. Because of the large diversity of organizations in this sector, DOE does not expect to see operating hours, lamp types, or event response behaviors that vary significantly from the commercial sector as a whole. However, DOE believes that the majority of organizations serving low-income populations are small nonprofits. For this reason, DOE chose a subgroup scenario with a discount rate that is 3.8 percent higher than the average discount rate for the commercial sector (for a discount rate of 10.8 percent), based on the sources used to develop the discount rate for small business subgroups in the Ovens and Commercial Clothes Washers NOPR analysis.[62]

Although NEMA did not request that DOE analyze consumers of T12 electronic systems, DOE decided to analyze this subgroup as well, because consumers that already have a T12 electronic system could potentially benefit less from standards than those consumers with magnetic systems. Specifically, consumers that own a T12 electronic system in the base case would need to purchase a T8 electronic system in the case of an energy conservation standard at EL4 or EL5. Because the T12 electronic system is more efficient than T12 magnetic systems, consumers with electronic systems would experience lower operating cost savings than those consumers with magnetic systems. In order to analyze the affect on consumers of T12 electronic systems, DOE established a new baseline electronic T12 system and modified standards-case systems so that both light output is maintained in the case of a standard and energy is saved. For this subgroup, DOE only analyzed the event where a consumer purchases a T12 lamp in the baseline and a T8 lamp and ballast system in the case of a standard at EL4 and EL5, as T12 lamps are no longer available. All other factors of the LCC subgroup analysis remained the same as in the primary analysis. See the NOPR TSD chapter 12 for further information on the LCC analyses for all subgroups.

G. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impact of higher energy conservation standards on GSFL and IRL manufacturers, and to calculate the impact of such standards on domestic manufacturing employment and capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on two separate Government Regulatory Impact Models (GRIMs)—industry-cash-flow models customized for this rulemaking. The GRIM inputs are data characterizing the industry cost structure, shipments, and revenues. The key output is the industry net present value. Different sets of assumptions (scenarios) will produce different results. The qualitative part of the MIA addresses factors such as product characteristics, characteristics of particular firms, and market and product trends, and it also includes an assessment of the impacts of standards on subgroups of manufacturers. The complete MIA is outlined in chapter 13 of the TSD.

DOE conducted the MIA in three phases. Phase 1, ''Industry Profile,'' consisted of the preparation of an industry characterization. Phase 2, ''Industry Cash Flow,'' focused on the industry as a whole. In this phase, DOE used two separate GRIMs (one for the GSFL industry and one for IRL industry) to prepare an industry cash-flow analysis. DOE used publicly-available information developed in Phase 1 to adapt each GRIM structure to facilitate the analysis of amended GSFL and IRL standards. In Phase 3, ''Subgroup Impact Analysis,'' DOE conducted interviews with manufacturers representing the majority of domestic GSFL and IRL sales. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics specific to each company, and also obtained each manufacturer's view of the industry as a whole. The interviews provided valuable information DOE used to evaluate the impacts of amended energy conservation standards on manufacturer cash flows, manufacturing capacities, and employment levels.

a. Phase 1, Industry Profile

In Phase 1 of the MIA, DOE prepared a profile of the GSFL and IRL industries based on the market and technology assessment prepared for this rulemaking. Before initiating the detailed impact studies, DOE collected information on the present and past structure and market characteristics of the GSFL and IRL industries. The information DOE collected included market share, product shipments, markups, and cost structure for various manufacturers. The industry profile includes further detail on the overall market, product characteristics, estimated manufacturer market shares, the financial situation of manufacturers, and trends in the number of firms in the lamp industry.

The industry profiles included a top-down cost analysis of GSFL and IRL manufacturers that DOE used to derive product costs and preliminary financial inputs for the GRIM (*e.g.*, revenues; material, labor, overhead, and depreciation expenses; selling, general, and administrative expenses (SG&A); and research and development (R&D) expenses). DOE also used public information to further calibrate its initial characterization of the industry, including Securities and Exchange Commission (SEC) 10–K and 20–F reports, Standard & Poor's (S&P) stock reports, and corporate annual reports.

[62] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, *Technical Support Document: Energy Conservation Standards for Certain Consumer Products (Dishwashers, Dehumidifiers, Electric and Gas Kitchen Ranges and Ovens, and Microwave Ovens) and for Certain Commercial and Industrial Equipment (Commercial Clothes Washers): Chapter 12* (2008). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/home_appliances_tsd/chapter_12.pdf.* (Last accessed Dec. 8, 2008).

b. Phase 2, Industry Cash-Flow Analysis

Phase 2 of the MIA focused on the financial impacts of potential amended energy conservation standards on the industries as a whole. DOE used the GRIMs to calculate the financial impacts of standards on manufacturers. DOE used two separate GRIMs, one for each industry analyzed (GSFL and IRL). In Phase 2, DOE used each GRIM to perform a preliminary industry cash-flow analysis. In performing this analysis, DOE used the financial values determined during Phase 1 and the shipment scenarios used in the NIA analysis.

c. Phase 3, Subgroup Impact Analysis

Using average cost assumptions to develop an industry-cash-flow estimate does not adequately assess differential impacts among manufacturer subgroups. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected. DOE used the results of the industry characterization analysis (in Phase 1) to group manufacturers that exhibit similar characteristics.

During the ANOPR public meeting, Industrial Ecology commented that small lamp manufacturers may be disproportionately affected by IRL and GSFL standards. (Public Transcript, No. 21 at pp. 354–356) DOE established two subgroups for the MIA corresponding to large and small business manufacturers of GSFL and IRL products. For the GSFL and IRL manufacturing industries, small businesses, as defined by the Small Business Administration (SBA), are manufacturing enterprises with 1,000 or fewer employees. Based on identification of these two subgroups, DOE prepared one interview guide with questions related to both GSFL and IRL manufacturing for large and small manufacturers. DOE used the interview guide to tailor the GRIMs to address unique financial characteristics of manufacturers of each industry. DOE interviewed companies from each subgroup, including subsidiaries and independent firms and public and private corporations. The purpose of the meetings was to develop an understanding of how manufacturer impacts vary by TSL. During the course of the MIA, DOE interviewed manufacturers representing the vast majority of domestic GSFL and IRL sales. Many of these same companies also participated in interviews for the engineering analysis. However, the MIA interviews broadened the discussion from primarily technology-related issues to include business-related topics. One objective was to obtain feedback from industry on the assumptions used in the GRIM and to isolate key issues and concerns. See chapter 13 of the TSD for details.

2. Discussion of Comments

In response to DOE's March 2008 ANOPR presentation of the steps DOE would take during the MIA for the NOPR, DOE received several comments related to the high price and limited availability of xenon. NEMA commented that xenon gas was the only viable option for higher-efficiency fill gas and cited manufacturer concerns about its limited supply and quickly escalating prices. (NEMA, No. 22 at p. 8) NEMA also stated that assumptions DOE uses in its analysis can become invalid quickly, citing the price of xenon as an example of an assumption that could seriously affect their business. (NEMA, No. 21 at p. 108–109) During the manufacturer interviews, manufacturers contended that the global supply of xenon was fixed and that competition with other applications (*i.e.*, anesthesia) has caused the price of xenon to increase ten-fold over the last year. After receiving these comments, DOE conducted its own research to determine if market conditions for xenon could affect its use as a higher-efficiency fill gas.

According to DOE's research, xenon is one of three rare gases (along with neon and krypton) produced by cryogenic air separation. Given the low concentration of the rare gases in the air (neon 0.002 percent, krypton 0.0001 percent, and xenon 0.00001 percent),[63] the only cost-effective recovery options are large air-separation units. Most worldwide supply is met by the three largest industrial gas companies (Air Liquide, Praxair, and Linde); another major supplier is Iceblick, a former State-controlled enterprise of the Soviet Union.

Major applications for xenon include lighting, television flat panel displays, the space industry (for ion engines and satellite repositioning), medical imaging and anesthesia, and electronic chip manufacturing. All applications are growing rapidly. Demand from the semiconductor industry alone increased from less than 1 million liters per year in June 2007 to almost 3 million liters per year in June 2008. Demand for xenon has also grown significantly in the last 18 months, greatly outpacing the 12 million liters of worldwide xenon production.[64] While there remain essentially inexhaustible supplies of xenon in the atmosphere, considerable investment would be required to expand global production substantially. Since it is impossible to immediately increase supply to meet demand, spot prices have increased from $3–$4 per liter to $28–$35 per liter for large cylinders.[65] These higher prices are likely to be sustained in the near-term until supply can meet the growing demand.

DOE estimates that the increased demand for xenon as a result of this rulemaking would range from 3.2 percent to 12.8 percent of current worldwide production in the first year the rulemaking takes effect. Over the 30-year analysis period, the increased demand for xenon could range from 0.5 percent to 18 percent of current worldwide production, depending on the scenario analyzed. This increased demand is expected to have little long-term effect on the price or availability of xenon, considering the other contributing factors. Rapid growth or decline of existing markets or the discovery of a new application could significantly affect the total demand for xenon, perhaps even more than this rulemaking. Furthermore, the above numbers are based on the current worldwide production (12 million liters) and assume no increase in production over the analysis period. This is highly unlikely, given that current demand substantially exceeds supply. Any future increase in xenon production would decrease the percentages mentioned above. Thus, DOE has tentatively concluded that the amount of xenon required by lamp manufacturers to produce lamps that meet the proposed standards would not significantly affect the price or availability of xenon. DOE also conducted an LCC sensitivity analysis to determine the impact of higher xenon prices on the consumer. For more information on the xenon market analysis and the consumer impacts of higher xenon prices, see appendix 3B of the TSD.

In the GSFL industry, manufacturers stated that the ''rare earth phosphors'' are a key component of GSFL performance. During the comment period, some manufacturers expressed concern that higher CSLs would necessitate increasing mixes of the costly rare earth phosphors in the lamp coating. These manufacturers stated that more stringent standards would drive

[63] See *http://www.airliquide.com/file/otherelement/pj/airliquide2007gb_bd_ok12439.pdf*, p. 110.

[64] Betzendahl, Richard, ''The Rare Gets More Rare: The Rare Gases Market Update'' (*CryoGas International*) (June 2008) 26.

[65] Id.

up demand for (and the price of) rare earth phosphors, which already face significant supply constraints. These manufacturers added that continued growth in the CFL market will also capture an increasing share of available phosphor supply in the future, potentially increasing prices and jeopardizing the cost-effectiveness of the standards. Depending on the lamp type, rare earth phosphors can be the highest input cost of a GSFL.

Manufacturers also noted that higher standards could drive manufacturing processes to China, where the vast majority of rare earth phosphors are mined. Coupled with cheaper labor and high export tariffs, the incentive to move production of lamps to China might prove too great to resist. To address these concerns, DOE analyzed the rare earth phosphor market to understand the potential impact of the standards on supply and demand, pricing, growth, and innovation. DOE also analyzed the impact on employment for domestic manufacturers.

Because the UV radiation emitted within the lamp by the reaction of the electrons and mercury vapor is invisible, manufacturers must coat the inside of the lamp's glass with powered phosphors. The phosphors fluoresce when struck by the UV radiation and convert it into visible light. Less-efficient, low-cost lamps only use ''halophosphors'' to coat the lamp. Halophosphors are more abundant and much less costly than rare earth phosphors, but are also less efficient and produce a lower quality light. Coating a lamp with a layer of rare earth phosphors in addition to, or in place of, halophosphors can increase efficacy, while dramatically improving color quality and lumen maintenance. The coating's blend of phosphors determines, in part, the CCT and CRI of the lamp. The lamp coating of high-performance GSFL, often called a ''triband'' or ''triphosphor'' blend, commonly includes three key elements—terbium, europium, and yttrium. Terbium and europium are the rarest and reflect the greatest portion of the coating's cost.

DOE evaluated the impact of standards on the phosphor markets and concluded that mandating TSL5 would increase the global demand and prices of these phosphors. DOE expects 2012 terbium demand to be 31 percent greater at TSL5 in the Shift-High Consumer Expertise scenario than it would be in the Existing Technologies base case. DOE estimates europium demand would increase by 10 percent, while Yttrium demand would increase marginally. These estimates reflect the upper bound of demand increases.

Given the historically volatile prices of these phosphors and the unpredictable future determinants of supply and demand (such as Chinese policy, additional mining operations, and future technological changes), DOE has not developed supply and demand curves in order to estimate future phosphor prices. However, DOE recognizes significant price increases are possible given the expected surge in demand, particularly for terbium and europium. Therefore, to analyze the impact of higher phosphor prices, DOE also conducted a sensitivity analysis to address the potential increases in lamp prices attributable to greater phosphor costs on the consumer. That is, DOE compares LCC savings with current phosphor costs to LCC savings under a scenario with higher phosphor prices. Appendix 3C shows the results of this sensitivity analysis and the rare earth phosphor market analysis.

Additionally, DOE found several rare earth mining projects in development around the world that have the capacity to increase rare earth supply. If prices continue to climb, DOE expects the economics of mining rare earths to encourage more projects, and make less-concentrated rare earth deposits economically viable, which will increase supply. For these reasons, DOE does not believe standards, and their potential impact on phosphor prices, will affect product availability.

3. Government Regulatory Impact Model Analysis

The GRIM analysis uses a standard, annual cash-flow analysis that incorporates manufacturer prices, manufacturing costs, shipments, and industry financial information as inputs and models changes in costs, distribution of shipments, investments, and associated margins that would result from new or amended regulatory conditions (in this case, standard levels). The GRIM spreadsheet uses a number of inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis (2007) and continuing to 2042. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period.

DOE used the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between a base case and various TSLs (the standards cases). Essentially, the difference in INPV between the base case and a standards case represents the financial impact of the amended energy conservation standards on manufacturers. DOE collected this information from a number of sources, including publicly-available data and interviews with manufacturers. See chapter 13 of the TSD for details.

4. Manufacturer Interviews

As part of the MIA, DOE discussed potential impacts of amended energy conservation standards with manufacturers responsible for the vast majority of domestic GSFL and IRL sales. The manufacturers interviewed produce approximately 90 percent of GSFL for sale and 85 percent of IRL for sale. These interviews were in addition to those DOE conducted as part of the engineering analysis. The interviews provided valuable information that DOE used to evaluate the impacts of amended energy conservation standards on manufacturer cash flows, manufacturing capacities, and employment levels.

a. Key Issues

i. GSFL

Rare earth phosphor availability and price—All of the GSFL manufacturers DOE interviewed are concerned about the availability and price of rare earth phosphors. Due to the importation of rare earth phosphors, any increases in duties paid to producing countries, such as China, could have significant impacts on lamp manufacturing costs. Any increase in lamp material costs directly affects manufacturer profitability. According to manufacturers, meeting higher energy conservation standards for GSFL would require an increase in rare earth phosphor content in lamp coatings. These manufacturers stated that higher energy conservation standards would drive up demand for and prices of rare earth phosphors, which are already in short supply. In addition, manufacturers stated that the continued growth in the CFL market will erode future supply, jeopardizing the cost-effectiveness of the standards. Depending on the lamp type, rare earth phosphors can be the highest input cost of a GSFL. Some manufacturers also noted that higher standards could drive manufacturing processes to China, where the vast majority of rare earth phosphors are mined. Issues with rare earth phosphors are specifically addressed in appendix 3C of the TSD.

Reduction in product portfolio—Some manufacturers are concerned that energy conservation standards will force manufacturers to eliminate some product lines, shrinking their overall marketability. According to manufacturers, the ability to survive in the industry is related to the companies' diverse product portfolios. Companies benefit from a wide range of products and efficiencies. Depending on the characteristics of the product, manufacturers can up-sell to products that reap higher profits. Manufacturers are concerned that reducing the product portfolio will reduce options for customers and, ultimately, profitability.

Profit margin impact—All manufacturers stated that energy conservation standards have the potential to greatly harm their profitability. Manufacturers enjoy a higher profit margin on higher-efficacy or premium products than lower-end or baseline products. Since higher-efficacy or premium products tend to incorporate design options that increase energy efficiency, a high-efficiency standard would commoditize such products and subsequently lower the overall manufacturer markup on shipments. Several manufacturers stated it is very difficult to pass along cost increases to customers because of the competitive nature of the industry. Therefore, they believe any cost increase due to standards set by DOE would automatically lower profit margins.

ii. IRL

Product performance issues—All manufacturers stated that implementation of design options to meet the proposed energy conservation standards could cause a reduction in product lifetime. Manufacturers stated that all standard levels could be met by lamps that combine improved technology with shorter life. In addition to this broad possibility, manufacturers indicated that the product lifetime of infrared lamps that meet efficacy levels prescribed by TSL3, TSL4, and TSL5 could be lowered due to the ''hot shock'' application problem. If infrared lamps are installed in a live fixture, sections of the lamp's filament can fuse together, possibly decreasing the lifetime by 25 to 30 percent. Manufacturers are concerned that both the performance issues of hot shock and shorter life could impact consumers' acceptance of covered IRL products. Any dissatisfaction resulting lower lifetimes of standards-compliant lamps could hasten the shift to competing technologies, which have much longer lifetimes.

Xenon gas availability and price—According to several manufacturers, most higher-efficacy model lamps at each TSL use xenon to increase efficacy. While using a different fill gas does not require significant capital investments, manufacturers stated that xenon prices have increased as much as ten-fold in the past few years. In the short term, global supplies of xenon are limited by existing production capacity, so the IRL industry has to compete with other industries, such as medical applications, that are better able to support higher prices. For more information on DOE's analysis of this issue, see appendix 3B of the TSD and section V.G.2 of today's notice.

Elimination of product types in the manufacturers' product portfolio—Manufacturers are concerned that at higher efficacy levels, all lamps will need to switch to all infrared technology, which would significantly reduce product offerings.

Elimination of small-diameter lamps—Manufacturers are concerned that energy conservation standards could eliminate smaller-diameter lamps. Because of the small size, all manufacturers use a single-ended quartz burner in lamps smaller than PAR30, limiting potential efficacy improvements. Although DOE scales its standard to smaller-diameter lamps and there are existing PAR20 lamps at all TSLs, manufacturers are concerned that the improvements for small-diameter lamps at high TSLs could be impossible or cost prohibitive. DOE addresses the issues of small-diameter lamps in section V.C.7.b.ii of today's notice.

Competition—Manufacturers stated that some TSLs could affect competition within the industry. For example, one manufacturer has a patent on silverized reflectors. While DOE did not set TSLs around this technology, this manufacturer could meet TSL2 with cheaper lamps than its competitors. One manufacturer has a cross license on the technology, but has not made silverized lamps recently and would incur substantial capital and conversion costs to produce them. There are competitive concerns at TSL4 and TSL5 as well. Two manufacturers have a full line of products that currently meet TSL4. The third manufacturer has some products at this level, but is concerned that it would have to incur significantly larger capital costs at TSL4 to redesign and manufacture different burners, which could put it at a competitive disadvantage. Only one manufacturer currently has a full line of products at TSL5. At TSL4 and TSL5, standards-compliant lamps could combine HIR technology with an improved reflector, potentially putting the company that does not have access to silverized reflectors at a disadvantage.

Market erosion—Manufacturers stated that emerging technology is already starting to penetrate the IRL market. A standard on IRL would be unique because it would force investments in a market that would shrink over the entire lifetime of the investment. Depending on market penetration of emerging technology, these investments might never be recouped. Also, manufacturers are concerned that a standard on IRL could hasten the switch to emerging technology by lowering the difference in their first cost price. If the standard did increase the natural migration toward new technology, it would be less likely that manufacturers would make the substantial investments to modify IRL production equipment. Finally, manufacturers are concerned that the BR exemptions in EISA 2007 could also erode the market: The higher the IRL standard, the lower the relative cost of the exempted incandescent lamps. If a lower relative cost causes a large shift to exempted incandescent lamps, it is less likely that investments in improved halogen lamps could be justified. To address emerging technologies and BR exemptions issues discussed by manufacturers, DOE included several shipment scenarios in both the NIA and the GRIM. See chapter 10 and chapter 13 of the TSD for a discussion of the shipment scenarios used in the respective analysis.

b. Government Regulatory Impact Model Scenarios and Key Inputs

i. GSFL Base-Case Shipment Forecast

In the GSFL GRIM, DOE estimated manufacturer revenues, based on unit shipment forecasts and distribution by product class and efficacy. Changes in the product mix at each standard level are a key driver of manufacturer finances. For this analysis, the GSFL GRIM incorporated the two base-case shipment scenarios from the NIA. In the Existing Technologies base case shipment scenario, DOE assumed that in the base case customers would not migrate to emerging technologies. DOE also modeled an Emerging Technologies base-case shipment scenario. In this scenario, GSFL shipments are eroded in the base case as more customers purchase emerging technology rather than covered GSFL. Table V.7 and Table V.8 show total shipments forecasted by the NIA for the 2012 and 2042 GSFL base cases. For further information on the GSFL base-case shipment forecast, see chapter 10 of the TSD.

TABLE V.7—GSFL EMERGING TECHNOLOGIES BASE CASE TOTAL NIA-FORECASTED SHIPMENTS IN 2012 AND 2042

Product class	Total industry shipments for 2012*	Total industry shipments for 2042*
4-Foot MBP	479,177,000	490,528,000
8-Foot SP Slimline	22,448,000	6,873,000
8-Foot RDC HO	17,654,000	2,320,000
4-Foot T5	24,225,000	79,906,000
4-Foot T5 HO	23,610,000	67,857,000

* Figures rounded to the nearest thousand.

TABLE V.8—GSFL EXISTING TECHNOLOGIES BASE CASE TOTAL NIA-FORECASTED SHIPMENTS IN 2012 AND 2042

Product class	Total industry shipments for 2012*	Total industry shipments for 2042*
4-Foot MBP	479,177,000	645,323,000
8-Foot SP Slimline	22,448,000	6,873,000
8-Foot RDC HO	17,654,000	2,320,000
4-Foot T5	24,225,000	105,863,000
4-Foot T5 HO	23,610,000	67,857,000

* Figures rounded to the nearest thousand.

ii. IRL Base Case Shipments Forecast

As with the GSFL GRIM, the IRL GRIM incorporated the two base-case shipment scenarios from the NIA for the period of 2007 to 2042 (Existing and Emerging Technologies base cases). Table V.9 and Table V.10 show total shipments forecasted by the NIA for the 2012 and 2042 IRL for both base cases. The tables include the base-case shipments in 2020 because the impacts under the Emerging Technologies base case are most apparent in the years after the standard becomes effective and the differences between the base cases are easily demonstrated in 2020. For further information on IRL base case shipment forecast, see chapter 10 of the TSD.

TABLE V.9—IRL EXISTING TECHNOLOGIES BASE CASE TOTAL NIA-FORECASTED SHIPMENTS IN 2012 AND 2042

Product class	Total industry shipments in 2012*	Total industry shipments in 2020*	Total industry shipments in 2042*
PAR38 90W	56,459,000	62,990,000	88,566,000
PAR38 75W	44,065,000	49,163,000	69,124,000
PAR30 50W	30,738,000	35,759,000	51,180,000

* Figures rounded to the nearest thousand.

TABLE V.10—IRL EMERGING TECHNOLOGIES BASE CASE TOTAL NIA-FORECASTED SHIPMENTS IN 2012 AND 2042

Product class	Total industry shipments in 2012*	Total industry shipments in 2020*	Total industry shipments in 2042*
PAR38 90W	52,393,000	31,654,642	52,978,000
PAR38 75W	40,892,000	24,706,062	41,349,000
PAR30 50W	28,417,000	17,318,155	30,058,000

* Figures rounded to the nearest thousand.

iii. GSFL Standards Case Shipments Forecast

All shipment forecasts in the GSFL GRIM are obtained from the GSFL NIA. Consequently, the GSFL GRIM included two efficacy distribution scenarios (shift and roll-up), and two lighting expertise scenarios (high- and market segment-based lighting expertise). For additional details on the various shipment scenarios, see TSD chapter 10.

iv. IRL Standards-Case Shipments Forecast

To characterize consumer behavior in the IRL standards-case GRIM, DOE considered the four shipment scenarios found in the NIA. The IRL GRIM considered two efficacy distributions scenarios (shift and roll-up) and two product substitution scenarios (product substitution and no product substitution). See chapter 10 of the TSD for additional details on the IRL standards-case shipment scenarios.

v. Manufacturing Production Costs

DOE derived manufacturing production costs by using end-user prices found in the NIA and discounting them using typical markups along the retail distribution chain. To calculate manufacturer selling prices from these end-user prices, DOE divided the medium end-user prices in the NIA by a typical markup for retail locations that sell the covered products. DOE calculated the markup for retail locations using the revenues and cost of goods sold from the annual reports of publicly-traded companies. To determine manufacturer production costs from manufacturing selling price, DOE divided manufacturing selling prices by the manufacturer markup. The manufacturer markup was calculated with the same publicly-available information used to calculate other GRIM financial inputs (*e.g.*, industry-wide tax rate and working capital). Further discussion of how DOE calculated other GRIM financial inputs from publicly-available information is found in chapter 13 of the TSD.

vi. Amended Energy Conservation Standards Markup Scenarios

In both the IRL and GSFL GRIM, DOE modeled a flat markup scenario. This scenario assumed that the cost of goods sold for each lamp is marked up by a flat percentage to cover standard SG&A expenses, R&D expenses, and profit. To derive this percentage, DOE evaluated publicly-available financial information for manufacturers of lighting equipment.

For GSFL only, DOE also modeled a four-tier markup scenario. In this scenario, DOE assumed that the markup on lamps varies by efficacy in both the base case and the standards case. DOE learned from manufacturers that pricing for GSFL is typically determined on the basis of four product tiers, corresponding to different phosphor series. During the MIA interviews, manufacturers provided information on the range of typical efficacy levels in these four tiers and the change in profitability for each level. DOE used this information, retail prices derived in its product price determination, and industry average gross margins to estimate markups for GSFL under a four-tier pricing strategy in the base case. In the standards case, DOE modeled the situation in which portfolio reduction squeezes the margin of higher-efficacy products as they are ''demoted'' to lower-relative-efficacy-tier products. This scenario is in line with information submitted during manufacturing interviews, which responds to manufacturers' concern that DOE standards could severely disrupt profitability.

The four-tier markup scenario was not modeled for IRL because markups do not increase as a function of efficacy as is the case for GSFL. Thus, this scenario is not representative of the IRL industry.

vii. Product and Capital Conversion Costs

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

DOE assessed the R&D expenditures manufacturers would be required to make at each TSL. DOE obtained financial information through manufacturer interviews and aggregated the results to mask any proprietary or confidential information from any one manufacturer. DOE considered a number of manufacturer responses for GSFL and IRL at each TSL. DOE estimated the total product conversion expenses by gathering manufacturer responses, then weighted these data by market share.

DOE also evaluated the level of capital conversion expenditures manufacturers would incur to comply with amended energy conservation standards. DOE used the manufacturer interviews to gather data on the level of capital investment required at each TSL. Manufacturers explained how different TSLs affected their ability to use existing plants, tooling, and equipment. From the interviews, DOE was able to estimate what portion of existing manufacturing assets would need to be replaced and/or reconfigured, and what additional manufacturing assets would be required to manufacture the higher-efficacy products. In most cases, DOE projected that the proportion of existing assets that manufacturers would have to replace would increase as standard levels for GSFL and IRL increase. For GSFL, DOE included capital costs for the natural market shift from T12 to T8 lamps in the base case. For IRL, the capital conversion expenses manufacturers provided during interviews were based on converting their manufacturing equipment to meet the current volume of shipments. Since the shipments projected in the NIA decrease in the base cases, DOE scaled the conversion capital investments to account for the decline in shipments from 2008 to the year the standard becomes effective. DOE also consulted an independent supplier of IRL coaters to identify additional costs above TSL4 that would be needed for manufacturers to meet TSL5.

The investment figures used in the GRIM can be found in section VI.B.2.a of today's notice. For additional information on the estimated product conversion and capital conversion costs, see chapter 13 of the TSD.

H. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a proposed standard. Employment impacts include direct and indirect impacts. Direct employment impacts are any changes in the number of employees for manufacturers of the appliance products that are the subject of this rulemaking, their suppliers, and related service firms. Indirect employment impacts are employment changes in the larger economy that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. The MIA addresses the portion of direct employment impacts that concern manufacturers of GSFL and IRL (see section V.G); this section addresses indirect impacts.

Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, due to: (1) Reduced spending by end users on energy (*i.e.*, electricity); (2) reduced spending on new energy supply by the utility industry; (3) increased spending on the purchase price of new products; and (4) the effects of those three factors throughout the economy. DOE expects the net monetary savings from standards to be redirected to other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor in the short term, as explained below.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sectoral employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS).[66] BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility

[66] Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202–691–5618) or by sending a request by e-mail to *dipsweb@bls.gov*. Available at: *http://www.bls.gov/news.release/prin1.nr0.htm.*

sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. There are many reasons for these differences, including differences in wages and the fact that the utility sector is more capital intensive and less labor intensive than other sectors. See Bureau of Economic Analysis, ''A User Handbook for the Regional Input-Output Modeling System (RIMS II),'' Third Edition, Washington, DC, U.S. Department of Commerce, March 1997.[67]

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

In developing this proposed rule, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called ''Impact of Sector Energy Technologies'' (ImSET); ImSET is a spreadsheet model of the U.S. economy that focuses on 188 sectors most relevant to industrial, commercial, and residential building energy use.[68] ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output (I–O) Model,'' which has been designed to estimate the national employment and income effects of energy-saving technologies deployed by DOE's Office of Energy Efficiency and Renewable Energy. Compared with previous versions of the model used in earlier rulemakings, this version allows for more complete and automated analysis of the essential features of energy efficiency investments in buildings, industry, transportation, and the electric power sectors. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 188 sectors. ImSET's national economic I–O structure is based on the 1997 U.S. benchmark table (Lawson, *et al.*, 2002),[69] specially aggregated to 188 sectors. DOE estimated changes in expenditures using the NIA spreadsheet. Using ImSET, DOE then estimated the net national indirect-employment impacts on employment in the manufacturing and energy industries of the new efficacy standards on employment by sector.

While both ImSET and the direct use of BLS employment data suggest the proposed standards could increase the net demand for labor in the economy, the gains would most likely be very small relative to total national employment. Therefore, DOE concludes only that the proposed standards are likely to produce employment benefits that are sufficient to fully offset, any adverse impacts on employment in the manufacturing or energy industries related to GSFL and IRL. See the TSD chapter 15.

NEMA agreed that ImSET would be the most appropriate tool to analyze employment impacts on a national scale. NEMA also suggested that DOE should be mindful of changes in production technologies and the associated flows of labor and capital across industries that could be needed under more-stringent efficacy standards, which would not necessarily be reflected in the ImSET I–O analysis. (NEMA, No. 22, p. 34)

In response, DOE believes that the fixed I–O matrix is generally adequate in predicting the range of magnitude of lighting savings. Changes in production technologies and the associated economic flows with direct employment implications are addressed in the MIA chapter (chapter 13) of the TSD. DOE uses the ImSET model to address indirect employment effects of the standards. For more details on the employment impact analysis, see TSD chapter 15.

I. Utility Impact Analysis

The utility impact analysis estimates the change in the forecasted power generation capacity of the Nation which would be expected to result from the adoption of new efficacy standards. This section discusses the methodology used, the results of which can be found in section 0. DOE used a version of EIA's National Energy Modeling System (NEMS) for this utility impact analysis. NEMS, which is available in the public domain, is a large, multisectoral, partial-equilibrium model of the U.S. energy sector. EIA uses NEMS to produce its *AEO*, a widely-recognized baseline energy forecast for the United States. The version of NEMS used for appliance standards analysis is called NEMS–BT and is primarily based on the *AEO 2008* with minor modifications.[70] The NEMS–BT offers a sophisticated picture of the effect of standards, since it accounts for the interactions between the various energy supply and demand sectors and the economy as a whole.

Specifically, NEMS–BT models certain policy scenarios, such as the effect of reduced electricity consumption, for each trial standard level. The analysis output provides a forecast for the needed generation capacities at each TSL. The estimated net benefit of the standard is the difference between the forecasted generation capacities by NEMS–BT and the *AEO2008* Reference Case.

DOE obtained the energy savings inputs for the utility impact analysis from the NIA's electricity consumption savings. These inputs reflect the effects on electricity of efficiency improvements due to the deployment of GSFL and IRL. Chapter 14 of the TSD accompanying this notice presents results of the utility impact analysis.

DOE received comments requesting that DOE report gas and electricity price impacts, and the economic benefits of reduced need for new electric power plants and infrastructure. The expectation is that lower electricity demand will lead to lower prices for both electricity and natural gas that would benefit consumers. The Joint Comment also stated that the benefits of reduced power plant and infrastructure costs may not be fully reflected in prices because consumers generally pay retail rates for electricity that are based on the average embedded cost of all the facilities used to serve them, rather than on marginal costs. (Joint Comment, No. 23 at pp. 20–22)

DOE considered reporting gas and electricity price impacts but found that the uncertainty of price projections, together with the fairly small impact of the standards relative to total electricity demand, makes these price changes highly uncertain. As a result, DOE believes that they should not be weighed heavily in the decision concerning the standard level. Given the current complexity of utility regulation

[67] Available at: ***http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf***.

[68] Roop, J. M., M. J. Scott, and R. W. Schultz. *ImSET: Impact of Sector Energy Technologies*, PNNL–15273 (Pacific Northwest National Laboratory) (2005).

[69] 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) 19–117.

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

in the United States (with significant variances among States), it does not seem appropriate to attempt to measure impacts on infrastructure costs and prices where there is likely to be significant overlap.

J. Environmental Analysis

DOE has prepared a draft environmental assessment (EA) pursuant to the National Environmental Policy Act and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a), to determine the environmental impacts of the proposed amended standards. Specifically, DOE estimated the reduction in power sector emissions of carbon dioxide (CO_2) using the NEMS–BT computer model. DOE calculated a range of estimates for reduction in oxides of nitrogen (NO_X) emissions and mercury (Hg) emissions using current power sector emission rates. However, the Environmental Assessment (see the Environmental Assessment report of the TSD accompanying this notice) does not include the estimated reduction in power sector impacts of sulfur dioxide (SO_2), because DOE has determined that due to the presence of nationals caps on SO_2 emissions as addressed below, any such reduction resulting from an energy conservation standard would not affect the overall level of SO_2 emissions in the United States.

The NEMS–BT is run similarly to the *AEO2008* NEMS, except the energy use is reduced by the amount of energy saved due to the TSLs. DOE obtained the inputs of national energy savings from the NIA spreadsheet model. For the Environmental Assessment, the output is the forecasted physical emissions. The net benefit of the standard is the difference between emissions estimated by NEMS–BT and the *AEO2008* Reference Case. The NEMS–BT tracks CO_2 emissions using a detailed module that provides results with a broad coverage of all sectors and inclusion of interactive effects.

The Clean Air Act Amendments of 1990 set an emissions cap on SO_2 for all power generation. The attainment of this target, however, is flexible among generators and is enforced through the use of emissions allowances and tradable permits. Because SO_2 emissions allowances have value, they will almost certainly be used by generators, although not necessarily immediately or in the same year with and without a standard in place. In other words, with or without a standard, total cumulative SO_2 emissions will always be at or near the ceiling, while there may be some timing differences between year-by-year forecast. Thus, it is unlikely that there will be an SO_2 environmental benefit from electricity savings as long as there is enforcement of the emissions ceilings.

Although there may not be an actual reduction in SO_2 emissions from electricity savings, there still may be an economic benefit from reduced demand for SO_2 emission allowances. Electricity savings decrease the generation of SO_2 emissions from power production, which can decrease the need to purchase or generate SO_2 emissions allowance credits, and decrease the costs of complying with regulatory caps on emissions.

Like SO_2, future emissions of NO_X and Hg would have been subject to emissions caps under the Clean Air Interstate Act (CAIR) and Clean Air Mercury Rule (CAMR). As discussed later in section VI.B.6, these rules have been vacated by a Federal court. But the NEMS–BT model used for today's final rule assumed that both NO_X and Hg emissions would be subject to CAIR and CAMR emissions caps. In the case of NO_X emissions, CAIR would have permanently capped emissions in 28 eastern States and the District of Columbia. Because the NEMS–BT modeling assumed NO_X emissions would be subject to CAIR, DOE established a range of NO_X reductions based on the use of a NO_X low and high emissions rates (in metric kilotons (kt) of NO_X emitted per terawatt-hours (TWh) of electricity generated) derived from the *AEO2008*. To estimate the reduction in NO_X emissions, DOE multiplied these emission rates by the reduction in electricity generation due to the standards considered. For mercury, because the emissions caps specified by CAMR would have applied to the entire country, DOE was unable to use NEMS–BT model to estimate the physical quantity changes in mercury emissions due to energy conservation standards. To estimate mercury emission reductions due to standards, DOE used an Hg emission rate (in metric tons of Hg per energy produced) based on *AEO2008*. Because virtually all mercury emitted from electricity generation is from coal-fired power plants, DOE based the emission rate on the metric tons of mercury emitted per TWh of coal-generated electricity. To estimate the reduction in mercury emissions, DOE multiplied the emission rate by the reduction in coal-generated electricity associated with standards considered.

DOE received comments from stakeholders on the valuation of CO_2 emissions savings that result from standards. The Joint Comment stated that by not placing an economic value on the benefits from reduced CO_2 emissions, DOE makes it difficult to weigh these benefits in comparison to other benefits and costs resulting from a given standard level. Implicitly, the Joint Comment argued that DOE is arbitrarily valuing pollution reductions at $0. The best way to avoid this mistake would be to estimate an economic value for pollutant reductions. According to the Joint Comment, voluminous work, both from academia and the business world, exists on the range of potential carbon prices under various regulatory scenarios. (Joint Comment, No. 23 at pp. 19–20). NEMA also suggested a CBO report as a potential starting point. (NEMA, No. 22 at p. 34) DOE has made several additions to its monetization of environmental emissions reductions in today's proposed rule, which are discussed in section 0, but has chosen to continue to report these benefits separately from the net benefits of energy savings. Nothing in EPCA, nor in the National Environmental Policy Act, requires that the economic value of emissions reduction be incorporated in the net present value analysis of the value of energy savings. Unlike energy savings, the economic value of emissions reduction is not priced in the marketplace.

VI. Analytical Results

A. Trial Standard Levels

DOE analyzed the costs and benefits of many TSLs for the GSFL and IRL covered in today's proposed rule. Table VI.2 and Table VI.4 present the TSLs and the corresponding product class efficiencies for GSFL and IRL. See the engineering analysis in section V.C of this NOPR for a more detailed discussion of the efficacy levels.

In this section, DOE is only presenting the analytical results for the TSLs of the product classes that DOE analyzed directly (the "representative product classes"). DOE scaled the standards for these representative product classes to create standards for other product classes that were not directly analyzed (such as modified-spectrum lamps), as set forth in chapter 5 of the TSD.

The Joint Comment stated that DOE should use separate TSLs for GSFL and IRL. The Joint Comment also stated that the sets of CSLs in the ANOPR should be made into a single set of TSLs, without further regrouping. (Joint Comment, No. 23 at p. 18) In the NOPR, DOE has generally followed the methodology suggested by the Joint Comment. In this notice, DOE did not group GSFL with IRL. For example, each GSFL TSL reflects a set of efficacy levels across all products classes only within GSFL. DOE believes that this approach is appropriate because GSFL and IRL, though often produced by the same manufacturers, frequently serve different lighting applications, so energy conservation standards for one lamp type are not likely to affect the market or energy consumption of the other lamp type. The following sections describe the TSLs and corresponding efficacy levels.

1. General Service Fluorescent Lamps

DOE developed product classes for GSFL based on the utility of the covered lamps and how they are used in the market. DOE observed that 4-foot medium bipin lamps constitute the vast majority of GSFL sales. These lamps are followed in order of unit sales by 8-foot single pin slimline lamps and 8-foot recessed double contact high output lamps. Because 4-foot medium bipin, 8-foot single pin slimline, and 8-foot recessed double contact HO lamps are the most common GSFL, DOE selected them as representative lamps for its analysis. Lamps with a CCT greater than 4,500K comprise a small share of the GSFL market. Therefore, DOE chose to analyze lamps with a CCT less than or equal to 4,500K. For the NOPR, DOE also chose to analyze 4-foot miniature bipin T5 standard output (SO) and HO lamps with a CCT less than or equal to 4,500K. (DOE did not analyze T5 lamps in the March 2008 ANOPR.)

The following lamps with a CCT less than 4,500K compose the five representative product classes: (1) 4-foot medium bipin; (2) 8-foot single pin slimline; (3) 8-foot recessed double contact HO lamps; (4) 4-foot miniature bipin T5 SO; and (5) 4-foot miniature bipin T5 HO lamps. Standards for other product classes were established by scaling the standards developed for these representative product classes. All 12 GSFL classes are shown in Table VI.1.

TABLE VI.1—GSFL PRODUCT CLASSES

GSFL lamp type	CCT
4-Foot Medium Bipin.	≤ 4,500K (representative).
	> 4,500K.
2-Foot U-Shaped.	≤ 4,500K.
	> 4,500K.
8-Foot Single Pin Slimline.	≤ 4,500K (representative).
	> 4,500K.
8-Foot RDC HO	≤ 4,500K (representative).
	> 4,500K.
4-Foot T5 SO ...	≤ 4,500K (representative).
	> 4,500K.
4-Foot T5 HO ..	≤ 4,500K (representative).
	> 4,500K.

DOE developed TSLs that generally follow a trend of increasing efficacy by using higher-quality phosphors. The TSLs also represent a general move from higher-wattage technologies to lower-wattage, lower-diameter lamps with higher efficacies. Table VI.2 shows the TSLs for GSFL. Each TSL is generally composed of the efficacy level of the same number across all product classes. That is, TSL1 is composed of EL1 for all classes, TSL2 is composed of EL2, etc. For T5 standard output lamps, however, DOE selected EL1 for all TSLs except TSL5, to which DOE assigned EL2 (the maximum technologically feasible efficacy level for T5 SO lamps). For T5 high output lamps, DOE selected EL1 for all TSLs because it is the maximum efficacy for this lamp type. With the methodology, TSL5 represents all maximum technologically feasible GSFL efficacy levels for this NOPR.

The efficacy levels for the five representative product classes are shown in Table VI.2; Efficiency levels for all product classes in the TSLs can be found in the NOPR TSD chapter 5. DOE analyzes systems that meet each efficacy level in the TSLs by pairing standard and reduced-wattage lamps featuring a variety of design options with appropriate magnetic or electronic ballasts. As discussed in the screening analysis (NOPR TSD chapter 4), DOE uses design options with highly emissive electrode coatings, higher efficiency lamp fill gas composition, higher efficiency phosphors, glass coatings, or lamp diameter to achieve higher efficacy levels.

TABLE VI.2—TRIAL STANDARD LEVELS FOR GSFL—EFFICIENCY LEVELS FOR THE FIVE REPRESENTATIVE GSFL PRODUCT CLASSES

Representative product class	Trial standard level (lm/w)					
	EPCA standard *	TSL1	TSL2	TSL3	TSL4	TSL5
4-Foot Medium Bipin, CCT ≤ 4,500K	75.0	78	81	84	89	94
8-Foot Single Pin Slimline, CCT ≤ 4,500K	80.0	89	93	95	97	100
8-Foot RDC HO, CCT ≤ 4,500K	80.0	83	87	88	92	95
4-Foot Miniature Bipin T5 SO, CCT ≤ 4,500K	[None]	103	103	103	103	108
4-Foot Miniature Bipin T5 HO, CCT ≤ 4,500K	[None]	89	89	89	89	89

* 42 U.S.C. 6295(i)(1)(B). Applies to GSFL as defined by EPCA.

TSL1, which would set energy conservation standards for GSFL to EL1 for all product classes, would eliminate the 4-foot medium bipin T12 baselines, the 95W T12 8-foot recessed double contact HO baseline, and the 75W T12 8-foot single pin slimline baseline from the market. In the 4-foot medium bipin product class, this TSL could be met either with a 40W T12 lamp using improved 700-series or 800-series phosphors, or with a 34W T12 lamp using a 700-series phosphor. At this TSL, 4-foot medium bipin lamps using only halophosphors would not be able to meet this TSL. The 75W 8-foot single pin slimline T12 and 110W recessed double contact HO lamps would need to use an 800-series rare earth phosphor to meet TSL1. TSL1 also represents a level which would likely prevent the commercialization of T5 lamps with halophosphor coatings while allowing for 800-series 4-foot T5 miniature bipin and 4-foot T5 miniature bipin HO lamps that are currently commercially available to remain on the market.

TSL2 would set energy conservation standards for GSFL at EL2 for 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO lamps. The 34W T12 4-foot medium bipin lamps would likely be required to use 800-series rare earth phosphors to meet TSL2. For 40W T12 lamps, TSL2 is expected to require a premium 800-series rare earth phosphor and is the maximum TSL that a 40W T12 would be able meet. In the 8-foot single pin slimline product class, TSL2 is expected to require a premium 800-series rare earth phosphor for the 75W T12 and is the maximum TSL that 75W T12 would likely be able to meet. This standard level would eliminate the 60W T12 baseline and require a 700-series phosphor for this lamp. In the 8-foot recessed double contact HO product class, TSL2 would eliminate 110W T12 lamps and the 95W T12 baseline and would require rare earth 700-series phosphors for 95W T12 lamps. For T5s, TSL2 still represents the first efficacy level, which would allow for 800-series 4-foot T5 miniature bipin and 4-foot T5 miniature bipin HO lamps to remain on the market.

TSL3 would set energy conservation standards for GSFL at EL3 for 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO lamps. In this product class, the 32W T8 baseline would be eliminated from the market, and to produce a TSL3-compliant 32W T8 lamp, manufacturers would need to use an 800-series rare earth phosphor. The 34W T12 lamps would likely require an improved 800-series rare earth phosphor mixture and possibly other design options, such as a different gas fill or increased thickness of the bulb-wall phosphor. Only reduced-wattage (34W) 4-foot medium bipin T12 lamps are expected to meet this TSL. In the 8-foot single pin slimline product class, TSL3 would require the use of an 800-series 60W T12 lamp. This standard level is expected to eliminate all 75W T12 lamps and to require an improved 700-series phosphor for the 60W T12. In the 8-foot recessed double contact HO class, TSL3 requires 95W T12 lamps to shift to 800-series rare earth phosphors. TSL3 also represents the first efficacy level for 4-foot T5 miniature bipin and 4-foot T5 miniature bipin HO lamps, retaining 800-series versions of those lamps on the market.

TSL4, which would set energy conservation standards for GSFL at EL4 for 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO, would be expected to eliminate 4,100K T12 lamps from the marketplace. TSL4 would also be expected to raise the efficacy of all full-wattage T8 lamps above the baselines for the aforementioned product classes. In the 4-foot medium bipin product class, TSL4 could be met by improved 800-series full-wattage T8 lamps, or by 800-series 30W and 25W T8 lamps. For the 8-foot SP slimline product class, 59W T8 lamps would likely need to use an 800-series rare earth phosphor to meet TSL4. TSL4, while expected to eliminate 8-foot T12 RDC HO lamps from the market, would require an improved 700-series mixture to be used in T8 lamps for this product class. TSL4 also represents the first efficacy level for 4-foot T5 miniature bipin and 4-foot T5 miniature bipin HO lamps, retaining 800-series T5 lamps on the market.

TSL5 represents the max-tech EL for all GSFL product classes. T12 lamps and 700-series T8 lamps are expected to not be able to meet this level. In the 4-foot medium bipin and 8-foot single pin slimline product class, T8 lamps would need to have a premium 800-series rare earth phosphor coating to meet TSL5. TSL5 could also be met by the 28W reduced-wattage 4-foot medium bipin T8 lamp and the 57W and 55W reduced-wattage 8-foot single pin slimline T8 lamps. TSL5 would require movement 800-series T8 lamps in the 8-foot recessed double contact HO product class. For the 4-foot T5 MiniBP SO product class, a standard-wattage (28W) and reduced-wattage (26W) T5 with an improved 800-series phosphor would need to be used in order to meet TSL5. Because DOE created only one efficacy level for the 4-foot T5 miniature bipin HO lamps, TSL5 would set energy conservation standards for 4-foot T5 MiniBP HO lamps at EL1 and allow 800-series T5 HO lamps to remain on the market. For more information on the TSLs for GSFL, see chapter 9 of the TSD.

2. Incandescent Reflector Lamps

As discussed in section V.C, for IRL, DOE has established five efficacy levels based on an equation relating efficacy (in lumens per watt) to lamp wattage. Also discussed in section V.C, DOE has analyzed only one representative product class and intends to scale minimum efficacy requirements to other product classes. All IRL classes are listed in Table VI.3. As seen in the table, DOE only directly analyzed the standard-spectrum IRL with a diameter greater than 2.5 inches and voltage less than 125 volts.

TABLE VI.3—IRL PRODUCT CLASSES

Lamp type	Diameter	Voltage
Standard Spectrum	> 2.5 inches	≥ 125
		> 125 (representative).
	≤ 2.5 inches	≥ 125.
		< 125.
Modified Spectrum	> 2.5 inches	≥ 125.
		< 125.
	≤ 2.5 inches	≥ 125.
		< 125.

In establishing TSLs for IRL, in this NOPR, DOE analyzes five TSLs, each one corresponding to one efficacy level. For example, TSL1 corresponds to EL1 and TSL5 corresponds to EL5. TSL1 could be achieved with an improved halogen lamp that uses xenon, a higher-efficiency inert fill gas. TSL2 could be achieved with a standard halogen infrared lamp with a lifetime of 6,000 hours or a halogen lamp with an improved reflector, such as silver. TSL3 could be met with a 3,000-hour-lifetime standard halogen infrared lamp. TSL4 could be met with a 4,000-hour-lifetime improved halogen infrared lamp. Improvements in the halogen infrared lamp may include the use of a double-ended halogen infrared burner, higher-efficiency inert fill gas, or more-efficient filament orientation. Finally, TSL5 could be achieved with a 4,200-hour-lifetime halogen infrared lamp (even further improved). These further improvements include an improved reflector, improved IR coating, or filament design that produces higher temperature operation (and may reduce lifetime to 3,000 hours).

The efficacy levels for the representative analyzed product class are shown in Table VI.4 for the TSLs to which they correspond. The efficacy levels for this representative product class were then scaled to create the efficacy levels for the seven other IRL product classes as described in section V.C.7.b of this notice. For more information on efficacy standard levels for the other seven product classes, see chapter 5 of the TSD.

TABLE VI.4—TRIAL STANDARD LEVELS FOR IRL—EFFICIENCY LEVELS FOR THE STANDARD SPECTRUM, DIAMETER > 2.5 INCHES, VOLTAGE < 125 IRL PRODUCT CLASS

Trial standard level (lm/W)*					
EPCA standard**	TSL1	TSL2	TSL3	TSL4	TSL5
10.5 (40–50 Watts) 11.0 (51–66 Watts) 12.5 (67–85 Watts) 14.0 (86–115 Watts) 14.5 (116–155 Watts) 15.0 (156–205 Watts)	$4.6P^{0.27}$	$4.8P^{0.27}$	$5.5P^{0.27}$	$6.2P^{0.27}$	$6.9P^{0.27}$

* P is the rated wattage of the lamp.
** 42 U.S.C. 6295(i)(1)(B). Applies to IRL as defined by EPCA.

B. Economic Justification and Energy Savings

The following section discusses the results of the analyses discussed in section 0. Section VI.C contains further discussion regarding DOE's consideration of these results in the selection of proposed standards levels.

1. Economic Impacts on Consumers

a. Life-Cycle Cost and Payback Period

DOE calculated the average LCC savings relative to the baseline for each product class, as in the March 2008 ANOPR. 73 FR 13620, 13665 (March 13, 2008). A new standard would affect different lamp consumers differently, depending on the market segment to which they belong. DOE designs the LCC analysis around lamp purchasing events, in order to characterize the circumstances under which consumers need to replace a lamp. The LCC spreadsheet calculates the LCC impacts for each lamp replacement event separately. Examining the impacts on each event separately allows DOE to view the results of many subgroup populations in the LCC analyses.

For the NOPR, as in the March 2008 ANOPR, DOE decided not to aggregate the results of the various event scenarios together into a single LCC at each efficacy level. 73 FR 13620, 13655 (March 13, 2008). To do so would have required too many assumptions, such as the relative occurrence of each event over time, and the market share of each lamp in the base case and each standards case. DOE believes it is more appropriate to incorporate assumptions about consumer decisions and long-term market trends in the NIA, and leave the LCC as a direct head-to-head comparison between lamp and lamp-and-ballast designs under different events. Further, the LCC savings results help DOE estimate consumer behavior decisions for the NIA.

DOE recognizes that the large number of LCC and PBP results can make it difficult to draw conclusions about the cost-effectiveness of efficacy standards. The following discussion presents salient results from the LCC analysis. The LCC results are presented according to the lamp purchasing events that culminate in purchase of lamp-and-ballast designs. These results reflect a subset of all of the possible events, although they represent the most prevalent purchasing events.[71] The analysis provides a range of LCC savings for each efficacy level. The range reflects the results of multiple systems (*i.e.*, multiple lamp-ballast pairings) that consumers could purchase to meet an efficacy level.

In addition, DOE has chosen not to present detailed PBP results by efficacy level in this NOPR because DOE believes that LCC results are a better measure of cost-effectiveness. However, a full set of both LCC and PBP results for the systems DOE analyzed are available in chapter 8 and appendix 8B of the TSD. All the LCC results shown here were generated using *AEO2008* reference case electricity prices and medium-range lamp and ballast prices.

i. General Service Fluorescent Lamps

Table VI.5 through Table VI.11 present the results for the baseline lamps in each of the four product classes DOE analyzed (*i.e.*, 4-foot medium bipin, 4-foot miniature bipin SO, 4-foot miniature bipin HO, 8-foot single pin slimline, and 8-foot recessed double contact HO). When a standard results in ''positive LCC savings,'' the life cycle cost of the standards-compliant lamp is less than the life cycle cost of the baseline lamp, and the consumer benefits. When a standard results in ''negative LCC savings,'' the life cycle cost of the standards-compliant lamp is higher than the life cycle cost of the baseline lamp, and the consumer is adversely affected. The range of values represents the multiple ways a consumer can meet a certain efficacy standard under each lamp purchasing event. For example, at EL3, a consumer retrofitting a 4-foot 34W T12 medium bipin baseline system can either purchase a high-efficacy T12 lamp on an electronic ballast or a high-efficacy T8 lamp on an electronic ballast. While consumers have both choices, selecting a T8 system offers positive LCC savings.

Not all baselines have suitable replacement options for every lamp purchasing event at every efficacy level. For instance, because DOE assumed that consumers wish to purchase systems or lamp replacements with a lumen output within 10 percent of their baseline system output, in some cases, the only available replacement options produce less light than this. Thus, the replacement options are considered unsuitable substitutions. These cases are marked with ''LL'' (less light) in the LCC results tables below. In some cases, when consumers who currently own a T12 system need to replace their lamps, no T12 energy saving lamp replacements are available. In these cases, in order to save energy, the consumers must switch to other options, such as a T8 lamp and appropriate ballast. These cases are marked with ''NER'' (no energy-saving replacement) in tables.

Because some baseline lamps already meet higher efficacy levels (e.g., the baseline 32W 4-foot T8 MBP lamp achieves EL2), LCC savings at the levels below the baseline are zero. In these cases, ''BAE'' (baseline above efficacy level) is listed in the tables to indicate that the consumer makes the same purchase decision in the standards-case as they do in the base-case. Also, not all lamp purchase events apply for all baseline lamps or efficacy levels. For example, DOE assumed that the standards-induced retrofit event does not apply to the 32W T8 system, because it is already the most

[71] In many cases, DOE omitted events I(b) and IV in this notice, because DOE believes these lamp purchase events to be relatively less frequent. However, DOE did present all analyzed events in chapter 8 of the TSD.

efficacious 4-foot medium bipin GSFL system. For these events, an ''EN/A'' (event not applicable) exists in the table. Finally, because LCC savings are not relevant when no energy conservation standard is established, ''N/A'' (not applicable) exists in the LCC savings column for the baseline system.

DOE is also presenting the installed prices of the lamp-and-ballast systems in order to compare the up-front costs that consumers must bear when purchasing baseline or standards-case systems. The installed price results for a lamp replacement in response to a lamp failure event (Event IA) only include the lamp purchase price and lamps installation costs. For 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO, at EL1 through EL3, consumers with T12 systems would have the option of purchasing a T12 lamp in the face of a lamp failure. At EL4 and EL5, because no T12 lamps are standard-compliant, consumers would not be able to proceed with a lamp replacement; therefore, no installed price increases are shown.

Instead, at EL4 and EL5, consumers with T12 lamps that either fail at the beginning of the analysis period (Event IB: Lamp Failure, Lamp and Ballast Replacement) or fail in the middle of the analysis period (Event II: Standards-Induced Retrofit) would need to purchase a new lamp-and-ballast T8 system. In these situations, the installed price in the baseline includes the cost of purchasing replacement lamps, whereas the installed price at EL4 and EL5 is much greater, because the consumer would need to purchase and install a T8 lamp-and-ballast system.

The ballast failure event (Event III) and the new construction/renovation event (Event IV) include the purchase and installation costs for lamps and a ballast for the baseline and standards-case systems. This is because the occurrences of these events require the purchase of new lamps and ballasts in all cases. Although in most cases standards-case lamp-and-ballast systems are generally more expensive than baseline lamp-and-ballast systems, in some cases (primarily for owners of the T12 baseline systems purchasing a T8 system instead), the standards-case lamp-and-ballast systems are less expensive than the baseline systems.

Table VI.5 presents the findings of an LCC analysis on various 3-lamp 4-foot medium bipin GSFL systems operating in the commercial sector. The analysis period (based on the longest-lived baseline lamp's lifetime) for this product class in the commercial sector is 5.5 years. As seen in the table, DOE analyzes three baseline lamps: (1) 40W T12; (2) 34W T12; and (3) 32W T8.

For the 40W T12 baseline, when commercial consumers are confronted with a lamp failure in the base case, they purchase the 40W T12 baseline lamp as a lamp replacement on their magnetic T12 ballast. In general, the only energy-saving lamp replacement option for this system is a 34W T12 lamp. However, as seen in Table VI.5, the EL1 and EL2 34W T12 lamps do not produce sufficient light compared to the baseline lumen output. Therefore, for the purposes of the LCC analysis, DOE assumes that at these ELs, 40W T12 consumers would purchase the EL3 34W T12 lamp (which has sufficient lumen output) in response to a lamp failure, and achieve positive LCC savings. Because no T12 lamps would be standards-compliant at EL4 and EL5, consumers with T12 ballasts who are confronted with a lamp failure beyond EL3 would be forced to retrofit their ballasts and instead purchase a T8 system. The LCC savings and incremental costs related to this action can be seen in Table VI.5 under the standards induced retrofit event. At EL4 and EL5, consumers who are forced to retrofit their ballast would achieve positive LCC savings; however, they would also incur an incremental installed price (baseline installed price minus standards-case installed price) greater than $49.30 per system. In particular, 40W T12 consumers who retrofit would obtain the greatest LCC savings at EL4 and EL5 by retrofitting to an electronically-ballasted 32W T8 system.

For the 40W T12 baseline, when commercial consumers are confronted with a ballast failure in the base case, they purchase the 40W T12 baseline lamps and a 0.88 ballast factor electronic ballast. In order to save energy with similar lumen output at EL1 and EL2, consumers would purchase a higher-efficacy 40W T12 with a lower-BF ballast. As seen in Table VI.5, these choices result in negative LCC savings. However, under such a standard, 40W T12 consumers would be able to achieve positive LCC savings under a ballast failure scenario by purchasing systems at EL4 and EL5. Similar to the standards-induced retrofit, at EL4 and EL5 consumers are forced to purchase T8 systems. Those who purchase a 32W T8 lamp generally achieve the highest LCC savings.

For the 34W T12 baseline, when commercial consumers are confronted with a lamp failure in the base case, they purchase the 34W T12 baseline lamp as a lamp replacement on their magnetic T12 ballast. As this is the lowest-wattage commercially-available T12 lamp, there are no energy-saving lamp replacement options for this system. However, as seen in Table VI.5 in the Event IA installed price column, consumers do have the option to purchase a higher-efficacy 34W T12 lamps, resulting in no energy-savings and an installed price increase ranging from $3.69 to $13.91. For the purposes of the LCC analysis, at EL1, EL2, and EL3, DOE analyzes the economics of standards-retrofit, an energy-saving response available to the 34W T12 consumer under a lamp failure scenario. As seen in the table, some LCC savings results at EL1, EL2, and EL3 are negative, representing consumers retrofitting to a 34W T12 lamp on an electronic T12 ballast or the baseline 32W T8 lamp on an electronic T8 ballast. However, under such a standard, consumers would also be able to achieve positive savings by purchasing EL3, EL4, and EL5 T8 systems with either a higher-efficacy 32W T8 lamp or other reduced-wattage lamps. Because no T12 lamps would be standards-compliant at EL4 and EL5, consumers with T12 ballasts who are confronted with a lamp failure at these levels would be forced to retrofit their ballasts and instead purchase a T8 system. The incremental installed prices associated with this forced retrofit are greater than $51.62 per system.

For the 34W T12 baseline, when commercial consumers are confronted with a ballast failure in the base case, they purchase the 34W T12 baseline lamps and a 0.88 ballast factor electronic ballast. In order to save energy with similar lumen output at EL1 and EL2, consumers would purchase a higher-efficacy 34W T12 with a lower-BF ballast. In addition, at EL3, consumers may purchase a 34W T12 lamp with a lower-BF ballast as well. As seen in Table VI.5, these choices result in negative LCC savings. However, under such a standard, 34W T12 consumers can achieve positive LCC savings under a ballast failure scenario by purchasing systems at EL4 and EL5. Similar to the standards-induced retrofit, at EL4 and EL5, consumers would be forced to purchase T8 systems. Those who purchase the reduced-wattage 25W and 28W T8 lamps achieve the highest LCC savings.

For the 32W T8 baseline, commercial consumers purchase either the 32W T8 baseline lamp (under lamp failure) or the 32W T8 baseline lamp and an electronic 0.88 BF ballast (under ballast failure). As the efficacy of this baseline lamp exceeds EL2, no LCC results or installed prices are presented for EL1 and EL2. In order to save energy by only replacing the lamp, the consumer must purchase reduced wattage lamps (these only lie at EL4 and EL5). Therefore, although there are no EL3 energy-saving lamp replacements, consumers may purchase EL4 and EL5 lamps at this standard level. At EL4, consumers who purchase 30W T8 lamps achieve lower LCC savings than those who purchase 25W T8 lamps. At EL5, the only reduced-wattage lamp replacement option (the 28W T8) achieves positive LCC savings.

When confronted with a ballast failure, consumers who would have purchased the 32W T8 baseline system, would achieve positive LCC savings at EL3 by purchasing higher-efficacy 32W T8 lamps on a lower-BF ballast. At EL4, these consumers could obtain the greater LCC savings by purchasing an electronically-ballasted 25W T8 system on a 0.88 BF ballast. At EL5, they achieve highest savings by purchasing the 32W T8 lamp on a lower-BF ballast.

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Table VI.5 LCC Results for a 3-Lamp Four-Foot Medium Bipin GSFL System Operating in the Commercial Sector

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event IA: Lamp Replacement*	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)*	Event III: Ballast Failure*†	Event IA: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure†
40 Watt T12	Base-line	N/A	N/A	N/A	13.96	13.96	65.89
	EL1	LL	EN/A	-7.34 to -5.63	LL	EN/A	72.51 to 77.16
	EL2	LL	EN/A	-7.60	LL	EN/A	77.45
	EL3	22.27	EN/A	13.08 to 15.01	25.13	EN/A	68.21 to 77.06
	EL4	NR	14.30 to 26.65	22.12 to 34.47	NR	63.26 to 75.56	60.96 to 73.25
	EL5	NR	21.04 to 25.26	28.85 to 33.08	NR	64.83 to 71.19	62.52 to 68.89
34 Watt T12	Base-line	N/A	N/A	N/A	11.22	11.22	63.15
	EL1	NER	-17.51	-1.72	14.91	69.15	66.84
	EL2	NER	-22.56 to -3.67	-8.74 to 10.15	21.94	59.74 to 76.18	57.43 to 73.87
	EL3	NER	-22.83 to 6.09	-9.01 to 19.91	25.13	62.84 to 79.37	60.53 to 77.06
	EL4	NR	11.37 to 22.33	25.20 to 36.15	NR	63.26 to 67.88	60.96 to 65.57
	EL5	NR	15.13 to 18.22	28.95 to 32.04	NR	63.51 to 64.83	61.20 to 62.52
32 Watt T8	Base-line	N/A	N/A	N/A	11.97	11.97	57.43
	EL1	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL2	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL3	NER	EN/A	9.76	NER	EN/A	60.53
	EL4	4.89 to 25.99	EN/A	15.04 to 25.99	16.35 to 20.11	EN/A	60.96 to 65.57
	EL5	10.69	EN/A	10.69 to 13.65	15.74	EN/A	61.20 to 62.52

†For 32 Watt T8 baseline, includes Event V (New Construction and Renovation).
*Analysis period is 5.5 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; BAE: Baseline Above Efficiency Level; NR: No Replacement

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As discussed in section V.D, DOE performed research on the usage of GSFL in the residential sector and found a number of variations from the commercial sector. In particular, DOE uses separate electricity prices (higher than commercial), operating hours (lower than commercial), discount rates (higher than commercial), and lamp lifetimes (higher than commercial). DOE also assumes that residential consumers of GSFL generally install their own lamps; thus, labor costs were modeled only for ballast replacements. DOE also uses a 40W T12 baseline lamp that has a lower efficacy, lower price, and shorter lifetime (in hours). DOE found that the most common ballast in the residential sector is a low-power-factor, 2-lamp magnetic rapid-start T12 ballast with a ballast factor of 0.68. Therefore, DOE uses the combination of the magnetic T12 ballast and two 40W T12 lamps as the residential sector GSFL baseline lamp-and-ballast system.

Based on DOE's analysis, the average operating hours for GSFL in the residential sector are 789 hours per year, which is lower than the commercial sector average of 3,435 annual operating hours. This would suggest a 19-year service life for the baseline lamp, which has a lifetime of 15,000 hours. Based on measured-life reports, DOE uses a 15-year average ballast and fixture lifetime in the residential sector. Under these assumptions, lamps used under average residential operating hours would not fail before the fixture reached the end of its life; thus, there would be no lamp-only replacements, but there would be lamp-and-ballast replacements in the residential sector. However, with higher operating hours, lamp service life does decrease below 15 years, resulting in a lamp failure event prior to ballast or fixture replacement. Because DOE believes that the lamp failure event is an important event to analyze, DOE has presented the residential sector LCC analysis under both average operating hours (789 hours per year) and high operating hours (1,210 hours per year). The high operating hours are typical of kitchens, living rooms, dining rooms, and outdoor spaces.

Table VI.7 presents the LCC results for a 4-foot medium bipin system operating in the residential sector under average operating hours. As discussed earlier, under average operating hours, only the ballast failure event (Event III) applies because the ballast and fixture reach the end of their 15 year life before the baseline lamp (which would otherwise have a lifetime of 19 years when operated for 789 hours per year) fails. DOE uses a 15-year analysis period, based on the effective service life of the lamp (limited by the fixture or ballast life). Because DOE assumes that the residential consumer discards the lamp when replacing a ballast or fixture, DOE does not assign any residual value to the remaining life of the lamp at the end of the analysis period. In this event, residential consumers purchase the 40W T12 baseline lamp with a magnetic T12 system in the base case, and an electronic or magnetic T12 system or electronic T8 system in the standards case.

At EL1 and EL2, although consumers may purchase an EL1 or EL2 T12 lamp with a magnetic ballast, none of these systems are both energy saving and produce similar lumen output at the baseline system. Therefore at EL1 and EL2, the only T12 systems analyzed are those purchased with electronic T12 ballasts. At EL1, as seen in Table VI.6, higher LCC savings occur for consumers purchasing 34W T12 lamps than those purchasing 40W T12 lamps. When purchasing at EL2, consumers have the option of either purchasing an electronically-ballasted T12 system or a T8 system with the lowest efficacy 32W T8 lamp. LCC savings are the least when a consumer purchases a higher-efficacy 40W T12 lamp with an electronic T12 ballast. Consumers purchasing 32W T8 lamps on an electronic ballast would obtain the greatest savings at EL2. At EL3, in addition to the T8 and electronically-ballasted T12 purchase options, consumers also can obtain energy savings and similar lumen output by purchasing 34W T12 lamps on magnetic T12 ballasts. However, as seen in the Table VI.6, this option results in the least savings of all ELs. Consumers achieve higher LCC savings by purchasing EL3 32W T8 lamps with electronic ballasts. As discussed in relation to the commercial sector, EL4 and EL5 eliminate T12 lamps from the market and require the purchasing of a T8 system. Those consumers who select a 32W T8 lamp on an electronic ballast obtain the least LCC savings at EL4, while LCC savings are greatest of all ELs when a consumer purchases an electronically-ballasted 25W T8 system. At EL5, consumers choosing a 32W T8 system obtain lower LCC savings than those purchasing a 28W T8 system.

TABLE VI.6—LCC RESULTS FOR A 2-LAMP FOUR-FOOT MEDIUM BIPIN GSFL SYSTEM OPERATING IN THE RESIDENTIAL SECTOR WITH AVERAGE OPERATING HOURS

Baseline	Efficiency level	LCC savings 2007$	Installed price 2007$
		Event III: Ballast failure*	Event III: Ballast failure
40 Watt T12	Baseline	N/A	49.47.
	EL1	5.87 to 9.24	47.22 to 54.10.
	EL2	5.67 to 16.88	48.64 to 54.29.
	EL3	0.27 to 16.63	50.71 to 57.95.
	EL4	16.34 to 21.24	50.99 to 54.07.
	EL5	17.72 to 19.66	51.16 to 52.03.

* Analysis period is 15 years.
N/A: Not Applicable.

In addition to conducting the LCC analysis under average operating hours, DOE also computed residential LCC results under high operating hours (1,210 hours per year) in order to analyze the economic impacts of the lamp failure event (Event I). Table VI.7 presents these LCC and installed-price results for a 2-lamp four-foot medium bipin GSFL system under the lamp failure event and high operating hours.

As seen in Table VI.7, DOE divides the residential GSFL lamp failure event into Events IA (Lamp Failure: Lamp Replacement) and IB (Lamp Failure: Lamp and Ballast Replacement). Event IA, presented also in the commercial sector analysis, models solely a lamp purchase (in response to lamp failure) in both the base case and standards case.

With high operating hours, DOE calculates that the baseline lamp initially purchased with a ballast fails after 12.5 years. Therefore, a replacement lamp will operate for only 2.5 additional years before the entire lamp-and-ballast system is discarded (due to either ballast failure or fixture replacement). Therefore, for this high operating hour scenario's lamp failure event calculation, DOE uses a 2.5 year analysis period. Similar to the average operating hour analysis, when a lamp-and-ballast system is discarded, DOE does not attribute any residual value to the remaining life of the lamp.

Similar to the commercial analysis, the only viable energy-saving lamp replacement option for the 40W T12 residential system is the 34W T12 lamp at EL3. Thus, under a standard at either EL1 and EL2, DOE assumes, for the purpose of the LCC analysis, that consumers would purchase the 34W T12 lamp at EL3. DOE recognizes that not all consumers can use a 34W T12 lamp on a residential magnetic low-power-factor ballast because not all ballasts are designated to operate this lamp. However, in its review of manufacturer literature, DOE identified several low-power-factor residential magnetic ballasts designated to operate the 34W T12 lamp. Therefore, DOE considers this to be a viable option for some residential consumers.

However, as seen in Table VI.7, these consumers who purchase the EL3 34W T12 lamp would encounter negative LCC savings. Although more efficacious than the baseline, the reduced-wattage 34W T12 lamp that meets this EL does not save sufficient energy to offset its increased purchase price within the 2.5-year analysis period. The replacement lamp would need to be in service for exactly 8 years or greater in order for the energy cost savings to offset the increased purchase price of the higher-efficacy 34W lamp.

Because no T12 lamps would be standards-compliant at EL4 and EL5, consumers with T12 ballasts who are confronted with a lamp failure at these levels are forced to retrofit their ballasts and instead purchase a T8 system. The LCC savings and incremental costs related to this action can be seen in Table VI.7 under the lamp and ballast replacement event (Event IB). In the commercial sector, DOE presented the standards-induced retrofit event (Event II), where consumers proactively (before their lamp fails) retrofit their lamp and ballast in anticipation of the inability to purchase a standards-compliant, equal-lumen T12 replacement lamp due to standards. In contrast, for the residential sector, DOE believes that consumers would replace their systems only when forced by a lamp failure. Thus, instead of presenting the standards-induced retrofit event (Event II), for the residential sector, DOE models Event IB, where a consumer replaces a lamp-and-ballast system in direct response to a lamp failure. At EL4 and EL5, the available T8 system options do not save sufficient energy savings to offset the increased purchase price of the lamp and ballast in 2.5 years, leading to negative LCC savings. In addition consumers who would be forced to retrofit their ballast would incur an installed price increase greater than $47.01 per system. DOE requests comment on all inputs used in the LCC analysis for GSFL operating in the residential sector.

TABLE VI.7—LCC RESULTS FOR A 2–LAMP FOUR-FOOT MEDIUM BIPIN GSFL SYSTEM OPERATING IN THE RESIDENTIAL SECTOR WITH HIGH OPERATING HOURS

Baseline	Efficiency level	LCC savings 2007$		Installed price 2007$	
		Event IA: Lamp replacement*	Event IB: Lamp and ballast replacement*	Event IA: Lamp replacement	Event IB: Lamp and ballast replacement
40 Watt T12	Baseline	N/A	N/A	3.98	3.98.
	EL1	LL	EN/A	LL	EN/A.
	EL2	LL	EN/A	LL	EN/A.
	EL3	−5.42	EN/A	12.46	EN/A.
	EL4	NR	−4.67 to −2.78	NR	50.99 to 54.07.
	EL5	NR	−4.13 to −3.50	NR	51.16 to 52.03.

*Analysis period is 2.5 years.
N/A: Not Applicable; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; NR: No Replacement

Table VI.8 presents the results for an electronically-ballasted 4-foot T5 miniature bipin standard-output, baseline system operating in the commercial sector. Table VI.9 presents the results for an electronically-ballasted 4-foot T5 miniature bipin high-output baseline system operating in the industrial sector. For the standard-output baseline, the analysis period is 5.5 years. For the high-output baseline, the analysis period is 3.9 years. In general, positive LCC savings exist at all of the efficacy levels analyzed. However, negative LCC savings exist for Event I (Lamp Replacement) in the 4-foot T5 miniature bipin HO product class. Yet for the 4-foot T5 miniature bipin standard-output product class, consumers selecting a reduced-wattage T5 achieve positive LCC savings. Event II (Standards Induced Retrofit) is not shown because the 4-foot miniature bipin product class is composed entirely of T5 lamps. For Event V, consumers can change the physical layout of their system to match the mean lumen output of the baseline system. Because the T5 baseline halophosphors have such poor lumen maintenance compared to the 800-series T5 lamps, LCC savings for the new construction event are high.

TABLE VI.8—LCC RESULTS FOR A 2-LAMP FOUR-FOOT MINIATURE BIPIN STANDARD OUTPUT GSFL SYSTEM OPERATING IN THE COMMERCIAL SECTOR

Baseline	Efficiency level	LCC savings 2007$		Installed price 2007$	
		Event IA: Lamp replacement*	Event V: New construction/renovation*	Event IA: Lamp replacement	Event V: New construction/renovation
28 Watt T5	Baseline	N/A	N/A	9.39	69.20.
	EL1	NER	42.84	13.15	72.96.
	EL2	1.22	45.27 to 47.03	14.86	74.67 to 75.16.

*Analysis period is 5.5 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement.

TABLE VI.9—LCC RESULTS FOR A 2-LAMP FOUR-FOOT MINIATURE BIPIN HIGH OUTPUT GSFL SYSTEM OPERATING IN THE INDUSTRIAL SECTOR

Baseline	Efficiency level	LCC savings 2007$		Installed price 2007$	
		Event IA: Lamp replacement*	Event V: New construction/renovation*	Event IA: Lamp replacement	Event V: New construction/renovation
54 Watt T5	Baseline	N/A	N/A	10.44	71.33.
	EL1	−3.42	55.60 to 56.60	19.85	76.36 to 80.74.

*Analysis period is 3.9 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement.

Table VI.10 presents the results for an 8-foot single-pin slimline GSFL system operating in the commercial sector. The analysis period is 4 years. For this product class, DOE analyzes three baseline lamps: (1) 75W T12; (2) 60W T12; and (3) 59W T8.

For the 75W T12 baseline, consumers confronted with a lamp failure purchase the baseline 75W T12 for their magnetic T12 ballast in the base case. In the face of standards, consumers could save energy by purchasing reduced-wattage (60W) T12 lamps as replacements. The only 60W T12 lamp that produces sufficient light on the baseline ballast, however, exists at EL3. For the purposes of the LCC analysis, DOE assumes that at standard levels EL1 and EL2, 75W T12 consumers confronted with a lamp failure would purchase the EL3 replacement lamp. These consumers would achieve positive LCC savings. Note that any standard level beyond EL3 would likely require consumers to replace their T12 lamps and ballasts with T8 systems, since no T12 lamp currently meets the efficacy requirements of EL4 and EL5. The LCC savings and installed costs associated with this action are shown in the standards induced retrofit event in Table VI.10. The EL4 lamp available in this event does not produce sufficient light output, so DOE assumes that at standard level EL4, 75W T12 consumers would retrofit to the EL5 59W T8 and 0.88 ballast factor ballast. At EL4 and EL5, 75W T12 consumers who retrofit to the EL5 T8 system achieve positive LCC savings while incurring an incremental installed price of $78.96 per system.

In response to a ballast failure, 75W T12 consumers can purchase more-efficacious 75W T12 lamps and lower-ballast-factor ballasts at EL1 and EL2. These systems do not save enough energy over their lifetimes to offset their increased installed prices, however, resulting in negative LCC savings for consumers. The systems at EL3 and EL4 do not produce sufficient lumen output in comparison to the baseline system, so DOE assumes that 75W T12 consumers encountering ballast failures would purchase the EL5 59W T8 and 0.88 ballast factor ballast at standard levels EL3 and EL4. At standard levels EL4 and EL5, only T8 systems are available. It is possible, however, for 75W T12 consumers to achieve positive LCC savings by purchasing the EL5 T8 system.

In response to a lamp failure, consumers of 60W T12 lamps do not have access to any energy-saving T12 replacement lamps. At EL1, consumers could still purchase the 60W T12 baseline lamp for their magnetic ballast. T12 lamps that do not save energy are also available at standard levels EL2 and EL3, with installed price increases ranging from $4.88 to $8.30. To save energy at EL2 and EL3, consumers of 60W T12 lamps can instead choose to retrofit to T12 or T8 systems with electronic ballasts. 60W T12 consumers would not be able to achieve positive LCC savings with any of the systems available for a standards-induced retrofit at any EL, although they would save energy. Standard levels EL4 and EL5 also force T12 lamps from the market, requiring consumers to retrofit to T8 systems and incur installed price increases of at least $82.08.

In response to a ballast failure, DOE assumes that 60W T12 consumers would purchase 60W T12 lamps and 0.88 ballast factor electronic ballasts in the base case. Consumers can also purchase this system at standard level EL1. At standard levels EL2 and EL3, consumers could purchase more-efficacious 60W T12 lamps and lower-ballast-factor electronic ballasts when faced with a ballast failure. Consumers cannot save enough energy with these systems to achieve positive LCC savings, however. Instead, they can purchase the T8 systems on electronic ballasts available at EL4 and EL5 and achieve positive LCC savings. In the face of standard levels EL4 and EL5, T12 systems would be eliminated from the market. Consumers can achieve the greatest positive LCC savings with a 57W T8 on a 0.78 ballast factor electronic ballast at EL5, while consumers purchasing the 59W T8 on a 0.78 ballast factor electronic ballast at EL4 achieve the least positive LCC savings.

Consumers of 59W T8 lamps can purchase the baseline 59W T8 to install on an electronic ballast at standard levels EL1 through EL3 when faced with a lamp failure. At EL4, there are no energy-saving lamp replacement options, so DOE assumes that consumers of 59W T8 lamps would instead purchase the 57W or 55W T8 lamps that comply with EL5. Consumers purchasing these lamps achieve positive LCC savings and incur installed price increases ranging from $3.94 to $4.76. Those purchasing the 55W T8 achieve the greatest positive LCC savings.

In response to a ballast failure, consumers of 59W T8 lamps can purchase the baseline 59W T8 system at EL1 through EL3. The available system at EL4 is a 59W T8 lamp on a 0.85 ballast factor electronic ballast, and consumers purchasing this system would achieve negative LCC savings. At EL5, 59W T8 consumers could purchase 59W, 57W, or 55W T8 systems on electronic ballasts and achieve positive LCC savings. Those purchasing the 55W T8 system would achieve the greatest positive LCC savings, while those purchasing the 57W T8 system would achieve the least positive LCC savings.

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Table VI.10 LCC Results for a 2-Lamp Eight-Foot Single-Pin Slimline GSFL System Operating in the Commercial Sector

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event IA: Lamp Replacement*	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)*	Event III: Ballast Failure*†	Event IA: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure†
75 Watt T12	Base-line	N/A	N/A	N/A	16.16	16.16	88.94
	EL1	LL	EN/A	-4.59	LL	EN/A	95.31
	EL2	LL	EN/A	-0.59	LL	EN/A	97.21
	EL3	36.73	EN/A	LL	19.43	EN/A	LL
	EL4	NR	LL	LL	NR	LL	LL
	EL5	NR	11.45	28.45	NR	95.12	92.82
60 Watt T12	Base-line	N/A	N/A	N/A	11.33	11.33	84.11
	EL1	NER	BAE	BAE	BAE	BAE	BAE
	EL2	NER	-24.86	-2.48	16.01	91.10	88.79
	EL3	NER	-24.31 to -23.98	-1.61	19.43	89.03 to 94.52	92.21
	EL4	NR	-14.90	7.47	NR	93.41	91.10
	EL5	NR	-14.02 to -12.26	8.35 to 10.12	NR	93.79 to 95.12	91.48 to 92.82
59 Watt T8	Base-line	N/A	EN/A	N/A	12.74	EN/A	86.72
	EL1	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL2	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL3	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL4	NER	EN/A	-0.24	NER	EN/A	91.10
	EL5	6.48 to 10.42	EN/A	8.15 to 10.42	16.68 to 17.50	EN/A	90.67 to 92.82

†For 59-Watt T8 baseline, includes Event V (New Construction and Renovation).
*Analysis period is 4 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; BAE: Baseline Above Efficiency Level; NR: No Replacement

Table VI.11 shows LCC results for an 8-foot recessed double-contact GSFL system operating in the industrial sector. The analysis period for this product class is 2.3 years. DOE analyzes 110W T12 and 95W T12 baseline lamps on magnetic ballasts.

Consumers who own 110W T12 lamps and are faced with a lamp failure would be expected to purchase 110W T12 baseline lamps for their magnetic ballast in the base case. The available replacement lamps at EL1 and EL2 do not produce sufficient light output in comparison to the baseline system, so DOE assumes that 110W T12 consumers would purchase the reduced-wattage

(95W) T12 lamp options at EL3 when faced with standard levels EL1 and EL2. Consumers could achieve positive LCC savings with these lamps while incurring installed price increases of $12.64 or $13.27. Standard levels EL4 and EL5 eliminate T12 lamps from the market, requiring consumers to retrofit their systems to T8 systems in the face of a lamp failure. The available T8 system at EL4 does not produce sufficient light in comparison with the baseline system, so DOE assumes that at EL4, consumers would instead purchase the 86W T8 system and 0.88 ballast factor electronic ballast at EL5. 110W T12 consumers purchasing this system could achieve positive LCC savings while incurring an installed price increase of $106.75.

In the face of a ballast failure, 110W T12 consumers would be expected to purchase the 110W T12 baseline lamp and a 0.95 ballast factor magnetic ballast in the base case. Consumers who own 110W T12 systems can purchase replacement systems that comply with EL1, EL3, or EL5 and achieve positive LCC savings. The available systems at EL2 and EL4 do not produce sufficient light, so DOE assumes that in the face of standard levels EL2 or EL4, consumers would purchase systems meeting higher standard levels. At EL1, 110W T12 consumers could purchase a 110W T12 lamp on an electronic ballast but would achieve the least positive LCC savings. At EL3, consumers could purchase reduced-wattage (95W) T12 lamps on a magnetic ballast or on an electronic ballast. Consumers could achieve the most positive LCC savings of any EL by purchasing the 86W T8 system available at EL5. Standard levels EL4 and EL5 would eliminate T12 systems from the market, making the 86W T8 system the only available option.

When faced with a lamp failure, consumers of the 95W T12 baseline lamp would be expected to purchase the 95W T12 baseline for their magnetic ballast in the base case. This lamp also complies with EL1. None of the lamps available at EL1 through EL3, when in combination with the magnetic ballast save energy as compared to the baseline system. However, consumers can purchase these lamps and incur installed price increases ranging from $6.14 to $19.09. Consumers of the 95W T12 baseline lamp could instead retrofit their systems to save energy. The EL1 system available for retrofit does not produce sufficient light output, and consumers could not achieve positive LCC savings with any of the system options available for retrofit at EL2 through EL5. Furthermore, standard levels EL4 and EL5 would eliminate T12 lamps from the market, thereby forcing consumers of the 95W T12 baseline lamp to retrofit to T8 systems when faced with a lamp failure and incur installed price increases ranging from $109.35 to $112.57.

When faced with a ballast failure, consumers of 95W T12 lamps could purchase a 95W T12 baseline lamp on a magnetic ballast in the base case. Consumers purchasing a higher efficacy 95WT12 at EL2 on an electronic ballast achieve positive LCC savings. However, consumers purchasing these systems at EL3, would not achieve positive LCC savings. EL4 and EL5 would likely eliminate T12 systems from the market, making the EL4 and EL5 86W T8 system the only available option for consumers faced with a ballast failure. Those who purchase the 86W T8 system at EL4 or EL5 can achieve positive LCC savings.

Table VI.11 LCC Results for a 2-Lamp Eight-Foot Recessed Double-Contact High Output GSFL System Operating in the Industrial Sector

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event I: Lamp Replacement *	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement) *	Event III: Ballast Failure*	Event I: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure
110 Watt T12	Baseline	N/A	N/A	N/A	19.74	19.74	97.60
	EL1	LL	EN/A	6.01	LL	EN/A	113.23
	EL2	LL	EN/A	LL	LL	EN/A	LL
	EL3	7.05 to 7.67	EN/A	7.05 to 16.07	32.38 to 33.01	EN/A	110.24 to 114.96
	EL4	NR	LL	LL	NR	LL	LL
	EL5	NR	5.13	42.23	NR	126.49	124.19
95 Watt T12	Baseline	N/A	N/A	N/A	13.92	13.92	91.77
	EL1	NER	LL	LL	BAE	LL	LL
	EL2	NER	-28.71	5.47	20.06	104.32	102.01
	EL3	NER	-39.07 to -38.44	-4.89 to -4.27	32.38 to 33.01	116.64 to 117.27	114.33 to 114.96
	EL4	NR	-16.04 to -12.88	18.13 to 21.30	NR	123.27 to 123.60	120.96 to 121.29
	EL5	NR	-12.70	21.47	NR	126.49	124.19

*Analysis period is 2.3 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; NR: No Replacement

ii. Incandescent Reflector Lamps

Table VI.12 shows the commercial and residential sector LCC results for IRL. The results are based on the reference case *AEO2008* electricity price forecast and medium-range lamp prices. The analysis period is 3.4 years for the residential sector and 0.9 years for the commercial sector. DOE assessed three efficacy levels for the March 2008 ANOPR. 73 FR 13620, 13666–13667 (March 13, 2008). For the NOPR, DOE added two additional efficacy levels—one below the lowest EL considered in the March 2008 ANOPR, and one above the highest EL considered in the March 2008 ANOPR See the engineering analysis in chapter 5 of the TSD or section V.C.4.b of this notice for details.

The majority of efficacy levels result in positive LCC savings in spite of the higher installed prices of the standards-case lamps in comparison with the baseline lamps. In general, the higher lumen package lamps (*i.e.*, those replacing the 90W baseline lamp) achieve higher LCC savings that the lower lumen package lamps (*i.e.*, those replacing the 75W and 50W baselines). This is due to the larger energy savings, and, thus, operating cost savings associated with higher-wattage lamps. At EL1, in all but the residential 90W PAR38 baseline, consumers would achieve negative LCC savings when purchasing the improved halogen lamp. The improved halogen lamp at this efficacy level would not save enough energy to recover its increased initial cost from the baseline lamp. Maximum LCC savings would be achieved at EL5 for the 90W and 75W baselines when a consumer purchases an improved HIR lamp. For the 50W baseline, both the EL4 and EL5 replacement lamps are 40W, as this is the lowest-wattage IRL covered by standards. Therefore, EL4, consuming the same amount of energy and with a lower lamp price, would have higher LCC savings than EL5. In general, the lamps with the highest LCC savings are more efficacious and have longer lifetimes than the baseline lamps.

TABLE VI.12—LCC RESULTS FOR INCANDESCENT REFLECTOR LAMPS

Baseline	Efficiency level	Event I: Lamp replacement/Event V: New construction and renovation			
		LCC savings 2007$		Installed price 2007$	
		Commercial *	Residential **	Commercial	Residential
90 Watt PAR38	Baseline	N/A	N/A	6.20	5.13.
	EL1	−0.03	0.12	7.14	6.07.
	EL2	3.81 to 6.04	3.06 to 4.68	7.58 to 7.76	6.52 to 6.70.
	EL3	6.19	5.55	7.76	6.70.
	EL4	8.14	7.09	9.08	8.02.
	EL5	9.41	8.76	9.65	8.59.
75 Watt PAR38	Baseline	N/A	N/A	6.20	5.13.
	EL1	−0.31	−0.18	7.14	6.07.
	EL2	3.24 to 5.67	2.46 to 4.30	7.58 to 7.76	6.52 to 6.70.
	EL3	4.77	4.07	7.76	6.70.
	EL4	7.00	5.90	9.08	8.02.
	EL5	7.50	6.77	9.65	8.59.
50 Watt PAR30	Baseline	N/A	N/A	5.59	4.53.
	EL1	−0.31	−0.28	6.53	5.46.
	EL2	0.04 to 2.72	0.10 to 2.21	6.98 to 7.15	5.92 to 6.09.
	EL3	0.77	0.87	7.15	6.09.
	EL4	1.95	1.62	8.47	7.41.
	EL5	1.51	1.49	9.04	7.98.

*Analysis period is 0.9 years.
**Analysis period is 3.4 years.

b. Consumer Subgroup Analysis

Certain consumer subgroups may be disproportionately affected by standards. In the March 2008 ANOPR, DOE requested comment on which consumer subgroups should be considered as well as methods of analyzing those subgroups. 73 FR 13620, 13682 (March 13, 2008). In response to comments it received, DOE performed LCC subgroup analyses in this NOPR for low-income consumers, institutions of religious worship, and institutions that serve low-income populations. See section 0 of this NOPR for a review of the inputs to the LCC analysis. The following discussion presents the most significant results from the LCC subgroup analysis.

All of the LCC results shown here were generated using *AEO2008* reference case electricity prices. In addition, DOE presents subgroup results using medium-range lamp and ballast prices, as DOE believes that these prices represent average prices for the consumer subgroups as well. As in the primary LCC analysis, not all baselines and lamp purchase events have suitable replacement options at every efficacy level. See the primary LCC analysis results in section VI.B.1.a of this NOPR for more details on this analysis, as well as the TSD chapter 12 for a full set of LCC and PBP results for the subgroup analysis.

i. Low-Income Households

DOE conducted the low-income consumer subgroup analysis based on the 4-foot MBP 40W baseline operating in the residential sector and IRL operating in the residential sector. The low-income consumer subgroup analysis is identical to the residential average consumer LCC analysis, except that it includes slightly lower electricity prices, which DOE determined using data in the 2001 RECS. In comparing this subgroup's LCC results to the primary results presented in Table VI.5, Table VI.6, and Table VI.12, positive primary LCC savings results remained positive and negative primary LCC savings results remained negative. In general, LCC savings for GSFL and IRL are approximately 1 to 2 percent lower for low-income residential consumers than they are for the average consumer in the residential sector.

ii. Institutions of Religious Worship

DOE found that institutions of religious worship have the lowest operating hours of any non-mall commercial building. Specifically, operating hours were 1,705 hours per year for GSFL (vs. the commercial sector average of 3,435 hours per year) and 1,609 hours per year for IRL (vs. the commercial sector average of 3,450 hours per year). The LCC analysis for this subgroup is identical to the main commercial sector LCC analysis except for the lower operating hours, resulting in an analysis period of 11 years for 4-foot GSFL, 8 years for 8-foot GSFL, and 1.9 years for IRL. Results are shown in Table VI.13 through Table VI.16 of this notice.

Institutions of religious worship experience lower LCC savings than the rest of the commercial sector, particularly for standards-induced retrofit events. This is because the longer analysis period (due to lower operating hours) causes operating cost savings and residual values to be discounted more heavily than in the primary commercial LCC analysis. In general, LCC savings that were positive for the 4-foot medium bipin product class in the primary commercial sector analysis remain positive for institutions of religious worship. For example, in Event II, LCC savings for institutions of religious worship are approximately $17 lower than savings for the rest of the commercial sector for the 40W T12 baseline. However, LCC savings for the standards-induced retrofit event for the 34W T12 baseline lamp and 40W T12 baseline lamp are negative for certain T8 systems at EL4 and EL5.

In the 4-foot T5 miniature bipin product class, LCC savings for institutions of religious worship are several dollars lower than savings for the rest of the commercial sector. This is also true for the 8-foot single-pin slimline product class except for the standards-induced retrofit event, where LCC savings for such institutions are approximately $20 lower than savings for the rest of the commercial sector. DOE notes that the standards-induced retrofit of a 75W T12 system at EL5 is not cost-effective for religious institutions.

For IRL, LCC savings for institutions of religious worship are generally lower by several cents compared to the rest of the commercial sector due to the longer analysis period. LCC savings are slightly higher, however, at EL1 for the 90W and 75W PAR38 baselines.

Table VI.13 LCC Subgroup Results for a 3-Lamp Four-Foot Medium Bipin GSFL System Operating in Institutions of Religious Worship

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event IA: Lamp Replacement*	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)*	Event III: Ballast Failure*†	Event IA: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure†
40 Watt T12	Base-line	N/A	N/A	N/A	13.96	13.96	65.89
	EL1	LL	EN/A	-8.34 to -5.79	LL	EN/A	72.51 to 77.16
	EL2	LL	EN/A	-8.62	LL	EN/A	77.45
	EL3	16.43	EN/A	10.35 to 10.49	25.13	EN/A	68.21 to 77.06
	EL4	NR	-2.17 to 9.71	17.84 to 29.71	NR	63.26 to 75.56	60.96 to 73.25
	EL5	NR	4.02 to 8.27	24.03 to 28.27	NR	64.83 to 71.19	62.52 to 68.89
34 Watt T12	Base-line	N/A	N/A	N/A	11.22	11.22	63.15
	EL1	NER	-28.33	-2.04	14.91	69.15	66.84
	EL2	NER	-33.71 to -14.90	-9.07 to 9.74	21.94	59.74 to 76.18	57.43 to 73.87
	EL3	NER	-34.85 to -7.25	-10.17 to 17.39	25.13	62.84 to 79.37	60.53 to 77.06
	EL4	NR	-3.13 to 4.96	21.51 to 29.60	NR	63.26 to 67.88	60.96 to 65.57
	EL5	NR	-0.27 to 3.24	24.37 to 27.88	NR	63.51 to 64.83	61.20 to 62.52
32 Watt T8	Base-line	N/A	N/A	N/A	11.97	11.97	57.43
	EL1	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL2	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL3	LL	EN/A	7.64	LL	EN/A	60.53
	EL4	3.37 to 19.86	EN/A	11.77 to 19.86	16.35 to 20.11	EN/A	60.96 to 65.57
	EL5	8.77	EN/A	8.77 to 10.33	15.74	EN/A	61.20 to 62.52

†For 32-Watt T8 baseline, includes Event V (New Construction and Renovation).
*Analysis period is 11 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; BAE: Baseline Above Efficiency Level; NR: No Replacement

TABLE VI.14—LCC SUBGROUP RESULTS FOR A 2-LAMP FOUR-FOOT T5 MINIATURE BIPIN GSFL SYSTEM OPERATING IN INSTITUTIONS OF RELIGIOUS WORSHIP

Baseline	Efficiency level	LCC savings 2007$		Installed price 2007$	
		Event IA: Lamp replacement*	Event V: New construction/ renovation*	Event IA: Lamp replacement	Event V: New construction/ renovation
28 Watt T5	Baseline	N/A	N/A	9.39	69.20.
	EL1	NER	38.73	13.15	72.96.
	EL2	−0.08	39.74 to 42.31	14.86	74.67 to 75.16.

* Analysis period is 11 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement.

Table VI.15 LCC Subgroup Results for a 2-lamp Eight-Foot Single-Pin Slimline GSFL System Operating in Institutions of Religious Worship

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event IA: Lamp Replacement*	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)*	Event III: Ballast Failure*†	Event IA: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure†
75 Watt T12	Base-line	N/A	N/A	N/A	16.16	16.16	88.94
	EL1	LL	EN/A	-4.93	LL	EN/A	95.31
	EL2	LL	EN/A	-1.28	LL	EN/A	97.21
	EL3	31.83	EN/A	LL	19.43	EN/A	LL
	EL4	NR	LL	LL	NR	LL	LL
	EL5	NR	-6.68	24.20	NR	95.12	92.82
60 Watt T12	Base-line	N/A	N/A	N/A	11.33	11.33	84.11
	EL1	NER	BAE	BAE	BAE	BAE	BAE
	EL2	NER	-37.81	-2.85	16.01	91.10	88.79
	EL3	NER	-37.19 to -36.83	-2.23	19.43	89.03 to 94.52	92.21
	EL4	NR	-29.22	5.75	NR	93.41	91.10
	EL5	NR	-28.95 to -27.42	6.01 to 7.54	NR	93.79 to 95.12	91.48 to 92.82
59 Watt T8	Base-line	N/A	EN/A	N/A	12.74	EN/A	86.72
	EL1	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL2	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL3	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL4	LL	EN/A	-0.78	LL	EN/A	91.10
	EL5	4.56 to 8.30	EN/A	6.01 to 8.30	16.68 to 17.50	EN/A	90.67 to 92.82

†For 59-Watt T8 baseline, includes Event V (New Construction and Renovation).
*Analysis period is 8 years.
N/A: Not applicable; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; BAE: Baseline Above Efficiency Level; NR: No Replacement

TABLE VI.16—LCC SUBGROUP RESULTS FOR INCANDESCENT REFLECTOR LAMPS OPERATING IN INSTITUTIONS OF RELIGIOUS WORSHIP

Baseline	Efficiency level	Event I: Lamp replacement/Event V: New construction and renovation *	
		LCC savings 2007$	Installed price 2007$
90 Watt PAR38	Baseline	N/A	6.20.
	EL1	0.00	7.14.
	EL2	2.97 to 5.14	7.58 to 7.76.
	EL3	5.21	7.76.
	EL4	6.87	9.08.
	EL5	8.28	9.65.
75 Watt PAR38	Baseline	N/A	6.20.
	EL1	−0.26	7.14.
	EL2	2.43 to 4.79	7.58 to 7.76.
	EL3	3.87	7.76.
	EL4	5.80	9.08.
	EL5	6.48	9.65.
50 Watt PAR30	Baseline	N/A	5.59.
	EL1	−0.35	6.53.
	EL2	−0.04 to 2.55	6.98 to 7.15.
	EL3	0.64	7.15.
	EL4	1.58	8.47.
	EL5	1.37	9.04.

* Analysis period is 1.9 years.

iii. Institutions That Serve Low-Income Populations

Table VI.17 through Table VI.20 show the LCC subgroup results for institutions that serve low-income populations. DOE assumed that the majority of these institutions are small nonprofits; thus, DOE used a higher discount rate of 10.8 percent (versus the 7.0-percent discount rate for the primary commercial sector analysis). All other factors of the LCC subgroup analysis remained the same as in the primary commercial sector analysis. As a result of the higher discount rate, LCC savings are lower for institutions that serve low-income populations than for the rest of the commercial sector. For Events I and III for all analyzed GSFL product classes, savings are several dollars lower than for the rest of the commercial sector. For Event II for GSFL, LCC savings are approximately $10 lower than for the rest of the commercial sector. For IRL, LCC savings are several cents lower than for the rest of the commercial sector. Although LCC savings are lower, positive primary LCC results remained positive for this subgroup, while negative primary LCC results remained negative.

Table VI.17 LCC Subgroup Results for a 3-Lamp Four-Foot Medium Bipin GSFL System Operating in Institutions That Serve Low-Income Populations

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event IA: Lamp Replacement*	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)*	Event III: Ballast Failure*†	Event IA: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure
40 Watt T12	Base-line	N/A	N/A	N/A	13.96	13.96	65.89
	EL1	LL	EN/A	-7.99 to -5.73	LL	EN/A	72.51 to 77.16
	EL2	LL	EN/A	-8.26	LL	EN/A	77.45
	EL3	18.66	EN/A	11.49 to 12.12	25.13	EN/A	68.21 to 77.06
	EL4	NR	4.49 to 16.57	19.49 to 31.57	NR	63.26 to 75.56	60.96 to 73.25
	EL5	NR	10.12 to 15.15	25.12 to 30.15	NR	64.83 to 71.19	62.52 to 68.89
34 Watt T12	Base-line	N/A	N/A	N/A	11.22	11.22	63.15
	EL1	NER	-23.97	-1.91	14.91	69.15	66.84
	EL2	NER	-29.23 to -10.34	-8.94 to 9.94	21.94	59.74 to 76.18	57.43 to 73.87
	EL3	NER	-30.05 to -1.88	-9.76 to 18.41	25.13	62.84 to 79.37	60.53 to 77.06
	EL4	NR	2.67 to 11.81	22.96 to 32.09	NR	63.26 to 67.88	60.96 to 65.57
	EL5	NR	5.87 to 8.48	26.16 to 28.76	NR	63.51 to 64.83	61.20 to 62.52
32 Watt T8	Base-line	N/A	N/A	N/A	11.97	11.97	57.43
	EL1	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL2	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL3	LL	EN/A	8.46	LL	EN/A	60.53
	EL4	3.96 to 22.15	EN/A	13.01 to 22.15	16.35 to 20.11	EN/A	60.96 to 65.57
	EL5	8.74	EN/A	8.74 to 11.59	15.74	EN/A	61.20 to 62.52

†For 32-Watt T8 baseline, includes Event V (New Construction and Renovation).
*Analysis period is 5.5 years.
N/A: No Replacement; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; BAE: Baseline Above Efficiency Level; NR: No Replacement

TABLE VI.18—LCC SUBGROUP RESULTS FOR A 2-LAMP FOUR-FOOT MINIATURE BIPIN GSFL SYSTEM OPERATING IN INSTITUTIONS THAT SERVE LOW-INCOME POPULATIONS

Baseline	Efficiency level	LCC savings 2007$		Installed price 2007$	
		Event IA: Lamp replacement*	Events V: New construction/ renovation*	Event IA: Lamp replacement	Events V: New construction/ renovation
28 Watt T5	Baseline	N/A	N/A	9.39	69.20.
	EL1	NER	40.41	13.15	72.96.
	EL2	0.37	41.91 to 44.24	14.86	74.67 to 75.16.

* Analysis period is 5.5 years.
N/A: Not Applicable; NER: No Energy-Saving Replacement.

Table VI.19 LCC Subgroup Results for a 2-Lamp Eight-Foot Single-Pin Slimline GSFL System Operating in Institutions That Serve Low-Income Populations

Baseline	Efficiency Level	LCC Savings 2007$			Installed Price 2007$		
		Event IA: Lamp Replacement*	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)*	Event III: Ballast Failure*†	Event IA: Lamp Replacement	Event II: Standards-Induced Retrofit (Lamp and Ballast Replacement)	Event III: Ballast Failure†
75 Watt T12	Base-line	N/A	N/A	N/A	16.16	16.16	88.94
	EL1	LL	EN/A	-4.81	LL	EN/A	95.31
	EL2	LL	EN/A	-0.97	LL	EN/A	97.21
	EL3	33.78	EN/A	LL	19.43	EN/A	LL
	EL4	NR	LL	LL	NR	LL	LL
	EL5	NR	1.57	25.94	NR	95.12	92.82
60 Watt T12	Base-line	N/A	N/A	N/A	11.33	11.33	84.11
	EL1	NER	BAE	BAE	BAE	BAE	BAE
	EL2	NER	-31.84	-2.72	16.01	91.10	88.79
	EL3	NER	-31.08 to -30.98	-1.96	19.43	89.03 to 94.52	92.21
	EL4	NR	-22.67	6.45	NR	93.41	91.10
	EL5	NR	-22.13 to -20.54	7.00 to 8.59	NR	93.79 to 95.12	91.48 to 92.82
59 Watt T8	Base-line	N/A	EN/A	N/A	12.74	EN/A	86.72
	EL1	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL2	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL3	BAE	EN/A	BAE	BAE	EN/A	BAE
	EL4	LL	EN/A	-0.57	LL	EN/A	91.10
	EL5	5.32 to 9.16	EN/A	6.86 to 9.16	16.68 to 17.50	EN/A	90.67 to 92.82

†For 59-Watt T8 baseline, includes Event V (New Construction and Renovation).
*Analysis period is 4 years.
N/A: Not applicable; NER: No Energy-Saving Replacement; LL: Available Options Produce Less Light; EN/A: Event Not Applicable; BAE: Baseline Above Efficiency Level; NR: No Replacement

TABLE VI.20—LCC SUBGROUP RESULTS FOR INCANDESCENT REFLECTOR LAMPS OPERATING IN INSTITUTIONS THAT SERVE LOW-INCOME POPULATIONS

Baseline	Efficiency level	Event I: Lamp replacement/Event V: New construction and renovation *	
		LCC savings 2007$	Installed price 2007$
90 Watt PAR38	Baseline	N/A	6.20.
	EL1	−0.09	7.14.
	EL2	3.84 to 6.00	7.58 to 7.76.
	EL3	6.14	7.76.
	EL4	7.97	9.08.
	EL5	9.18	9.65.
75 Watt PAR38	Baseline	N/A	6.20.
	EL1	−0.37	7.14.
	EL2	3.29 to 5.64	7.58 to 7.76.
	EL3	4.76	7.76.
	EL4	6.87	9.08
	EL5	7.34	9.65.
50 Watt PAR30	Baseline	N/A	5.59.
	EL1	−0.33	6.53.
	EL2	−0.01 to 2.57	6.98 to 7.15.
	EL3	0.69	7.15.
	EL4	1.78	8.47.
	EL5	1.34	9.04.

*Analysis period is 0.9 years.

iv. Historical Facilities

DOE found that historical facilities have similar operating hours, discount rates, and electricity prices as the typical consumer, although they do own more T12 systems. Accordingly, for this subgroup, no separate findings are warranted. See section VI.B.1.a.i of this notice to view the impacts on those consumers with T12 lamps.

v. Consumers of T12 Electronic Ballasts

Table VI.21 through Table VI.24 show the LCC subgroup results for consumers of T12 electronic ballasts. Specifically, DOE analyzed the LCC savings of a consumer that owns a T12 electronic system in the base case. In the case of an energy conservation standard at EL4 or EL5, this consumer would need to purchase a T8 electronic system, as T12 lamps would no longer available. DOE established a new baseline electronic T12 system and modified standards case systems so that both of the following conditions are met: (1) Light output is maintained in the case of a standard; and (2) energy is saved. All other factors of the LCC subgroup analysis remained the same as in the primary analysis. Because electronic T12 systems are much more efficient than magnetic T12 systems, the LCC savings for this subgroup are lower than the LCC savings for systems in the primary analysis. For 4-foot medium bipin lamps operating in the commercial sector, LCC savings are reduced by approximately $20 to $30, going from positive LCC savings in the primary analysis to negative LCC savings for this subgroup. The source of this reduction is primarily due to the increased efficacy of the baseline system.

TABLE VI.21—LCC SUBGROUP RESULTS FOR A 3-LAMP FOUR-FOOT ELECTRONIC MEDIUM BIPIN GSFL SYSTEM OPERATING IN THE COMMERCIAL SECTOR

Baseline	Efficiency level	Event II: Standards-induced retrofit (lamp & ballast replacement)	
		LCC savings * 2007$	Installed price 2007$
40 Watt T12	Baseline	N/A	13.96.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	−16.72 to −4.37	63.26 to 75.56.
	EL5	−9.98 to −5.76	64.83 to 71.19.
34 Watt T12	Baseline	N/A	11.22.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	−12.38 to −1.43	63.26 to 67.88.
	EL5	−8.63 to −5.53	63.51 to 64.83.

* Analysis period is 5.5 years.
EN/A: Event Not Applicable; N/A: Not Applicable.

For 4-foot medium bipin lamps operating in the residential sector, LCC savings, already negative in the primary analysis, become slightly more negative for this subgroup. The change in the savings is not as large in the residential sector as in the commercial sector because consumers for this event have a shortened analysis period.

TABLE VI.22—LCC SUBGROUP RESULTS FOR A 2-LAMP FOUR-FOOT ELECTRONIC MEDIUM BIPIN GSFL SYSTEM OPERATING IN THE RESIDENTIAL SECTOR USING HIGH OPERATING HOURS

Baseline	Efficiency level	Event IB: Lamp & ballast replacement	
		LCC savings 2007$	Installed price 2007$
40 Watt T12	Baseline	N/A	3.98.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	−8.35 to −6.45	50.99 to 54.07.
	EL5	−7.80 to −7.18	51.16 to 52.03.

* Analysis period is 2.5 years.
EN/A: Event Not Applicable; N/A: Not Applicable.

For 8-foot single pin slimline lamps, LCC savings are reduced by approximately $18 to $25. For the 75W T12 baseline, consumers experience negative LCC savings for this subgroup as opposed to the positive LCC savings experienced by consumers in the primary analysis. For the 60W T12 baseline, LCC savings, already negative in the primary analysis, become more negative for this subgroup. The source of this reduction is primarily due to the increased efficacy of the baseline system.

TABLE VI.23—LCC SUBGROUP RESULTS FOR A 2-LAMP EIGHT-FOOT ELECTRONIC SINGLE-PIN SLIMLINE GSFL SYSTEM OPERATING IN THE COMMERCIAL SECTOR

Baseline	Efficiency level	Event II: Standards-induced retrofit (lamp & ballast replacement)	
		LCC savings* 2007$	Installed price 2007$
75 Watt T12	Baseline	N/A	16.16.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	LL	93.41.
	EL5	−14.18	95.12.
60 Watt T12	Baseline	N/A	11.33.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	−32.74	93.41.
	EL5	−31.86 to −30.09	93.79 to 95.12.

* Analysis period is 4.0 years.
EN/A: Event Not Applicable; N/A: Not Applicable.

For 8-foot recessed double contact high output lamps, LCC savings are reduced by approximately $10 to $15. For the 110W T12 baseline, consumers experience negative LCC savings for this subgroup as opposed to the positive LCC savings experienced by consumers in the primary analysis. For the 95W T12 baseline, LCC savings, already negative in the primary analysis, become more negative. The source of this reduction is again primarily due to the increased efficacy of the baseline system.

TABLE VI.24—LCC SUBGROUP RESULTS FOR A 2-LAMP EIGHT-FOOT ELECTRONIC RECESSED DOUBLE-CONTACT HIGH OUTPUT GSFL SYSTEM OPERATING IN THE INDUSTRIAL SECTOR

Baseline	Efficiency level	Event II: Standards-induced retrofit (lamp & ballast replacement)	
		LCC savings 2007$	Installed price 2007$
110 Watt T12	Baseline	N/A	19.74.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	LL	123.27 to 123.60.
	EL5	−10.09	126.49.

TABLE VI.24—LCC SUBGROUP RESULTS FOR A 2-LAMP EIGHT-FOOT ELECTRONIC RECESSED DOUBLE-CONTACT HIGH OUTPUT GSFL SYSTEM OPERATING IN THE INDUSTRIAL SECTOR—Continued

Baseline	Efficiency level	Event II: Standards-induced retrofit (lamp & ballast replacement)	
		LCC savings 2007$	Installed price 2007$
95 Watt T12	Baseline	N/A	13.92.
	EL1	EN/A	EN/A.
	EL2	EN/A	EN/A.
	EL3	EN/A	EN/A.
	EL4	−26.41 to −23.25	123.27 to 123.60.
	EL5	−23.07	126.49.

* Analysis period is 2.3 years.
EN/A: Event Not Applicable; N/A: Not Applicable.

2. Economic Impacts on Manufacturers

DOE used the INPV in the MIA to compare the financial impacts of different TSLs on GSFL and IRL manufacturers. The INPV is the sum of all net cash flows discounted by the industry's cost of capital (discount rate). DOE used the GRIMs to compare the INPV of the base case (no amended energy conservation standards) to that of each TSL for the GSFL and IRL industries. To evaluate the range of cash-flow impacts on the industries, DOE constructed different scenarios for each industry using different assumptions for markups and shipments that correspond to the range of anticipated market responses. Each scenario results in a unique set of cash flows and corresponding industry value at each TSL. These steps allowed DOE to compare the potential impacts on industries as a function of TSLs in the GRIMs. The difference in INPV between the base case and the standards case is an estimate of the economic impacts that implementing that standard level would have on the entire industry.

a. Industry Cash-Flow Analysis Results

i. General Service Fluorescent Lamps

To assess the lower end of the range of potential impacts for the GSFL industry, DOE considered the flat markup scenario under the Existing Technologies base case, shipments with high lighting expertise, and a shift in efficacy distributions. Besides the impact of shipments on the INPV, this case assumed that manufacturers would be able to maintain gross margins as a percentage of revenues as production cost increases with efficacy. To assess the higher end of the range of potential impacts for the GSFL industry, DOE considered the scenario reflecting the four-tier markup scenario under the Emerging Technologies base case, shipments with market-based lighting expertise, and a rollup in efficacy distributions. Besides the impact of shipments on the INPV, this case assumed standards would reduce manufacturers' portfolio, thereby squeezing the margin of higher-efficacy products as they are ''demoted'' to lower-relative-efficacy tier products. Table VI.25 and Table VI.26 show the low end and high end of the range of MIA results, respectively, for each TSL using the cases described above.

TABLE VI.25—MANUFACTURER IMPACT ANALYSIS FOR GSFL WITH THE FLAT MARKUP SCENARIO UNDER THE EXISTING TECHNOLOGIES BASE CASE—HIGH LIGHTING EXPERTISE—SHIFT IN EFFICIENCY DISTRIBUTIONS

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2007$ millions)	602	652	653	673	594	616
Change in INPV	(2007$ millions)		49	50	71	−9	13
	(%)		8.18%	8.31%	11.78%	−1.48%	2.21%
Amended Energy Conservation Standards Product Conversion Expenses.	(2007$ millions)		3.3	8.8	8.8	11.6	29.6
Amended Energy Conservation Standards Capital Conversion Expenses.	(2007$ millions)		38.5	60.5	104.5	181.5	181.5
Total Investment Required	(2007$ millions)		41.8	69.3	113.3	193.1	211.1

TABLE VI.26—MANUFACTURER IMPACT ANALYSIS FOR GSFL WITH THE FOUR-TIER MARKUP SCENARIO UNDER THE EMERGING TECHNOLOGIES BASE CASE—MARKET SEGMENT LIGHTING EXPERTISE—ROLLUP IN EFFICIENCY DISTRIBUTIONS

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2007$ millions)	575	668	638	436	380	312
Change in INPV	(2007$ millions)		93	63	−139	−195	−263
	(%)		16.09%	11.02%	−24.15%	−33.96%	−45.80%
Amended Energy Conservation Standards Product Conversion Expenses.	(2007$ millions)		3.3	8.8	8.8	11.6	29.6
Amended Energy Conservation Standards Capital Conversion Expenses.	(2007$ millions)		38.5	60.5	104.5	181.5	181.5
Total Investment Required	(2007$ millions)		41.8	69.3	113.3	193.1	211.1

For the GSFL MIA, margin impacts are the most significant driver of INPV. The potential margin impacts on manufacturers are based on their ability to maintain higher margins as standards remove efficacy as a differentiator of premium products. The potential for standards to disrupt the premium margins for efficacy is captured in the higher-bound and lower-bound scenarios DOE presents. The lower-bound scenario represents the situation where manufacturers maintain their current ''good, better, best'' marketing strategy by basing higher margins on features other than efficacy or coming up with more-efficient products. The large impacts on industry value in the upper-bound scenario are caused by higher standards disrupting manufacturers' current marketing strategy. In this scenario, manufacturers cannot maintain higher margins when efficacy is lost as a differentiator and higher standards lower profitability. Other drivers of INPV are less significant because: (1) The capital costs required at each TSL are relatively small compared to the industry revenue; and (2) shipments do not substantially change regardless of the scenario.

DOE estimated the impacts on INPV at TSL1 to range from $49 million to $93 million, equal to a 8.2 percent to 16.1 percent increase. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, industry cash flow decreases by approximately 37 percent, to $32 million, compared to the base-case value of $50 million in the year leading up to the standards. Product conversion costs are low at TSL1 because manufacturers have existing products that meet the efficacy levels. Capital conversion costs are also low at this TSL because a minimal amount of T12 machinery needs to be converted to meet the growing volume of T8 production induced by standards. The necessary conversion costs to meet TSL1 are low relative to the conversion costs for the natural market migration from T12 to T8 lamps in the base case, which helps to mitigate the impact of the standards-induced conversion costs. The positive INPV predicted in the flat markup scenario is indicative that product conversion and capital conversion outlays are also low relative to the increase in variable production costs. Whereas GSFL production is capital intensive, the capital requirements are a function primarily of the tube diameter. Efficiency standards which do not require a change in diameter will typically require a change in phosphors which is not capital intensive. Under the tiered markup scenario, manufacturers are left with a range of products after standards, so they still earn higher markups on a wide variety of premium products. In fact, the products eliminated at TSL1 are commodity products which have a lower-than-average profit margin. Thus, industry revenues and cash flows are not negatively affected, and manufacturers actually benefit from the higher prices of remaining products.

At TSL2, DOE estimated the impacts in INPV at TSL2 to range from $50 million to $63 million, equal to a 8.3 percent to 11.0 percent increase. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, industry cash flow decreases by approximately 60 percent, to $20 million, compared to the base-case value of $50 million in the year leading up to the standards. Product conversion costs are still relatively low at TSL2, because few manufacturers will have to modify exiting products to meet this standard level. Capital conversion costs are also low at this TSL, but the investments required to meet TSL2 are larger than TSL1, because more T12 machinery needs to be converted to meet the growing volume of T8 production induced by standards. INPV is less positive at TSL2 than at TSL1, because the higher conversion costs necessary to meet TSL2 lower the mitigating impact of the conversion costs for the natural market migration from T12 to T8 lamps included in the base case. At TSL2, more of the most-efficient, higher-priced T12 lamps are shifting to less-expensive T8 lamps. INPV in the four-tier markup scenario is also not as positive, because manufacturers have fewer premium products and the profit margins on some more-efficient T12 products begin to shrink. While TSL2 eliminates some of the premium T12 lamps, the T8 lamps to which consumers must migrate still earn a higher markup.

At TSL3, the impact on INPV and cash flow depends heavily on the ability of manufacturers to differentiate products and maintain higher margins as standards move consumers to previously premium products. DOE estimated that the impacts on INPV at TSL3 range from approximately $71 million to −$139 million, equal to a 11.8 percent to −24.2 percent change. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, industry cash flow decreases by approximately 100 percent, to $0 million, compared to the base-case value of $50 million in the year leading up to the standards. At TSL3, most manufacturers expressed concerns about the ability to maintain production volumes of T12 and T8 lamps, because all but the most efficient T12 lamps are eliminated. Because a large portion of existing T12 shipments migrate to T8, manufacturers have to convert or replace a significant portion of their T12 production lines to T8, making capital conversion costs higher at TSL3 than at TSL1 or TSL2. Conversion costs are also higher at TSL3, because manufacturers have to make more R&D expenditures to offer a full line of T12 and T8 products that meet the standard. Because TSL3 greatly accelerates the migration of T12 to T8 products, the conversion costs in the base case have a minimal effect on offsetting INPV impacts from high standards-induced conversion costs at TSL3 and all higher TSLs. If manufacturers can pass along the increased production costs of more-efficient products by differentiating the products with features such as low mercury content and longer life, they can recoup margins, thereby mitigating some of the impacts. If manufacturers can fully differentiate their products and earn the same profit margins as in the base case (the lower range of impacts), they will benefit from higher prices and INPV will be positive at this TSL. However, if manufacturers cannot differentiate their products and the margins on previously premium products begin to erode with commoditization, DOE expects manufacturer margins to be negative and the higher end of the range of negative INPV will be reached.

At TSL4, DOE estimated the impacts on INPV range from approximately −$9 million to −$195 million, equal to a −1.5 percent to −34.0 percent change. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, industry cash flow decreases by approximately 171 percent, to −$36 million, compared to the base-case value of $50 million in the year leading up to the standards. At TSL4, there are significant conversion capital expenditures because all T12 production lines need to be converted to T8 lines; the capital requirement for this conversion is nearly double the amount needed at TSL3. The large capital costs make INPV negative even if manufacturers maintain the margin on all lamps, as in the base case. Also, manufacturers expressed concern that the highest-grade phosphor mixtures would be necessary on most lamps to meet efficiencies prescribed by TSL4. The more-efficient phosphor blends substantially increase lamp costs, decreasing profitability if the cost increases cannot be passed on to consumers. That is, at TSL4, more T8 lamps that previously earned a premium are commoditized because the standard eliminates all T12 lamps from the market, thereby squeezing margins on all lamps and causing more negative impacts in the four-tier markup scenario.

At TSL5, DOE estimated that the impacts on INPV range from approximately $13 million to −$263 million, equal to a 2.2 percent to −45.8 percent change. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, industry cash flow decreases by approximately 183 percent, to −$42 million, compared to the base-case value of $50 million in the year leading up to the standards. At TSL5, the necessary conversion capital is identical to TSL4 because this TSL also requires manufacturers to convert all existing T12 production to T8 production. These large costs make INPV negative even if manufacturers pass along all production cost increases to the consumer. At TSL5, all products are commoditized because all lamps must use the most efficient phosphor coatings. There are few options available for manufacturers to differentiate lamps at TSL5, thereby making it more likely that manufacturers will be negatively affected.

Based on interviews with manufacturers, DOE understands that manufacturers are constantly forced to revise their marketing strategies as new products are introduced and older products become commoditized. DOE also understands that higher efficacy is not the only feature available to differentiate premium products. Lifetime, lower mercury content, and removing lead are all features that also differentiate products. Therefore, DOE believes that after significant early disruptions in pricing, over time the industry will recover the profitability levels that existed prior to standards as manufacturers rebalance their product mix. The net effect on INPV is uncertain but should tend toward the midpoint of the two GRIM scenarios. DOE seeks comment on the ability of manufacturers to maintain these margins through the differentiation of products by other means. DOE also seeks comment on how the ability to differentiate products might vary over time.

ii. Incandescent Reflector Lamps

During the manufacturer interviews DOE learned that for IRL lamps, markups do not increase as a function of efficacy (in contrast to GSFL). Instead, manufacturers indicated that the range of potential impacts would depend on the magnitude of the capital investments required and the expected reduction in product sales. Thus, DOE modeled manufacturing impacts using all IRL shipments scenarios described in sections V.G.4.b.ii and V.G.4.b.iv. To assess the lower end of the range of potential impacts for the IRL industry, DOE considered the Existing Technologies base case reflecting the no product substitution scenario with a shift in efficacy distributions. In this scenario: (1) Manufacturers benefit from higher prices from consumers switching to more-efficient products on their own (the shift scenario); (2) IRL base-case shipments are not eroded due to emerging technologies; and (3) standards-case shipments do not decrease due to substitutions of R–CFL and exempted BR lamps for IRL. To assess the higher end of the range of potential impacts for the IRL industry, DOE considered the Emerging Technologies base case reflecting the product substitution scenario with a rollup in efficacy distributions. In this scenario: (1) IRL base-case shipments are eroded due to emerging technologies; and (2) standards-case shipments decrease due to substitutions of R–CFL and exempted BR lamps for IRL. Table VI.27 and Table VI.28 show the MIA results for each TSL for IRL under the shipment scenarios which result in the highest and lowest INPV impacts.

TABLE VI.27—MANUFACTURER IMPACT ANALYSIS FOR IRL UNDER THE EXISTING TECHNOLOGIES BASE CASE—NO PRODUCT SUBSTITUTION SCENARIO—SHIFT IN EFFICIENCY DISTRIBUTION

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2007$ millions)	267	263	215	205	190	185
Change in INPV	(2007$ millions)		(4)	(52)	(62)	(77)	(82)
	(%)		−1.55%	−19.36%	−23.06%	−28.85%	−30.85%
Amended Energy Conservation Standards Product Conversion Expenses.	(2007$ millions)		$3	$3	$2	$3	$7
Amended Energy Conservation Standards Capital Conversion Expenses.	(2007$ millions)		$31	$83	$134	$166	$185
Total Investment Required	(2007$ millions)		$35	$87	$136	$170	$192

TABLE VI.28—MANUFACTURER IMPACT ANALYSIS FOR IRL UNDER THE EMERGING TECHNOLOGIES BASE CASE—PRODUCT SUBSTITUTION—ROLL-UP IN EFFICIENCY DISTRIBUTIONS

	Units	Base case	Trial standard level				
			1	2	3	4	5
INPV	(2007$ millions)	207	191	149	131	112	104
Change in INPV	(2007$ millions)		(16)	(58)	(76)	(94)	(103)
	(%)		−7.69%	−27.87%	−36.85%	−45.60%	−49.60%
Amended Energy Conservation Standards Product Conversion Expenses.	(2007$ millions)		$3	$3	$2	$3	$7
Amended Energy Conservation Standards Capital Conversion Expenses.	(2007$ millions)		$31	$83	$134	$166	$185

TABLE VI.28—MANUFACTURER IMPACT ANALYSIS FOR IRL UNDER THE EMERGING TECHNOLOGIES BASE CASE—PRODUCT SUBSTITUTION—ROLL-UP IN EFFICIENCY DISTRIBUTIONS—Continued

	Units	Base case	Trial standard level				
			1	2	3	4	5
Total Investment Required	(2007$ millions)		$35	$87	$136	$170	$192

To meet TSL1, manufacturers must replace less-efficient fill gases in the capsule with xenon. At TSL1, DOE estimated the impacts on INPV to be between −$4 million and −$16 million, or a change in INPV of between −1.6 percent and −7.7 percent. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, the industry cash flow decreases by approximately 68 percent, to $7.1 million, compared to the base case value of $22.5 million in the year leading up to the standards. All manufacturers have a full range of products that meet this TSL. Conversion expenses are relatively low at this level because using xenon does not require substantial changes to the manufacturing process. Because the lifetimes of standards-compliant lamps do not change at TSL1, shipments in the standards cases are not further impacted by lower shipments due to higher lamp lifetimes. In fact, at this TSL, manufacturers benefit from the increased prices of standards-compliant lamps. However, this positive impact on revenues is not enough to overcome the product and capital conversion expenses, making overall INPV negative. The greater impact on shipments in the Emerging Technologies base case with product substitution drives INPV more negative.

TSL2 is based on a 6,000 hour HIR lamp, but this level may also be achieved using an improved reflector. At TSL2, the impact on INPV and cash flow depends on a manufacturer's ability to recoup the conversion capital and product conversion expenses and the extent to which shipments are reduced in the base case due to emerging technologies and in the standards case due to changes in the product mix (including lamp lifetime). DOE estimated the impacts in INPV at TSL2 to be between −$52 million and −$58 million or a change in INPV of −19.4 percent and −27.9 percent. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, the industry cash flow decreases by approximately 172 percent, to −$16.2 million, compared to the base-case value of $22.5 million in the year leading up to the standards. At TSL2, there are negative impacts on manufacturers due to decreased shipments and significant product conversion expenses. At this TSL, conversion expenses vary greatly among manufacturers but are significant in the aggregate due to the need to increase production of HIR lamps or invest in improved reflector technology. Two manufacturers have a complete line of standards-compliant lamps but must spend a considerable amount of resources to expand production of a low-volume, premium product for mass production. Another manufacturer must spend a significant amount of capital to purchase the machinery to meet demand with exclusively higher technology (infrared) lamps in addition to replacing krypton with xenon as fill gas in the capsule. The shipment scenarios chosen account for the range in INPV. Shipments have a significant impact on INPV at this TSL in all cases because the products that meet this standard have the longest lifetimes in the standards cases, further decreasing shipments relative to the base cases. Some manufacturers have expressed concerns about competitive impacts at this TSL. One manufacturer has a patent on silverized reflectors. Another manufacturer is believed to have a cross license on the technology. Despite the large capital expense to expand this reflector technology for all baseline lamps to meet this TSL, both these manufacturers could capture market share by selling less-expensive lamps based on improved reflector coating instead of HIR technology. The other manufacturer without access to the enhanced reflectors would have to make large expenditures on capital and product conversion to produce lamps with a comparable efficacy, but at higher costs.

TSL3 is based on 3,000-hour HIR technology. DOE estimated the impacts on INPV at TSL3 to be between −$62 million and −$76 million, or a change in INPV of between −23.1 percent and −36.9 percent. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, the industry cash flow decreases by approximately 272 percent, to −$38.6 million, compared to the base-case value of $22.5 million in the year leading up to the standards. There are significant capital conversion costs at this TSL that make INPV negative. Manufacturers must purchase additional infrared coaters to increase the production of these low-volume lamps. Since current HIR production is very small relative to standard halogen IRL, all manufacturers voiced their concerns about meeting demand at this level. Also, since all existing HIR capsules use xenon as the fill gas, manufactures are concerned about the high material costs for this gas and the potential for the price to increase over time. The high costs to convert all lamps to HIR technology drive INPV negative and strand existing equipment for standard halogen capsules. The range of INPV arises from the shipment scenarios that account for different market erosion due to emerging technology and standards inducing a switch to exempted BR lamps and R–CFL. If manufacturer concerns about consumers switching to exempted BR and R–CFL are realized in addition to emerging technology eroding the IRL market, then the higher end of the range of negative INPV will be reached.

TSL4 requires the production of an improved HIR lamp. At TSL4, DOE estimated the impacts in INPV to be between −$77 million and −$94 million, or a change in INPV of −28.9 percent and −45.6 percent. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, the industry cash flow decreases by approximately 338 percent, to −$53.6 million, compared to the base-case value of $22.5 million in the year leading up to the standards. The significant capital and product conversion expenses at this TSL make INPV negative. At this TSL, all manufacturers must expand production of the more-efficient HIR technology to meet demand of the entire market. Since current HIR production is relatively low, these substantial costs make INPV negative. The capital conversion expenses are large because, in addition to HIR technology, manufacturers must also use enhanced reflectors or the most efficient burners and add xenon. Also, since all existing HIR capsules use xenon as the fill gas, manufactures are concerned about the high material costs for this gas and the potential for the price to increase over time. The lifetimes of products that meet this TSL are longer than the baseline, creating a negative impact on INPV from shipments regardless of the shipment scenario selected. Manufacturers also voiced concerns about competition at TSL4. Because lamps can use an enhanced reflector with HIR to meet TSL4, manufacturers have the same competitive concerns as at TSL2. Finally, two manufacturers currently have a full line of lamps that meet TSL4. A third manufacturer has some products, but would have to undertake a costly redesign of its burners in order to sell a full line of those lamps.

TSL5 requires the production of lamps with an improved HIR coating and an additional improvement. At TSL5, DOE estimated the impacts in INPV to be between −$82 million and −$103 million, or a change in INPV of between −30.9 percent and −49.6 percent. At this level, the highest impact on cash flow in the year leading up to the standards occurs under the Emerging Technologies base case. Under this scenario, the industry cash flow decreases by approximately 381 percent, to −$63.1 million, compared to the base-case value of $22.5 million in the year leading up to the standards. The impacts at TSL5 are the most severe for manufacturers, because the capital and product conversion expenses are greatest at this TSL. At this TSL, all manufacturers must expand production of a lamp with multiple improvements over standard HIR lamps. Manufacturers must use HIR technology with an improved coating and with either enhanced reflectors or more-efficient burners. Since even standard HIR production is currently low compared to standard halogen, expanding the production of the most-efficient HIR technology to meet demand of the entire market is very costly. Due to the large conversion costs, INPV is greatly negative even if the market is not eroded by emerging technology and customers do not substitute R–CFL and exempted BR lamps for IRL. If manufacturers concerns about emerging technology and substitutions for IRL are realized, DOE expects the higher range of negative impacts to be reached (a 49.6 percent decrease in INPV).

b. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, DOE understands the combined effects of several existing and impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. For this reason, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

In its written comment, NEMA submitted a list of regulatory requirements that included numerous reporting requirements, the Restriction on Hazardous Substances directive (RoHS), and legislatively-prescribed minimum performance requirements that contribute to the industries' cumulative regulatory burden (NEMA, No. 22 at p 34). DOE discusses the suggested regulatory provisions submitted by NEMA in chapter 13 of the TSD.

In addition to the energy conservation standards on GSFL and IRL products, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can quickly strain profits and possibly cause an exit from the market. Besides the list of suggested regulatory provisions that NEMA submitted, DOE also identified other regulations these manufacturers are facing for other products and equipment they manufacture within three years prior to and three years after the effective date of the amended energy conservation standards for GSFL and IRL.

DOE believes that the EISA 2007 requirements for GSIL could have the greatest cumulative burden on manufacturers of GSFL and IRL. DOE understands that manufacturers of GSFL and IRL will also incur large capital and product conversion investments to comply with the GSIL minimum efficacy standards. The GSIL investments will compete with IRL and GSFL for company resources. For example, GSFL, IRL, and GSIL all share many of the same limited engineering resources. In addition, the capital costs to comply with EISA 2007 could potentially limit the funding available for GSFL and IRL conversions because these investments will compete for the same sources of capital. DOE understands that these are important but surmountable challenges for GSFL and IRL manufacturers.

c. Impacts on Employment

To assess the impacts of energy conservation standards on GSFL and IRL direct manufacturing employment, DOE used the GRIM to estimate domestic labor expenditures and employment levels. DOE used statistical data from the U.S. Census Bureau's 2006 Annual Survey of Manufacturers (2006 ASM), results from other analyses, and interviews with manufacturers to estimate the inputs necessary to calculate industry-wide labor expenditures and employment levels. In the GRIM, total labor expenditures are a function of the labor content, the sales volume, and the wage rate which remains fixed in real terms over time. The total employment figures presented for the GSFL and IRL industries include both production and non-production workers.

DOE does not believe that standards will alter the domestic employment levels of the GSFL industry. During interviews with manufacturers, DOE learned that GSFL are produced on high-speed, fully-automated lines. Production workers are not involved in the physical assembly of the final product (*e.g.*, in inserting components, transferring partly assembled lamps, soldering lamp bases). The production workers counted in DOE's figure include plant workers involved in clearing glass, overseeing a portion of the assembly line, monitoring quality control, mixing phosphors, and moving finished products to loading. The employment levels required for these tasks are a function of the total volume of the facility, not the labor content of the product mix produced by the plant. Since higher TSLs involve using more-efficient phosphors, employment will not be impacted because standards will not change the overall scale of the facility. DOE estimates that there are approximately 1,806 U.S. production and non-production workers in the GSFL industry.

Table VI.29 and Table VI.30 show the domestic employment impacts calculated in the GRIM for the two cash flow scenarios used to bound the range of INPV impacts. The total employment figures include both production and non-production workers.

TABLE VI.29—CHANGE IN AVERAGE NUMBER OF DOMESTIC EMPLOYEES IN THE IRL INDUSTRY UNDER THE EXISTING TECHNOLOGIES BASE CASE—NO PRODUCT SUBSTITUTION SCENARIO—SHIFT IN EFFICIENCY DISTRIBUTION

	Baseline	TSL1	TSL2	TSL3	TSL4	TSL5
Average Number of Domestic IRL Employees from 2012–2042	1,319	1,518	1,303	1,492	1,396	1,426
Change in the Average Number of Domestic IRL Employees from 2012–2042	....	199	−16	173	77	107

TABLE VI.30—CHANGE IN AVERAGE NUMBER OF DOMESTIC EMPLOYEES IN THE IRL INDUSTRY UNDER THE EMERGING TECHNOLOGIES BASE CASE—PRODUCT SUBSTITUTION SCENARIO—ROLL-UP IN EFFICIENCY DISTRIBUTION

	Baseline	TSL1	TSL2	TSL3	TSL4	TSL5
Average Number of Domestic IRL Employees from 2012–2042	699	783	623	724	617	621
Change in the Average Number of Domestic IRL Employees from 2012–2042	....	84	−77	24	−82	−78

DOE believes that amended energy conservation standards will not significantly impact IRL direct employment. The impact that new standards will have on employment is far less significant than the potential impact from emerging technologies. Both scenarios show that the absolute magnitudes of employment impacts due to standards are small. Whether standards have a positive or negative impact on employment is largely determined by the extent to which consumers elect to substitute IRL with other lamp technologies (such as R–CFL or exempted IRL) in the standards case.

The employment impacts calculated by DOE are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 15 of the TSD accompanying this notice. The employment conclusions also do not account for the possible relocation of domestic jobs to lower-labor-cost countries because the potential relocation of U.S. jobs is uncertain and highly speculative. During interviews, manufacturers did not emphasize the risk of shifting production facilities abroad.

d. Impacts on Manufacturing Capacity

DOE anticipates that amended energy conservation standards would not significantly affect the production capacity of GSFL manufacturers. For GSFL manufacturers, any necessary redesign of GSFL would not change the fundamental assembly of the equipment because higher TSLs require the use of more-efficient phosphor coatings, which are largely a materials issue. Therefore, in the long-term there should be no capacity constraints. However, higher standards would also be expected to expedite a natural conversion of T12 shipments to T8 shipments. Because most production lines are specific to lamp diameter, shifting production from T12 to T8 lamps requires shutting down the line and retooling. Based on the duration of line changes described by manufactures, DOE believes that the conversion of machinery to T8 lamp production could occur between the announcement date and the effective date of the standards. In addition, manufacturers indicated it is possible to ramp up production before shutting down a line to maintain a constant supply of shipments during retooling.

Manufacturers are concerned that IRL standards could cause capacity constraints if amended standards were to alter the assembly of standard halogen burners. In particular, IRL manufacturers are concerned about the ability to convert their equipment in time to meet an exclusively HIR standard (TSL3, TSL4, and TSL5). Although all manufacturers DOE interviewed produce lamps with infrared burners, the current volume of these lamps is many times lower than the volume of standard halogen lamps. In addition, the production of infrared capsules is much more time consuming, requiring additional time for the coating process and quality control due to the precision necessary for the technology to increase efficacy. In general, the large lamp manufacturers are concerned about their ability to increase the production volume of HIR capsules in time to meet the standard. However, interviews with suppliers of HIR capsules and coating decks suggest that the capacity could be met under an HIR standard. Based on discussions with suppliers of infrared coaters, DOE also believes that lamp manufacturers will have enough time in between the announcement date and the effective date of the standards to purchase and install the necessary coaters to meet TSL3 and higher and produce all burners in their own facilities. Independent of manufacturers' ability to install coaters to produce all infrared burners in-house, independent suppliers of infrared capsules suggested that they have the ability to supply a significant portion of the market. Because manufacturers could install additional coaters, purchase infrared burners from a supplier, and use existing excess capacity, DOE believes IRL manufacturers will be able to maintain production capacity levels and continue to meet market demand for all IRL standard levels.

e. Impacts on Manufacturer Subgroups

As discussed above, using average cost assumptions to develop an industry cash-flow estimate is inadequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche players, and manufacturers exhibiting a cost structure that differs largely from the industry average could be affected differently. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics.

During its interviews, DOE did not identify any small manufacturers of covered IRL, but DOE did identify one small manufacturer that produces covered GSFL.[72] This manufacturer suggested that it could be less impacted by amended energy conservation standards on GSFL than the large manufacturers. Unlike its larger competitors, the small manufacturer focuses on specialty products not covered by this rulemaking and has had

[72] DOE identified and contacted 12 businesses that could potentially be classified as small business manufacturers of the products that are the subject of this rulemaking. Four of those businesses agreed to be interviewed. Of these, DOE verified that only one of those businesses met all the criteria to be classified as a small manufacturer of covered GSFL or IRL. For further detail on DOE's inquiry regarding small manufacturers, please see section VII.B on the review under the Regulatory Flexibility Act.

a better ability to pass along product cost increases. For a discussion of the impacts on the small manufacturer, see chapter 13 of the TSD and section 0 of today's notice.

3. National Impact Analysis

a. Significance of Energy Savings

To estimate the energy savings through 2042 due to amended energy conservation standards, DOE compared the energy consumption of the lamps under the base case to the energy consumption of these products under the trial standard levels. Table VI.31 and Table VI.32 show the forecasted national energy savings (including rebound effect and HVAC interactions where applicable) in quads (quadrillion BTU) at each TSL for GSFL and IRL. As discussed in section V.E, DOE models two base-case shipment scenarios and several standards-case shipment scenarios. For each lamp type, these scenarios combined produce eight possible sets of NES results. The tables below present the results of the two scenarios that represent the maximum and minimum energy savings resulting from all the scenarios analyzed.

For GSFL, DOE presents ''Existing Technologies, High Lighting Expertise, Shift'' and ''Emerging Technologies, Market Segment-Based Lighting Expertise, Roll-Up'' in Table VI.31 as the scenarios that produce the maximum and minimum energy savings, respectively. Due to a larger reduction in the installed stock of lamps affected by standards, the Emerging Technologies base-case forecast results in lower energy savings than the Existing Technologies base-case forecast. In addition, due to a portion of consumers purchasing non-energy-saving, higher-lumen-output systems, the Market Segment-Based Lighting Expertise scenario results in lower energy savings than the High Lighting Expertise scenario. Finally, because in the Shift scenario more consumers move to higher-efficacy lamps than in the Roll-Up scenario, the Shift scenario results in higher energy savings than the Roll-Up scenario.

Table VI.31 presents total national energy savings for each TSL (labeled as ''Total'' savings). The table also reports national energy savings due to individually regulating each type of GSFL (presented next to the lamp type names), assuming no amended standard on all other lamp types. However, it is important to note that individual lamp type energy savings (due to separate regulation) do not sum to equal total energy savings achieved at the trial standard levels due to standards-induced substitution effects between lamp types. Instead, these savings are provided merely to illustrate the approximate relative energy savings of each lamp type under a TSL. As discussed in the March 2008 ANOPR, due to their relatively small shipments-based market share, DOE did not directly model the national impacts of 2-foot U-shaped lamps. In the ANOPR, DOE stated that in order to develop NES and NPV for this lamps type, it intended to scale the NIA results from other analyzed product classes. Given the similarities in historical shipment trends (showing a decrease in T12 lamps and an increase in T8 lamps) and in system input power, in this NOPR, DOE has decided to scale results from the 4-foot medium bipin product classes to approximate NES and NPV of 2-foot U-Shaped product classes. As historical shipments 4-foot medium bipin lamps were 22 times that of 2-foot U-shaped lamp shipments, DOE used this scaling factor to approximate the energy savings of 2-foot U-shaped lamps.

As seen in the tables below, the highest energy savings result from TSL 5 and from EL5 for all lamp types. In addition, DOE notes that at EL 1 and EL 2 for 4-foot medium bipin and at EL 1, EL 2, and EL 3 for 8-foot single pin slimline and 8-foot RDC HO lamps, all energy savings originate from shifts to higher-efficacy T12 lamps and voluntary early retrofits to the more-efficacious T8 systems (not applicable to 8-foot RDC HO). At these ELs, all T8 lamps are compliant and, therefore, unaffected by standards. At TSL 3, a large increase in total energy savings of GSFL can be observed, stemming from the conversion of all 40W, 4-foot MBP T12 lamps to 34W T12 lamps and also from 4-foot T8 lamps (the majority of the GSFL stock) being affected by the regulations. It is also important to note that at TSL 4 and TSL 5, all 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO T12 lamp systems would be automatically retrofitted to T8 lamp systems, because no T12 standards-compliant lamps would be available.

TABLE VI.31—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR GSFL

TSL/EL	Lamp type	National energy savings (quad)	
		Existing technologies, high lighting expertise, shift	Emerging technologies, market segment-based lighting expertise, roll-up
1	4-foot MBP	1.52	0.43
	8-foot SP Slimline	0.10	0.08
	8-foot RDC HO	0.18	0.02
	4-foot MiniBP SO	0.76	0.12
	4-foot MiniBP HO	1.14	0.65
	2-foot U-Shaped	0.07	0.02
	Total	3.77	1.32
2	4-foot MBP	1.57	0.60
	8-foot SP Slimline	0.13	0.11
	8-foot RDC HO	0.24	0.20
	4-foot MiniBP SO	0.76	0.12
	4-foot MiniBP HO	1.14	0.65
	2-foot U-Shaped	0.07	0.03
	Total	3.90	1.70
3	4-foot MBP	4.76	1.99

TABLE VI.31—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR GSFL—Continued

TSL/EL	Lamp type	National energy savings (quad)	
		Existing technologies, high lighting expertise, shift	Emerging technologies, market segment-based lighting expertise, roll-up
	8-foot SP Slimline	0.18	0.17
	8-foot RDC HO	0.25	0.20
	4-foot MiniBP SO	0.76	0.12
	4-foot MiniBP HO	1.14	0.65
	2-foot U-Shaped	0.22	0.09
	Total	7.33	3.24
4	4-foot MBP	8.23	2.70
	8-foot SP Slimline	0.38	0.23
	8-foot RDC HO	0.66	0.66
	4-foot MiniBP SO	0.76	0.12
	4-foot MiniBP HO	1.14	0.65
	2-foot U-Shaped	0.37	0.12
	Total	11.64	4.49
5	4-foot MBP	9.53	3.72
	8-foot SP Slimline	0.38	0.25
	8-foot RDC HO	0.72	0.67
	4-foot MiniBP SO	0.91	0.29
	4-foot MiniBP HO	1.14	0.65
	2-foot U-Shaped	0.43	0.17
	Total	13.17	5.75

For IRL, DOE presents ''Existing Technologies, Product Substitution, Shift'' and ''Emerging Technologies, No Product Substitution, Roll-Up'' in Table VI.32 as the scenarios that produce the maximum and minimum energy savings, respectively. Similar to GSFL, the Existing Technologies base-case forecast results in higher energy savings than the Emerging Technologies base-case forecast due to the greater installed stock of IRL affected by standards. Also, although a relatively small difference, the Product Substitution scenario (including migration to both higher-efficacy R–CFL and lower-efficacy, exempted BR lamps) results in marginally higher energy savings than the No Product Substitution scenario. In addition, while the effect is greater for GSFL than for IRL, the Shift scenario (only affecting commercial consumers) also represents higher energy savings than the Roll-Up scenario for IRL. As seen in the table below, TSL 5 achieves maximum energy savings for both scenarios.

TABLE VI.32—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR INCANDESCENT REFLECTOR LAMPS

TSL	National energy savings (quads)	
	Existing technologies, product substitution, shift	Emerging technologies, no product substitution, roll-up
1	0.37	0.22
2	1.06	0.52
3	1.89	1.00
4	2.32	1.25
5	2.60	1.48

b. Net Present Value

The NPV analysis is a measure of the cumulative benefit or cost of standards to the Nation. In accordance with the OMB's guidelines on regulatory analysis,[73] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy, and reflects the returns to real estate and small business capital, as well as corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, because recent OMB analysis has found the average rate of return to capital to be near this rate. DOE also used the 3-percent rate to capture the potential effects of standards on private consumption (*e.g.*, through higher prices for equipment and the purchase of reduced amounts of energy). This rate represents the rate at which society discounts future consumption flows to

[73] OMB Circular A–4, section E (Sept. 17, 2003).

their present value. This rate can be approximated by the real rate of return on long-term government debt (*i.e.*, yield on Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the last 30 years.

The table below shows the forecasted net present value at each trial standard level for GSFL and IRL. Similar to the results presented for NES, Table VI.33 DOE presents the ''Existing Technologies, High Lighting Expertise, Shift'' scenario and the ''Emerging Technologies, Market Segment-Based Lighting Expertise, Roll Up'' scenario as the maximum and minimum NPVs for GSFL, respectively. In general, the NPV results at each trial standard level are a reflection of the life-cycle cost savings at the corresponding efficacy levels. As seen in section VI.B.1.a.i for most lamp purchasing events and most baseline lamps, increasing efficacy levels generally result in increased LCC savings. Due to this general cost-effectiveness of higher-efficacy GSFL, the Existing Technologies base-case forecast (which increases the affected stock and shipments) and the Shift scenario (which results in the shipment of more high-efficacy lamps) represent the high-range scenario for NPV. The Market Segment-Based Lighting Expertise scenario models consumers who purchase higher-first-cost lamps, but may not achieve energy savings. As these consumers generally have overall lower NPV (and often negative NPV) than their energy-saving counterparts, the Market Segment-Based Lighting Expertise scenario results in lower NPV than the High Lighting Expertise scenario.

As seen in Table VI.33, NPV generally increases with increasing trial standard levels, consistent with the same trend in the LCC results. For the Market Segment-Based Lighting Expertise scenario, due to a large lack of lighting expertise in the residential sector (DOE assumes 0 percent consumers conducting T12 fixture replacements have high lighting expertise), the NPV from 4-foot medium bipin lamps is negative at EL1 and EL2. At efficacy levels above EL2, 4-foot medium bipin lamps achieve positive NPV due to the integration of more-efficacious T8 lamps into both commercial stocks (where lighting sophistication is higher) and residential stocks. In addition, the Emerging Technologies, Market Segment-Based Lighting Expertise, Roll-Up scenario shows decreased NPV from TSL4 to TSL5. This is primarily due to the portion of consumers (without lighting expertise) that are forced to purchase much higher cost lamps, but do not take advantage of the energy savings they provide.

TABLE VI.33—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR GSFL

TSL/EL	Product class	NPV (billion 2007$)			
		Existing technologies, high lighting expertise, shift		Emerging technologies, market segment-based lighting expertise, roll-up	
		7% Discount	3% Discount	7% Discount	3% Discount
1	4-foot MBP	3.93	9.04	−0.01	0.73
	8-foot SP Slimline	0.10	0.34	0.03	0.21
	8-foot RDC HO	0.35	0.60	−0.17	−0.24
	4-foot MiniBP SO	1.11	2.70	0.05	0.19
	4-foot MiniBP HO	1.46	3.38	0.81	1.91
	2-foot U-Shaped	0.18	0.41	0.00	0.03
	Total	7.12	16.46	0.71	2.82
2	4-foot MBP	3.14	7.78	−0.35	0.52
	8-foot SP Slimline	0.15	0.45	0.09	0.35
	8-foot RDC HO	0.43	0.73	0.53	0.87
	4-foot MiniBP SO	1.11	2.70	0.05	0.19
	4-foot MiniBP HO	1.46	3.38	0.81	1.91
	2-foot U-Shaped	0.14	0.35	−0.02	0.02
	Total	6.43	15.39	1.11	3.85
3	4-foot MBP	7.56	17.53	1.79	5.58
	8-foot SP Slimline	0.37	0.81	0.37	0.80
	8-foot RDC HO	0.12	0.26	0.06	0.14
	4-foot MiniBP SO	1.11	2.70	0.05	0.19
	4-foot MiniBP HO	1.46	3.38	0.81	1.91
	2-foot U-Shaped	0.34	0.80	0.08	0.25
	Total	11.09	25.67	3.23	8.98
4	4-foot MBP	17.47	35.93	5.97	13.34
	8-foot SP Slimline	0.87	1.89	0.38	0.97
	8-foot RDC HO	1.33	2.53	1.33	2.53
	4-foot MiniBP SO	1.11	2.70	0.05	0.19
	4-foot MiniBP HO	1.46	3.38	0.81	1.91
	2-foot U-Shaped	0.79	1.63	0.27	0.61
	Total	23.37	48.61	8.85	19.59
5	4-foot MBP	18.37	38.56	5.53	12.80
	8-foot SP Slimline	0.87	1.89	0.45	1.11
	8-foot RDC HO	1.38	2.62	1.28	2.46
	4-foot MiniBP SO	1.45	3.46	0.23	0.69

TABLE VI.33—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR GSFL—Continued

TSL/EL	Product class	NPV (billion 2007$)			
		Existing technologies, high lighting expertise, shift		Emerging technologies, market segment-based lighting expertise, roll-up	
		7% Discount	3% Discount	7% Discount	3% Discount
	4-foot MiniBP HO	1.46	3.38	0.81	1.91
	2-foot U-Shaped	0.83	1.75	0.25	0.58
	Total	24.49	51.90	8.54	19.53

For IRL, DOE presents the ''Existing Technologies, Product Substitution, Shift'' and ''Emerging Technologies, No Product Substitution, Roll-Up'' scenarios as the maximum and minimum NPVs, respectively. As seen in Table VI.34, NPV increases with TSL, consistent with LCC savings generally increasing with efficacy level. In particular, for the No Product Substitution scenario, the negative NPV at TSL1 results because the life-cycle cost savings at EL1 (the associated EL) are primarily negative. However, as seen in the Product Substitution scenario, TSL1 achieves positive NPV due to primarily the increased movement to highly cost-effective R–CFLs. NPV results are the most positive at TSL5, because the most cost-effective IRL lamp is purchased at this TSL.

TABLE VI.34—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR INCANDESCENT REFLECTOR LAMPS

TSL	NPV (billion 2007$)			
	Existing technologies, product substitution, shift		Emerging technologies, no product substitution, roll-up	
	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate
1	0.19	0.55	−0.06	0.00
2	3.47	7.11	1.82	3.71
3	4.75	9.85	2.58	5.30
4	6.75	13.97	3.72	7.68
5	7.52	15.55	4.34	8.99

c. Impacts on Employment

In addition to considering the direct employment impacts for the manufacturers of products covered in this rulemaking (discussed above), DOE also develops estimates of the indirect employment impacts of proposed standards on the economy in general. As noted previously, DOE expects energy conservation standards for the GSFL and IRL covered by these standards to reduce energy bills for consumers, with the resulting net savings being redirected to other forms of economic activity. DOE also realizes that these shifts in spending and economic activity could affect the demand for labor. To estimate these effects, DOE used an input/output model of the U.S. economy using BLS data (see section V.H). See chapter 15 of the TSD accompanying this notice for details.

This input/output model suggests the proposed standards are likely to slightly increase the net demand for labor in the economy. Neither the BLS data nor the input/output model DOE uses includes the quality or wage level of the jobs. As Table VI.35 and Table VI.36 show, the net increase in jobs due to standards for GSFL and IRL, respectively, is so small that it would likely be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment.

TABLE VI.35—NET NATIONAL CHANGE IN INDIRECT EMPLOYMENT FOR GSFL, JOBS IN 2042

Trial standard level	Net national change in jobs (thousands)	
	Existing technologies, shift, high lighting expertise	Emerging technologies, roll up, market segment based lighting expertise
1	15.4	5.2
2	15.2	5.7
3	21.6	10.1
4	27.6	13.3
5	32.4	15.2

TABLE VI.36—NET NATIONAL CHANGE IN INDIRECT EMPLOYMENT FOR IRL, JOBS IN 2042

Trial standard level	Net national change in jobs (thousands)	
	Existing technologies, product substitution, shift	Emerging technologies, no product substitution, roll up
1	1.4	0.9
2	3.5	2.9
3	5.8	5.2
4	7.5	6.9
5	8.2	7.8

4. Impact on Utility or Performance of Products

As discussed in section IV.D.1.d of this notice, DOE concluded that none of the efficacy levels considered in this notice would reduce the utility or performance of the GSFL and IRL under consideration in this rulemaking. (42 U.S.C. 6295(o)(2)(B)(i)(IV)). Furthermore, manufacturers of these products currently offer GSFL and IRL that meet or exceed the proposed standards.

5. Impact of Any Lessening of Competition

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

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

6. Need of the Nation To Conserve Energy

An improvement in the energy efficiency of GSFL and IRL is likely to improve the security of the Nation's energy system by reducing overall demand for energy, thereby reducing the Nation's reliance on foreign sources of energy. Reduced demand could improve the reliability of the electricity system, particularly in the short run during peak-load periods. As a measure of this reduced demand, DOE expects the energy savings from the proposed standards to eliminate the need for approximately 1100 to 3400 megawatts (MW) of generating capacity for GFSL and up to 450 MW for IRL by 2042.

Enhanced energy efficiency also produces environmental benefits. The expected energy savings from higher standards would reduce the emissions of air pollutants and greenhouse gases associated with electric energy production and may reduce the cost of maintaining nationwide emissions standards and constraints. Table VI.37 and Table VI.38 show cumulative CO_2, NO_X, and Hg emissions reductions for GSFL and IRL by TSL over the rulemaking period.

TABLE VI.37—SUMMARY OF EMISSIONS REDUCTIONS FOR GSFL

[Cumulative reductions for products sold from 2012 to 2042]

		TSL1	TSL2	TSL3	TSL4	TSL5
Existing Technologies, Shift, High Lighting Expertise						
CO_2 (MMt)		236.4	233.7	395.2	597.7	679.7
NO_X (kt)	low	14	15	25	39	43
NO_X (kt)	high	347	361	623	951	1,072
Hg (t)	low	0.0	0.0	0.0	0.0	0.0
Hg (t)	high	4.2	3.8	6.9	7.9	9.1
Emerging Technologies, Roll Up, Market Segment Based Lighting Expertise						
CO_2 (MMt)		85.7	103.5	184.3	239.7	312.8
NO_X (kt)	low	5	7	12	17	20
NO_X (kt)	high	127	167	289	407	503
Hg (t)	low	0.0	0.0	0.0	0.0	0.0
Hg (t)	high	1.5	1.5	2.9	3.2	4.4

TABLE VI.38—SUMMARY OF EMISSIONS REDUCTIONS FOR IRL

[Cumulative reductions for products sold from 2012 to 2042]

		TSL1	TSL2	TSL3	TSL4	TSL5
Existing Technologies, Product Substitution, Shift						
CO_2 (MMt)		17.7	44.8	88.1	114.4	118.8
NO_X (kt)	low	1	3	6	7	8
NO_X (kt)	high	29	78	141	181	193

TABLE VI.38—SUMMARY OF EMISSIONS REDUCTIONS FOR IRL—Continued

[Cumulative reductions for products sold from 2012 to 2042]

		TSL1	TSL2	TSL3	TSL4	TSL5
Hg (t)	low	0.0	0.0	0.0	0.0	0.0
Hg (t)	high	0.2	0.6	1.3	1.7	1.7
Emerging Technologies, No Product Substitution, Roll Up						
CO_2 (MMt)		10.3	25.1	46.2	58.6	79.3
NO_X (kt)	low	1	2	3	4	1
NO_X (kt)	high	17	39	75	94	17
Hg (t)	low	0.0	0.0	0.0	0.0	0.0
Hg (t)	high	0.1	0.3	0.6	0.8	1.3

MMt = million metric tons.
kt = thousand metric tons.
t = metric tons.
NOTE: The derivation for the emission ranges are described below.

The estimated cumulative CO_2, NO_X, and Hg emissions reductions for the proposed amended energy conservation standards range up to a maximum of 680 MMt for CO_2, 1072 kt for NO_X, and 9.1 metric tons for Hg for GSFL and 119 MMt for CO_2, 193 kt for NO_X and 1.7 tons for Hg for IRL over the period from 2012 to 2042. In the Environmental Assessment (see the Environmental Assessment report of the TSD), DOE reports estimated annual changes in CO_2, NO_X, and Hg emissions attributable to each TSL. As discussion in section V.J of this NOPR, DOE does not report SO_2 emissions reduction from power plants because reductions from an energy conservation standard would not affect the overall level of SO_2 emissions in the United States due to the emissions caps for SO_2.

The NEMS–BT modeling assumed that NO_X would be subject to the Clean Air Interstate Rule (CAIR) issued by the U.S. Environmental Protection Agency on March 10, 2005.[74] 70 FR 25162 (May 12, 2005). On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit (DC Circuit) issued its decision in *North Carolina* v. *Environmental Protection Agency*,[75] in which the court vacated the CAIR. If left in place, the CAIR would have permanently capped emissions of NO_X in 28 eastern States and the District of Columbia. As with the SO_2 emissions cap, a cap on NO_X emissions would have meant that energy conservation standards are not likely to have a physical effect on NO_X emissions in States covered by the CAIR caps. While the caps would have meant that physical emissions reductions in those States would not have resulted from the energy conservation standards that DOE is proposing today, the standards might have produced an environmental-related economic impact in the form of lower prices for emissions allowance credits, if large enough. DOE notes that the estimated total reduction in NO_X emissions, including projected emissions or corresponding allowance credits in States covered by the CAIR cap was insignificant and too small to affect allowance prices for NO_X under the CAIR.

Even though the DC Circuit vacated the CAIR, DOE notes that the DC Circuit left intact EPA's 1998 NO_X SIP Call rule, which capped seasonal (summer) NO_X emissions from electric generating units and other sources in 23 jurisdictions and gave those jurisdictions the option to participate in a cap and trade program for those emissions. 63 FR 57356, 57359 (Oct. 27, 1998).[76] DOE notes that the SIP Call rule may provide a similar, although smaller in extent, regional cap and may limit actual reduction in NO_X emissions from revised standards occurring in States participating in the SIP Call rule. However, the possibility that the SIP Call rule may have the same effect as CAIR is highly uncertain. Therefore, DOE established a range of NO_X reductions due to the standards being considered in today's proposed rule. DOE's low estimate was based on the emission rate of the cleanest new natural gas combined-cycle power plant available for electricity generated based on the assumption that efficiency standards would result in only the cleanest available fossil-fueled generation being displaced. DOE used the emission rate, specified in 0.0310 kilotons (0.0341 thousand short tons) of NO_X emitted per TWh of electricity generated, associated with an advanced natural gas combined-cycle power plant, as specified by NEMS–BT. To estimate the reduction in NO_X emissions, DOE multiplied this emission rate by the reduction in electricity generation due to the amended energy conservation standards considered. DOE's high estimate of 0.764 kilotons (0.843 thousand short tons) of NO_X per TWh was based on the use of a nationwide NO_X emission rate for all electrical generation. Use of such an emission rate assumes that future efficiency standards would result in displaced electrical generation mix that is equivalent to today's mix of power plants (*i.e.*, future power plants displaced are no cleaner than what are being used currently to generate electricity). In addition, under the high estimate assumption, energy conservation standards would have little to no effect on the generation mix.

[74] On December 23, 2008, the D.C. Circuit decided to allow CAIR to remain in effect until it is replaced by a rule consistent with the court's earlier opinion. *North Carolina* v. *EPA*, No. 05–1244, 2008 WL 5335481 (DC Cir. Dec. 23, 2008). Neither the July 11, 2008 nor the December 23, 2008 decisions of the D.C. Circuit change the standard-setting proposals reached in this rule. See *http://www.epa.gov/cleanairinterstaterule*.

[75] 531 F.3d 896 (D.C. Cir. 2008).

[76] In the NO_X SIP Call rule, EPA found that sources in the District of Columbia and 22 "upwind" States (States) were emitting NO_X (an ozone precursor) at levels that significantly contributed to "downwind" States not attaining the ozone NAAQS or at levels that interfered with States in attainment maintaining the ozone NAAQS. In an effort to ensure that "downwind" States attain or continue to attain the ozone NAAQS, EPA established a region-wide cap for NO_X emissions from certain large combustion sources and set a NO_X emissions budget for each State. Unlike the cap that CAIR would have established, the NO_X SIP Call Rule's cap only constrains seasonal (summer time) emissions. In order to comply with the NO_X SIP Call Rule, States could elect to participate in the NO_X Budget Trading Program. Under the NO_X Budget Trading Program, each emission source is required to have one allowance for each ton of NO_X emitted during the ozone season. States have flexibility in how they allocate allowances through their State Implementation Plans but States must remain within the EPA-established budget. Emission sources are allowed to buy, sell, and bank NO_X allowances as appropriate. It should be noted that, on April 16, 2008, EPA determined that Georgia is no longer subject to the NO_X SIP Call rule. 73 FR 21528 (April 22, 2008).

Based on *AEO2008* for a recent year (2006) in which no regulatory or non-regulatory measures were in effect to limit NO_X emissions, DOE multiplied this emission rate by the reduction in electricity generation due to the standards considered. DOE is considering whether changes are needed to its plan for addressing the issue of NO_X reduction. DOE invites public comment on how the agency should address this issue, including how it might value NO_X emissions for States now that the CAIR has been vacated.[77]

The range in NO_X emission changes calculated under using the low- and high-estimate scenarios are shown in Table VI.37 and Table VI.38 by TSL. The range of total cumulative NO_X emission reductions is from 5 to 1071 kt for GSFL and 1 to 193 kt for IRL for the range of TSLs considered. These changes in NO_X emissions are extremely small, at less than 0.1 percent of the national base-case emissions forecast by NEMS–BT, depending on the TSL.

As noted above in section V.J, with regard to Hg emissions, DOE is able to report an estimate of the physical quantity changes in these emissions associated with an energy conservation standard. As opposed to using the NEMS–BT model, DOE established a range of Hg rates to estimate the Hg emissions that could be reduced from standards. DOE's low estimate was based on the assumption that future standards could displace electrical generation from natural gas-fired power plants as the cleanest possible fossil-fueled generation displacement consistent with the low end of range established for NO_X emissions, thereby resulting in an effective emission rate of zero. The low-end emission rate is zero because virtually all Hg emitted from electricity generation is from coal-fired power plants. Based on an emission rate of zero, no emissions would be reduced from energy conservation standards. DOE's high estimate was based on the use of a nationwide mercury emission rate from *AEO2008*. Because power plant emission rates are a function of local regulation, scrubbers, and the mercury content of coal, it is extremely difficult to come up with a precise high-end emission rate. Therefore, DOE believes that the most reasonable estimate is based on the assumption that all displaced coal generation would have been emitting at the average emission rate for coal generation as specified by *AEO2008*. As noted previously, because virtually all mercury emitted from electricity generation is from coal-fired power plants, DOE based the emission rate on the tons of mercury emitted per TWh of coal-generated electricity. Based on the emission rate for a recent year (2006), DOE derived a high-end emission rate of 0.023 metric tons (0.0255 short tons) per TWh. To estimate the reduction in mercury emissions, DOE multiplied the emission rate by the reduction in coal-generated electricity due to the standards considered as determined in the utility impact analysis. The estimated changes in Hg emissions are shown in Table VI.37 for both GSFL and IRL from 2012 to 2042. The range of total Hg emission reductions is from 0 to 9.1 tons for GSFL and 0 to 1.7 tons for IRL for the range of TSLs considered. These changes in Hg emissions are extremely small, generally being less than 0.1 percent of the national base-case emissions forecast by NEMS–BT, depending on the TSL.

The NEMS–BT model used for today's rulemaking could not be used to estimate Hg emission reductions due to standards, as it assumed that Hg emissions would be subject to EPA's Clean Air Mercury Rule[78] (CAMR), which would have permanently capped emissions of mercury for new and existing coal-fired plants in all States by 2010. Similar to SO_2 and NO_X, DOE assumed that under such a system, energy conservation standards would have resulted in no physical effect on these emissions, but might have resulted in an environmental-related economic benefit in the form of a lower price for emissions allowance credits, if large enough. DOE estimated that the change in the Hg emissions from energy conservation standards would not be large enough to influence allowance prices under CAMR.

On February 8, 2008, the DC Circuit issued its decision in *New Jersey* v. *Environmental Protection Agency*,[79] in which the DC Circuit, among other actions, vacated the CAMR referenced above. Accordingly, DOE is considering whether changes are needed to its plan for addressing the issue of mercury emissions in light of the DC Circuit's decision. DOE invites public comment on addressing mercury emissions in this rulemaking.

In today's proposed rule, DOE is taking into account a monetary benefit of CO_2 emission reductions associated with this rulemaking. To put the potential monetary benefits from reduced CO_2 emissions into a form that is likely to be most useful to decision-makers and stakeholders, DOE used the same methods used to calculate the net present value of consumer cost savings: the estimated year-by-year reductions in CO_2 emissions were converted into monetary values and these resulting annual values were then discounted over the life of the affected appliances to the present using both 3 percent and 7 percent discount rates.

These estimates discussed below are based on a previous analysis that used a range of no benefit to an average benefit value reported by the IPCC.[80] It is important to note that the IPCC estimate used as the upper bound value was derived from an estimate of the mean value of worldwide impacts from potential climate impacts caused by CO_2 emissions, and not just the effects likely to occur within the United States. This previous analysis assumed that the appropriate value should be restricted to a representation of those costs/benefits likely to be experienced in the United States. DOE expects that such domestic values would be lower than comparable global values; however, there currently are no consensus estimates for the U.S. benefits likely to result from CO_2 emission reductions. Because U.S.-specific estimates were not available, and DOE did not receive any additional information that would help serve to narrow the proposed range as a representative range for domestic U.S. benefits, DOE believes it is appropriate to propose the global mean value as an appropriate upper bound U.S. value for purposes of the sensitivity analysis.

As already discussed in section V.J, DOE received a comment on the March 2008 ANOPR in the present rulemaking for estimating the value of CO_2 emissions reductions. The Joint

[77] In anticipation of CAIR replacing the NO_X SIP Call Rule, many States adopted sunset provisions for their plans implementing the NO_X SIP Call Rule. The impact of the NO_X SIP Call Rule on NO_X emissions will depend, in part, on whether these implementation plans are reinstated.

[78] 70 FR 28606 (May 18, 2005).

[79] 517 F.3d 574 (D.C. Cir. 2008).

[80] During the preparation of its most recent review of the state of climate science, the Intergovernmental Panel on Climate Change (IPCC) identified various estimates of the present value of reducing carbon-dioxide emissions by one ton over the life that these emissions would remain in the atmosphere. The estimates reviewed by the IPCC spanned a range of values. In the absence of a consensus on any single estimate of the monetary value of CO_2 emissions, DOE used the estimates identified by the study cited in Summary for Policymakers prepared by Working Group II of the IPCC's Fourth Assessment Report to estimate the potential monetary value of CO_2 reductions likely to result from standards finalized in this rulemaking. According to IPCC, the mean social cost of carbon (SCC) reported in studies published in peer-reviewed journals was $43 per ton of carbon. This translates into about $12 per ton of carbon dioxide. The literature review (Tol 2005) from which this mean was derived did not report the year in which these dollars were denominated. However, we understand this estimate was denominated in 1995 dollars. Updating that estimate to 2007 dollars yields a SCC of $15 per ton of carbon dioxide.

Comment argued for assigning an economic value to CO_2 emissions. DOE's approach for assigning a range to the dollars per ton of CO_2 emissions recognizes and addresses the concerns of the Joint Comment.

The Department of Energy, together with other Federal agencies, is currently reviewing various methodologies for estimating the monetary value of reductions in CO_2 and other greenhouse gas emissions. This review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues, such as whether the appropriate values should represent domestic U.S. or global benefits (and costs). Given the complexity of the many issues involved, this review is ongoing. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this rulemaking the values and analyses previously conducted.

Given the uncertainty surrounding estimates of the societal cost of carbon (SCC), DOE previously concluded that relying on any single study may be inadvisable since its estimate of the SCC will depend on many assumptions made by its authors. The Working Group II's contribution to the Fourth Assessment Report of the IPCC notes that:

> The large ranges of SCC are due in the large part to differences in assumptions regarding climate sensitivity, response lags, the treatment of risk and equity, economic and non-economic impacts, the inclusion of potentially catastrophic losses, and discount rates.[81]

Because of this uncertainty, DOE previously relied on Tol (2005), which was presented in the IPCC's Fourth Assessment Report, and was a comprehensive meta-analysis of estimates for the value of SCC. As a result, DOE previously decided to rely on the Tol study reported by the IPCC as the basis for its analysis.

DOE continues to believe that the most appropriate monetary values for consideration in the development of efficiency standards are those drawn from studies that attempt to estimate the present value of the marginal economic benefits likely to result from reducing greenhouse gas emissions, rather than estimates that are based on the market value of emission allowances under existing cap and trade programs or estimates that are based on the cost of reducing emissions—both of which are largely determined by policy decisions that set the timing and extent of emission reductions and do not necessarily reflect the benefit of reductions. DOE also believes that the studies it relies upon generally should be studies that were the subject of a peer review process and were published in reputable journals.

In today's NOPR, DOE is essentially proposing to continue to use the range of values based on the values presented in Tol (2005). Additionally, DOE has applied an annual growth rate of 2.4% to the value of SCC, as suggested by the IPCC Working Group II (2007, p. 822), based on estimated increases in damages from future emissions reported in published studies. Because the values in Tol (2005) were presented in 1995 dollars, DOE is assigning a range for the SCC of $0 to $20 ($2007) per ton of CO_2 emissions.

DOE is proposing to use the median estimated social cost of CO_2 as an upper bound of the range. This value is based on Tol (2005), which reviewed 103 estimates of the SCC from 28 published studies, and concluded that when only peer-reviewed studies published in recognized journals are considered, ''that climate change impacts may be very uncertain but [it] is unlikely that the marginal damage costs of carbon dioxide emissions exceed $50 per ton carbon [comparable to a 2007 value of $20 per ton carbon dioxide when expressed in 2007 U.S. dollars with a 2.4% growth rate].''

In proposing a lower bound of $0 for the estimated range, DOE's previous analysis agreed with the IPCC Working Group II (2007) report that ''significant warming across the globe and the locations of significant observed changes in many systems consistent with warming is very unlikely to be due solely to natural variability of temperatures or natural variability of the systems'' (pp. 9), and, thus, tentatively concluded that a global value of zero for reducing emissions cannot be justified. However, DOE previously tentatively concluded that it is reasonable to allow for the possibility that the U.S. portion of the global cost of carbon dioxide emissions may be quite low. In fact, some of the studies looked at in Tol (2005) reported negative values for the SCC. DOE assumed that it would be most appropriate to use U.S. benefit values, and not world benefit values, in its analysis, and, further, that U.S. domestic values will be lower than the global values. As indicated above, DOE, together with other Federal agencies, is now reviewing whether this previous analysis should be modified.

The resulting estimates of the potential range of net present value benefits associated with the reduction of CO_2 emissions are reflected in Table VI.39 and Table VI.40.

TABLE VI.39—PRELIMINARY ESTIMATES OF SAVINGS FROM CO_2 EMISSIONS REDUCTIONS FOR GSFL

TSL	Estimated cumulative CO_2 (MMt) emission reductions	Value of estimated CO_2 emission reductions (billion 2007$) at 7% discount rate	Value of estimated CO_2 emission reductions (billion 2007$) at 3% discount rate
1	85.7 to 236.4	$0 to $1.2	$0 to $2.5
2	103.5 to 233.7	$0 to $1.2	$0 to $2.5.
3	184.3 to 395.2	$0 to $2.1	$0 to $4.3.
4	239.7 to 597.7	$0 to $3.5	$0 to $6.8.
5	312.8 to 679.7	$0 to $4.0	$0 to $7.7.

TABLE VI.40—PRELIMINARY ESTIMATES OF SAVINGS FROM CO_2 EMISSIONS REDUCTIONS FOR IRL

TSL	Estimated cumulative CO_2 (MMt) emission reductions	Value of estimated CO_2 emission reductions (billion 2007$) at 7% discount rate	Value of estimated CO_2 emission reductions (billion 2007$) at 3% discount rate
1	10.3 to 17.7	$0 to $0.1	$0 to $0.2.
2	25.1 to 44.8	$0 to $0.3	$0 to $0.5.

[81] *Climate Change 2007—Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the IPCC, 17. *Available at http://www.ipcc-wg2.org* (last accessed Aug. 7, 2008).

TABLE VI.40—PRELIMINARY ESTIMATES OF SAVINGS FROM CO_2 EMISSIONS REDUCTIONS FOR IRL—Continued

TSL	Estimated cumulative CO_2 (MMt) emission reductions	Value of estimated CO_2 emission reductions (billion 2007$) at 7% discount rate	Value of estimated CO_2 emission reductions (billion 2007$) at 3% discount rate
3	46.2 to 88.1	$0 to $0.5	$0 to $1.0.
4	58.6 to 114.4	$0 to $0.6	$0 to $1.3.
5	79.3 to 118.8	$0 to $0.7	$0 to $1.3.

DOE also investigated the potential monetary impact resulting from the impact of today's energy conservation standards on SO_2, NO_X, and Hg emissions. As previously stated, DOE's initial analysis assumed the presence of nationwide emission caps on SO_2 and Hg, and caps on NO_X emissions in the 28 States covered by the CAIR caps. In the presence of these emissions caps, DOE concluded that no physical reductions in power sector emissions would likely occur; however, the lower generation requirements associated with energy conservation standards could potentially put downward pressure on the prices of emissions allowances in cap-and-trade markets. Estimating this effect is very difficult because of factors such as credit banking, which can change the trajectory of prices. DOE has further concluded that the effect from energy conservation standards on SO_2 allowance prices is likely to be negligible, based upon runs of the NEMS–BT model. See Environmental Assessment report of the TSD for further details regarding SO_2 allowance price impacts.

As discussed earlier, with respect to NO_X, the CAIR rule had been vacated by the courts, so projected annual NO_X allowances from NEMS–BT were no longer relevant. In DOE's subsequent analysis, NO_X emissions were not controlled by a nationwide regulatory system. For the range of NO_X reduction estimates (and Hg reduction estimates), DOE estimated the national monetized benefits of emissions reductions from today's proposed rule based on environmental damage estimates from the literature. Available estimates suggest a very wide range of monetary values for NO_X emissions, ranging from $370 per ton to $3,800 per ton of NO_X from stationary sources, measured in 2001 dollars [82] or a range of $432 per ton to $4,441 per ton in 2007 dollars. As discussed above, DOE is considering how it should address the issue of NO_X reduction and corresponding monetary valuation. DOE invites public comment on how the agency should address this issue.

DOE has already conducted research for today's NOPR and determined that the basic science linking mercury emissions from power plants to impacts on humans is considered highly uncertain. However, DOE identified two estimates of the environmental damages of mercury based on two estimates of the adverse impact of childhood exposure to methyl mercury on IQ for American children, and subsequent loss of lifetime economic productivity resulting from these IQ losses. The high-end estimate is based on an estimate of the current aggregate cost of the loss of IQ in American children that results from exposure to mercury of U.S. power plant origin ($1.3 billion per year in year 2000$), which works out to $32.6 million per ton emitted per year (2007$).[83] The low-end estimate was $664,000 per ton emitted in 2004$ or $729,000 per ton in 2007$, which DOE derived from a published evaluation of mercury control using different methods and assumptions from the first study, but also based on the present value of the lifetime earnings of children exposed.[84] DOE invites public comment on how the agency should address this issue, including how to value mercury emissions in the absence of the CAMR. The resulting estimates of the potential range of the present value benefits associated with the national reduction of NO_X and national reductions in Hg emissions are reflected in Table VI.41 through Table VI.44.

TABLE VI.41—PRELIMINARY ESTIMATES OF SAVINGS FROM NO_X EMISSIONS REDUCTIONS FOR GSFL

TSL	Estimated cumulative NO_X (kt) emission reductions	Value of estimated NO_X emission reductions (billion 2007$) at 7% discount rate	Value of estimated NO_X emission reductions (billion 2007$) at 3% discount rate
1	5.1 to 347.4	$0.0 to $0.5	$0.0 to $0.9.
2	6.8 to 361.1	$0.0 to $0.5	$0.0 to $0.9.
3	11.7 to 623.0	$0.0 to $0.8	$0.0 to $1.6.
4	16.5 to 950.7	$0.0 to $1.3	$0.0 to $2.6.
5	20.3 to 1071.6	$0.0 to $1.4	$0. to $2.8.

[82] 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'' (2006).

[83] Trasande, L., *et al.*, ''Applying Cost Analyses to Drive Policy that Protects Children,'' 1076 ANN. N.Y. ACAD. SCI. 911 (2006).

[84] Ted Gayer and Robert Hahn, *Designing Environmental Policy: Lessons from the Regulation of Mercury Emissions*, Regulatory Analysis 05–01 (AEI-Brookings Joint Center for Regulatory Studies) p. 31 (2004). A version of this paper was published in the *Journal of Regulatory Economics* in 2006. The estimate was derived by back-calculating the annual benefits per ton from the net present value of benefits reported in the study.

TABLE VI.42—PRELIMINARY ESTIMATES OF SAVINGS FROM NO_X EMISSIONS REDUCTIONS FOR IRL

TSL	Estimated cumulative NO_X (kt) emission reductions	Value of estimated NO_X emission reductions (billion 2007$) at 7% discount rate	Value of estimated NO_X emission reductions (billion 2007$) at 3% discount rate
1	0.7 to 29.0	$0 to $0.0	$0 to $0.1.
2	1.6 to 77.6	$0 to $0.1	$0 to $0.2.
3	3.0 to 140.6	$0 to $0.2	$0 to $0.4.
4	3.8 to 180.7	$0 to $0.2	$0 to $0.5.
5	4.5 to 193.1	$0 to $0.2	$0 to $0.5.

TABLE VI.43—PRELIMINARY ESTIMATES OF SAVINGS FROM HG EMISSIONS REDUCTIONS FOR GSFL

TSL	Estimated cumulative Hg (Tons) emission reductions	Value of estimated Hg emission reductions (million 2007$) at 7% discount rate	Value of estimated Hg emission reductions (million 2007$) at 3% discount rate
1	0 to 4.2	$0 to $38.	$0 to $80.
2	0 to 3.8	$0 to $35.	$0 to $73.
3	0 to 6.9	$0 to $65.	$0 to $134.
4	0 to 7.9	$0 to $88.	$0 to $166.
5	0 to 9.1	$0 to $102.	$0 to $192.

TABLE VI.44—PRELIMINARY ESTIMATES OF SAVINGS FROM HG EMISSIONS REDUCTIONS FOR IRL

TSL	Estimated cumulative Hg (tons) emission reductions	Value of estimated Hg emission reductions (million 2007$) at 7% discount rate	Value of estimated Hg emission reductions (million 2007$) at 3% discount rate
1	0 to 0.2	$0 to $2	$0 to $5.
2	0 to 0.6	$0 to $7	$0 to $13.
3	0 to 1.3	$0 to $13	$0 to $26.
4	0 to 1.7	$0 to $16	$0 to $33.
5	0 to 1.7	$0 to $16	$0 to $33.

C. Proposed Standard

1. Overview

Under 42 U.S.C. 6295(o)(2)(A), EPCA requires that any new or amended energy conservation standard for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens to the greatest extent practicable, in light of the following seven factors:

(1) The economic impact of the standard on manufacturers and consumers of the products or equipment subject to the standard;

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

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

(4) Any lessening of the utility or the performance of the covered products or equipment 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))

The new or amended standard also must ''result in significant conservation of energy.'' (42 U.S.C. 6295(o)(3)(B))

As discussed in section 0, DOE established a separate set of TSLs for GSFL and IRL. Therefore, DOE analyzed each lamp type (GSFL or IRL) separately while establishing the proposed standards.

During the screening phase of this rulemaking, DOE eliminated the maximum technologically feasible levels for GSFL that would incorporate the use of a higher-efficiency gas fill composition than what is currently available on the market today. DOE's research had indicated that further usage of heavier gas fills to increase lamp efficacy beyond GSFL TSL5 would likely result in decreased utility of the product. Thus, DOE screened out the maximum technologically feasible levels that would be based on these reduced-utility GSFLs. TSL5 represents the most efficient level analyzed for GSFL.

For IRL, in the engineering analysis, DOE eliminated the maximum technologically feasible level that would require the use of a silver reflector, which DOE understands to be a proprietary technology. DOE does not believe there are any alternate technology pathways to this efficacy level. Therefore, TSL5 represents the most efficient level analyzed for IRL which does not require installation of the proprietary silver reflector. See sections IV.B.2 and VI.A.2 of this notice for more information on maximum technologically feasible levels and other efficacy levels DOE analyzed.

DOE then considered the impacts of standards at each trial standard level, beginning with the most efficient level, to determine whether the given level was economically justified. DOE then considered less efficient levels until it reached the highest level that is technologically feasible and economically justified and saves a significant amount of energy.

DOE discusses the benefits and/or burdens of each trial standard level in the following sections. DOE bases its discussion on quantitative analytical results for each trial standard level (presented in section VI) such as national energy savings, net present value (discounted at 7 percent and 3 percent), emissions reductions, industry net present value, life-cycle cost, and consumers installed price increases. In addition to providing a summary of results, DOE discusses below the life-cycle cost and consumer installed price increase results for each product class and baseline where appropriate. Beyond the quantitative results, DOE also considers other burdens and benefits that affect economic justification, including how impacts on competition, supply constraints, and lamp input prices may affect the economic results presented.

2. General Service Fluorescent Lamps Conclusion

a. Trial Standard Level 5

For GSFL, DOE first considered the most efficient level, TSL5, which would save an estimated total of 5.8 to 13.2 quads of energy through 2042—a significant amount of energy. For the Nation as a whole, TSL5 would have a net savings of $8.5 billion to $24.5 billion at a 7-percent discount rate. The emissions reductions at TSL5 are estimated at 313 to 680 MMt of CO_2, 20 to 1072 kt of NO_X, up to 9 metric tons of Hg. Total generating capacity in 2042 is estimated to decrease compared to the reference case by 1.8 to 5.4 GW under TSL5.

The impacts on manufacturers would be very significant, because TSL5 would commoditize high-efficacy lamps and require a complete conversion of all T12 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO lines to T8 lines, requiring a capital investment of $181.5 million. The projected change in industry value ranges from a decrease of $263 million to an increase of $13 million. The extent of the industry impacts is driven primarily by the ability to maintain current gross margins as efficient products become commoditized. Currently, manufacturers obtain higher margins for more-efficient products so to avoid the higher end of the anticipated impacts, they must find new ways to differentiate GSFL to maintain full product lines. At TSL5, DOE recognizes the risk of very large negative impacts if the high end of the range of impacts is reached, resulting in a net loss of 46 percent in INPV.

At TSL5, DOE projects that most GSFL consumers would experience life-cycle cost savings. The following discussion outlines specific impacts on the separate product classes and baseline lamps.

Table VI.5 presents the findings of an LCC analysis on various three-lamp, 4-foot medium bipin GSFL systems operating in the commercial sector. Regardless of the baseline lamp currently employed, consumers have available lamp designs which result in positive LCC savings at TSL5. At this standard level, users of 40W or 34W 4-foot MBP T12 baseline lamps installed on a magnetic ballast who need to replace their lamp would incur the cost of a lamp and ballast replacement ($63.51 to $71.19) because no T12 lamp currently meets the efficacy requirements of TSL5. Comparing this cost of lamp-and-ballast replacements to the cost of only baseline lamp replacements ($11.22 to $13.96) results in installed price increases of $50.87 to $57.23. These ranges in prices depend on the specific baseline lamps previously owned by consumers and the specific combinations of lamps and ballasts they select in the standards case. However, over the life of the lamp, these consumers would save $15.13 to $25.26.

Table VI.6 presents LCC results for a two-lamp 4-foot MBP system operating in the residential sector under average operating hours. The results are presented for a system operating 40W T12 lamps with a magnetic ballast, as this configuration is typical of the installed base of residential GSFL systems. As discussed in section V.D, DOE believes that the vast majority of lamps sold in the residential market are sold with new ballasts or luminaires. At TSL5, residential consumers are expected to purchase T8 lamps with electronic ballasts in lieu of the T12 lamps with magnetic ballasts that they would purchase absent standards. These consumers would see LCC savings of $17.72 to $19.66. DOE recognizes that not all residential GSFL lamps would be sold in conjunction with a new ballast or luminaire in the base case. In particular, consumers with higher operating hours may need to replace their lamp on an existing system. However, at TSL5, there are no standards-compliant T12 replacement lamps available. As seen in Table VI.7, the consumer economics of retrofitting a typical high-use residential 4-foot MBP system are negative, with life-cycle cost savings of −$3.50 to −$4.13.

With regard to 4-foot MBP consumer subgroups, all consumer subgroups analyzed achieve similar LCC savings to the average consumer with the exception of commercial consumers who own 40W or 34W 4-foot MBP T12 lamps installed on electronic ballasts. These consumers, upon lamp failure, are forced to retrofit their existing ballasts, resulting in negative LCC savings of −$11.53 to −$5.53 (seen in Table VI.21). Overall, based on the NIA model, DOE estimates that at TSL5 in 2012, approximately 2 percent of 4-foot MBP shipments result in negative LCC savings, and 9 percent of shipments are associated with the high installed price increases due to forced retrofits.

Table VI.10 presents the findings of an LCC analysis on various two-lamp, 8-foot SP slimline GSFL systems operating in the commercial sector. Except for consumers who purchase reduced-wattage 60W T12 lamps absent standards (and experience a lamp failure), all other consumers have available lamp designs that result in positive LCC savings at TSL5. At this standard level, users of 75W or 60W 8-foot SP slimline T12 baseline lamps installed on a magnetic ballast who need to replace their lamp would incur the cost of a lamp and ballast replacement ($93.79 to $95.12) because no T12 lamp currently meets the efficacy requirements of TSL5. Comparing the cost of a lamp-and-ballast replacement to the cost of only baseline lamp replacement ($11.33 to $16.16) results in an installed price increase of $78.96 to $83.99. In addition, users of 60W T12 lamps who need to replace their lamp experience negative LCC savings of −$14.02 to −$12.26. On the other hand, over the life of the lamp, users of 75W T12 lamps who require a lamp replacement would save $11.45.

With regard to 8-foot SP slimline consumer subgroups, all consumer subgroups analyzed achieve similar LCC savings to the average consumer with the exception of consumers of T12 lamps operating in religious institutions or users of T12 lamps installed on electronic ballasts. These consumers, upon lamp failure, are forced to retrofit their existing ballasts, resulting in negative LCC savings. In particular, as seen in Table VI.15, these consumers in institutions of religious worship (with low operating hours) experience increases in life-cycle costs of $6.68 to $28.95. As seen in Table VI.23, consumers with T12 lamps installed on electronic ballasts experience increases in life-cycle costs of $14.18 to $31.86. Overall, based on the NIA model, DOE estimates that at TSL5 in 2012, approximately 24 percent of 8-foot SP slimline shipments would result in negative LCC savings, and 65 percent of shipments would be associated with the high installed price increases due to forced retrofits.

Table VI.11 presents the findings of an LCC analysis on various two-lamp, 8-foot RDC HO GSFL systems operating in the industrial sector. With the exception to consumers who purchase reduced-wattage 95W T12 lamps absent standards (and purchase a lamp in response to a lamp failure), all other consumers have available lamp designs that result in positive LCC savings at TSL5. At this standard level, users of 110W or 95W 8-foot RDC HO T12 baseline lamps installed on a magnetic ballast who need to replace their lamp would incur the cost of a lamp and ballast replacement ($126.49), because no T12 lamp currently meets the efficacy requirements of TSL5. Comparing the cost of a lamp-and-ballast replacement to the cost of only baseline lamp replacement ($13.92 to $19.74) results in an installed price increase of $106.75 to $112.57. In addition, users of 95W T12 lamps who need to replace their lamp experience negative LCC savings of −$12.70. On the other hand, over the life of the lamp, users of 110W T12 lamps who require a lamp replacement would save $5.13.

With regard to 8-foot RDC HO consumer subgroups, all consumer subgroups analyzed achieve similar LCC savings to the average consumer except consumers who own T12 lamps installed on electronic ballasts. These consumers, upon lamp failure, are forced to retrofit their existing ballasts, resulting in negative LCC savings of −$10.09 to −$23.07 (seen in Table VI.24). Overall, based on the NIA model, DOE estimates that at TSL5 in 2012, approximately 33 percent of 8-foot RDC HO shipments would result in negative LCC savings, and 86 percent of shipments would be associated with the high installed price increases due to forced retrofits.

Table VI.8 and Table VI.9 present the LCC analyses on two-lamp 4-foot MiniBP T5 standard-output and high-output systems, respectively. The standard-output system is modeled as operating in the commercial sector, and the high-output system is modeled as operating in the industrial sector. The baseline lamps for these systems are the model 28W and 54W halophosphor lamps, as discussed in section V.C.3.a. At TSL5 (EL2 for standard output T5 lamps), all consumers of standard output lamps have available lamp designs which result in positive LCC savings of $1.22 (for lamp replacement) and $45.27 to $47.03 (for new construction or renovation). At TSL5 (EL1 for high output T5 lamps), consumers of high-output lamps who need only a lamp replacement would experience negative LCC savings of −$3.42. However, purchasing a T5 high-output system for new construction or renovation would result in positive LCC savings of $55.60 to $56.60.

After carefully considering the analysis and weighing the benefits and burdens of TSL5, the Secretary has reached the following initial conclusion: At TSL 5, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and the positive net economic savings to the Nation (over 30 years) would be outweighed by the economic burden on some consumers (as indicated by the large increase in total installed cost) and the potentially large reduction in INPV for manufacturers resulting from large conversion costs and reduced gross margins. Specifically, consumers who operate a 4-foot MBP, 8-foot SP slimline, or 8-foot RDC HO T12 ballast prior to 2012 would be forced to retrofit their system upon lamp failure, incurring an initial cost six to thirteen times that of a simple lamp replacement. Additionally, consumers who installed T12 electronic ballasts before 2012 would bear the large increases in first cost without benefiting from LCC savings. Consequently, the Secretary has tentatively concluded that trial standard level 5 is not economically justified.

b. Trial Standard Level 4

Next, DOE considered TSL 4, which would save an estimated total of 4.5 to 11.6 quads of energy through 2042, a significant amount of energy. For the Nation as a whole, TSL4 would have a net savings of $8.9 billion to $23.4 billion at a 7-percent discount rate. The emissions reductions at TSL4 are estimated at 240 to 598 MMt of CO_2, 17 to 951 kt of NO_X, and up to 8 metric tons of Hg. Total generating capacity in 2042 is estimated to decrease compared to the reference case by 1.3 to 4.3 GW under TSL4.

Similar to TSL5, the impacts on manufacturers would be very significant because TSL4 also would commoditize most high-efficacy lamps and require a complete conversion of all T12 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO lines to T8 lines, a capital investment of $181.5 million. The projected change in industry value ranges from a decrease of $195 million to a decrease of $9 million. At TSL4, DOE recognizes the risk of very large negative impacts if the high end of the range of impacts is reached, resulting in a net loss of 34 percent in INPV.

As seen in Table VI.5 through Table VI.11, at TSL4, DOE projects that 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO consumers would experience similar life-cycle cost savings and increases as they would experience at TSL5. Like TSL5, consumers who own T12 ballasts prior to 2012 at TSL4 would likely experience negative economic impacts, either through life-cycle cost increases or by large increases in total installed cost. For 4-foot MiniBP T5 standard-output lamps, TSL4 would require these lamps to meet EL1, resulting in positive LCC savings of $1.22 for lamp replacement and $42.84 for new construction or renovation (seen in Table VI.8). For 4-foot MiniBP T5 high-output lamps, TSL4 would require the same efficacy level (EL1) as TSL5, resulting in identical life-cycle cost impacts.

After carefully considering the analysis and weighing the benefits and burdens of TSL4, the Secretary has reached the following initial conclusion: At TSL4, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and the positive net economic savings to the Nation (over 30 years) would be outweighed by the economic burden on some consumers (as indicated by the large increase in total installed cost) and the potentially large reduction in INPV for manufacturers. Specifically, consumers who operate a 4-foot MBP, 8-foot SP slimline, or 8-foot RDC HO T12 ballast prior to 2012 would be forced to retrofit their system upon lamp failure, incurring an initial cost six to thirteen times that of a simple lamp replacement. Additionally, consumers who installed T12 electronic ballasts before 2012 would bear the large increases in first cost without benefiting from LCC savings. Consequently, the Secretary has tentatively concluded that trial standard level 4 is not economically justified.

c. Trial Standard Level 3

Next, DOE considered TSL3, which would save an estimated total of 3.2 to 7.3 quads of energy through 2042, a significant amount of energy. For the Nation as a whole, TSL3 would have a net savings of $3.2 billion to $11.1 billion at a 7-percent discount rate. The emissions reductions at TSL3 are estimated at 184 to 395 MMt of CO_2, 12 to 623 kt of NO_X, and up to 7 metric tons of Hg. Total generating capacity in 2042 would be estimated to decrease compared to the reference case by 1100 to 3400 megawatts under TSL3.

As opposed to TSL4 and TSL5, TSL3 does not eliminate all T12 lamps from the market. The impacts on manufacturers are less significant because TSL3 does not require a complete conversion of all T12 4-foot MBP, 8-foot SP slimline, and 8-foot RDC HO lines to T8 lines. Instead, the required capital investments of $104.5 million are to account for the likely accelerated consumer migration toward T8 lamps. The projected change in industry value ranges from a decrease of $139 million to an increase of $71 million. The upper range of these impacts results from the reduced efficacy range of the product line and the corresponding reduction in gross margins. Compared with TSL 4 and TSL 5, TSL 3 maintains a broader product line and, thus, provides manufacturers with a greater opportunity to differentiate lamp offerings.

At TSL3, DOE projects that most GSFL consumers would experience life-cycle cost savings. Because the minimum efficacy levels for the T5 product classes are the same for TSL3 as they are for TSL4, the life-cycle cost impacts on these consumers are identical as well. However, for the other GSFL product classes, the consumer economic impacts do differ at TSL3 from TSL4 and TSL5. Because T12 lamps are still available at this level, all consumers have viable lamp replacement options without needing to retrofit their ballasts. As a result, initial costs for 4-foot MBP, 8-foot SP slimline, or 8-foot RDC HO T12 lamp replacements are significantly lower than initial costs required at TSL4 and TSL5 when consumers must purchase a new lamp and new ballast with standards. For example, for 4-foot MBP lamps, installed costs at TSL3 may increase by $13.91 over a baseline lamp cost of $11.22 in the commercial sector or by $8.48 over the baseline lamp cost of $3.98 in the residential sector.

Although incremental total installed costs are considerably reduced in comparison to TSL4 and TSL5, some consumers would still experience negative life-cycle cost savings at TSL3. These are many of the same consumers that would have negative savings at TSL4 and TSL5. Residential consumers who own T12 ballasts prior to 2012 would experience negative LCC savings when replacing only their lamps (approximately 2 percent of 4-foot MBP shipments in 2012). Consumers who, absent standards, replace reduced-wattage T12 lamps on 8-foot SP slimline systems (24 percent of 8-foot SP slimline shipments in 2012) experience net life-cycle cost increases. Approximately 33 percent of 8-foot RDC HO shipments in 2012 (those consumers who replace reduced-wattage T12 lamps) result in negative LCC savings. As seen in section VI.B.1.a.i, for GSFL, often higher efficacy level lamps result in higher (or less negative) life-cycle cost savings. At TSL3, consumers have the option of purchasing these higher-efficacy lamps, and, therefore, can achieve similar life-cycle cost savings as at TSL4 and TSL5.

After considering the analysis and the benefits and burdens of trial standard level 3, the Secretary has reached the following tentative conclusion: Trial standard level 3 offers the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. The Secretary has reached the initial conclusion that the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and the positive net economic savings to the Nation would outweigh the economic burden on some consumers (as indicated by negative life-cycle cost savings) and the potentially large reduction in INPV for manufacturers. TSL 3 offers almost all consumers the choice to select lamp and ballast systems that will reduce their life-cycle costs but does not force them to incur the increased first costs of a new ballast if they elect not to do so. Therefore, DOE today proposes to adopt the energy conservation standards for GSFL at trial standard level 3.

DOE will seriously consider adopting a more stringent standard level in the final rule that would eliminate T12 lamps, as described in discussions regarding TSL4 and TSL5. An example may be for DOE to adopt a more stringent standard level in the final rule that, similar to TSL4 and TSL5, would eliminate T12 lamps, but allow an extended lead time before compliance would be required. A second example may be for DOE to adopt a more stringent standard level, while continuing to allow the sale of specially packaged or labeled T12 lamps in the residential sector only. DOE seeks comment on these or other possible alternative scenarios.

3. Incandescent Reflector Lamps Conclusion

a. Trial Standard Level 5

For IRL, DOE first considered the most efficient level, TSL5, which would save an estimated total of 1.5 to 2.6 quads of energy through 2042—a significant amount of energy. For the Nation as a whole, TSL5 would have a net savings of $4.3 billion to $7.5 billion at a 7-percent discount rate. The emissions reductions at TSL5 are estimated at 79 to 119 MMt of CO_2, 5 to 193 kt of NO_X, and up to 2 metric tons of Hg. Total generating capacity in 2042 is estimated to decrease compared to the reference case by 40 to 500 MW under TSL5. As seen in Table VI.12, regardless of the baseline lamp purchased absent standards, consumers have available lamp designs which result in positive LCC savings, ranging from $1.49 to $9.41, at TSL5. The higher savings result from consumers who purchase lamps with larger lumen packages, while the lower savings result from consumers who purchase lamps with smaller lumen packages.

The projected change in industry value would range from a decrease of $82 million to $103 million, or a net loss of 31 to 50 percent in INPV. The range in impacts is attributed in part to uncertainty concerning the future share of emerging technologies in the IRL market, as well as the expected migration to R–CFL and exempted IRL technologies under standards.

DOE based TSL5 on commercially-available IRL which employ a silver reflector, an improved IR coating, and a filament design that results in a lifetime of 4,200 hours. To DOE's knowledge, only one manufacturer currently sells products that meet TSL5. In addition, it is DOE's understanding that the silver reflector is a proprietary technology that all manufacturers may not be able to employ. However, DOE considered TSL5 in its analysis because it believes that there are alternate pathways to achieve this level. A combination of redesigning the filament to achieve higher-temperature operation (and thus reducing lifetime to 3,000 hours), employing other non-proprietary high-efficiency reflectors, or applying higher-efficiency IR coatings has the potential to result in an IRL that meets an equivalent efficacy level. However, to DOE's knowledge, no prototype IRL exists that meets this efficacy level and does not use proprietary technology. Therefore, DOE is uncertain as to whether there are barriers to implementing these alternate pathways. In addition, DOE is uncertain of the manufacturer costs associated with producing such an IRL. As documented in appendix 5D of the TSD, DOE received manufacturer cost estimates from an IR coating manufacturer. Based on these cost estimates, DOE estimated that a medium-range end-user price for PAR 38 IRL that meet TSL5 and do not employ the proprietary silverized reflector would be $7.91. This price, when compared to the end-user price of the commercially-available PAR38 IRL that meet TSL5 and use the silverized reflector ($8.03), would appear to be cost-competitive. However, DOE requires verification of these cost estimates before proposing a standard that would require this higher-efficiency IR coating technology. If it is significantly more costly for some manufacturers to meet this level than others, it is likely to cause a lessening of competition and distortions in the marketplace.

After carefully considering the analysis and weighing the benefits and burdens of TSL5, the Secretary has reached the following initial conclusion: At TSL5, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), the positive net economic savings to the Nation (over 30 years) would be outweighed by the large capital conversion costs that could result in a reduction in INPV for manufacturers and possible lessening of competition. Consequently, the Secretary has tentatively concluded that trial standard level 5 is not economically justified.

As discussed above, DOE is not proposing TSL5 because DOE finds that the benefits to the Nation of TSL5 do not outweigh the costs, and, therefore, DOE proposes that TSL5 is not economically justified. This proposal reflects DOE's tentative conclusion that there remains too much uncertainty regarding the ability for manufacturers to produce lamps that meet this level. While information is available that suggests that there are other economical pathways (without the use of proprietary technology) to meet this efficacy level, DOE believes that it must have a higher degree of confidence that these pathways exist and a clearer understanding of the economic burdens (to consumers and manufacturers) to warrant higher standards before it imposes such requirements. DOE is soliciting public comments on these and other issues, and will reconsider this tentative conclusion during the development of its final rule. Specifically, DOE requests comment on other technology pathways that may be utilized to meet TSL5, and whether these pathways may have any adverse effects on consumer utility or the ability for the product to be mass produced. In addition, DOE requests comment on the manufacturer costs associated with these pathways and resulting consumer product prices for lamps that meet this efficacy level. Based upon the information it receives, DOE may consider adoption of TSL5 at the final rule stage.

b. Trial Standard Level 4

DOE next considered TSL4, which would save an estimated total of 1.3 to 2.3 quads of energy through 2042—a significant amount of energy. For the Nation as a whole, TSL4 would have a net savings of $3.7 billion to $6.8 billion at a 7-percent discount rate. The emissions reductions at TSL4 are estimated at 59 to 114 MMt of CO_2, 4 to181 kt of NO_X, and up to 2 metric tons of Hg. Total generating capacity in 2042 is estimated to decrease compared to the reference case by 0 to 500 MW under TSL4. As seen in Table VI.12, regardless of the baseline lamp currently employed, consumers have available lamp designs which would result in positive LCC savings, ranging from $1.62 to $8.14, at TSL4.

To DOE's knowledge, two of the three major manufacturers of IRL currently sell a full product line (across common wattages) that meet this standard level. In addition, it is DOE's understanding that the third manufacturer employs a technology platform that, due to the positioning of the filament in the HIR capsule, is inherently less efficient. Therefore, it is likely that in order to meet TSL4, this manufacturer would have to make considerably higher investments than the other manufacturers, placing it at a competitive disadvantage. DOE projects that change in industry value at TSL4 ranges from a decrease of $77 million to $94 million, or net loss of 29 to 46 percent in INPV. However, compared to each of the baselines, TSL4 showed significant positive life-cycle cost savings on a national average basis and for all consumer subgroups. In addition, TSL4 is projected to result in significant net economic savings to the Nation.

After considering the analysis, comments on the ANOPR, and the benefits and burdens of trial standard level 4, the Secretary has reached the following tentative conclusion: Trial standard level 4 offers the maximum improvement in efficacy that is technologically feasible and economically justified, and will result in significant conservation of energy. The Secretary has reached the initial conclusion that the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), the positive net economic savings to the Nation, and positive life-cycle cost savings would outweigh the potentially large reduction in INPV for manufacturers. Therefore, DOE today proposes to adopt the energy conservation standards for IRL at trial standard level 4.

VII. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

Today's regulatory action has been determined to be an economically significant regulatory action under Executive Order 12866, "Regulatory Planning and Review." 58 FR 51735 (Oct. 4, 1993). Accordingly, this action was subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA) at OMB.

The Executive Order requires that each agency identify in writing the specific market failure or other specific problem that it intends to address that warrant new agency action, as well as assess the significance of that problem, to enable assessment of whether any new regulation is warranted. Executive Order 12866, § 1(b)(1).

DOE's analysis for GSFL and IRL explicitly accounts for the percentage of consumers that already purchase more-efficient products and takes these consumers into account when determining the national energy savings associated with various trial standard levels. The analysis suggests that accounting for the market value of energy savings alone (*i.e.*, excluding any possible "externality" benefits such as those noted below) would produce enough benefits to yield net benefits across a wide array of products and circumstances. In its ANOPR, DOE requested additional data on and suggestions for testing the existence and extent of potential market failures to assess the significance of these failures and, thus, the net benefits of regulation. 73 FR 13620, 13688 (March 13, 2008) In particular, DOE sought to verify the estimates of the percentage of consumers purchasing efficient lighting equipment and the extent to which consumers will continue to purchase more-efficient equipment in future years. DOE received no such data in response to the ANOPR but continues to request such data in today's proposed rule.

DOE believes that there is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the lighting market. If this is the case, DOE would expect the efficiency for lighting products to be randomly distributed across key variables such as electricity prices and usage levels. Although DOE has identified the percentage of consumers that already purchase more-efficient lighting products, DOE does not correlate the consumers' usage pattern and electricity price with the efficiency of the purchased product. In its ANOPR, DOE sought data on the correlation between the efficacy of existing lamps, usage patterns (*e.g.*, how many hours the product is used), and its associated electricity price (geographic region of the country). 73 FR 13620, 13688 (March 13, 2008) DOE received no such data from interested parties in response to the ANOPR but continues to request this data in today's proposed rule. DOE plans to use these data to test the extent to which purchasers of this equipment behave as if they are unaware of the costs associated with their energy consumption.

DOE believes several factors contribute to the lack of consumer information for lighting products. In the residential sector, consumers that base purchases on wattage rather than lumen output may reject higher efficacy or energy-saving lamp designs. For example, consumers may not recognize that a higher efficacy, reduced-wattage lamp fulfills the same utility as a higher-wattage lamp, although both lamps may have similar lumen outputs. For this reason, higher-efficiency products may be unduly rejected in the marketplace. In the commercial and industrial sectors, the complexity of GSFL systems may introduce high information costs. GSFL systems are composed of lamps and ballasts with a multitude of varying properties, such as lamp wattage, lumen output, lifetime, and ballast factor. These variables impose high information costs which may prevent purchasers from selecting the most cost-effective GSFL system. In its ANOPR, DOE sought comment on the potential for the Federal ENERGY STAR program to increase consumer knowledge of the availability and benefits of energy-efficient lamps. DOE received no data in response to the ANOPR but continues to request this data in today's proposed rule.

A related issue is the problem of asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services). In many instances, the party responsible for the lamp purchase may not pay to operate it. For example, in the commercial and industrial sectors, building owners and developers may make purchasing decisions about lighting fixtures that include ballasts and lamps, but tenants pay the utility bills. Although renters often have the opportunity to purchase replacement lamps, renters are severely limited in their choices by prior fixture and ballast selections. The separation of fixture purchases and payment for the operating costs imposes transaction costs on the renter. If there were no transactions costs, building developers and owners would install the lighting fixtures renters would choose on their own. For example, a tenant who knowingly faces higher utility bills from low-efficacy lighting would be willing to pay less in rent, and the building owner would indirectly bear the higher utility cost. However, this information is not costless, and it may not be in the interest of the renter to take the time to develop the knowledge of the higher operating cost of low-efficacy lighting. Similarly, it may not be in the interest of the building owner who installs lighting systems to convey operating cost information to the renter.

DOE did not receive any data that would enable it to conduct tests of market failure in response to the March 2008 ANOPR. DOE would not expect a correlation between higher rents for office space with high-efficacy lighting systems if there were a market failure due to asymmetric information and/or high transactions costs. If there were symmetric information with low transaction costs, renters would be fully knowledgeable about the lower operating costs of high-efficacy lighting systems and would compensate owners for their reduced costs.

This proposed rulemaking is likely to yield certain external benefits resulting from improved energy efficiency of GSFL and IRL that are not captured by the users of such products. These benefits include externalities related to environmental protection and energy security which are not reflected in energy prices, such as reduced emissions of greenhouse gases. The emissions reductions in today's proposed rule are projected to be 184 to 395 MMt and 59 to 114 MMt of CO_2 for GSFL and IRL, respectively, and 12 to 623 kt, 4 to 181 kt of NO_X, for GSFL and IRL, respectively. In addition, today's proposed rule is projected to result in Hg emissions reduction of up to 7 metric tons and 2 metric tons for GSFL and IRL, respectively. DOE invites comments on the weight that DOE should place on these factors in determining the maximum energy efficacy level at which the total benefits are likely to exceed the total burdens resulting from an amended standard.

As previously stated, DOE generally seeks data that might enable it to conduct tests of market failure for products under consideration for standard-setting. For example, given adequate data, there are ways to test for the extent of market failure for commercial GSFL. One would expect the owners of fluorescent lamps who also pay for their electricity consumption to purchase more-efficient lamps compared to owners who do not pay for their electricity usage. To test for this form of market failure, DOE needs data on energy efficiency of such units and whether the owner of the equipment also pays the operating costs. DOE is also interested in other potential tests of market failure and data that would enable such tests.

DOE conducted a regulatory impact analysis (RIA) and, under the Executive Order, was subject to review by OIRA. DOE presented to OIRA for review the draft proposed rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. They are available for public review in the Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC 20024, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

The RIA is contained in the TSD as a separate report. The RIA consists of: (1) A statement of the problem addressed by this regulation, and the mandate for government action; (2) a description and analysis of the feasible policy alternatives to this regulation; (3) a quantitative comparison of the impacts of the alternatives; and (4) the national economic impacts of the proposed standard.

The RIA calculates the effects of feasible policy alternatives to energy conservation standards for GSFL and IRL and provides a quantitative comparison of the impacts of the alternatives. DOE identified the following major policy alternatives for achieving increased energy efficiency in GSFL and IRL:

- No new regulatory action.
- Consumer rebates.
- Consumer tax credits.
- Manufacturer tax credits.
- Voluntary energy-efficiency targets.
- Bulk government purchases.
- Early replacement.
- The proposed energy conservation standards.

DOE evaluated each alternative's ability to achieve significant energy savings at reasonable costs (Table VII.1 and Table VII.2) and compared it to the effectiveness of the proposed rule. DOE analyzed these alternatives using a series of regulatory scenarios as inputs to the NIA spreadsheets for the two products, which it modified to allow inputs for voluntary measures.

TABLE VII.1—GSFL NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE OF NON-REGULATORY ALTERNATIVES COMPARED TO THE PROPOSED STANDARDS

Policy alternatives [1]	National energy savings (quads)	Net present value (billion $2007)	
		7% Discount rate	3% Discount rate
No New Regulatory Action	0	0	0
Consumer Rebates	1.33–1.74	1.93–2.67	4.72–6.58
Consumer Tax Credits	0.63–0.83	1.13–1.33	2.47–3.17
Manufacturer Tax Credits	0.35–0.44	0.68–0.73	1.49–1.64
Voluntary Energy Efficiency Targets	1.09–1.44	1.54–2.10	3.83–5.19
Bulk Government Purchases	1.21–1.61	1.69–2.36	4.23–5.82
Proposed Standards [2]	3.15–7.12	3.15–10.75	8.73–24.87

Notes:
[1] NPV discounted to 2007; Non-regulatory alternatives encourage purchases of GSFL at TSL 3.

TABLE VII.2—IRL NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE OF NON-REGULATORY ALTERNATIVES COMPARED TO THE PROPOSED STANDARDS

Policy alternatives [1]	National energy savings (quads)	Net present value (billion $2007)	
		7% Discount rate	3% Discount rate
No New Regulatory Action	0	0	0
Consumer Rebates	0.52–0.69	1.52–1.89	3.19–3.97
Consumer Tax Credits	0.32–0.42	0.96–1.17	1.97–2.44
Manufacturer Tax Credits	0.16–0.21	0.53–0.64	1.05–1.28
Voluntary Energy Efficiency Targets	0.26–0.45	0.83–1.28	1.65–2.59
Bulk Government Purchases	0.04–0.24	0.23–0.72	0.32–1.33
Proposed Standards	1.25–2.21	3.72–6.00	7.68–12.45

Notes:
[1] NPV discounted to 2007, Non-regulatory alternatives encourage purchases of IRL at TSL 4.

The results for each scenario are reported at the TSLs proposed by DOE in this rulemaking; they are TSL 3 for GSFL and TSL 4 for IRL. For GSFL, the range presented results from the effects of applying the lighting expertise scenario discussed in section V.E.4.b. The lower end of the range represents the Emerging Technologies, market-segment based lighting expertise scenario. In contrast, the upper end of the range for GSFL represents the Existing Technologies, high-lighting expertise scenario. For IRL, the range of impacts results from the two base-case shipment scenarios analyzed in the NIA. The lower end of the range for IRL represents the Emerging Technologies scenario, whereas the upper end of the range represents the Existing Technologies scenario.

DOE did not analyze one of the policy alternatives (early replacement), because, as discussed below, DOE believes that the lifetimes of the lamps analyzed are too short for early replacement to result in significant savings. In overview, of the other alternatives that DOE examined, none would save as much energy nor have an NPV as high as the proposed standards. Also, some of the alternatives would require new enabling legislation (*e.g.,* consumer or manufacturer tax credits), as authority to carry out those alternatives does not presently exist. The following paragraphs summarize each policy alternative. Additional details can be found in the regulatory impact analysis report of the TSD.

No New Regulatory Action. The case in which DOE takes no regulatory action regarding GSFL and IRL is the base case (or no action) scenario. Because this is the base case, energy savings and NPV for GSFL and IRL are zero by definition. In this case, between 2012 and 2042, as determined in the NIA, energy consumption for GSFL is expected to range from 82.16 to 94.73 quads of primary energy and energy consumption for IRL is expected to range from 5.64 to 10.52 quads of primary energy.

Consumer Rebates. Consumer rebates cover a portion of the difference in incremental product price between products meeting baseline efficacy levels and those meeting higher efficacy levels, resulting in a higher percentage of consumers purchasing more efficient models. For GSFL, DOE estimated the impact of improving the simple payback through a rebate that paid 70 percent of the incremental product price. DOE based the 70-percent rebate on existing utility rebate programs for replacing a T12 lamp with a T8 lamp or upgrading an existing T8 lamp to a more-efficacious T8 GSFL.[85] DOE studied each program and found that the average rebate amounted to about 70 percent of the incremental product price for GSFL. DOE assumed that the consumer rebate policy would reduce the incremental product price for IRL during the analysis period by the same percentage. DOE calculated the simple payback period of each higher efficacy lamp, both with and without the rebate. Then by using the market penetration curves discussed in section V.E.2.c, DOE estimated percent market adoption of a technology as a function of technology simple payback. The difference between the market penetration with and without the rebate was assumed to represent the market share that would participate in a consumer rebate program. For both GSFL and IRL, DOE assumed that the impact of this policy would be to permanently transform the market so that the increased market penetration seen in the first year of the program would be maintained throughout the forecast period.

[85] DOE averaged the rebates from utility programs across the United States, including NSTAR, Pacific Gas & Electric, Xcel, Idaho Power and Light, Duke Energy, and Alliant. (See the RIA to the TSD for additional detail.)

At the estimated participation rates for GSFL, DOE calculated that consumer rebates would provide between 1.33 and 1.74 quads of national energy savings and an NPV between $1.93 and $2.67 billion (at a 7-percent discount rate). For IRL, DOE calculated that consumer rebates at the estimated participation rates would provide between 0.52 and 0.69 quads of national energy savings and an NPV between $1.52 and $1.89 billion (at a 7-percent discount rate).

Although DOE estimated that consumer rebates would provide national benefits for GSFL and IRL products, these benefits would be smaller than the benefits resulting from the proposed energy conservation standards. Thus, DOE rejected consumer rebates as a policy alternative to energy conservation standards.

Consumer Tax Credits. Consumer tax credits cover a percentage of the difference in incremental product price between products meeting baseline efficacy levels and those with higher efficiencies. Consumer tax credits are considered a viable non-regulatory market transformation program, as the inclusion of Federal consumer tax credits in EPACT 2005 for various residential appliances shows. (section 1333 of EPACT 2005; codified at 26 U.S.C. 25C) DOE assumed a consumer tax credit equivalent to the amount covered by rebates (*i.e.*, 70 percent of the difference in incremental product price between the base case and higher-efficacy products).

DOE estimated that for both lamp types, the consumer participation rate for tax credits would be lower than the rate of participation in consumer rebates. Research on tax credits has shown that the time delay to the consumer in receiving a reimbursement through a tax credit, plus the added transaction costs in tax-return preparation, make the tax credit incentive less effective than a rebate received at the time of purchase. Based on previous analyses, DOE assumed that only 60 percent as many consumers would take advantage of the tax credit as would take advantage of a rebate. DOE assumed the impact of the policy would be to permanently transform the market at this market penetration level.

For GSFL, at the estimated participation rate, consumer tax credits would provide national energy savings between 0.63 and 0.83 quads and an NPV between $1.13 and $1.33 billion (at a 7-percent discount rate). At the estimated participation rates for IRL, consumer tax credits would provide between 0.32 and 0.42 quads of national energy savings and an NPV between $0.96 and $1.17 billion (at a 7-percent discount rate). DOE estimated that while consumer tax credits would yield national benefits for GSFL and IRL, these benefits would be much smaller than the benefits from the proposed energy conservation standards. Thus, DOE rejected consumer tax credits as a policy alternative to energy conservation standards.

Manufacturer Tax Credits. Manufacturer tax credits are considered a viable non-regulatory market transformation program, as the inclusion of Federal tax credits in EPACT 2005 for manufacturers of residential appliances shows. (section 1334 of EPACT 2005; codified at 26 U.S.C. 45M) Similar to consumer tax credits, manufacturer tax credits would effectively result in lower product prices for consumers by an amount that covered part of the incremental product price difference between products meeting baseline efficacy levels and those meeting higher efficacy levels. Because these tax credits would go to manufacturers instead of consumers, fewer consumers would be affected by a manufacturer tax credit program than by consumer tax credits.[86] [87] Although consumers would benefit from price reductions passed through to them by manufacturers, approximately half the consumers who would benefit from a consumer tax credit program would be aware of the economic benefits of more-efficient technologies included in an appliance manufacturer tax credit program. Therefore, DOE estimated that the effect of a manufacturer tax credit program would be only half of the maximum impact of a consumer tax credit program. For both GSFL and IRL, DOE assumed that this policy would permanently transform the market so that the increased market penetration seen in the first year of the program would be maintained throughout the forecast period.

At the estimated participation rates for GSFL, DOE calculated that manufacturer tax credits would provide between 0.35 and 0.44 quads of national energy savings and an NPV between $0.68 and $0.73 billion (at a 7-percent discount rate). For IRL, DOE estimated national energy savings between 0.16 and 0.21 quads and an NPV between $0.53 and $0.64 billion (at a 7-percent discount rate). DOE estimated that while manufacturer tax credits would yield national benefits for GSFL and IRL, these benefits would be much smaller than the benefits from the proposed energy conservation standards. Thus, DOE rejected manufacturer tax credits as a policy alternative to energy conservation standards.

Voluntary Energy Efficiency Targets. DOE estimated the impact of a voluntary energy efficiency program by reviewing the historical and projected market transformation performance of past and current ENERGY STAR programs. The Environmental Protection Agency (EPA) introduced the Green Lights program in January of 1991. Green Lights was a voluntary (non-regulatory) program tasked with a goal of reducing air pollution by promoting energy-efficient lighting. Companies that elected to participate installed energy-efficient lighting where it proved to be cost-effective (as long as lighting quality was not diminished). In return, the EPA provided technical assistance and public recognition. In a similar effort, the EPA launched the ENERGY STAR program in 1992 as a voluntary labeling program to help consumers identify the most energy-efficient products on the market. In 1995, Green Lights became a part of the ENERGY STAR program.[88]

In order to determine how a lighting market would respond to a voluntary energy program, DOE analyzed the success of the Green Lights program in the 1990s. One of the significant results of the Green Lights program was demonstrated in its initiative to encourage consumers to purchase higher-efficiency electronic ballasts over less-efficient magnetic ballasts. As a result of this initiative, electronic ballasts began to enter the market in increasing numbers. A study that analyzed the impact of public programs on fluorescent ballast shipments concluded that of all the electronic ballasts shipped between 1986 and 2000, 61 percent were due to this public program.[89] DOE used data from the US Census to calculate the percent of the market that opted to use more efficient ballasts as a result of a voluntary program. Based on this analysis, DOE concluded that 20 percent of the market would shift to more-efficient products as a result of a voluntary energy efficiency program. DOE assumed this participation rate would be the same for

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[86] Kenneth Train, *Customer Decision Study: Analysis of Residential Customer Equipment Purchase Decisions* (Prepared for Southern California Edison by Cambridge Systematics, Pacific Consulting Services, The Technology Applications Group, and California Survey Research Services) (1994).

[87] Lawrence Berkeley National Laboratory, End-Use Forecasting Group, *Analysis of Tax Credits for Efficient Equipment* (1997). Available at: *http://enduse.lbl.gov/Projects/TaxCredits.html* (Last accessed April 24, 2008).

[88] Available at: *http://www.energystar.gov/index.cfm?c=about.ab_milestones*.

[89] Horowitz, Marvin J., "Economic Indicators of Market Transformation: Energy Efficient Lighting and EPA's Green Lights," *Energy Journal*, Vol. 22, No. 4, (2001) pp. 95–122.

both GSFL and IRL. DOE also assumed that the impact of this policy would be to permanently transform the market so that the increased market penetration seen in the first year of the program would be maintained throughout the forecast period.

For GSFL, DOE estimated that voluntary energy efficiency targets would provide between 1.09 and 1.44 quads of national energy savings and an NPV between $1.54 and $2.10 billion (at a 7-percent discount rate). For IRL, DOE estimated national energy savings between 0.26 and 0.45 quads and an NPV between $0.83 and $1.28 billion (at a 7-percent discount rate). DOE estimated that while voluntary energy-efficiency targets would yield national benefits for GSFL and IRL, these benefits would be much smaller than the benefits from the proposed energy conservation standards. Thus, DOE rejected voluntary energy efficiency targets as a policy alternative to energy conservation standards.

Early Replacement. The early replacement policy alternative envisions a program to replace old, inefficient units with models meeting efficacy levels higher than baseline equipment. DOE did not model this alternative because the lifetimes of GSFL and IRL are very short (on the order of 1 to 5 years), so the savings would not be very great. Early replacement policies are generally beneficial for products with long lifetimes (*e.g.*, washers and dryers, furnaces) and that represent a significant upfront investment, neither of which apply to GSFL and IRL.

Bulk Government Purchases. Under this policy alternative, the government sector would be encouraged to shift its purchases to products that meet the target efficacy levels. DOE assumed that Federal, State, and local government agencies would administer such a program. DOE modeled this program by assuming an increase in the installation of equipment meeting higher efficacy levels for those locations where government agencies purchase or influence the purchase of appliances.

Similar to previous analysis, DOE used floor space data from CBECS 2003 to derive the proportion of government-owned floor space to total commercial floor space, which is 21.4 percent. DOE assumed that the portion of government-owned floor space is proportional to the portion of government lamp purchases. DOE then added a 1.4 percent market-pull impact to arrive at a conservative 22.8 percent market penetration rate.[90] Bulk government purchases will not affect the residential market as DOE believes that most government-owned buildings are in the commercial sector. DOE assumed that the impact of this policy would be to permanently transform the market so that the increased market penetration seen in the first year of the program would be maintained throughout the forecast period.

At the above estimated participation rates, the bulk government purchases scenario would provide between 1.21 and 1.61 quads of national energy savings and an NPV between $1.69 and $2.36 billion (at a 7-percent discount rate) for GSFL, and between 0.04 and 0.24 quads of national energy savings and an NPV between $0.23 and $0.72 billion (at a 7-percent discount rate) for IRL. DOE estimated that while bulk government purchases would yield national benefits for GSFL and IRL, these benefits would be much smaller than the benefits from the proposed energy conservation standards. Thus, DOE rejected voluntary energy efficiency targets as a policy alternative to energy conservation standards.

Energy Conservation Standards. As indicated in the paragraphs above, none of the alternatives DOE examined would save as much energy as the proposed energy conservation standards. Therefore, DOE proposes to adopt the efficacy levels listed in section VI.C

B. Review Under the Regulatory Flexibility Act

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

DOE reviewed today's proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. A regulatory flexibility analysis examines the impact of the rule on small entities and considers alternative ways of reducing negative impacts. DOE identified producers of all products covered by this rulemaking which have manufacturing facilities located within the United States. DOE then looked at publicly-available data and contacted manufacturers, as necessary, to determine if they meet the Small Business Administration (SBA) definition of a small manufacturing facility.

In the context of this rulemaking, ''small businesses,'' as defined by the SBA, for the GSFL and IRL manufacturing industries, are manufacturing enterprises with 1,000 employees or fewer. DOE used the small business size standards published on March 11, 2008, as amended, by the SBA to determine whether any small entities would be required to comply with the rule. 61 FR 3286 (codified at 13 CFR part 121). The size standards are listed by North American Industry Classification System (NAICS) code and industry description. GSFL and IRL manufacturing is classified under NAICS 335110, ''Electric Lamp Bulb and Part Manufacturing,'' which sets a threshold of 1,000 employees or less for an entity in this category to be considered a small business.

In overview, the GSFL and IRL industries include both domestic and international manufacturers. The majority of covered GSFL and IRL are manufactured by three large companies, with a small percentage of the market being manufactured by either large or small companies that are primarily specialized in lamps not covered by this rulemaking. Prior to issuing this notice of proposed rulemaking, DOE interviewed one small business affected by the rulemaking. DOE also obtained information about small business impacts while interviewing manufacturers that exceeded the small business size threshold of 1,000 employees.

To better assess the potential impacts of this rulemaking on small entities, DOE proceeded to conduct a more focused inquiry, as explained below. During its market survey, DOE created a list of every company that manufactures covered and non-covered GSFL and IRL for sale in the United States. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers. DOE then reviewed publicly-available data and contacted companies on its list, as necessary, to determine whether

[90] U.S. Department of Energy, *Regulatory Impact Analysis: Energy Conservation Standards for Consumer Products, Covering: Fluorescent Lamp Ballasts* (Oct. 1999). Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/regulatory_impact.pdf.*

they met the SBA's definition of a small business manufacturer in the GSFL or IRL industries. In total, DOE contacted 57 companies that could potentially be small businesses. During initial review of the 57 companies in its list, DOE either contacted or researched each company to determine if it sold covered GSFL and IRL. Based on its research, DOE screened out companies that did not offer lamps covered by this rulemaking. Consequently, DOE estimated that only 12 out of 57 companies listed were potentially small business manufacturers of covered products. DOE contacted these potential small business manufacturers to request an interview about the possible impacts on small business manufacturers. Of the 12 potential small business manufacturers, four agreed to be interviewed. Based on its initial screening and subsequent interviews, DOE identified only one company as a small business manufacturer based on SBA's definition of a small business manufacturer for this industry. The small business manufacturer that DOE identified only produces covered GSFL products.

DOE found that the small manufacturer of covered GSFL shared some of the same concerns about energy conservation standards as large manufacturers. DOE summarized the key issues in section V.G.4.a of today's notice. However, the small manufacturer was less concerned about the potential of standards to severely harm its business. Because the small manufacturer is more focused on specialty products not covered by this rulemaking, covered GSFL represents a smaller portion of its revenue and product portfolio. In addition, this manufacturer stated that it is possible to pass along cost increases to consumers, thereby limiting margin impacts due to energy conservation standards.

DOE could not use the GSFL GRIM to model the impacts of energy conservation standards on the small business manufacturer of covered GSFL. The GSFL GRIM models the impacts on GSFL manufacturers if concerns about margin pressure and significant capital investments necessitated by standards are realized. The small manufacturer did not share these concerns, and, therefore, the GRIM model would not be representative of the identified small business manufacturer. Like large manufacturers, the small business manufacturer stated that more-efficient products earn a premium; however, unlike larger manufacturers, the small manufacturer stated that it could pass costs along to its customers. Since the GSFL GRIM models the financial impact of the standards commoditizing premium products, it is not representative of the small business manufacturer because the small business manufacturer did not share these concerns. Because of its focus on specialized products, the small manufacturer was more concerned about being able to offer the products to their customers than the impact on its bottom line. For further information about the scenarios modeled in the GRIM, see section VI.B.2.a of today's notice and chapter 13 of the TSD.

DOE seeks further comment on how small businesses could be impacted by standards on GSFL and IRL.

DOE reviewed the standard levels considered in today's notice of proposed rulemaking under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. On the basis of the foregoing, DOE certifies that this proposed rule, if promulgated, would not have a significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE's certification and supporting statement of factual basis will be provided to the Chief Counsel for Advocacy of the Small Business Administration pursuant to 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act

Under the Paperwork Reduction Act of 1995 (PRA) (44 U.S.C. 3501 *et seq.*), a person is not required to respond to a collection of information by a Federal agency, including a requirement to maintain records, unless the collection displays a valid OMB control number. (44 U.S.C. 3506(c)(1)(B)(iii)(V)) This rulemaking would impose no new information or record keeping requirements. Accordingly, OMB clearance is not required under the PRA.

D. Review Under the National Environmental Policy Act

DOE has prepared a draft environmental assessment (EA) of the impacts of the proposed rule pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR Parts 1500–1508), and DOE's regulations for compliance with the National Environmental Policy Act (10 CFR Part 1021). This assessment includes an examination of the potential effects of emission reductions likely to result from the rule in the context of global climate change, as well as other types of environmental impacts. The draft EA has been incorporated into the TSD. Before issuing a final rule for GSFL and IRL, DOE will consider public comments and, as appropriate, determine whether to issue a finding of no significant impact as part of a final EA or to prepare an environmental impact statement (EIS) for this rulemaking.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. Agencies are required to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined today's proposed rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations on energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d) and 6316(b)(2)(D)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

DOE reviewed this regulatory action under Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA), which requires each Federal agency to assess the effects of Federal regulatory actions on State, local and Tribal governments and the private sector. For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted for inflation), section 202 of UMRA requires an agency to publish a written statement assessing the costs, benefits, and other effects of the rule on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA (62 FR 12820) (also available at *http://www.gc.doe.gov*). Although today's proposed rule does not contain a Federal intergovernmental mandate, it may impose expenditures of $100 million or more on the private sector.

Section 202 of UMRA authorizes an agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the proposed rule. 2 U.S.C. 1532(c). The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of the notice of proposed rulemaking and the ''Regulatory Impact Analysis'' section of the TSD for this proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(i) and (o), today's proposed rule would establish energy conservation standards for GSFL and IRL that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the ''Regulatory Impact Analysis'' section of the TSD for today's proposed rule.

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

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

I. Review Under Executive Order 12630

DOE has determined under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), that this regulation would not result in any taking that would require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's proposed rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

Today's regulatory action is not a ''significant energy action'' because it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator of OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

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

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

VIII. Public Participation

DOE will make the entire record of this proposed rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Any person may buy a copy of the transcript from the transcribing reporter.

A. Submission of Comments

DOE began accepting comments, data, and information regarding the proposed rule at the public meeting, and will continue to accept comments until no later than the date provided at the beginning of this notice of proposed rulemaking. Information submitted should be identified by docket number EE–2006–STD–0131 and/or RIN 1904–AA92. Comments, data, and information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Stakeholders should avoid the use of special characters or any form of encryption and, wherever possible, comments should carry the electronic signature of the author. Comments, data, and information submitted to DOE via mail or hand delivery/courier should include one signed paper original. No telefacsimiles (faxes) will be accepted.

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: one copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

B. Issues on Which DOE Seeks Comment

DOE is particularly interested in receiving comments and views of interested parties concerning:

(1) The scope of covered products DOE considered in this rulemaking—specifically, DOE's decision to cover 4-foot T5 miniature bipin SO and 4-foot T5 miniature bipin HO lamps;

(2) DOE's decision to amend the definition of ''colored fluorescent lamp'' to exclude lamps with a CCT greater than 7,000K;

(3) The appropriateness of establishing separate product classes for IRL by lamp diameter and rated lamp voltage;

(4) The appropriateness of establishing separate product classes for 4-foot T5 miniature bipin SO and 4-foot T5 miniature bipin HO lamps;

(5) The added 4-foot MBP residential sector engineering analysis, particularly the choice of the baseline system (lamp and ballast);

(6) The performance characteristics (*e.g.*, lumen output, lifetime, wattage) established for both GSFL and IRL model lamps DOE used in the engineering analysis—specifically, the properties of the T5 halophosphor GSFL baseline lamps and the improved halogen IRL that uses xenon as a fill gas (the lamp established for TSL1);

(7) The efficacy levels DOE considered for IRL, in particular the added EL1 and EL5;

(8) The efficacy levels DOE used for each GSFL product class—particularly, DOE's decision to use compliance report data to establish GSFL efficacy levels;

(9) The methodology DOE used to scale efficacy levels from representative product classes to product classes DOE did not analyze (*i.e.*, 2-foot U-shaped lamps and high CCT lamps for GSFL, modified spectrum lamps, lamps with diameters less than or equal to 2.5 inches, lamps with rated voltage greater than 125V);

(10) The choice of ballast lifetimes DOE used in the commercial, residential, and industrial sectors and operating hours for GSFL in the residential sector;

(11) The growth rates DOE used in the residential sector IRL and GSFL shipments analysis, the market penetration of emerging technologies in the IRL and GSFL shipments analysis, and the T5 lamp shipment forecasts;

(12) Base-case market-share matrices and standards-case market-share matrices for IRL and GSFL—particularly the percentage of GSFL consumers with sufficient lighting expertise (*i.e.*, those consumers who will choose a lower-BF ballast or reduced-wattage lamp to maintain lumen output under standards) by market segment;

(13) The methodology and inputs DOE used for the manufacturer impact analysis—specifically, DOE's assumptions regarding markups, capital costs, conversion costs, and stranded assets;

(14) The determination of the environmental impacts of the proposed rule—specifically, methods for valuing the CO_2, NO_X, SO_X, and Hg emissions savings due to the proposed standards;

(15) The appropriateness of trial standard levels DOE considered for GSFL and IRL, in particular the combinations of efficacy levels of each GSFL product class;

(16) The proposed standard levels for GSFL and IRL;

(17) Alternative scenarios for GSFL standards that could achieve greater energy savings. One example may be for DOE to adopt a more stringent standard level in the final rule that would eliminate T12 lamps, as described in

relation to TSL4 and TSL5. Another example may be for DOE to adopt a more stringent standard level in the final rule that, similar to TSL4 and TSL5, would eliminate T12 lamps, but allow an extended lead time before compliance would be required. A third example may be for DOE to adopt a more stringent standard level, while continuing to allow the sale of specially packaged or labeled T12 lamps in the residential sector only.

(18) Other technology pathways that may be utilized to meet IRL TSL5, whether these pathways may have any adverse effects on consumer utility or the ability for the product to be mass-produced, manufacturer costs associated with these pathways, and resulting consumer product prices for lamps that meet this standard level.

IX. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this proposed rule.

List of Subjects in 10 CFR Part 430

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

Issued in Washington, DC on March 23, 2009.

Steven G. Chalk,

Principal Deputy Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE proposes to amend chapter II, subchapter D, of title 10 of the Code of Federal Regulations as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

2. Section 430.2 is amended by revising the definition of ''colored fluorescent lamp,'' ''fluorescent lamp,'' and ''rated wattage'' to read as follows:

§ 430.2 Definitions.

* * * * *

Colored fluorescent lamp means:

(1) A fluorescent lamp designated and marketed as a colored lamp with a CRI less than 40, as determined according to the method given in CIE Publication 13.2 (incorporated by reference, see § 430.3);

(2) A fluorescent lamp designed and marketed as a colored lamp with a correlated color temperature (CCT) less than 2,500K; or

(3) A fluorescent lamp with a CCT greater than 7,000K.

* * * * *

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 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 length between 45 and 48 inches and rated wattage of 51 or more.

* * * * *

Rated wattage, with respect to general service fluorescent lamps, means:

(1) If the lamp is listed in ANSI C78.81–2005 or ANSI C78.901–2005, the rated wattage of a lamp determined by the lamp designation of Clause 11.1 of ANSI C78.81–2005 or ANSI C78.901–2005;

(2) If the lamp is a residential straight-shaped lamp, and not listed in ANSI C78.81–2005, the wattage of a lamp when operated on a reference ballast for which the lamp is designed;

(3) If the lamp is neither listed in one of the ANSI guides referenced in (1) nor a residential straight-shaped lamp, the wattage of a lamp when measured according to the test procedures outlined in Appendix R to subpart B of this part; or

(4) With respect to general service incandescent lamps and incandescent reflector lamps, the wattage measured according to the test procedures outlined in Appendix R to subpart B of this part.

* * * * *

3. Section 430.32 is amended by revising paragraph (n) to read as follows:

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

* * * * *

(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.
	≤ 35W	45	64.0	Nov. 1, 1995.
8-foot slimline	> 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 C78.1–1978 or related supplements, or not 0.800 nominal amperes; or

(iii) Any 8-foot slimline lamp not defined in ANSI C78.3–1978 (R1984) or related supplement ANSI C78.3a–1985.

(3) Each of the following general service fluorescent lamps manufactured after June 30, 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	84
	> 4,500K	78
2-foot U-shaped	≤ 4,500K	78
	> 4,500K	73
8-foot slimline	≤ 4,500K	95
	> 4,500K	91
8-foot high output	≤ 4,500K	88
	> 4,500K	84
4-foot miniature bipin standard output	≤ 4,500K	103
	> 4,500K	97
4-foot miniature bipin high output	≤ 4,500K	89
	> 4,500K	85

(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 June 30, 2012, shall meet or exceed the lamp efficacy standards shown in the table:

Lamp spectrum	Lamp diameter	Rated voltage	Minimum average lamp efficacy (lm/W)
Standard Spectrum	> 2.5″	≥ 125V	$7.1P^{0.27}$
		< 125V	$6.2P^{0.27}$
	≤ 2.5″	≥ 125V	$6.3P^{0.27}$
		< 125V	$5.5P^{0.27}$
Modified Spectrum	> 2.5″	≥ 125V	$5.8P^{0.27}$
		< 125V	$5.0P^{0.27}$
	≤ 2.5″	≥ 125V	$5.1P^{0.27}$
		< 125V	$4.4P^{0.27}$

NOTE: P is equal to the rated lamp wattage, in watts.

(6)(i)(A) Subject to the exclusions in paragraph (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 (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.

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