FEDERAL REGISTER

Vol. 81 Wednesday,
No. 3 January 6, 2016

Part II

Department of Energy

10 CFR Parts 429 and 430
Energy Conservation Program: Energy Conservation Standards for Ceiling Fan Light Kits; Final Rule

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket Number EERE–2012–BT–STD–0045]

RIN 1904–AC87

Energy Conservation Program: Energy Conservation Standards for Ceiling Fan Light Kits

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including ceiling fan light kits (CFLKs). EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more-stringent standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this final rule, DOE is adopting more-stringent energy conservation standards for CFLKs. It has determined that the amended energy conservation standards for these products would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is March 7, 2016. Compliance with the amended standards established for CFLKs in this final rule is required on and after January 7, 2019.

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

A link to the docket Web page can be found at: *http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-STD-0045*. The *www.regulations.gov* Web page will contain instructions on how to access all documents, including public comments, in the docket.

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

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SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Final Rule

Title III, Part B [1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles.[2] These products include CFLKs, the subject of this document.

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) EPCA also provides that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1))

In accordance with these and other statutory provisions discussed in this document, DOE is adopting amended energy conservation standards for CFLKs. The amended standards, which are expressed in minimum lumen output per watt (lm/W), are shown in Table I.1. These standards apply to all products listed in Table I.1 and manufactured in, or imported into, the United States starting on January 7, 2019.

TABLE I.1—ENERGY CONSERVATION STANDARDS FOR CEILING FAN LIGHT KITS

[Compliance starting January 7, 2019]

Product type	Lumens [1]	Minimum efficacy (lm/W)
All CFLKs	<120	50
	≥120	$74.0 - 29.42 \times 0.9983^{\text{lumens}}$

[1] Use the lumen output for each basic model of lamp packaged with the basic model of CFLK or each basic model of integrated SSL in the CFLK basic model to determine the applicable standard.

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of the adopted standards on consumers of CFLKs, as measured by the average life-cycle cost (LCC) savings and the simple payback period (PBP).[3] The average LCC savings are positive for the product class, and the PBP is less than the average lifetime of CFLKs, which is estimated to be 13.8 years (see section IV.F.6).

TABLE I.2—IMPACTS OF AMENDED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF CFLKS

Product class	Average LCC savings (2014$)	Simple payback period (years)
Residential Sector		
All CFLKs	24.3	1.2
Commercial Sector		
All CFLKs	53.4	0.3

DOE's analysis of the impacts of the adopted standards on consumers is described in section IV.F of this document.

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the reference year through the end of the analysis period (2015 to 2048). Using a real discount rate of 7.4 percent, DOE estimates that the INPV for manufacturers of CFLKs in the no-new-standards case is $174.9 million in 2014$. Under the adopted standards, DOE expects that manufacturers may lose up to 3.7

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

[2] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Public Law 114–11 (Apr. 30, 2015).

[3] The average LCC savings are measured relative to the efficacy distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of standards (see section IV.F.10). The simple PBP, designed to compare specific efficacy levels, is measured relative to the least efficient model on the market (see section IV.C.3).

percent of this INPV, which is approximately $6.4 million. Additionally, based on DOE's interviews with the manufacturers of CFLKs, DOE does not expect significant impacts on manufacturing capacity or loss of employment for the industry as a whole to result from the standards for CFLKs.

DOE's analysis of the impacts of the adopted standards on manufacturers is described in section IV.J of this document.

C. National Benefits and Costs [4]

DOE's analyses indicate that the adopted energy conservation standards for CFLKs would save a significant amount of energy. Relative to the case where no amended energy conservation standard is set (hereinafter referred to as the ''no-new-standards case''), the lifetime energy savings for CFLKs purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2019–2048), amount to 0.049 quadrillion Btu (quads).[5] This represents a savings of 3.6 percent relative to the energy use of these products in the no-new-standards case.

The cumulative net present value (NPV) of total consumer costs and savings of the standards for CFLKs ranges from $0.50 billion (at a 7-percent discount rate) to $0.66 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for CFLKs purchased in 2019–2048.

In addition, the standards for CFLKs are projected to yield significant environmental benefits. DOE estimates that the standards would result in cumulative greenhouse gas emission reductions (over the same period as for energy savings) of 3.4 million metric tons (Mt) [6] of carbon dioxide (CO_2), 2.6 thousand tons of sulfur dioxide (SO_2), 5.2 tons of nitrogen oxides (NO_X), 11.2 thousand tons of methane (CH_4), 0.05 thousand tons of nitrous oxide (N_2O), and 0.01 tons of mercury (Hg).[7] The cumulative reduction in CO_2 emissions through 2030 amounts to 3.1 Mt, which is equivalent to the emissions resulting from the annual electricity use of almost 400 thousand homes.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the ''Social Cost of Carbon'', or SCC) developed by a Federal interagency working group.[8] The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values (see Table I.3), DOE estimates that the net present monetary value of the CO_2 emissions reduction (not including CO_2 equivalent emissions of other gases with global warming potential) is between $0.03 billion and $0.40 billion, with a value of $0.13 billion using the central SCC case represented by $40.0/t in 2015. DOE also estimates that the net present monetary value of the NO_X emissions reduction to be $0.02 billion at a 7-percent discount rate, and $0.03 billion at a 3-percent discount rate.[9]

Table I.3 summarizes the national economic benefits and costs expected to result from the adopted standards for CFLKs.

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF AMENDED ENERGY CONSERVATION STANDARDS FOR CFLKS *

Category	Present value (billion 2014$)	Discount rate (%)
Benefits		
Consumer Operating Cost Savings	0.56	7
	0.73	3
CO_2 Reduction Value ($12.2/t case) **	0.03	5
CO_2 Reduction Value ($40.0/t case) **	0.13	3
CO_2 Reduction Value ($62.3/t case) **	0.20	2.5
CO_2 Reduction Value ($117/t case) **	0.40	3
NO_X Reduction Monetized Value †	0.02	7
	0.03	3
Total Benefits ††	0.71	7
	0.89	3
Costs		
Consumer Incremental Installed Costs	0.06	7

[4] All monetary values in this section are expressed in 2014 dollars and, where appropriate, are discounted to 2015 unless explicitly stated otherwise. Energy savings in this section refer to the full-fuel-cycle savings (see section IV.H for discussion).

[5] A quad is equal to 10^{15} British thermal units (Btu). The quantity refers to full-fuel-cycle (FFC) energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.

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

[7] DOE calculated emissions reductions relative to the no-new-standards-case, which reflects key assumptions in the *Annual Energy Outlook 2015* (*AEO 2015*) Reference case, which generally represents current legislation and environmental regulations for which implementing regulations were available as of October 31, 2014.

[8] *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* Interagency Working Group on Social Cost of Carbon, United States Government. May 2013; revised November 2013. Available at: *http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf.*

[9] DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, ''Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,'' published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011), the values would be nearly two-and-a-half times larger. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule. Note that DOE is currently investigating valuation of avoided SO_2 and Hg emissions.

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF AMENDED ENERGY CONSERVATION STANDARDS FOR CFLKS *—Continued

Category	Present value (billion 2014$)	Discount rate (%)
	0.07	3
Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value ††	0.65 0.82	7 3

* This table presents the costs and benefits associated with CFLKs shipped in 2019–2048. These results include benefits to consumers which accrue after 2048 from the products purchased in 2019–2048. The costs account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule.

** The CO_2 values represent global monetized values of the SCC, in 2014$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series incorporate an escalation factor. The value for NO_X is the average of high and low values found in the literature.

† The $/ton values used for NO_X are described in section IV.L. DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, "Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants," published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. Note that the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011), the values would be nearly two-and-a-half times larger. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

†† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with 3-percent discount rate ($40.0/t case).

The benefits and costs of the adopted standards, for CFLKs sold in 2019–2048, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are the sum of (1) the national economic value of the benefits in reduced operating costs, minus (2) the increases in product purchase prices and installation costs, plus (3) the value of the benefits of CO_2 and NO_X emission reductions, all annualized.[10]

Although the value of operating cost savings and CO_2 emission reductions are both important, two issues are relevant. First, the national operating cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, whereas the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of CFLKs shipped in 2019–2048. Because CO_2 emissions have a very long residence time in the atmosphere,[11] the SCC values in future years reflect future CO_2-emissions impacts that continue beyond 2100.

Estimates of annualized benefits and costs of the adopted standards are shown in Table I.4. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, (for which DOE used a 3-percent discount rate along with the SCC series that has a value of $40.0/t in 2015),[12] the estimated cost of the standards in this rule is $6.0 million per year in increased equipment costs, while the estimated annual benefits are $55 million in reduced equipment operating costs, $7.5 million in CO_2 reductions, and $1.7 million in reduced NO_X emissions. In this case, the net benefit amounts to $59 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series has a value of $40.0/t in 2015, the estimated cost of the standards is $4.0 million per year in increased equipment costs, while the estimated annual benefits are $41 million in reduced operating costs, $7.5 million in CO_2 reductions, and $1.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $46 million per year.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF AMENDED STANDARDS FOR CFLKS *

	Discount rate	(million 2014$/year)		
		Primary estimate	Low net benefits estimate	High net benefits estimate
Benefits				
Consumer Operating Cost Savings	7% 3%	55 41	36 24	59. 43.
CO_2 Reduction Value ($12.2/t case) **	5%	3	1	3.

[10] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2015, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2020 or 2030), and then discounted the present value from each year to 2015. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates, as shown in Table I.3. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

[11] The atmospheric lifetime of CO_2 is estimated of the order of 30–95 years. Jacobson, MZ (2005), "Correction to 'Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming,' " *J. Geophys. Res.* 110. pp. D14105.

[12] DOE used a 3-percent discount rate because the SCC values for the series used in the calculation were derived using a 3-percent discount rate (see section IV.L).

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF AMENDED STANDARDS FOR CFLKS *—Continued

	Discount rate	(million 2014$/year)		
		Primary estimate	Low net benefits estimate	High net benefits estimate
CO_2 Reduction Value ($40.0/t case) **	3%	7	4	8.
CO_2 Reduction Value ($62.3/t case) **	2.5%	11	5	11.
CO_2 Reduction Value ($117/t case) **	3%	22	11	23.
NO_X Reduction Value †	7%	1.7	1.0	4.0.
	3%	1.4	0.7	3.4.
Total Benefits ††	7% plus CO_2 range	60 to 79	38 to 48	66 to 86.
	7%	65	40	71.
	3% plus CO_2 range	45 to 64	26 to 36	50 to 70.
	3%	50	28	55.
Costs				
Consumer Incremental Product Costs	7%	6.0	3.5	6.4.
	3%	4.0	2.3	4.2.
Net Benefits				
Total ††	7% plus CO_2 range	54 to 73	34 to 44	59 to 80.
	7%	59	37	65.
	3% plus CO_2 range	41 to 60	24 to 33	45 to 66.
	3%	46	26	51.

* This table presents the annualized costs and benefits associated with CFLKs shipped in 2019–2048. These results include benefits to consumers which accrue after 2048 from the CFLKs purchased from 2019–2048. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary Estimate assumes the reference case electricity prices and housing starts from *AEO 2015* and decreasing product prices for light-emitting diode (LED) CFLKs, due to price learning. The Low Benefits Estimate uses the Low Economic Growth electricity prices and housing starts from *AEO 2015* and a faster decrease in product prices for LED CFLKs. The High Benefits Estimate uses the High Economic Growth electricity prices and housing starts from *AEO 2015* and the same product price decrease for LED CFLKs as in the Primary Estimate. The methods used to derive projected price trends are explained in section IV.G.

** The CO_2 values represent global monetized values of the SCC, in 2014$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series incorporate an escalation factor.

† The $/ton values used for NO_X are described in section IV.L. DOE estimated the monetized value of NOx emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, "Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants," published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf.*) See section IV.L.2 for further discussion. For DOE's Primary Estimate and Low Net Benefits Estimate, the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). For DOE's High Net Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011), which are nearly two-and-a-half times larger than those from the ACS study. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

†† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with 3-percent discount rate ($40.0/t case). In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

DOE's analysis of the national impacts of the adopted standards is described in sections IV.H, IV.K and IV.L of this document.

D. Conclusion

Based on the analyses culminating in this final rule, DOE found the benefits to the nation of the standards (energy savings, consumer LCC savings, positive NPV of consumer benefit, and emission reductions) outweigh the burdens (loss of INPV and LCC increases for some users of these products). DOE has concluded that the standards in this final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy.

II. Introduction

The following section briefly discusses the statutory authority underlying this final rule, as well as some of the relevant historical background related to the establishment of standards for CFLKs.

A. Authority

Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (codified as 42 U.S.C. 6291–6309) established the Energy Conservation Program for Consumer Products Other Than Automobiles, a program covering most major household appliances (collectively referred to as "covered products"), which includes the CFLKs that are the subject of this rulemaking. (42 U.S.C. 6295(ff)) EPCA, as amended, prescribed energy conservation standards for these products (42 U.S.C. 6295(ff)), and authorized DOE to consider whether to amend these standards. Under 42 U.S.C. 6295(m), DOE must also periodically review its already established energy conservation standards for a covered product.

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) Testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6295(o)(3)(A) and (r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for CFLKs appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendices V and V1 and 10 CFR 430.23(x).

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

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

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

(6) The need for national energy and water conservation; and

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

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

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

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

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

Finally, pursuant to the amendments contained in the Energy Independence and Security Act of 2007 (EISA 2007), Public L.aw 110–140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE published a final rule amending test procedures for CFLKs on December 24, 2015 (hereafter ''CFLK TP final rule''). 80 FR 80209. In the CFLK TP final rule, DOE specified that CFLKs do not consume power in off mode. Further, the CFLK TP final rule stated that the energy use in standby mode is attributed to the ceiling fan to which the CFLK is attached, and accounted for in the ceiling fan efficiency metric. 80 FR 80209, 80220 (December 24, 2015). Thus, DOE's test procedures and standards for CFLKs address energy consumption only in active mode, as do the amended standards adopted in this final rule.

B. Background

1. Current Standards

The current energy conservation standards apply to CFLKs with medium screw base and pin-based sockets manufactured on and after January 1, 2007, and CFLKs with all other socket types manufactured on or after January 1, 2009. 70 FR 60407, 60413 (October 18, 2005). These standards are set forth in DOE's regulations at 10 CFR 430.32(s).

2. History of Standards Rulemaking for CFLKs

Current energy conservation standards for CFLKs (42 U.S.C. 6295(ff)) were established by the Energy Policy

Act of 2005 (EPAct 2005) (Title I, Subtitle C, section 135(c)), which were later amended by EPCA. Specifically, EPAct 2005 established individual energy conservation standards for three groups of CFLKs: (1) Those having medium screw base sockets (hereafter ''Medium Screw Base product class''); (2) those having pin-based sockets for fluorescent lamps (hereafter ''Pin-Based product class''); and (3) any CFLKs other than those included in the Medium Screw Base product class or the Pin-Based product class (hereafter ''Other Base Type product class''). (42 U.S.C. 6295(ff)(2)–(4)) In a technical amendment published on October 18, 2005, DOE codified the EPCA requirements for the Medium Screw Base and Pin-Based product classes. 70 FR 60413 EPAct 2005 also specified that if DOE did not issue a final rule on energy conservation standards for Other Base Type product class CFLKs by January 1, 2007, a 190 W limit would apply to those products. (42 U.S.C. 6295(ff)(4)(C)) Because DOE did not issue a final rule on standards for CFLKs by that date, DOE published a technical amendment that codified the statute's requirements for Other Base Type product class CFLKs, which applied to Other Base Type product class CFLKs manufactured on or after January 1, 2009. 72 FR 1270 (Jan. 11, 2007). In another technical amendment final rule, DOE added a provision that CFLKs with sockets for pin-based fluorescent lamps must be packaged with lamps to fill all sockets. 74 FR 12058 (Mar. 3, 2009). (42 U.S.C. 6295(ff)(4)(C)(ii)) These standards for CFLKs are codified at 10 CFR 430.32(s)(2)–(4).

To initiate the rulemaking cycle to consider amended energy conservation standards for ceiling fans and CFLKs, on March 15, 2013, DOE published a notice announcing the availability of the framework document, ''Energy Conservation Standards Rulemaking Framework Document for Ceiling Fans and Ceiling Fan Light Kits,'' and a public meeting to discuss the proposed analytical framework for the rulemaking. 76 FR 56678. DOE also posted the framework document on its Web site, in which DOE described the procedural and analytical approaches DOE anticipated using to evaluate the establishment of energy conservation standards for ceiling fans and CFLKs.

DOE held the public meeting for the framework document on March 22, 2013 to present the framework document, describe the analyses DOE 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.

DOE published a preliminary analysis for the CFLK energy conservation standards rulemaking in the **Federal Register** on October 31, 2014. 78 FR 13563. DOE posted the preliminary analysis, as well as the complete preliminary technical support document (TSD), on its Web site. The preliminary TSD includes the results of the following DOE preliminary analyses: (1) Market and technology assessment; (2) screening analysis; (3) engineering analysis; (4) energy use analysis; (5) product price determination; (6) LCC and PBP analyses; (7) shipments analysis; (8) national impact analysis (NIA); and (9) preliminary manufacturer impact analysis (MIA).

In August 2015, DOE published a notice of proposed rulemaking (NOPR) in the **Federal Register** proposing amended energy conservation standards for CFLKs. 80 FR 48624 (August 13, 2015). In conjunction with the NOPR, DOE also published on its Web site the complete TSD for the proposed rule.[13] The NOPR TSD included updated results of the analyses conducted in the preliminary analysis stage as well as the following additional analyses: 1) LCC subgroup analysis, 2) manufacturer impact analysis, 3) employment impact analysis, 4) utility impact analysis, 5) emissions analysis, 6) monetization of emission reduction benefits, and 7) regulatory impact analysis (RIA). The NOPR TSD was accompanied by the LCC spreadsheet, the NIA spreadsheet, and the MIA spreadsheet—all of which are available on regulations.gov.[14] In the NOPR, DOE invited comment on these analyses and related issues. DOE held a NOPR public meeting on August 18, 2015, to hear oral comments on and solicit information relevant to the proposed rule (hereafter the NOPR public meeting). DOE considered the comments received in response to the NOPR after its publication and at the NOPR public meeting when developing this final rule, and responds to these comments in this rule.

[13] The NOPR TSD is available at regulations.gov under docket number EERE–2012–BT–STD–0045.

[14] Supporting spreadsheets for the NOPR TSD are available at regulations.gov under docket number EERE–2012–BT–STD–0045.

III. General Discussion

A. Product Classes and Scope of Coverage

EPCA defines a ''ceiling fan light kit'' as equipment designed to provide light from a ceiling fan that can be: (1) Integral, such that the equipment is attached to the ceiling fan prior to the time of retail sale; or (2) attachable, such that at the time of retail sale the equipment is not physically attached to the ceiling fan, but may be included inside the ceiling fan at the time of sale or sold separately for subsequent attachment to the fan. (42 U.S.C. 6291(50)(A), (B)) In the CFLK TP final rule, DOE withdrew the current guidance on accent lighting and reinterpreted the EPCA definition of ''ceiling fan light kit'' to include all lighting, including accent lighting. As a result, all lighting packaged with a CFLK is subject to energy conservation requirements. 80 FR 80209, 80213–15 (December 24, 2015). Additionally, in the CFLK TP final rule, DOE reinterpreted the definition of a ceiling fan to include hugger fans, and clarified that the definition includes multi-mount fans and fans that produce a large volume of airflow. 80 FR 80209, 80215–16 (December 24, 2015).

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or other performance-related features that justify differing standards. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (42 U.S.C. 6295(q)) For further details on product classes, see section IV.A.1 and chapter 3 of the final rule TSD.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE published a final rule amending test procedures for CFLKs on December 24, 2015. 80 FR 80209. Test procedures for CFLKs are provided 10 CFR 430.23(x) and in appendices V and V1 to 10 CFR part 430, subpart B.

1. Standby and Off-Mode Energy Consumption

EPCA directs DOE to update its test procedures to account for standby mode and off-mode energy consumption, with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor, unless the current test procedure already accounts for standby mode and off-mode energy use. (42 U.S.C. 6295(gg)(2)(A)) Furthermore, if an integrated test procedure is technically infeasible, DOE must prescribe a separate standby mode and off-mode test procedure for the covered product, if technically feasible.

In the CFLK TP final rule, DOE determined that CFLKs do not consume power in off mode, and that only CFLKs offering the functionality of a wireless remote control may consume power in standby mode. Because the standby sensor and controller nearly always provide functionality shared between the ceiling fan and the CFLK, DOE concluded that the energy use from standby mode associated with CFLKs is attributed to the ceiling fan to which they are attached, and thus any standby mode energy use will be accounted for in the ceiling fan efficiency metric. Therefore, DOE's test procedures for CFLKs account for only active mode power consumption. 80 FR 80209, 80220 (December 24, 2015).

C. Technological Feasibility

1. General

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

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

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for CFLKs, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C.5 of this final rule and in chapter 5 of the final rule TSD.

D. Energy Savings

1. Determination of Savings

For each trial standard level (TSL), DOE projected energy savings from application of the TSL to CFLKs purchased in the 30-year period that begins in the year of compliance with any amended standards (2019–2048).[15] The savings are measured over the entire lifetime of products purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis (NIA) spreadsheet models to estimate energy savings from potential amended standards for CFLKs. The NIA spreadsheet model (described in section IV.H of this document) calculates savings in site energy, which is the energy directly consumed by products at the locations where they are used. Based on the site energy, DOE calculates national energy savings (NES) in terms of primary energy savings at the site or at power plants, and also in terms of full-fuel-cycle (FFC) energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[16] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

To adopt standards for a covered product, DOE must determine that such action would result in ''significant'' energy savings. (42 U.S.C. 6295(o)(3)(B)) Although the term ''significant'' is not defined in the Act, the U.S. Court of Appeals for the District of Columbia Circuit opined in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (D.C. Cir. 1985), that Congress intended ''significant'' energy savings in the context of EPCA to be savings that were not ''genuinely trivial.'' The energy savings for all the TSLs considered in this rulemaking, including the adopted standards, are nontrivial, and, therefore, DOE considers them ''significant'' within the meaning of section 325 of EPCA.

E. Economic Justification

1. Specific Criteria

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

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a potential amended standard on manufacturers, DOE conducts a manufacturer impact analysis (MIA), as discussed in section IV.J. DOE first uses an annual cash-flow approach to

[15] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

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

determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) Industry net present value (INPV), which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and payback period (PBP) associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national net present value of the economic impacts applicable to a particular rulemaking. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national standard.

b. Savings in Operating Costs Compared to Increase in Price (LCC and PBP)

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of a product (including its installation) and the operating cost (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

For its LCC and PBP analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with amended standards. The LCC savings for the considered ELs are calculated relative to the no-new-standards case that reflects projected market trends in the absence of amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F.

c. Energy Savings

Although 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)) As discussed in section III.D.1, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing product classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards adopted in this final rule would not reduce the utility or performance of the products under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) DOE transmitted a copy of its proposed rule to the Attorney General with a request that the Department of Justice (DOJ) provide its determination on this issue. DOE received no adverse comments from DOJ regarding the proposed rule.

f. Need for National Energy Conservation

DOE also considers the need for national energy conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from the adopted standards are likely to provide improvements to the security and reliability of the nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the nation's needed power generation capacity, as discussed in section IV.M.

The adopted standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K; the emissions impacts are reported in section V.C.2 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L.

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)) To the extent interested parties submit any relevant information regarding economic justification that does not fit into the other categories described above, DOE could consider such information under ''other factors.''

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effect potential amended energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F of this final rule.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to CFLKs. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the standards adopted in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments forecasts and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (GRIM), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the Web site for this rulemaking: *http://www.regulations.gov/#!docketDetail;dct=FR%252BPR%252BN%252BO%252BSR%252BPS;rpp=25;po=25;D=EERE-2012-BT-STD-0045*. Additionally, DOE used output from the latest version of the U.S. Energy Information Administration's (EIA's) *Annual Energy Outlook* (*AEO*), a widely known energy forecast for the United States, for the emissions and utility impact analyses.

A. Market and Technology Assessment

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

1. Product Classes

DOE divides covered products into classes by: (a) The type of energy used; (b) the capacity of the product; or (c) other performance-related features that justify different standard levels, considering the consumer utility of the feature and other relevant factors. (42 U.S.C. 6295(q)) The current product class structure for CFLKs, which was established by EPACT 2005, divides CFLKs into three product classes: CFLKs with medium screw base (E26) sockets (Medium Screw Base product class), CFLKs with pin-based sockets for fluorescent lamps (Pin-Based product class), and any CFLKs other than those in the Medium Screw Base or Pin-Based product classes (Other Base Type product class). In the NOPR analysis, DOE restructured the current three CFLK product classes to one product class: All CFLKs.

Products in the All CFLKs product class are currently subject to either ENERGY STAR Program Requirements for Residential Light Fixtures version 4.0, ENERGY STAR Program requirements for Compact Fluorescent Lamps, version 3, or a 190 watt limitation. (10 CFR 430.32(s)) ENERGY STAR Program Requirements for Residential Light Fixtures version 4.0 minimum efficacy requirements are specific to wattage and length, and ENERGY STAR Program requirements for Compact Fluorescent Lamps version 3 are specific to wattage and whether the lamp is bare or covered. Because DOE is not adopting length or lamp cover as product class setting factors, minimum efficacy requirements for this product class were determined by lamp wattage. Consistent with 42 U.S.C. 6295(o)(1), DOE determined that products in the All CFLKs product class are subject to the highest of the existing standards for each wattage bin. Therefore, for products less than 15 W, DOE set the minimum baseline efficacy at 50 lm/W. For products greater than or equal to 15 W and less than 30 W, DOE set the baseline efficacy at 60 lm/W. For products greater than or equal to 30 W, DOE set the baseline efficacy at 70 lm/W. The combined minimum efficacy requirements based on wattage are shown in Table IV.1.

TABLE IV.1—ALL CFLKS PRODUCT CLASS CURRENT MINIMUM EFFICACY REQUIREMENTS

Lamp power (W)	Minimum efficacy (lm/W)
<15	50.0
≥15 and <30	60.0
≥30	70.0

DOE received several comments agreeing with the restructuring of product classes. Westinghouse stated that having only one product class makes compliance less complex and the standard fairly easy to understand, and provides design flexibility. However, Westinghouse cautioned that if the proposed EL 2 is adjusted even slightly, some of the design flexibility would be lost under a single product class structure. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 26–27) Hunter agreed with Westinghouse's comments. (Hunter, Public Meeting Transcript, No. 112 at p. 27)

Subject to adoption of TSL 2, the American Lighting Association (ALA) also agreed with the proposed class structure because it would simplify compliance. (ALA, No. 115 at p. 7) ASAP and PG&E agreed with the product class combination from a structural perspective. (ASAP, Public Meeting Transcript, No. 112 at p. 27; PG&E, Public Meeting Transcript, No. 112 at p. 27) ASAP and the California Investor Owned Utilities (CA IOUs) supported not using base type as a class setting factor. ASAP also supported not using light source technology as a class setting factor. ASAP and CA IOUs stated that a single product class would eliminate the current standard's product class definitions, which have driven the CFLK market towards inefficient candelabra base lamps to avoid the more stringent standards for CFLKs that use medium screw base lamps. In a joint comment, ASAP, the American Council for an Energy-Efficient Economy, the National Resources Defense Council, and the Northwest Energy Efficiency Alliance (hereafter the ''Joint Comment'') and CA IOUs noted that as

SSL technology continues to improve, and more CFLKs with integrated SSL circuitry (which do not have removable lamps) enter the market, they will be assessed alongside CFLKs with removable lamps under a single product class structure. This would prevent future standards from driving the market to less efficient technology. (Joint Comment, No. 117 at p. 1; CA IOUs, No. 118 at pp. 1–2)

DOE did not receive any comments that disagreed with the product class structure proposed in the NOPR. In this final rule, DOE did not identify any class setting factors for CFLKs that use a different type of energy, offer a different capacity of the product, or provide unique performance-related features to consumers, and thereby warrant a separate product class. Therefore, in this final rule analysis, DOE is adopting a single ''All CFLKs'' product class. (See chapter 3 of the final rule TSD for further details on the CFLK product class.)

2. Metrics

In the NOPR, DOE proposed luminous efficacy as the efficiency metric for CFLKs. DOE used lamp efficacy except where the components in the CFLK necessary to measure lamp efficacy are not designed to be consumer replaceable from the CFLK (*i.e.,* for CFLKs with integrated SSL circuitry, such as those with inseparable LED lighting). In those cases, DOE used luminaire efficacy.

ALA asked DOE to confirm that the lumens per watt requirements for CFLKs that utilized an ANSI base are determined by lumen output per light source rather than the total lumen output of all light sources in the CFLK. (ALA, Public Meeting Transcript, No. 112 at pp. 10–11, 43)

In the final rule, DOE continued to base its analysis on luminous efficacy as the efficiency metric for CFLKs. DOE used lamp efficacy except where the components in the CFLK necessary to measure lamp efficacy are not designed to be consumer replaceable from the CFLK. In those cases, DOE used luminaire efficacy. Hence, for a CFLK packaged with three medium screw base lamps, the minimum efficacy standard applies to each lamp individually.

3. 190 W Limiter Requirement

Current standards require that CFLKs with medium screw base sockets, or pin-based sockets for fluorescent lamps, be packaged with lamps that meet certain efficiency requirements. All other CFLKs must not be capable of operating with lamps that exceed 190 W. In the final rule for energy conservation standards for certain CFLKs published on January 11, 2007, DOE interpreted this 190 W limitation as a requirement to incorporate an electrical device or measure that ensures the light kit is not capable of operating with a lamp or lamps that draw more than a total of 190 W. 72 FR 1270, 1271 (Jan. 11, 2007).

In the NOPR, DOE proposed that CFLKs with solid-state lighting (SSL) circuitry that (1) have SSL drivers and/ or light sources that are not consumer replaceable, (2) do not have both an SSL driver and light source that are consumer replaceable, (3) do not include any other light source, and (4) include SSL drivers with a maximum operating wattage of no more than 190 W are considered to incorporate some electrical device or measure that ensures they do not exceed the 190 W limit.[17] DOE proposed to incorporate the clarification in this rulemaking and make it effective 30 days after the publication of the final rule.

DOE received several comments regarding this proposal and addressed these comments in the CFLK TP final rule. 80 FR 80209, 80216–18 (December 24, 2015). In the CFLK TP final rule, DOE clarified that, for purposes of compliance with the CFLK standards at 10 CFR 430.32(s)(4), CFLKs that (1) include only SSL technology; (2) do not include an SSL lamp with an ANSI standard base, and (3) include only SSL drivers with a combined maximum operating wattage of no more than 190 W meet the 190 W limit requirement. 80 FR 80209, 80218 (December 24, 2015)

ALA requested that DOE make the clarification of the 190 W limiter requirement for CFLKs with integrated SSL components effective as soon as possible, either in a separate notice or in the forthcoming final rule of the CFLK test procedure. (ALA, No. 115 at p. 4, 6) The interpretation of the 190 W limit requirement for CFLKs with SSL technology will be effective with the publication of the CFLK TP final rule in the **Federal Register**. 80 FR 80209, 80218 (December 24, 2015)

ALA also requested that DOE clarify that CFLKs subject to amended energy efficiency standards are not to be subject to the 190 W limit requirement or, alternatively, that CFLKs that comply with the amended energy efficiency standards also comply with the 190 wattage limit requirement. ALA reasoned that amended energy efficiency standards would require any CFLK to meet a minimum efficacy standard of 50 lm/W and therefore a CFLK modified to operate a total of more than 190 watts would emit more than 9,500 lumens. Because this is too much light for residential and commercial CFLK applications, consumers would not modify CFLKs subject to DOE's amended efficiency standards to operate at wattages higher than 190 watts. (ALA, No. 115 at p. 7)

As described in section IV.C.3, DOE determined that any amended energy efficiency standards would require lamps packaged with CFLKs to comply with a minimum efficacy of 50 lm/W. CFLKs that are currently packaged with lamps totaling 190 W typically offer a total lumen output of about 1,600 total lumens, or approximately 8 lm/W per lamp included. If each lamp included were to comply with a minimum efficacy standard of 50 lm/W, the lumen output of the CFLK would increase to at least 9,500 lumens, or almost six times greater than the existing light output. This light output is substantially higher than suitable for almost all applications in which CFLKs are used. Therefore, DOE has determined that the amended efficiency standards require lamps to be more efficient than if complying with the 190 W limit requirement. As a result, lamps complying with the amended energy efficiency standards adopted in this rulemaking will be presumed to meet the 190 W limit requirement, and manufacturers will not be required to incorporate an electrical device or measure that ensures the light kit is not capable of operating with a lamp or lamps that draw more than a total of 190 W.

4. Technology Options

In the NOPR market analysis and technology assessment, DOE identified 21 technology options that would be expected to improve the efficiency of CFLKs, as measured by the DOE test procedure. DOE reviewed manufacturer catalogs, recent trade publications, technical journals, and patent filings to identify these technology options.

For compact fluorescent lamps (CFLs), DOE considered technology options related to improvements in electrode coatings, fill gas, phosphors, glass coatings, cold spot optimization, and ballast components. For LED lamps, DOE considered technology options related to improvements in down converters, package architectures, emitter materials, substrate materials, thermal interface materials, heat sink design, thermal management, device-level optics, light utilization, driver design, and electric current.

NEMA asserted that CFLs have reached their ultimate balance of price

[17] DOE proposed these four conditions in the preamble of the NOPR. However, the proposed associated regulatory text incorrectly specified that *both* the SSL light source and SSL driver had to be non-consumer replaceable.

and performance and are no longer a product experiencing a lot of innovation. NEMA followed that CFLs were always intended to be a bridge technology and although there may be minor tweaks left, they have already reached their peak in investment. (NEMA, Public Meeting Transcript, No. 112 at p. 30)

Although CFLs may not be experiencing a lot of innovation, DOE reviewed manufacturer catalogs, recent trade publications, technical journals, and patent filings and identified some technology options that could be used to increase the efficacy of CFLs relative to that of the baseline lamp. DOE considers product price or industry investment in the LCC, NIA and/or MIA analyses, rather than when identifying technology options.

Westinghouse noted that they have provided feedback through NEMA on individual LED technology options. (Westinghouse, Public Meeting Transcript, No. 112 at p. 29) NEMA stated that they preferred to have LED technology evolve naturally, unencumbered by regulatory constraints, because options that might not look useful now may become essential in the future. (NEMA, Public Meeting Transcript, No. 112 at pp. 30–31)

To determine potential ELs in the engineering analysis, DOE considers only technology options that meet the four criteria outlined in the screening analysis. As described in section IV.B, one criterion is to maintain product utility and/or product availability. Thus, features and capabilities of existing products are maintained at higher ELs. Furthermore, all ELs considered specify only the minimum required efficacy rather than specific design options that must be used to comply with that EL. Thus, manufacturers can use the combination of options that works best for current market needs.

Summary of CFLK Technology Options

In summary, DOE has developed the list of technology options shown in Table IV.2 to increase efficacy of CFLKs. See chapter 3 of the final rule TSD for more information on the CFLK technology options.

TABLE IV.2—CFLK TECHNOLOGY OPTIONS

Lamp type	Name of technology option	Description
CFL	Highly Emissive Electrode Coatings	Improved electrode coatings allow electrons to be more easily removed from electrodes, reducing lamp power and increasing overall efficacy.
	Higher-Efficiency Lamp Fill Gas Composition.	Fill gas compositions improve cathode thermionic emission or increase mobility of ions and electrons in the lamp plasma.
	Higher-Efficiency Phosphors	Techniques to increase the conversion of ultraviolet (UV) light into visible light.
	Glass Coatings	Coatings on inside of bulb enable the phosphors to absorb more UV energy, so that they emit more visible light.
	Multi-Photon Phosphors	Emitting more than one visible photon for each incident UV photon.
	Cold Spot Optimization	Improve cold spot design to maintain optimal temperature and improve light output.
	Improved Ballast Components	Use of higher-grade components to improve efficiency of integrated ballasts.
	Improved Ballast Circuit Design	Better circuit design to improve efficiency of integrated ballasts.
	Change in Technology	Replace CFL with LED technology.
LED	Efficient Down Converters	New high-efficiency wavelength conversion materials, such as optimized phosphor conversion, quantum-dots, have the potential for creating warm-white LEDs with improved spectral efficiency, high color quality, and improved thermal stability.
	Improved Package Architectures	Novel package architectures such as color mixing (RGB+) and hybrid architecture to improve package efficacy.
	Improved Emitter Materials	The development of efficient red, green, or amber LED emitters, will allow for optimization of spectral efficiency with high color quality over a range of correlated color temperature (CCT) and which also exhibit color and efficiency stability with respect to operating temperature.
	Alternative Substrate Materials	Alternative substrates such as gallium nitride (GaN), silicon carbide to enable high-quality epitaxy for improved device quality and efficacy.
	Improved Thermal Interface Materials (TIMs).	TIMs that enable high-efficiency thermal transfer for long-term reliability and performance optimization of the LED device.
	Optimized Heat Sink Design	Improve thermal conductivity and heat dissipation from the LED chip, thus reducing efficacy loss from rises in junction temperature.
	Active Thermal Management Systems	Devices such as internal fans and vibrating membranes to improve thermal dissipation from the LED chip.
	Device-Level Optics	Enhancements to the primary optic of the LED package such as surface etching that would optimize extraction of usable light from the LED package and reduce losses due to light absorption at interfaces.
	Increased Light Utilization	Reduce or eliminate optical losses from the lamp housing, diffusion, beam shaping, and other secondary optics to increase efficacy using mechanisms such as reflective coatings and improved diffusive coatings.
	Improved Driver Design	Increase driver efficiency through novel and intelligent circuit design.
	AC LEDs	Eliminate the requirements of a driver and therefore reduce efficiency losses from the driver.
	Reduced Current Density	Driving LED chips at lower currents while maintaining light output, and thereby reducing the efficiency losses associated with efficacy droop.

B. Screening Analysis

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

1. *Technological feasibility.* Technologies that are not incorporated in commercial products or in working

prototypes will not be considered further.

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

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

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

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

In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the above four criteria, it will be excluded from further consideration in the engineering analysis. The reasons for eliminating any technology are discussed below.

1. Screened-Out Technologies

In the NOPR, several technology options were screened out based on the four screening criteria. Table IV.3 summarizes the technology options DOE proposed to screen out and the associated screening criteria.

TABLE IV.3—CFLK TECHNOLOGY OPTIONS SCREENED OUT OF THE NOPR ANALYSIS

Technology	Design option excluded	Screening criteria
CFL	Multi-Photon Phosphors	Technological feasibility.
LED	Colloidal Quantum Dot Phosphors	Technological feasibility.
	Improved Emitter Materials	Technological feasibility.

Westinghouse commented that because there is little product development happening in CFL technology and none is expected in the future, DOE can screen in any CFL technology options identified as they are not in the research and development (R&D) phase. (Westinghouse, Public Meeting Transcript, No. 112 at p. 28) DOE uses the four screening criteria previously discussed to determine whether to screen out technology options. While DOE found that the vast majority of technology options for CFLs met all four screening criteria, DOE continues to screen out multi-photon phosphors in this final rule based on technological feasibility. (See chapter 4 of the final rule TSD for further detail.)

Westinghouse commented that there are active legal disputes between manufacturers, including NEMA members, on design and technology patents for three to five of the technology options for LED lamps. Westinghouse favored letting the technology develop naturally without forcing manufacturers to use another manufacturer's technology patents or designs. (Westinghouse, Public Meeting Transcript, No. 112 at p. 29) NEMA added that the LED market is very dynamic. Neither NEMA nor Westinghouse commented on which technology options were involved in the lawsuits, but Westinghouse noted that sometimes they do not realize that they are in violation of a patent or proprietary design until there is enough market share for the competitor to tell them. (NEMA, Public Meeting Transcript, No. 112 at pp. 29–30; Westinghouse, Public Meeting Transcript, No. 112 at p. 33)

DOE reviewed several sources, including patent filings, to determine technology options. DOE can identify technology options and subsequently determine that they meet the four screening criteria even if they require proprietary technology. However, DOE does not consider ELs in the engineering analysis that can only be achieved using proprietary technology.

In the final rule, DOE continued to screen out the technology options in Table IV.3.

2. Remaining Technologies

Through a review of each technology, DOE tentatively concludes that all of the other identified technologies listed in section IV.A.4 met all four screening criteria to be examined further as design options in DOE's final rule analysis. In summary, DOE retained the following technology options:

CFL Design Options
- Highly Emissive Electrode Coatings
- Higher-Efficiency Lamp Fill Gas Composition
- Higher-Efficiency Phosphors
- Glass Coatings
- Cold Spot Optimization
- Improved Ballast Components
- Improved Ballast Circuit Design

LED Design Options
- Efficient Down Converters (with the exception of colloidal quantum-dots phosphors)
- Improved Package Architectures
- Alternative Substrate Materials
- Improved Thermal Interface Materials
- Optimized Heat Sink Design
- Active Thermal Management Systems
- Device-Level Optics
- Increased Light Utilization
- Improved Driver Design
- AC LEDs
- Reduced Current Density

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

C. Engineering Analysis

DOE derives ELs in the engineering analysis and consumer prices in the product price determination. By combining the results of the engineering analysis and the product price determination, DOE determines typical inputs for use in the LCC and NIA.

1. General Approach

The engineering analysis is generally based on commercially available lamps that incorporate the design options identified in the technology assessment and screening analysis. (See chapters 3 and 4 of the final rule TSD for further information on technology and design options.) The methodology consists of the following steps: (1) Selecting representative product classes, (2) selecting baseline lamps, (3) identifying more efficacious substitutes, and (4) developing ELs by directly analyzing representative product classes and then scaling those ELs to non-representative product classes. For CFLKs, DOE based the efficiency of the product on the efficacy of the lamps packaged with CFLKs. The details of the engineering analysis are discussed in chapter 5 of the final rule TSD. The following discussion summarizes the general steps of the engineering analysis:

Representative product classes: DOE first reviews CFLKs covered under the scope of the rulemaking and the associated product classes. When a product has multiple product classes, DOE selects certain classes as ''representative'' and concentrates its analytical effort on these classes. DOE selects representative product classes primarily because of their high market volumes and/or distinct characteristics.

Baseline lamps: For each representative product class, DOE selects a baseline lamp as a reference point against which to measure changes resulting from energy conservation standards. Typically, a baseline lamp is the most common, least efficacious lamp in a CFLK sold in a given product class. DOE also considers other lamp characteristics in choosing the most appropriate baseline for each product class, such as wattage, lumen output, and lifetime.

More efficacious substitutes: DOE selects higher efficacy lamps as replacements for each of the baseline lamps considered. When selecting higher efficacy lamps, DOE considers only design options that meet the criteria outlined in the screening analysis (see section IV.B or chapter 4 of the final rule TSD).

Efficacy levels: After identifying the more efficacious substitutes for each baseline lamp, DOE develops efficacy levels (ELs). DOE bases its analysis on three factors: (1) The design options associated with the specific lamps studied; (2) the ability of lamps across different lumen outputs to comply with the standard level of a given product class; and (3) the max-tech EL. DOE then scales the ELs of representative product classes to any classes not directly analyzed.

2. Representative Product Classes

In the NOPR analysis, DOE established one product class (All CFLKs) and analyzed it as representative. DOE did not receive any comments on the representative product class identified in the NOPR analysis. Therefore, in this final rule, DOE continued to analyze the one product class as representative.

3. Baseline Lamps

Once DOE identifies representative product classes for analysis, it selects baseline lamps to analyze in each product class. DOE selects baseline lamps that are typically the most common, least efficacious lamps in a CFLK that meet existing energy conservation standards. Specific lamp characteristics are used to characterize the most common lamps packaged with CFLKs today (*e.g.,* wattage and light output). To identify baseline lamps, DOE reviews product offerings in catalogs and manufacturer feedback obtained during interviews.

In the NOPR analysis, DOE selected a lamp representative of the least efficacious lamp that can be packaged with a CFLK that just meets existing CFLK standards. To calculate lamp efficacy, DOE used the catalog lumens and the catalog wattage of the lamp. In the NOPR analysis, market information indicated that many 14 W CFLs with low lumen outputs typically had an additional feature (*e.g.,* a cover or a coating for rough service operation) that was not used for lamps packaged in CFLKs. Thus, DOE modeled a 14 W CFL as the baseline lamp without these additional features and a light output of 800 lumens, which is a common lumen output for this lamp. DOE assumed the modeled baseline lamp would have the same characteristics (spiral shape, 82 Color Rendering Index [CRI], 2,700 kelvin [K] correlated color temperature [CCT], and 10,000-hour lifetime) as the most common commercially available lamps. (For further detail on the baseline lamp selected in the NOPR analysis, see chapter 5 of the NOPR TSD.) DOE received several comments regarding the baseline selection.

Westinghouse and ALA stated that the proposed baseline was appropriate for medium screw bases. Westinghouse and ALA further stated that the baseline is not the most common lamp used in CFLKs, with Westinghouse noting that 80 percent of the current market uses incandescent candelabra base lamps. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 35–36; ALA, No. 115 at pp. 7–8) ALA added that such lamps, which are low efficiency incandescent lamps, cannot be replaced with the baseline lamp due to their physical size and shape. (ALA, No. 115 at pp. 7–8) Westinghouse and ALA acknowledged, however, that under the current product class structure, the candelabra base lamps are in a product class that is subject to a design standard that requires a power limiter rather than an efficacy standard. (Westinghouse, Public Meeting Transcript, No. 112 at p. 33; ALA, No. 115 at pp. 7–8) Hunter agreed with Westinghouse regarding the proposed baseline. (Hunter, Public Meeting Transcript, No. 112 at p. 36)

Westinghouse further pointed out that the efficacy of the proposed levels is significantly greater than the baseline when considering the baseline to be the candelabra base lamps with average efficacies of 10 to 12 lm/W. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 45–46) Westinghouse stated that there is a gap in the analysis because it neglects to consider the current products being purchased. Westinghouse elaborated that the lamps currently packaged with CFLKs have efficacies between 9 and 10 lm/W, with some 60 W candelabra lamps at 11 lm/W. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 54–55)

As discussed in section IV.A.1, DOE reviewed the existing product class structure and determined that all three existing product classes could be combined into a single product class. Because the existing product classes each are subject to different standards, DOE selected a sub-baseline representative lamp unit to account for the impacts of the product class restructuring in the LCC analysis and NIA. DOE determined that lamps in the Other Base Type product class, which includes candelabra base lamps, generally have the lowest efficacies and selected a sub-baseline representative lamp unit from this product class to serve as a reference point from which to measure changes resulting from the new product class structure. Therefore, DOE did account for the savings from CFLKs packaged with lower efficiency incandescent lamps that are currently being sold on the market. See appendix 7A of the final rule TSD for further detail on the sub-baseline representative lamp unit.

In the final rule analysis, DOE used the same baseline as specified in the NOPR. The modeled baseline for the new, combined All CFLKs product class is specified in Table IV.4. (See chapter 5 of the final rule TSD for further details.)

TABLE IV.4—ALL CFLKS PRODUCT CLASS BASELINE LAMP

Bulb shape	Base type	Lamp type	Lamp wattage (W)	Initial lumen output (lm)	Efficacy (lm/W)	Lamp lifetime (hr)	CRI	CCT (K)
Spiral	E26	CFL	14	800	57.1	10,000	80	2,700

4. More Efficacious Substitutes

After choosing a baseline lamp, DOE identifies commercially available lamps that can serve as more efficacious substitutes. DOE utilized a database of commercially available lamps and selected substitute lamps that both save energy and maintain comparable light output to the baseline lamp. Specifically, in the NOPR analysis, DOE ensured that potential substitutions maintained light output within 10 percent of the baseline lamp lumen output for the lamp replacement scenario and within 10 percent of the baseline fixture lumen output for the light kit replacement scenario. Further, DOE considered only technologies that met all four criteria in the screening analysis. Regarding the lamp characteristics of the substitutes, DOE selected replacement lamp units with lifetimes greater than or equal to that of the lifetime of the baseline lamp. DOE also selected replacement lamp units with a CRI, CCT, and bulb shape comparable to that of the baseline representative lamp unit. (For further detail on the more efficacious substitutes selected in the NOPR analysis, see chapter 5 of the NOPR TSD.)

In the NOPR analysis, DOE considered more efficacious lamps under two different substitution scenarios: (1) A lamp replacement scenario and (2) a light kit replacement scenario. DOE selected the baseline light kit for both scenarios as a two-socket medium base light kit because it was representative of the most common basic CFLK product. In the lamp replacement scenario, DOE assumed that manufacturers would maintain the original light kit design, including the same number of sockets, and replace only the lamp. Thus, DOE selected the more efficacious substitutes to have the same base type as that of the baseline lamp. In the light kit replacement scenario, DOE accounted for the possibility that manufacturers may change light kit designs. Thus, the base type of the more efficacious substitutes was not required to be the same as that of the baseline lamp and the number of sockets could be changed. Specifically, DOE considered replacement light kits with between one and four sockets and/or non-medium screw base types. For example, the EL 1 light kit replacement option utilized three medium screw base 9 W CFLs, and the EL 3 light kit replacement option included one medium screw base 16 W LED lamp.

For the NOPR analysis, DOE determined that a commercially available 3-way LED lamp operated at its middle setting was more efficacious than any other commercially available lamp that could be considered an adequate replacement for the baseline lamp (*i.e.,* has a non-reflector shape, a lumen output within 10 percent of the baseline lamp, a CCT around 2,700 K, a CRI greater than or equal to 80, a lifetime greater than or equal to that of the baseline, and a medium screw base). Specifically, the 3-way lamp is 8 W at its middle setting, and has a light output of 820 lumens, an efficacy of 102.5 lm/W, and a lifetime of 25,000 hours. DOE concluded that the higher EL achieved by the middle setting demonstrated the potential for a standard, non-3-way, 8 W LED lamp to achieve this EL. Therefore, DOE modeled an 8 W lamp with 820 lumens and an efficacy of 102.5 lm/W. DOE assumed the modeled lamp would have similar characteristics to the most common commercially available LED lamps in the 800-lumen range. Hence, DOE modeled the lamp to have an A19 shape, medium base type, 25,000-hour lifetime, 2,700 K CCT, 80 CRI, and dimming functionality.

Regarding the modeled lamp at max tech, Westinghouse commented that while they understood using this approach to determine where the level should be set, they were apprehensive of modeling potential lamps. In general, Westinghouse was cautious of selecting a particular feature and modeling other features. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 39–40) Westinghouse noted that the 3-way lamp used as the basis for the modeled lamp was an A21 shape rather than A19. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 39–40) Westinghouse looked at their own 3-way lamp and found that the highest setting is more efficient than the middle setting. Westinghouse also looked at a 3-way lamp from another manufacturer and found that the middle setting was the least efficient setting. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 39–40) Westinghouse acknowledged that the efficacy of the modeled lamp may have been achieved, but was unclear whether it was done through proprietary technology or just by accident. Either way, Westinghouse asserted that using the middle setting on a product not designed for a CFLK does not seem correct. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 39–40)

NEMA added that unless the modeled lamp is very special, it is probably not dimmable, which is a desired consumer feature. NEMA further stated that the circuitry for dimmability adds power consumption, and could add additional cost as well, so it is likely that the modeled lamp cannot be directly compared to a dimmable lamp. (NEMA, Public Meeting Transcript, No. 112 at p. 40)

PG&E, on the other hand, stated that in five years, lamps that are currently feasible will be obsolete. Thus, PG&E stated that the modeled 3-way max tech lamp will be viable and the best option for the market. (PG&E, Public Meeting Transcript, No. 112 at p. 41) Similarly, ASAP supported DOE's approach in choosing more efficacious substitutes. ASAP stated that an analysis based on currently available products and their performance characteristics will be obsolete when the standard requires compliance. (ASAP, Public Meeting Transcript, No. 112 at p. 41)

When DOE proposes to adopt a standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max tech'') improvements in energy efficiency using the design parameters for the most efficient product available on the market. DOE acknowledges that the 3-way lamp used as the basis for the modeled lamp has an A21 shape; however, DOE modeled the max tech representative lamp unit to have an A19 shape because that is a more common lamp shape. Based on its assessment of lamp catalogs, DOE determined that

LED lamps with A19 shapes include lamps with lumen outputs above and below 820 lumens. Therefore, it should be possible to make an LED lamp with an A19 shape and lumen output of 820 lumens. The modeled lamp has a higher efficacy and more efficient components than similar products currently on the market, and therefore, would achieve and maintain this efficacy within an A19 shape. DOE acknowledges that dimmability is a desired consumer feature and modeled the max tech representative lamp unit to be dimmable. While NEMA noted that dimmability requires additional circuitry, DOE notes that the efficacy of the modeled lamp is based on the performance of a 3-way lamp, which also has additional circuitry that is likely comparable to a dimmable lamp. Therefore, DOE concluded that the efficacy of the modeled lamp is representative of the efficacy of a dimmable product.

CA IOUs commented that LED technology continues to improve. CA IOUs pointed out that recent research and development in LED technology have significantly accelerated the speed of lighting efficiency innovation. DOE's Solid-State Lighting Research and Development Multi-Year Program Plan (MYPP) found that ''the light output of LEDs has increased 20 fold each decade for the last 40 years.'' [18] Some of the first projections for LED performance illustrate how the rate of LED technology innovation observed in the market has surpassed MYPP's original performance expectations. As an example, CA IOUs provided data from the MYPPs showing that in 2006, the MYPP did not expect cool white LED efficacy to exceed 135 lm/W until 2015; however, in 2011, LED efficacy was over 165 lm/W. Observing increases in LED performance with corresponding decreases in price, CA IOUs stated that these trends have surpassed previous forecasts, providing the market with higher performing and lower priced products than originally anticipated. (CA IOUs, No. 118 at pp. 3–4) CA IOUs stated that as LED technology continues to mature, it is critical that DOE account for these expected changes. (CA IOUs, No. 118 at p. 7, 8)

Further, CA IOUs stated that CFLKs primarily include medium screw base and candelabra base omnidirectional and decorative lamps, with CRI ≥80 and CCT ≤2,700 K and provided figures forecasting performance of these lamps. Specifically, based on data gathered from DOE's Lighting Facts Database since 2012, CA IOUs showed that the efficacies of average products and the top 15 percent of products would exceed EL 3 and EL 4 by 2019. (CA IOUs, No. 118 at pp. 5–7)

The Joint Comment noted that the standard would likely require compliance in early 2019 and that the evolution of SSL technology continues to outstrip projections. The Joint Comment continued that recent DOE research indicated that for 2013, the installed base of LEDs in the U.S. increased in all LED applications, more than doubling from 2012 to about 105 million units. The Joint Comment stated that by 2019, SSL options for CFLKs will be available at higher levels of performance than today. (Joint Comment, No. 117 at p. 2) Westinghouse commented that there may be more efficient lamps available on the market in five years than the max tech level. However, the standards from this rulemaking should not prevent consumers from purchasing lamps with a wide range of efficacies, with lower price points available for lower efficacy products. (Westinghouse, Public Meeting Transcript, No. 112 at p. 45)

The increase in the efficacy of LED lamps over the last several years could be indicative of future trends, but it is not certain. New products have been recently introduced to the market that have lower efficacy than previous iterations. DOE cannot be sure that the forecasted improvements in LED technology will occur and LED lamps at the predicted efficacies will be available at the compliance date of this rulemaking. DOE based the more efficacious substitutes in this analysis on technology that is available today. The engineering analysis is based on efficacies achievable through design options that can be found in commercially available products or working prototypes. (See chapter 4 of the final rule TSD for further information on design options.) As noted previously, DOE derives ELs from the efficacies of the more efficacious substitutes identified in the engineering analysis and consumer prices in the product price determination. These results are then combined to determine the cost and savings to the consumer associated with each EL in the LCC.

DOE's review of the market in the final rule analysis did not result in any changes that impacted the selection of more efficacious substitutes. The CFLK representative lamp units that DOE analyzed in the final rule are shown in Table IV.5 for the lamp replacement scenario and in Table IV.6 for the light kit replacement scenario.

TABLE IV.5—ALL CFLKS PRODUCT CLASS DESIGN OPTIONS: LAMP REPLACEMENT SCENARIO

Efficacy level	Lamp type	Base type	Bulb shape	Wattage (W)	Initial lumen output (lm)	Efficacy (lm/W)	CRI	CCT (K)	Lamp lifetime (hr)
Baseline	CFL	E26	Spiral	14	800	57.1	80	2,700	10,000
EL 1	CFL	E26	Spiral	13	800	61.5	80	2,700	10,000
EL 2	CFL	E26	Spiral	11	730	66.4	82	2,700	10,000
	LED	E26	A19	12	800	66.7	82	2,700	25,000
EL 3	LED	E26	A19	8.5	800	94.1	81	2,700	25,000
EL 4	LED	E26	A19	8	820	102.5	80	2,700	25,000

TABLE IV.6—ALL CFLKS PRODUCT CLASS DESIGN OPTIONS: LIGHT KIT REPLACEMENT SCENARIO

Efficacy level	Lamp type	Base type	Bulb shape	Fixture sockets	Lamp wattage (W)	Fixture wattage (W)	Lamp initial lumen output (lm)	Fixture initial lumen output (lm)	Efficacy (lm/W)	CRI	CCT (K)	Lamp life (hr)
Baseline	CFL	E26	Spiral	2	14	28	800	1,600	57.1	80	2,700	10,000

[18] ''Solid-State Lighting Research and Development Multi-Year Program Plan.'' March 2010. Available online at: *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2010_web.pdf.*

TABLE IV.6—ALL CFLKS PRODUCT CLASS DESIGN OPTIONS: LIGHT KIT REPLACEMENT SCENARIO—Continued

Efficacy level	Lamp type	Base type	Bulb shape	Fixture sockets	Lamp wattage (W)	Fixture wattage (W)	Lamp initial lumen output (lm)	Fixture initial lumen output (lm)	Efficacy (lm/W)	CRI	CCT (K)	Lamp life (hr)
EL 1	CFL	E26	Spiral	3	9	27	520	1,560	57.8	80	2,700	10,000
EL 2	LED	E26	G25	3	8	24	500	1,500	62.5	82	2,700	25,000
EL 3	LED	E26	A21	1	16	16	1,600	1,600	100.0	80	2,700	25,000
EL 4	LED	E26	A21	1	15	15	1,600	1,600	106.7	82	2,700	25,000

5. Efficacy Levels

DOE adopted an equation-based approach to establish ELs for CFLKs. In the NOPR analysis, DOE developed the general form of the equation by evaluating lamps with similar characteristics, such as technology, bulb shape, and lifetime, across a range of lumen packages. The continuous equations specify a minimum lamp efficacy for a given lumen package.

ALA and Westinghouse generally supported the equations used to define the minimum efficacy requirements at each EL. (ALA, Public Meeting Transcript, No. 112 at p. 43; Westinghouse, Public Meeting Transcript, No. 112 at pp. 43–44)

Westinghouse cautioned that lamp designs should be driven by the market and not restricted by requirements at high ELs. Westinghouse noted that the market is volatile and, while a year ago they would not have considered reducing lifetime of their lamps, currently omnidirectional, non-dimmable LED lamps with reduced lifetimes are popular products. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 107–08) While lamps with 25,000 hours and 40,000 hours remain popular, three brands, including Westinghouse, also sell LED lamps with lifetimes between 10,000 and 15,000 hours, no dimmable features, and efficacies of 65–70 lm/W that are in high demand. Westinghouse stated that if consumers want to make tradeoffs between features, such as giving up lifetime for aesthetics, they should have that option available to them. Westinghouse asserted that at higher ELs, manufacturers would lose this design flexibility and consumers will either not want to pay the higher price or not be satisfied with the product. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 52–53)

While certain consumers may opt for a product with low efficacy and minimal features because it has a lower price or offers an aesthetic appeal, DOE found that certain lamp characteristics are commonplace in the market. To maintain the existing product utility to the consumer, DOE ensured that lamps at higher levels can be omnidirectional, dimmable, and achieve the common lifetime on the market. (For LED lamps, DOE determined 25,000 hours to be the most common lifetime.)

In the NOPR analysis, DOE proposed four ELs. (For further details, see chapter 5 of the NOPR TSD.) In the final rule analysis, DOE maintained ELs 1–3 as proposed in the NOPR. In the NOPR, DOE set EL 4 according to the efficacy of the modeled 8 W lamp, but adjusted it to be slightly lower to allow for additional products to meet the level, such as consumer replaceable LED modules and driver systems. Based on a review of the market, in the final rule analysis, DOE determined that certain more efficacious products were now available and adjusted the level downward to a lesser extent to allow for any replacement options in the light kit replacement scenario.

CA IOUs noted that if DOE remains concerned that there will not be enough products on the market when proposed standards require compliance, DOE should consider an EL roughly halfway between EL 2 and EL 3, where many more high-efficiency LED options already exist. (CA IOUs, No. 118 at p. 7) Westinghouse disagreed, stating that an additional EL was not necessary between EL 2 and EL 3. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 54–55)

DOE considered ELs between EL 2 and EL 3, but determined that the price of the LED representative lamp units at those levels was higher than the price of the representative lamp unit at EL 3. It was unlikely that consumers would purchase a CFLK packaged with a less efficient, more expensive lamp. Further, DOE has found that as they introduce more efficacious LED lamps, manufacturers begin to phase out their less efficacious LED lamps which, due to the low volume and older technology, are priced higher. Therefore, DOE did not evaluate lamps at additional ELs.

Table IV.7 presents the ELs for CFLKs. See chapter 5 of the final rule TSD for additional information on the methodology and results of the engineering analysis.

TABLE IV.7—SUMMARY OF EFFICACY LEVELS FOR ALL CFLKS

Representative product class	Efficacy level	Lumen output (lm)	Minimum required efficacy (lm/W)
All CFLKs	EL 1	<260	50
		≥260 and ≤2040	$69.0 - 29.42 \times 0.9983^{lumens}$
		>2040 and <2100	>(1/30) × lumens
		≥2100	70
	EL 2	<120	50
		≥120	$74.0 - 29.42 \times 0.9983^{lumens}$
	EL 3	All	$101.0 - 29.42 \times 0.9983^{lumens}$
	EL 4	All	$108.0 - 29.42 \times 0.9983^{lumens}$

As shown in Table IV.7, DOE made adjustments to EL 1 and EL 2 to ensure that, consistent with 42 U.S.C. 6295(o), the efficacy remains above the current minimum standards summarized in Table IV.1. See sections II.A and IV.A.1 for further discussion of this issue. For lamps less than 15 W, the minimum efficacy is 50 lm/W. For a light output of less than 260 lumens, DOE found that the EL 1 equation could potentially allow lamps that are less than 50 lm/W to meet standards and therefore set the minimum efficacy requirement at 50 lm/W for lamps in this lumen range. For a light output of less than 120 lumens, DOE found that the EL 2 equation could potentially allow lamps that are less than 50 lm/W to meet standards and therefore set the minimum efficacy requirement at 50 lm/W for lamps in this lumen range. DOE determined that no adjustments to any ELs were necessary to meet the 60 lm/W current standard applicable to lamps greater than 15 W and less than 30 W.

For lamps greater than 30 W, DOE determined that the minimum efficacy is 70 lm/W. DOE found that the equation for EL 1 could potentially allow lamps that are less than 70 lm/W to meet standards. Therefore, for lumens greater than 2040 and less than 2100, DOE set the minimum efficacy requirement at greater than (1/30) × lumens for EL 1. For lumens greater than or equal to 2100, DOE set the minimum efficacy requirement at 70 lm/W. See chapter 5 of the final rule TSD for further information on the anti-backsliding adjustments that DOE made to the ELs.

Westinghouse agreed with setting a minimum level for EL 1 and EL 2 to prevent backsliding. Westinghouse further stated that the levels DOE had identified were appropriate and would not be disruptive to the market. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 43–44) DOE maintained these levels in the final rule.

6. Scaling to Other Product Classes

Typically DOE determines ELs for product classes that were not directly analyzed (''non-representative product classes'') by scaling from the ELs of the representative product classes. As DOE only identified one product class for CFLKs, no scaling was required.

D. Product Price Determination

Because the metric for CFLKs is the efficacy of the lamp with which it is packaged, DOE developed prices for the lamp component of a CFLK. Typically, DOE develops manufacturer selling prices (MSPs) for covered products and applies markups to create consumer prices to use as inputs to the LCC analysis and NIA. Because lamps are difficult to reverse-engineer (*i.e.,* not easily disassembled), DOE directly derives consumer prices for the lamp components of CFLKs in this rulemaking.

DOE first determined the consumer price of a CFLK. In doing so, DOE considered distributor net prices (DNP), distribution channels, and shipment volumes. DOE obtained distributor net prices for CFLKs packaged with a representative lamp unit (*i.e.,* the 13 W spiral CFL). DOE calculated the consumer price of a CFLK in each major distribution channel (electrical/specialty, home centers, and lighting showrooms) by applying the appropriate premium to the distributor net price. DOE developed a weighted average consumer price for a CFLK by using estimated shipments through each distribution channel (80 percent home centers, 12 percent electrical distributors/specialty, 8 percent lighting showrooms).

DOE then determined the consumer price of a lamp in a CFLK. DOE calculated this value based on manufacturer feedback and relative prices for commercially-available lamps. Based on manufacturer feedback, DOE determined that for a CFLK packaged with a CFL, the lamp component comprises an estimated 15 percent of the CFLK consumer price. To develop a consumer price for all other representative lamp units when sold in CFLKs, DOE applied a ratio based on the retail cost of the lamps at other levels relative to the retail cost of the 13 W spiral.

DOE received several comments on the methodology and results of the product price determination. Westinghouse stated that the consumer price results for ELs with LED lamp representative units were not accurate because DOE is forward-modeling prices based on observed retail shelf prices and including legacy products put on clearance to deplete their inventory. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 58–59)

DOE used the latest retail price data available at the time of the analysis and ensured these prices reflected the original lamp price rather than a discounted or rebated price. Based on the lamp prices collected in this rulemaking, DOE has noted a trend showing that lower wattage, more efficacious LED lamps have lower prices than higher wattage, less efficacious LED lamps. Comments received in response to the preliminary analysis of the general service lamp rulemaking indicated that lamp manufacturers begin to phase out their less efficacious LED lamps as they introduce lamps that are more efficacious.[19] The lower volume and older technology likely results in higher prices for the less efficacious products. The results of this product price determination accurately capture this consistently observed price trend for LED lamps.

Westinghouse provided specific comments regarding the consumer price of the EL 4 representative lamp unit that was modeled based on the middle setting of a commercially available 3-way lamp. Westinghouse stated that the price for a 3-way lamp is two to four times higher than the price for a non-dimmable, omnidirectional A-shape lamp, and therefore, would likely not be cost-effective. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 40–41) Further, Westinghouse commented that DOE's resulting average consumer price of $4.09 for the 8 W LED representative lamp unit at EL 4 is more accurate for a 9 W, non-dimmable LED lamp meeting EL 2. Westinghouse stated that a lamp meeting EL 4, if available, would be a commercial product closer to $40 rather than $4. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 57–58)

As noted in section IV.C.4, DOE modeled an 8 W LED lamp at EL 4 at the lumen output and efficacy of the middle (8 W) setting of a commercially available 3-way lamp. DOE determined that this efficacy was achievable by a standard 8 W, non-3-way LED lamp that could be packaged with a CFLK and made available through all CFLK distribution channels. DOE developed the retail price of the representative lamp unit at EL 4 by using a wattage-price trend based on retail prices of non-3-way LED lamps. As noted previously, DOE has observed a trend showing that lower wattage, more efficacious LED lamps are less expensive than higher wattage, less efficacious LED lamps. Therefore, a lower price for the less efficacious LED lamp at EL 2 than the more efficacious LED lamp at EL 4 would not reflect actual prices.

Westinghouse stated that they provide both dimmable and non-dimmable versions of the medium screw base, omnidirectional LED lamp. Westinghouse recommended DOE use a non-dimmable LED lamp as that is a true replacement for CFLs, which are generally not dimmable. Westinghouse noted that the price range for such a lamp at 8.5 W would be close to $4 and would increase by about a dollar with the addition of dimming functionality. (Westinghouse, Public Meeting Transcript, No. 112 at p. 58)

DOE believes that dimming is a feature desired by consumers. Although dimmable CFLs are not available at all levels, dimmable LED lamps are available at all ELs; thus this functionality is maintained in the analysis. In this rulemaking, DOE determines corresponding prices for

[19] Comments for the preliminary analysis of the General Service Lamps Energy Conservation Standards rulemaking can be accessed at: *http://www.regulations.gov/#!docketDetail;D=EERE-2013-BT-STD-0051.*

LED lamps that maintain consumer utility, including dimming functionality.

Westinghouse recommended that DOE obtain component cost information from manufacturers. (Westinghouse, Public Meeting Transcript, No. 112 at p. 59) In the light kit replacement scenario, DOE included the incremental cost due to changes in socket configuration when applicable. Based on manufacturer feedback, DOE estimated the cost of different socket types to the manufacturer and then applied the appropriate manufacturer and distributor markups to obtain the consumer price of the socket.

The Joint Comment stated that LED A-lamp pricing continues to decline, with non-dimmable, 60 W A19 replacement lamps now available for less than $10 per bulb. The Joint Comment continued, stating that the price drops even further in regions with utility rebates. The Joint Comment also stated that by 2019, SSL options for CFLKs will be available at lower cost than today. (Joint Comment, No. 117 at p. 2) CA IOUs stated that based on DOE's forecasts in its 2006 MYPP and 2015 MYPP reports, LED package prices, which are comparable to LED lamp prices, have steadily decreased from 2006 and at a rate faster than initially projected. Additionally, CA IOUs used price data collected since December 2013 [20] from nine retailers to show an observed trend in the past two years and forecasted trend until 2020 of decreasing prices for candelabra base and medium screw base LED lamps. CA IOUs concluded that LED market-level price trends as well as prices observed for products specific to this rulemaking have shown a consistent decline over time. CA IOUs stated that these trends have surpassed previous forecasts, providing the market with higher performing and lower priced products than originally anticipated. (CA IOUs, No. 118 at pp. 3–7)

Declining prices of LED lamps over the last several years can be indicative of a future trend, but it is not certain. DOE used the latest pricing data available at the time of the analysis to determine consumer prices. In this final rule, DOE maintains the same methodology for the product price determination as that used in the NOPR analysis. (See chapter 7 of the final rule TSD for further details on the methodology and results.)

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of CFLKs at different efficiencies in representative U.S. homes and commercial buildings, and to assess the energy savings potential of increased CFLK efficacy. To develop annual energy use estimates, DOE multiplied CFLK input power by the number of hours of use (HOU) per year. The energy use analysis estimates the range of energy use of CFLKs in the field (*i.e.,* as they are actually used by consumers). The energy use analysis also provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended standards.

1. Operating Hours

a. Residential Sector

In the NOPR analysis, to determine the average HOU of CFLKs in the residential sector, DOE collected data from a number of sources. Consistent with the approach taken in the general service lamps (GSL) preliminary analysis,[21] DOE used data from various field metering studies of GSL operating hours in the residential sector. To account for any difference in CFLK HOU compared to GSL HOU, DOE considered two factors: (1) The relative HOU for GSLs installed in ceiling light fixtures compared to all GSLs based on data from the Residential Lighting End-Use Consumption Study (RLEUCS),[22] and (2) the HOU associated with the specific room types in which CFLKs are installed based on installation location data from a Lawrence Berkeley National Laboratory survey of ceiling fan and CFLK owners (LBNL survey) [23] and room-specific HOU data from RLEUCS. As in the GSL preliminary analysis, DOE assumed that CFLK operating hours do not vary by light source technology. ALA agreed with the methodology used to estimate operating hours for CFLKs in the residential sector and also agreed that CFLK operating hours do not vary by light source technology. (ALA, No. 115 at p. 8) DOE, therefore, maintained its NOPR approach for the final rule.

DOE determined the regional variation in average HOU using average HOU data from regional metering studies, all of which are listed in the energy use chapter (chapter 6 of the final rule TSD). DOE organized the regional variation in HOU by each EIA Residential Energy Consumption Survey (RECS) reportable domain (*i.e.,* state, or group of states). For regions without HOU metered data, DOE used data from adjacent regions.

To estimate the variability in CFLK HOU by room type, DOE developed HOU distributions for each room type using data from the Northwest Energy Efficiency Alliance's Residential Building Stock Assessment Metering Study (RBSAM),[24] which is a metering study of 101 single-family houses in the Northwest. DOE assumed that the shape of the HOU distribution for a particular room type would be the same across the United States, even if the average HOU for that room type varied by geographic location. To determine the room and geographic location-specific HOU distributions, DOE scaled the HOU distribution for a given room type from the RBSAM study by the average HOU in a given region, adjusted based on the geographic location-specific variability in HOU between different room types from RLEUCS.

Based on the approach described in this section, DOE estimated the national weighted-average HOU of CFLKs to be 2.0 hours per day. For more details on the methodology DOE used to estimate the HOU for CFLKs in the residential sector, see chapter 6 of the final rule TSD.

b. Commercial Sector

The HOU for CFLKs in commercial buildings were developed using lighting data for 15 commercial building types obtained from the 2010 U.S. Lighting Market Characterization (LMC).[25] For each commercial building type presented in the LMC, DOE determined

[20] CA IOUs collected LED lamp price data from nine lighting retailers' Web sites (*i.e.,* Home Depot, Lowe's, Ace Hardware, Wal-Mart, Costco, 1000Bulbs.com, Bulbs.com, and BulbAmerica.com) for roughly each month since December 2013, with the most recent monthly data including over 2,000 unique products.

[21] DOE has published a framework document and preliminary analysis for amending energy conservation standards for general service lamps. Further information is available at *www.regulations.gov* under Docket ID: EERE–2013–BT–STD–0051.

[22] DNV KEMA Energy and Sustainability and Pacific Northwest National Laboratory. *Residential Lighting End-Use Consumption Study: Estimation Framework and Baseline Estimates.* 2012. (Last accessed October 13, 2015.) *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf.*

[23] Kantner, C.L.S., S.J. Young, S. M. Donovan, and K. Garbesi. *Ceiling Fan and Ceiling Fan Light Kit Use in the U.S.—Results of a Survey on Amazon Mechanical Turk.* 2013. Lawrence Berkeley National Laboratory: Berkeley, CA. Report No. LBNL–6332E. (Last accessed October 13, 2015.) *http://www.escholarship.org/uc/item/3r67c1f9.*

[24] Ecotope Inc. *Residential Building Stock Assessment: Metering Study.* 2014. Northwest Energy Efficiency Alliance: Seattle, WA. Report No. E14–283. (Last accessed October 13, 2015.) *http://neea.org/docs/default-source/reports/residential-building-stock-assessment-metering-study.pdf?sfvrsn=6.*

[25] Navigant Consulting, Inc. *Final Report: 2010 U.S. Lighting Market Characterization.* 2012. U.S. Department of Energy. (Last accessed October 13, 2015.) *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf.*

average HOU based on the fraction of installed lamps utilizing each of the light source technologies typically used in CFLKs and the HOU for each of these light source technologies. A national-average HOU for the commercial sector was then estimated by weighting the building-specific HOU for lamps used in CFLKs by the relative floor space of each building type as reported in the 2003 EIA Commercial Buildings Energy Consumption Survey (CBECS).[26] To capture the variability in HOU for individual consumers in the commercial sector, DOE applied a triangular distribution to each building type's weighted-average HOU with a minimum of 80 percent and a maximum of 120 percent of the weighted-average HOU value. For further details on the commercial sector operating hours, see chapter 6 of the final rule TSD.

2. Input Power

DOE developed its estimate of the power consumption of CFLKs by scaling the input power and lumen output of the representative lamp units for CFLKs characterized in the engineering analysis to account for the lumen output of CFLKs in the market. DOE estimated average CFLK lumen output based on a weighted average of CFLK models from data collected in 2014 from in-store shelf surveys and product offerings on the Internet. DOE estimated the market share of each identified CFLK model based on price. See chapter 6 of the final rule TSD for details on the price-weighting market share adjustment and how DOE estimated average weighted lumen output for all CFLKs.

3. Lighting Controls

Based on the technical issues pertaining to the ability of CFLs to dim, as well as the significant price premium for dimmable CFLs, DOE assumed in the NOPR analyses that CFLKs are not likely to feature dimmable CFLs. ALA agreed with this assumption. (ALA, No 115 at p. 8) In the final rule analyses, DOE again assumed CFL CFLKs are not operated with controls. On the other hand, in the NOPR analyses, DOE assumed that some fraction of LED and incandescent CFLKs are likely to be operated with a dimmer, which DOE considered to be the only relevant lighting control for CFLKs. ALA and Lutron supported this assumption. (ALA, No. 115 at p. 8; Lutron, No. 113 at p. 2) For the final rule analyses, as in the NOPR analyses, DOE used the results of an LBNL survey[27] to estimate that 11 percent of CFLKs are operated with dimmers. DOE assumed that the fraction of CFLKs used with dimmers is the same in the residential sector and the commercial sector. Furthermore, DOE assumed that an equal fraction of LED and incandescent CFLKs are operated with dimmers, based on the increasing fraction of commercially available dimmers that are now compatible with LEDs, the increase in LED lamps that are being designed to operate on legacy dimmers, and the assumption that integral LEDs have built-in dimming capability with no compatibility issues. DOE used the 2010 LMC[28] and the aforementioned LBNL survey to account for the likelihood that a CFLK with a dimmer will be installed in a given room type. This affects the impact of dimming controls on energy use because, as discussed previously, average HOU varies by room type.

In the NOPR analyses, DOE assumed dimmable CFLKs have an average energy reduction of 30 percent. This estimate was based on a meta-analysis of field measurements of energy savings from commercial lighting controls by Williams, *et al.*[29] Because field measurements of energy savings from controls in the residential sector are very limited, DOE assumed that controls would have the same impact as in the commercial sector. ALA and Lutron agreed with DOE's energy savings estimate from the use of dimmers in the residential sector. (ALA, No. 115 at p. 8; Lutron, No. 113 at p. 2). For the final rule analyses, DOE maintained its assumption of an average 30 percent energy reduction in both sectors. Chapter 6 of the final rule TSD provides details on how DOE accounted for the impact of dimmers on CFLK energy use.

F. Life-Cycle Cost and Payback Period Analysis

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for CFLKs. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

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

For each CFLK standards case (*i.e.,* case where a standard would be in place at a particular TSL), DOE measures the change in LCC based on the estimated change in efficacy distribution in the standards case relative to the estimated efficacy distribution in the no-new-standards case. These efficacy distributions include market trends for products that may exceed the efficacy associated with a given TSL as well as the current energy conservation standards. In contrast, the PBP for a given EL is measured relative to the baseline product.

For each considered EL, DOE calculated the LCC and PBP for a nationally representative consumer sample in each of the residential and commercial sectors. DOE developed consumer samples based on the 2009 RECS and the 2003 CBECS, for the residential and commercial sectors, respectively. For each consumer in the sample, DOE determined the energy consumption of CFLKs and the appropriate electricity price. By developing consumer samples, the analysis captured the variability in energy consumption and energy prices associated with the use of CFLKs.

DOE added sales tax, which varied by state, to the cost of the product developed in the product price determination to determine the total installed cost. DOE assumed that the installation costs did not vary by EL, and therefore did not consider them in the analysis. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. DOE created distributions of values for product

[26] U.S. Department of Energy-Energy Information Administration. *2003 CBECS Survey Data.* (Last accessed October 13, 2015.) *http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=microdata.*

[27] Kantner, *et al.* (2013), op. cit.

[28] *Navigant Consulting, Inc. Final Report: 2010 U.S. Lighting Market Characterization. 2012. U.S. Department of Energy. (Last accessed October 13, 2015.) http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf.*

[29] Williams, A., B. Atkinson, K. Garbesi, E. Page, and F. Rubinstein. Lighting Controls in Commercial Buildings. *LEUKOS.* 2012. 8(3): pp. 161–180. (Last accessed October 22, 2015.) *http://eetd.lbl.gov/publications/lighting-controls-commercial-buildings.*

lifetime and discount rates, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC and PBP relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and CFLK user samples. The model calculated the LCC and PBP for products at each EL for sample of 10,000 consumers per simulation run.

DOE calculated the LCC and PBP for all consumers as if each were to purchase a new product in the expected year of compliance with amended standards. At this time, DOE estimates publication of a final rule in 2016. For purposes of its analysis, DOE assumed a compliance date three years after publication of any final amended standard (*i.e.,* 2019).

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

TABLE IV.8—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *

Inputs	Source/method
Product Cost	Multiplied the weighted-average consumer price of each CFLK lamp and socket (determined in the product price determination) with a scaling factor to account for the total weighted-average CFLK lumen output. For LED lamps, DOE used a price learning analysis to project CFLK lamp prices to the compliance year.
Sales Tax	Derived 2019 population-weighted-average tax values for each state based on Census population projections and sales tax data from Sales Tax Clearinghouse.
Disposal Cost	Assumed 35% of commercial CFLs are disposed of at a cost of $0.70 per CFL. Assumptions based on industry expert feedback and a Massachusetts Department of Environmental Protection mercury lamp recycling rate report.
Annual Energy Use	Derived in the energy use analysis. Varies by geographic location and room type in the residential sector and by building type in the commercial sector.
Energy Prices	Electricity: Based on 2014 marginal electricity price data from the Edison Electric Institute. Variability: Marginal electricity prices vary by season, U.S. region, and baseline electricity consumption level.
Energy Price Trends	Based on *AEO 2015* price forecasts.
Lamp Replacements	For lamp failures during the lifetime of the CFLK, consumers replace lamps with lamp options available in the market that have the same base type and provide a similar lumen output to the initially packaged lamps.
Residual Value	Represents the value of surviving lamps at the end of the CFLK lifetime. DOE discounts the residual value to the start of the analysis period and calculates it based on the remaining lamp's lifetime and price in the year the CFLK is retired.
Product Lifetime	Based on a ceiling fan lifetime distribution, with a mean of 13.8 years.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Efficacy Distribution	Estimated by the market-share module of shipments model. See chapter 9 of the final rule TSD for details.
Compliance Date	2019.

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

1. Product Cost

DOE developed the weighted-average CFLK socket costs and consumer prices for all representative lamp units presented in the engineering analysis in the product price determination (chapter 7 of the final rule TSD). DOE did not account for the remaining price of the CFLKs (*i.e.,* CFLK price excluding the lamps and sockets) in the LCC calculation because these are assumed to be the same for all CFLKs regardless of efficacy. As discussed earlier, DOE scaled the lumen output of each representative lamp unit by a factor equal to the ratio of the market-weighted average total lumen output to the baseline lamp lumen output. For consistency, DOE also multiplied the price of the lamp and socket by the same scaling factor to determine the total product cost.

DOE also used a price learning analysis to account for changes in lamp prices that are expected to occur between the time for which DOE has data for lamp prices (2014) and the assumed compliance date of the rulemaking (2019). For details on the price learning analysis, see section IV.G.

DOE applied sales tax, which varies by geographic location, to the total product cost. DOE collected sales tax data from the Sales Tax Clearinghouse [30] and used population projections from the Census Bureau [31] to develop population-weighted-average sales tax values for each state in 2019.

2. Disposal Cost

Disposal cost is the cost a consumer pays to dispose of their retired CFLK. As in the NOPR analyses, DOE assumed in the final rule analyses that because LED lamps do not contain mercury, LED CFLKs do not have an associated disposal cost. DOE also assumed that the fraction of commercial consumers who pay to recycle CFLs is smaller than the fraction who pay to recycle linear fluorescent lamps. DOE estimates that the fraction of commercial consumers who pay disposal fees for fluorescent lamps will increase to 35 percent by 2019 based on a 2004 report from the Association of Lighting and Mercury Recyclers,[32] which estimated a 29 percent commercial recycling rate, and a 2009 draft report from the Massachusetts Department of Environmental Protection [33] that indicated a recycling rate of approximately 34 percent. Given this

[30] Sales Tax Clearinghouse, Inc. *The Sales Tax Clearinghouse.* (Last accessed October 22, 2015.) *https://thestc.com/STRates.stm.*

[31] U.S. Department of Commerce-Bureau of the Census. Table A1: Interim Projections of the Total Population for the United States and States: April 1, 2000 to July 1, 2030. *Population Division, Interim State Population Projections.* 2005.

[32] Association of Lighting and Mercury Recyclers. *National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.* 2004. (Last accessed October 13, 2015.) *http://www.lamprecycle.org/wp-content/uploads/2014/02/ALMR_capacity_statement.2004.-pdf.pdf.*

[33] Massachusetts Department of Environmental Protection. *Draft 2009 Mercury Lamp Recycling Rate Determination.* 2011. Massachusetts.

increased recycling percentage and DOE's assumption that the rate of commercial fluorescent lighting recycling would increase by the compliance date of this rulemaking, DOE has assumed that 35 percent of consumers of commercial CFLs pay to recycle their lamps by 2019. DOE assumes that this fraction will have saturated by 2019 and will remain constant throughout the analysis period due to the availability of free options for recycling small numbers of CFLs and the likelihood that some CFLs in the commercial sector will not be disposed of through recommended methods. DOE also assumed that the disposal cost is $0.70 per lamp based on feedback from a lighting industry expert and stakeholder comments received on the GSL preliminary analysis TSD.[34] ALA agreed with DOE's identical assumptions on disposal costs in the NOPR analyses. (ALA, No. 115 at p. 8)

3. Annual Energy Consumption

For each consumer sample, DOE determined the energy consumption for a CFLK at different ELs using the approach described above in section IV.E of this document.

4. Energy Prices

DOE used marginal electricity prices to calculate the operating costs associated with each EL in the final rule analyses. Marginal electricity prices may provide a better representation of consumer costs than average electricity prices because marginal electricity prices more accurately reflect the expected change in a consumer's electric utility bill due to an increase in end-use efficiency. In the LCC analysis, marginal electricity prices vary by season, region, and baseline household electricity consumption level. DOE estimated these prices using data published with the Edison Electric Institute (EEI) Typical Bills and Average Rates reports for summer and winter 2014.[35] DOE assigned seasonal marginal prices to each household or commercial building in the LCC sample based on its location and its baseline monthly electricity consumption for an average summer or winter month. For a detailed discussion of the development of electricity prices, see appendix 8D of the final rule TSD.

[34] These comments can be viewed on the General Service Lamps Energy Conservation Standards docket Web site: *http://www.regulations.gov/#!docketDetail;D=EERE-2013-BT-STD-0051.*

[35] Edison Electric Institute. *Typical Bills and Average Rates Report.* Winter 2014 published April 2014, Summer 2014 published October 2014: Washington, DC.

5. Energy Price Trends

To arrive at electricity prices in future years, DOE multiplied the marginal 2014 electricity prices by the forecast of annual residential or commercial electricity price changes for each Census division from EIA's *AEO 2015,* which has an end year of 2040.[36] For each purchase sampled, DOE applied the projection for the Census division in which the purchase was located. The *AEO* electricity price trends do not distinguish between marginal and average prices, so DOE used the *AEO 2015* trends for the marginal prices. DOE reviewed the EEI data for the years 2007 to 2014 and determined that there is no systematic difference in the trends for marginal vs. average electricity prices in the data.

DOE used the electricity price trends associated with the *AEO* reference case scenarios for the nine Census divisions. The reference case is a business-as-usual estimate, given known market, demographic, and technological trends. DOE also included *AEO* High Growth and *AEO* Low-Growth scenarios in the analysis. The high- and low-growth cases show the projected effects of alternative economic growth assumptions on energy markets. To estimate the trends after 2040, DOE used the average rate of change during 2025–2040.

6. Lamp Replacements

In the LCC analysis, DOE assumes that in both the commercial and residential sectors, lamps fail only at the end of the lamp service life. The service life (in years) is determined by dividing the lamps' rated lifetime (in hours) by the lamps' average operating hours per year.

Replacement costs include, in principle, both the lamps and labor associated with replacing a CFLK lamp at the end of its lifetime. However, DOE assumes that labor costs for lamp replacements are negligible and therefore did not include them in the analysis. Thus, DOE considers that the only first costs associated with lamp replacements are lamp purchase costs to consumers.

DOE assumed that consumers replace failed lamps with new lamps chosen from options available in the lighting market that have the same base type and provide an equivalent lumen output. DOE modeled this decision using a consumer-choice model, which incorporates consumer sensitivity to first cost and operation and maintenance (O&M) cost. DOE accounted for the first cost associated with purchasing a replacement lamp, the electricity consumption and operating costs which depend on the replacement lamp wattage, and the residual value of the lamp at the end of the CFLK lifetime. For details, see chapter 8 of the final rule TSD.

[36] U.S. Energy Information Administration. *Annual Energy Outlook 2015 with Projections to 2040.* 2015. Washington, DC Report No. DOE/EIA–0383(2015). (Last accessed October 13, 2015.) *http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf.*

7. Product Lifetime

DOE accounted for variability in the CFLK lifetimes by assigning a lifetime distribution[37] that is tied to the lifetime of the ceiling fan[38] to which the CFLK is attached. DOE used the ceiling fan lifetime distribution determined in the preliminary analysis of the energy conservation standards rulemaking for ceiling fans.[39] If originally packaged lamps fail before the end of the CFLK lifetime, DOE assumed that consumers replace those lamps with lamps of the same socket type and equivalent lumen output, as described in the previous section.

8. Residual Value

The residual value represents the remaining dollar value of surviving lamps at the end of the CFLK lifetime, discounted to the compliance year. DOE assumed that all lamps with lifetimes shorter than the CFLK lifetime are replaced. To account for the value of any initially packaged or replacement lamps with remaining life to the consumer, the LCC model applies this residual value as a ''credit'' at the end of the CFLK lifetime, which is discounted back to the start of the analysis period. Because DOE estimates that LED lamps undergo price learning, the residual value of these lamps is calculated based on the LED lamp price in the year the CFLK is retired.

9. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households to estimate the present value of future operating costs. DOE estimated a distribution of residential discount rates for CFLKs based on

[37] DOE used a Weibull distribution to model the lifetime of ceiling fans. Weibull distributions are commonly used to model appliance lifetimes.

[38] The lifetime of the ceiling fan, rather than that of the CFLK, is used because the fan, having moving parts, is likely to have a shorter life, and the available data suggest that when fans cease to function, their light kit is also retired.

[39] DOE has published a framework document and preliminary analysis for establishing energy conservation standards for ceiling fans. Further information is available at *www.regulations.gov* under Docket ID: EERE–2012–BT–STD–0045.

consumer financing costs and opportunity cost of funds related to appliance energy cost savings and maintenance costs.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. DOE estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances[40] (SCF) for 1995, 1998, 2001, 2004, 2007, and 2010. Further, using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.4 percent. See chapter 8 of the final rule TSD for further details on the development of consumer discount rates.

To establish commercial discount rates for the LCC analysis, DOE estimated the cost of capital for companies that purchase CFLKs. The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so their cost of capital is the weighted average of the cost to the firm of equity and debt financing, as estimated from financial data for publicly traded firms in the sectors that purchase CFLKs. For this analysis, DOE used Damodaran online[41] as the source of information about company debt and equity financing. The average rate across all types of companies, weighted by the shares of each type, is 5.0 percent. See chapter 8 of the final rule TSD for further details on the development of commercial sector discount rates.

10. Efficacy Distributions

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular EL, DOE's LCC analysis considered the projected distribution (market shares) of product efficacies in the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards) and each of the standards cases (*i.e.,* the cases where a standard would be set at each TSL) at the assumed compliance year. The estimated market shares for the no-new-standards case and each standards case for CFLKs are determined by the shipments analysis and are shown in Table IV.9. See section IV.G of this document and chapter 9 of the final rule TSD for further information on the derivation of the market efficacy distributions.

TABLE IV.9—MARKET EFFICACY DISTRIBUTION BY TRIAL STANDARD LEVEL IN 2019

Trial standard level	Sub-baseline (%)	EL 0 (%)	EL 1 (%)	EL 2 (%)	EL 3 (%)	EL 4 (%)	Total (%)
No-new-standards	55.9	0.0	26.3	10.2	3.5	4.1	100
TSL 0	0.0	0.0	82.2	10.2	3.5	4.1	100
TSL 1	0.0	0.0	82.2	10.2	3.5	4.1	100
TSL 2	0.0	0.0	0.0	51.3	3.5	45.2	100
TSL 3	0.0	0.0	0.0	0.0	3.5	96.5	100
TSL 4	0.0	0.0	0.0	0.0	0.0	100.0	100

11. LCC Savings Calculation

As in the NOPR analysis, in the final rule reference scenario, DOE calculated the LCC savings at each TSL based on the change in LCC for each standards case compared to the no-new-standards case, considering the efficacy distribution of products derived by the shipments analysis. Unlike the roll-up approach applied in the preliminary analysis, where the market share of ELs below the standard level 'rolls up' to the least efficient EL still available in each standards case, the reference approach allows consumers to choose more-efficient (and sometimes less expensive) products at higher ELs and is intended to more accurately reflect the impact of a potential standard on consumers.

DOE also performed the roll-up approach as an alternative scenario to calculate LCC savings. For details on both the reference scenario and the roll-up approach, see chapter 8 of the final rule TSD.

12. Payback Period Analysis

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

The inputs to the PBP calculation for each EL are the change in total installed cost of the product and the change in the initial operating expenditures relative to the least efficient product on the market. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates and energy price trends are not needed. DOE did not consider the impact of replacement lamps (that replace the initially packaged lamps when they fail) in the calculation of the PBP.

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

[40] Board of Governors of the Federal Reserve System. *Survey of Consumer Finances.* 1989, 1992, 1995, 1998, 2001, 2004, 2007, and 2010. (Last accessed October 13, 2015.) *http://www.federalreserve.gov/econresdata/scf/scfindex.htm.*

[41] Damodaran, A. *Cost of Capital by Sector.* January 2014. (Last accessed October 13, 2015.) *http://people.stern.nyu.edu/adamodar/New_Home_Page/datafile/wacc.htm.*

G. Shipments Analysis

DOE uses projections of product shipments to calculate the national impacts of potential amended energy conservation standards on energy use, NPV, and future manufacturer cash flows. Historical shipments data are used to build up an equipment stock, and to calibrate the shipments model to project shipments over the course of the analysis period based on the estimated future demand for CFLKs. Details of the shipments analysis are described in chapter 9 of the final rule TSD.

The shipments model projects total shipments and market share efficacy distributions in each year of the 30-year analysis period (2019–2048) for the no-new-standards case and each of the standards cases. Shipments are calculated for the residential and commercial sectors assuming 95 percent of shipments are to the residential sector and 5 percent are to the commercial sector. DOE further assumed in its analysis that CFLKs are primarily found on standard and hugger ceiling fans. DOE also assumed that the distribution of CFLKs by light source technology in the commercial sector is the same as the light source technology distribution in the residential sector.

The shipments model consists of three main components: (1) A demand model that determines the total demand for new CFLKs in each year of the analysis period, (2) a stock model that tracks the age distribution of the stock over the analysis period, and (3) a modified consumer-choice model that determines the market shares of purchased CFLKs across ELs.

1. Shipments Demand and Stock Accounting

The CFLK shipments demand model considers four market segments that impact the net demand for total shipments: Replacements for retired stock, additions due to new building construction, additions due to expanding demand in existing buildings, and reductions due to building demolitions, which erodes demand from replacements and existing buildings.

The stock accounting model tracks the age (vintage) distribution of the installed CFLK stock. The age distribution of the stock is a key input to both the NES and NPV calculations, because the operating costs for any year depend on the age distribution of the stock. Older, less efficient units may have higher operating costs, while newer, more-efficient units have lower operating costs. The stock accounting model is initialized using historical shipments data and accounts for additions to the stock (*i.e.,* shipments) and retirements. The age distribution of the stock in 2012 is estimated using results from the LBNL survey of ceiling fan owners.[42] The stock age distribution is updated in subsequent years using projected shipments and retirements determined by the stock age distribution and a product retirement function.

2. Market-Share Projections

The modified consumer-choice model estimates the market shares of purchases in each year in the analysis period for each EL presented in the engineering analysis. In the case of CFLKs, the lamps included with the CFLK are chosen by the CFLK manufacturer. A key assumption of DOE's CFLK consumer-choice model is that when LED lamps reach price parity with comparable CFLs, manufacturers will purchase LED lamps to package with a CFLK, making only those lamps available to the consumer. In other words, DOE assumes that CFLK manufacturers will not pay a price premium to package with CFLs compared to LED lamps. Prior to the point when LED lamps reach price parity with CFLs, market share to LED CFLKs is allocated following an adoption curve discussed in more detail below.

As described in the engineering analysis, DOE assumed that CFLK manufacturers could respond in two ways to an amended energy conservation standard. Manufacturers could maintain the current base type and number of lamps in a CFLK design and simply replace lamps currently packaged with CFLKs with a more-efficient option (lamp replacement scenario), or they could reconfigure CFLKs to include a different base type and/or number of lamps, in addition to packaging with more-efficient lamp options (light kit replacement scenario). DOE assumed that there was no inherent preference between the two scenarios and split market share evenly between them.

DOE's shipments model estimates the adoption of LED technologies using an incursion curve and a modified consumer-choice model in both the no-new-standards and amended standards cases. For the final rule analysis, DOE used the Bass diffusion curve developed in the *Energy Savings Potential of Solid-State Lighting in General Illumination Applications*[43] (SSL report) for GSLs to estimate the market share apportioned to LED ELs. DOE assumed the adoption of LEDs in the CFLK market would trail behind adoption of LED technology in the GSL market by 3.5 years. In the final rule analysis, DOE's LED incursion curve for CFLKs results in a market share of 14 percent for LED lamps in 2019.

In the NOPR analysis, DOE assumed the market for LED lamps would naturally move to more efficacious ELs in the no-new-standards case as well as the standards cases based on observed trends in the efficacy of LED lamps on the market over time. CA IOUs were supportive of DOE's efforts to model the efficacy trend of LEDs. (CA IOUs, No. 118 at p. 1) In the final rule, DOE continued to use the same methodology to project LED efficacy over the analysis period.

3. Price Learning

In the final rule analysis, DOE assumed that price learning would occur only for LEDs. DOE used the price trends developed in the GSLs preliminary analysis for the reference scenario in the base case of that rulemaking (*i.e.,* shipments of LED GSLs were affected by the EISA 2007 backstop but not by a GSL final rule). That scenario assumed that LED GSLs would experience the same learning rate historically observed for CFLs. Most recent estimates for LED GSL price trends indicate faster historic price decline;[44] therefore, DOE believes the scenario it used may be a conservative estimate of LED GSL price trends. Details on the development of the price trends are in chapter 9 of the final rule TSD and chapter 9 of the GSL preliminary analysis TSD.[45]

4. Impact of EISA 2007 Backstop

In the preliminary analysis for the ongoing GSL energy conservation standards rulemaking,[46] DOE

[42] Kantner, *et al.* (2013), op. cit.

[43] Navigant Consulting, Inc. *Energy Savings Potential of Solid-State Lighting in General Illumination Applications.* 2012. U.S. Department of Energy. (Last accessed October 23, 2015.) *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_energy-savings-report_jan-2012.pdf.*

[44] Navigant Consulting, Inc. *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications.* 2014. U.S. Department of Energy. Report No. DOE/EE–1133. (Last accessed October 23, 2015.) *http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/energysavings forecast14.pdf.*

[45] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy. Preliminary Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: General Service Lamps. December 2014. Washington, DC (Last accessed October 23, 2015.) *http://www.regulations.gov/#!documentDetail;D=EERE-2013-BT-STD-0051-0022.*

[46] The GSL energy conservation standards preliminary analysis technical support document and public meeting information are available at

Continued

determined that lamps that have base types specified by ANSI, have a lumen output of at least 310 lumens, and are intended to serve in general lighting applications meet the GSL definition. Therefore, DOE considers candelabra-base lamps that meet the lumen output and general application requirements to meet the GSL definition, which available information indicates would include all candelabra-base lamps currently packaged with CFLKs. All lamps that meet the GSL definition would be subject to the EISA 2007 backstop requirement prohibiting, beginning on January 1, 2020, the sale of any GSL that does not meet a minimum efficacy standard of 45 lm/W if the ongoing GSL rulemaking is not completed by January 1, 2017, or if the energy savings of the GSL final rule are not greater than or equal to the savings from a minimum efficacy standard of 45 lumens per watt. 42 U.S.C. 6295(i)(6)(A)(v).

The Continuing Appropriations Act, 2016 (Pub. L. 114–53, Sept. 30, 2015), in relevant part, continues to restrict the use of appropriated funds in connection with several aspects of DOE's incandescent lamps energy conservation standards program. Specifically, none of the funds made available by the Act may be used to implement or enforce standards for GSILs, intermediate base incandescent lamps and candelabra base incandescent lamps. Thus, DOE is not considering GSILs in the GSL rulemaking. Because GSILs are not included in the scope of the GSL rulemaking, DOE assumed that any GSL final rule would not yield sufficient energy savings to avoid triggering the EISA 2007 45 lm/W backstop. Therefore, DOE assumed that the backstop would go into effect on January 1, 2020.

As a result, in the CFLK NOPR analysis, DOE assumed in both the no-new-standards and the standards-case shipment projections that candelabra-base lamps with efficacy below the minimum requirement of 45 lm/W will no longer be an option available for packaging with CFLKs beginning January 1, 2020. The Joint Comment supported that all lamps packaged with CFLKs, including candelabra-based lamps, will be subject to a 45 lm/W standard starting January 1, 2020. (Joint Comment, No. 117 at p. 2). In the final rule, DOE continued to assume that all lamps packaged with CFLKs would be subject to the 45 lm/W standard beginning January 1, 2020.

5. Impact of a Standard on Shipments

For the CFLK final rule analyses, DOE used an initial relative price elasticity of demand of −0.34, which is the value DOE has typically used for residential appliances. DOE notes that the fractional drop in CFLK shipments in the standards cases is proportional to the change in CFLK purchase price compared to the total price of a ceiling fan and CFLK system.

For this final rule, DOE assumed that the vast majority of CFLKs are sold with ceiling fans and acknowledges that any standard adopted on ceiling fans that would increase the average price of ceiling fans would decrease shipments of CFLKs. However, DOE did not assume a standard on ceiling fans in its projections for CFLK shipments because DOE has not yet adopted a ceiling fan standard.[47] In any ECS NOPR for ceiling fans, DOE will consider the impact of these adopted CFLK standards in its projections of ceiling fan shipments.

H. National Impact Analysis

The NIA assesses the national energy savings (NES) and the national net present value (NPV) from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific ELs.[48] (''Consumer'' in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV based on projections of annual product shipments, along with the annual energy consumption, total installed cost, and the costs of relamping.[49] For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of CFLKs sold from 2019 through 2048.

DOE evaluates the impacts of amended standards by comparing a no-new-standards-case projection with standards-case projections. The no-new-standards-case projection characterizes energy use and consumer costs in the absence of amended energy conservation standards. The standards-case projections characterize energy use and consumer cost for the market distribution where CFLKs that do not meet the TSL being analyzed are excluded as options available to the consumer. As described in section IV.G of this final rule, DOE developed market share distributions for CFLKs at each EL in the no-new-standards case and each of the standards cases in its shipments analysis.

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

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

TABLE IV.10—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2019.
No-new-standards Case Forecasted Efficacies.	Estimated by market-share module of shipments model including impact of SSL incursion.
Standards Case Forecasted Efficacies.	Estimated by market-share module of shipments model including impact of SSL incursion.
Annual Energy Consumption per Unit.	Annual weighted-average values are a function of energy use at each EL, including impacts of relamping over the CFLK lifetime.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each EL. Incorporates projection of future LED lamp prices based on historical data.

regulations.gov under docket ID EERE–2013–BT–STD–0051–0022: *http://www.regulations.gov/#!docketDetail;D=EERE-2013-BT-STD-0051.*

[47] The ceiling fans energy conservation standards docket (docket number EERE–2012–BT–STD–0045–0065) is located at regulations.gov: *http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-STD-0045.*

[48] The NIA accounts for impacts in the 50 states and U.S. territories.

[49] For the NIA, DOE adjusts the installed cost data from the LCC analysis to exclude sales tax, which is a transfer.

TABLE IV.10—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS—Continued

Inputs	Method
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit.	Annual values do not change with efficacy level. Replacement lamp costs are calculated for each efficacy level over the analysis period.
Energy Prices	*AEO 2015* forecasts (to 2040) and extrapolation through 2048.
Energy Site-to-Primary and FFC Conversion.	A time-series conversion factor based on *AEO 2015.*
Discount Rate	Three and seven percent.
Present Year	2015.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.10 of this document describes how DOE developed an energy efficacy distribution for the no-new-standards case (which yields a shipment-weighted average efficacy) for the first year of the forecast period. To project the trend in efficacy for CFLKs over the entire shipments projection period, DOE used estimates for LED incursion and a modified consumer-choice model sensitive to the first cost of available lamp options. For standards cases, lamp options that do not meet the standard are eliminated as options for the consumer-choice model. The consumer-choice model used to project market shares over the course of the analysis period is further described in chapter 9 of the final rule TSD.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered products in each potential standards case (TSL) with consumption in the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE accounts for changes in unit energy consumption as the lamps packaged with the CFLK are retired at the end of the lamp lifetime and new lamps are purchased as replacements for the existing CFLK. DOE uses a consumer-choice model, described in section IV.G, to determine the mix of lamps chosen as replacements.

DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for the case where a standard is set at each TSL. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO 2015.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

In 2011, in response to the recommendations of a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' appointed by the National Academy of Sciences, DOE announced its intention to use full-fuel-cycle (FFC) measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [50] that EIA uses to prepare its *Annual Energy Outlook.* The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the final rule TSD.

3. Net Present Value Analysis

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

The operating cost savings are primarily energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of electricity. To estimate electricity prices in future years, DOE multiplied the average regional energy prices by the forecast of annual national-average residential or commercial electricity price changes in the Reference case from *AEO 2015,* which has an end year of 2040. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2025 to 2040.

DOE estimated the range of potential impacts of amended standards by considering high and low benefit scenarios. In the high benefits scenario, DOE used the High Economic Growth *AEO 2015* estimates for new housing starts and electricity prices along with its reference LED price learning trend. As discussed in section IV.G, the reference LED price trend assumes the learning rate measured from historical CFL price trends can be applied to cumulative LED shipments to determine future LED prices. In the low benefits scenario, DOE used the Low Economic Growth *AEO 2015* estimates for housing starts and electricity prices, along with a high LED learning rate. The high LED learning rate is estimated from historical LED price trends and shows a faster price decline in comparison to the CFL learning rate as estimated by LBNL.[51] The benefits to consumers from amended CFLK standards are lower if LED prices decline faster because consumers convert to LED CFLKs more

[50] For more information on NEMS, refer to *The National Energy Modeling System: An Overview,* DOE/EIA–0581 (98) (Feb. 1998) (Available at: *http://webapp1.dlib.indiana.edu/virtual_disk_library/index.cgi/4265704/FID3754/pdf/Multi/058198.pdf*).

[51] Gerke, B., A. Ngo, A. Alstone, and K. Fisseha. *The Evolving Price of Household LED Lamps: Recent Trends and Historical Comparisons for the US Market.* 2014. Lawrence Berkeley National Laboratory: Berkeley, CA. Report No. LBNL–6854E. (Last accessed October 13, 2015.) *http://eetd.lbl.gov/publications/the-evolving-price-of-household-led-l.*

quickly in the no-new-standards case. NIA results based on these alternative scenarios are presented in appendix 10C of the final rule TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[52] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this final rule, DOE analyzed the impacts of the considered standard levels on low-income households and small businesses that purchase CFLKs. Chapter 11 of the final rule TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

DOE conducted an MIA for CFLKs to estimate the financial impact of adopted standards on CFLK manufacturers. For this rulemaking, DOE considered CFLK manufacturers to be companies that produce ceiling fans with CFLKs or produce CFLKs for the purpose of attaching them to ceiling fans. While the adopted CFLK standards regulate the efficacy of the lamps used in CFLKs, DOE does not consider lamp manufacturers as part of the MIA for this rulemaking. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA relies on the GRIM, an industry cash-flow model customized for the CFLKs covered in this rulemaking. The key GRIM inputs are data on the industry cost structure, product costs, shipments, assumptions about markups, and conversion costs. The key MIA output is INPV. DOE used the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between a no-new-standards case and various TSLs (the standards cases). The difference in INPV between the no-new-standards and standards cases represents the financial impact of amended energy conservation standards on CFLK manufacturers. Different sets of assumptions (scenarios) produce different INPV results. The qualitative part of the MIA addresses factors such as manufacturing capacity; characteristics of, and impacts on, any particular subgroup of manufacturers; and impacts on competition.

DOE outlined its complete methodology for the MIA in the previously published NOPR. The complete MIA is also presented in chapter 12 of the final rule TSD.

1. Manufacturer Production Costs

Manufacturing more efficacious CFLKs can result in changes in manufacturer production costs (MPCs) as a result of varying components required to meet ELs at each TSL. Changes in MPCs for these more efficacious components can impact the revenue, gross margin, and the cash flows of CFLK manufacturers. In the final rule, DOE adjusted the number of lamps used per CFLK when calculating the overall CFLK MPCs to be consistent with calculations in other downstream analyses, such as the NIA and LCC. For a complete description of the MPCs, see chapter 12 of the final rule TSD.

2. Shipment Projections

INPV, which is the key GRIM output, depends on industry revenue, which depends on the quantity and prices of CFLKs shipped in each year of the analysis period. Industry revenue calculations require forecasts of: (1) Total annual shipment volume of CFLKs; (2) the distribution of shipments across the replacement scenarios (because prices vary by replacement scenario); and, (3) the distribution of shipments across ELs (because prices vary with CFLK efficacy). In the final rule, DOE included sub-baseline shipments that do not meet the 45 lm/W baseline efficacy. These shipments represent the number of shipments that would not meet or exceed the efficacy levels required by the EISA 2007 backstop in the years prior to the compliance date for the EISA 2007 backstop (January 1, 2020) in the no-new-standards case. For a complete description of the shipments analysis, see chapter 9 of the final rule TSD.

3. Markup Scenarios

In the final rule, DOE modeled only one markup scenario for the MIA, the preservation of gross margin markup scenario. DOE did not model additional manufacturer markup scenarios, because there are already significant market transformations taking place due to the implementation of the EISA 2007 backstop, which is included in the no-new-standards case. DOE finds that higher efficacy standards analyzed in the standards cases, above 45 lm/W, would not significantly alter the manufacturer markup modeled in the no-new-standards case for the CFLK market. DOE determined that the two-tiered markup scenario used in the NOPR was not applicable to the CFLK market in the final rule, because by 2021, the vast majority of CFLK shipments in the no-new-standards case use LED lamps. Therefore, DOE determined that by 2021, LEDs will no longer be considered a premium product and would not likely command a premium markup even in the no-new-standards case. For a complete description of the markup scenario used in the MIA, see chapter 12 of the final rule TSD.

4. Capital and Product Conversion Costs

Amended energy conservation standards could cause manufacturers to incur additional one-time conversion costs to bring their tooling and product designs into compliance with amended CFLK standards in the light kit replacement scenario. For the MIA, DOE classified these conversion costs into two major groups: (1) Capital conversion costs and (2) product conversion costs. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing tooling equipment such that new product designs can be fabricated and assembled. Product conversion costs are investments in research, development, testing, marketing, certification, and other non-capitalized costs necessary to make product designs comply with amended CFLK standards.

In the NOPR, DOE conducted a bottom-up analysis that used manufacturer feedback to develop capital and product conversion costs for CFLK manufacturers for each product class at each EL. Based on comments received from ALA, DOE modeled a high investment scenario in addition to the low investment scenario that was

[52] United States Office of Management and Budget. Circular A–4: Regulatory Analysis,'' (Sept. 17, 2003), section E (Available at: *www.whitehouse.gov/omb/memoranda/m03-21.html*).

used in the NOPR, due to the uncertainty of these conversion costs across the entire CFLK industry. ALA commented that to comply with TSL 4, CFLK manufacturers would be forced to redesign most of their CFLKs at a significant cost. (ALA, No. 115 at pp. 2–3) ALA added that CFLK manufacturers would be required to undertake costly redesigns of popular CFLK products to comply with TSLs 3 or 4. (ALA, No. 115 at p. 3)

The conversion costs calculated in the NOPR were used as the conversion costs in the low investment scenario and DOE estimated the high investment scenario conversion costs based on the range of responses given by manufacturers during manufacturer interviews. This high investment scenario reflects ALA's concerns that higher TSLs would present significant investments for CFLK manufacturers to comply with the analyzed TSLs. Each conversion cost investment scenario leads to different levels of investment by CFLK manufacturers, which, when used in the discounted cash flow model, result in varying free cash flow impacts on CFLK manufacturers.

In addition to modeling a high and low investment scenario in the final rule, DOE estimated conversion costs in the no-new-standards case incurred by CFLK manufacturers complying with the minimum 45 lm/W backstop required by EISA 2007. DOE also estimated the value of stranded assets in the form of production equipment made obsolete by the EISA 2007 backstop. DOE assumed that CFLK manufacturers would be required to make these investments regardless of DOE adopting the amended CFLK standards in this final rule. Therefore, the conversion costs and stranded assets associated with EISA 2007 backstop compliance are included in the no-new-standards case of the CFLK final rule and are additive to the conversion costs incurred in the standards cases analyzed by this rulemaking.

5. Other Comments From Interested Parties

During the NOPR public meeting and comment period, interested parties had the opportunity to comment on the assumptions, methodology, and results of the NOPR MIA. ALA commented that at TSLs 3 and 4, impact to CFLK manufacturers would be significant and that CFLK manufacturers cannot fully pass on the expected price increases to consumers in the highly-competitive CFLK market. ALA stated that, in summary, if DOE adopts TSL 3 or TSL 4 as a final energy conservation standard, CFLK manufacturers would be forced to significantly raise their prices to comply with the standard and this would be an untenable burden for industry to bear. (ALA, No. 115 at p. 3) DOE notes that the MPC and MSP of CFLKs using LEDs decrease throughout the analysis period and becomes less costly than CFLs just a few years after compliance with the CFLK standards is required. Because of the decreasing MPCs of CFLKs using LEDs, DOE has determined that manufacturers would most likely be able to maintain the no-new-standards case manufacturer margins estimated in the preservation of gross margin markup scenario. Additionally, DOE notes that both the decreasing MPCs of LEDs and the high percentage of CFLKs using LEDs in the no-new-standards case support DOE's decision to model only a preservation of gross margin markup in the final rule for the MIA. For more information on the benefits and burdens of the analyzed TSLs, see section V.C.1.

6. Manufacturer Interviews

DOE interviewed manufacturers representing more than 30 percent of covered CFLK sales in the United States. DOE conducted interviews as part of the preliminary analysis and NOPR analysis. DOE outlined the key issues for CFLK manufacturers in the NOPR. 78 FR 48657 (August 13, 2015). DOE considered the information received during these interviews in the development of the NOPR and this final rule. DOE did not conduct additional interviews with manufacturers between the publication of the NOPR and this final rule.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of carbon dioxide (CO_2), nitrogen oxides (NO_X), sulfur dioxide (SO_2), and mercury (Hg). The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, methane (CH_4) and nitrous oxide (N_2O), as well as the reductions to emissions of all species due to ''upstream'' activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion. The associated emissions are referred to as upstream emissions.

The analysis of power sector emissions uses marginal emissions factors that were derived from data in *AEO 2015,* as described in section IV.M. The methodology is described in chapters 13 and 15 of the final rule TSD.

Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the U.S. Environmental Protection Agency (EPA), GHG Emissions Factors Hub.[53] The FFC upstream emissions are estimated based on the methodology described in chapter 15 of the final rule TSD. The upstream emissions include both emissions from fuel combustion during extraction, processing, and transportation of fuel, and ''fugitive'' emissions (direct leakage to the atmosphere) of CH_4 and CO_2.

The emissions intensity factors are expressed in terms of physical units per megawatt hour (MWh) or million British thermal units (MMBtu) of site energy savings. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying each ton of gas by the gas' global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[54] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

The *AEO* incorporates the projected impacts of existing air quality regulations on emissions. *AEO 2015* generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of the end of October 2014. DOE's estimation of impacts accounts for the presence of the emissions control programs discussed in the following paragraphs.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap and trading programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous states and the District of Columbia (D.C.). SO_2 emissions from 28

[53] Available at: *http://www.epa.gov/climateleadership/inventory/ghg-emissions.html.*

[54] Intergovernmental Panel on Climate Change. Chapter 8: Anthropogenic and Natural Radiative Forcing. In *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* T. F. Stocker, D. Qin, G.-K. Plattner, M. M. B. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, Editors. 2013. Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA. (Last accessed October 23, 2015.) *http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf.*

eastern states and D.C. were also limited under the Clean Air Interstate Rule (CAIR), which created an allowance-based trading program that operates along with the Title IV program in those States and D.C. 70 FR 25162 (May 12, 2005). CAIR was remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) but parts of it remained in effect. On July 6, 2011 EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (August 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR. See *EME Homer City Generation, LP* v. *EPA,* 696 F.3d 7, 38 (D.C. Cir. 2012). The court ordered EPA to continue administering CAIR. On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion.[55] On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR.[56] Pursuant to this action, CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015.

EIA was not able to incorporate CSAPR into *AEO 2015,* so it assumes implementation of CAIR. Although DOE's analysis used emissions factors that assume that CAIR, not CSAPR, is the regulation in force, the difference between CAIR and CSAPR is not relevant for the purpose of DOE's analysis of emissions impacts from energy conservation standards.

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that no reductions in power sector emissions would occur for SO_2 as a result of standards.

Beginning in 2016, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *AEO 2015* assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2016. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, emissions will be far below the cap established by CAIR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU.[57] Therefore, DOE believes that energy conservation standards will generally reduce SO_2 emissions in 2016 and beyond.

CAIR established a cap on NO_X emissions in 28 eastern States and the District of Columbia.[58] Energy conservation standards are expected to have little effect on NO_X emissions in those States covered by CSAPR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions. However, standards would be expected to reduce NO_X emissions in the States not affected by CAIR, so DOE estimated NO_X emissions reductions from the standards considered in this final rule for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would likely reduce Hg emissions. DOE estimated mercury emissions reductions using the reference and side cases published with *AEO 2015,* which incorporates the MATS.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

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

For this final rule, DOE relied on a set of values for the social cost of carbon (SCC) that was developed by a Federal interagency process. The basis for these values is summarized in the next section, and a more detailed description of the methodologies used is provided as an appendix to chapter 14 of the final rule TSD.

1. Social Cost of Carbon

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

Under section 1(b) of Executive Order 12866, agencies must, to the extent permitted by law, ''assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.'' The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have small, or ''marginal,'' impacts on cumulative global emissions. The estimates are

[55] *See EPA* v. *EME Homer City Generation,* 134 S.Ct. 1584, 1610 (U.S. 2014). The Supreme Court held in part that EPA's methodology for quantifying emissions that must be eliminated in certain States due to their impacts in other downwind States was based on a permissible, workable, and equitable interpretation of the Clean Air Act provision that provides statutory authority for CSAPR.

[56] *See Georgia* v. *EPA,* Order *(D.C. Cir. filed October 23, 2014)* (*No. 11–1302),*

[57] DOE notes that the Supreme Court recently remanded EPA's 2012 rule regarding national emission standards for hazardous air pollutants from certain electric utility steam generating units. See *Michigan* v. *EPA* (Case No. 14–46, 2015). DOE has tentatively determined that the remand of the MATS rule does not change the assumptions regarding the impact of energy efficiency standards on SO_2 emissions. Further, while the remand of the MATS rule may have an impact on the overall amount of mercury emitted by power plants, it does not change the impact of the energy efficiency standards on mercury emissions. DOE will continue to monitor developments related to this case and respond to them as appropriate.

[58] CSAPR also applies to NO_X and it would supersede the regulation of NO_X under CAIR. As stated previously, the current analysis assumes that CAIR, not CSAPR, is the regulation in force. The difference between CAIR and CSAPR with regard to DOE's analysis of NO_X emissions is slight.

presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

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

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of CO_2 emissions, the analyst faces a number of serious challenges. A report from the National Research Council [59] points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) Future emissions of greenhouse gases (GHGs); (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO_2 emissions. The agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC values appropriate for that year. The NPV of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Development of Social Cost of Carbon Values

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

c. Current Approach and Key Assumptions

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

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: (1) Climate sensitivity; (2) socio-economic and emissions trajectories; and (3) discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

In 2010, the interagency group selected four sets of SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values grow in real terms over time, as depicted in Table IV.11. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[60] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.11 presents the values in the 2010 interagency group report,[61] which is reproduced in appendix 14A of the final rule TSD.

[59] National Research Council. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* 2010. National Academies Press: Washington, DC (Last accessed October 16, 2015.) *http://www.nap.edu/catalog/12794/hidden-costs-of-energy-unpriced-consequences-of-energy-production-and.*

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

[61] Interagency Working Group on Social Cost of Carbon. *Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866.* 2010. United States Government. (Last accessed October 16, 2015.) *http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.*

TABLE IV.11—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050

[2007$ per metric ton CO_2]

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

The SCC values used for this document were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature, as described in the 2013 update from the interagency working group (revised July 2015).[62]

Table IV.12 shows the updated sets of SCC estimates from the latest interagency update in 5-year increments from 2010 to 2050. The full set of annual SCC estimates between 2010 and 2050 is reported in appendix 14B of the final rule TSD. The central value that emerges is the average SCC across models at the 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

TABLE IV.12—ANNUAL SCC VALUES FROM 2013 INTERAGENCY REPORT (REVISED JULY 2015), 2010–2050

[2007$ per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable because they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Research Council report mentioned previously points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of analytical challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.[63]

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report (revised July 2015) adjusted to 2014$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. For each of the four sets of SCC cases specified, the values for emissions in 2015 were $12.2, $40.0, $62.3, and $117 per metric ton avoided (values expressed in 2014$). DOE derived values after 2050 using the relevant growth rates for the 2040–2050 period in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the

[62] Interagency Working Group on Social Cost of Carbon. *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* 2015. United States Government. (Last accessed October 23, 2015.) *https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf.*

[63] In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586. In July 2015, OMB published a detailed summary and formal response to the many comments that were received. *https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions.* It also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters.

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

In response to the CFLKs NOPR, DOE received a comment from a group of trade associations led by the U.S. Chamber of Commerce. This group objected to DOE's continued use of the SCC in the cost-benefit analysis and stated that the SCC calculation should not be used in any rulemaking until it undergoes a more rigorous notice, review and comment process. (U.S. Chamber of Commerce, No. 114 at p. 4) In contrast, DOE received another comment from the Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists affirming DOE's use of the SCC values proposed in the NOPR. (Environmental Defense Fund, *et al.,* No. 116 at p. 1)

In response to the U.S. Chamber of Commerce, *et al.,* in conducting the interagency process that developed the SCC values, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. Key uncertainties and model differences transparently and consistently inform the range of SCC estimates. These uncertainties and model differences are discussed in the interagency Working Group's reports, which are reproduced in appendices 14A and 14B of the final rule TSD, as are the major assumptions. Specifically, uncertainties in the assumptions regarding climate sensitivity, as well as other model inputs such as economic growth and emissions trajectories, are discussed and the reasons for the specific input assumptions chosen are explained. However, the three integrated assessment models used to estimate the SCC are frequently cited in the peer-reviewed literature and were used in the last assessment of the IPCC. In addition, new versions of the models that were used in 2013 to estimate revised SCC values were published in the peer-reviewed literature (see appendix 14B of the final rule TSD for discussion). Although uncertainties remain, the revised estimates that were issued in November 2013 are based on the best available scientific information on the impacts of climate change. The current estimates of the SCC have been developed over many years, using the best science available, and with input from the public. In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586. In July 2015, OMB published a detailed summary and formal response to the many comments that were received.[64] DOE stands ready to work with OMB and the other members of the interagency Working Group on further review and revision of the SCC estimates as appropriate.

2. Social Cost of Other Air Pollutants

The Environmental Defense Fund, *et al.* encouraged DOE to consider monetizing the benefits of greenhouse gas reductions other than CO_2. (Environmental Defense Fund, *et al.,* No. 116 at p. 1) As noted previously, DOE has estimated how the considered energy conservation standards would reduce site NO_X emissions nationwide and decrease power sector NO_X emissions in those 22 States not affected by the CAIR.

DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, ''Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,'' published in June 2014 by EPA's Office of Air Quality Planning and Standards. The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 discounted at 3 percent and 7 percent,[65] which are presented in chapter 14 of the Final Rule TSD. DOE assigned values for 2021–2024 and 2026–2029 using, respectively, the values for 2020 and 2025. DOE assigned values after 2030 using the value for 2030.

DOE multiplied the emissions reduction (tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate. DOE will continue for evaluate the monetization of avoided NO_X emissions and will make any appropriate updates in energy conservation standards rulemakings.

DOE is evaluating appropriate monetization of avoided SO_2 and Hg emissions in energy conservation standards rulemakings. DOE has not included monetization of those emissions in the current analysis.

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the electric power industry that would result from the adoption of new or amended energy conservation standards. The utility impact analysis estimates the changes in installed electrical capacity and generation that would result for each TSL. The analysis is based on published output from the NEMS associated with *AEO 2015.* NEMS produces the *AEO* Reference case, as well as a number of side cases to estimate the marginal impacts of reduced energy demand on the utility sector. These marginal factors are estimated based on the changes to electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the final rule TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity use calculated in the NIA to provide estimates of selected utility impacts of new or amended energy conservation standards.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the products subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards

[64] *https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions.* OMB also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters.

[65] For the monetized NO_X benefits associated with $PM_{2.5}$, the related benefits (derived from benefit-per-ton values) are based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009), which is the lower of the two EPA central tendencies. Using the lower value is more conservative when making the policy decision concerning whether a particular standard level is economically justified so using the higher value would also be justified. If the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2012), the values would be nearly two-and-a-half times larger. (See chapter 14 of the Final Rule TSD for further description of the studies mentioned above.)

consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) Reduced spending by end users on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased consumer spending on new products to which the new standards apply; and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector 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 sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[67] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (*i.e.,* the utility sector) to more labor-intensive sectors (*e.g.,* the retail and service sectors). Thus, based on the BLS data alone, DOE believes net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 3.1.1 (ImSET).[68] ImSET is a special-purpose version of the ''U.S. Benchmark National Input-Output'' (I–O) model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, DOE generated results for near-term timeframes, where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the final rule TSD.

O. Proposed Standards in August 2015 NOPR

1. Proposed Standard

In the NOPR, DOE proposed to adopt amended standards for CFLKs. DOE proposed adopting TSL 2, which would set energy conservation standards at EL 2 for All CFLKs. DOE received several comments on the proposed standard level.

Several stakeholders commented on the range and quality of products that would be available at TSL 3 and TSL 4, which can be met by only LED lamps, as opposed to TSL 2, which be met by both CFLs and LED lamps. CA IOUs supported amending standards for CFLKs, but requested DOE consider a standard higher than TSL 2. (CA IOUs, No. 118 at p. 2, 8) CA IOUs said that according to a 2014 press release from the European Council for an Energy-Efficient Economy,[69] many LED lamps with similar characteristics to the representative lamps presented in DOE's analysis (omnidirectional, approximately 800 lumens, 2,700 CCT, CRI of 80 or greater, and screw base) already comfortably exceed TSL 3. Especially as the market continues to advance, CA IOUs believe that setting a standard level at TSL 3 would not result in the unavailability of compliant products serving CFLK applications. (CA IOUs, No. 118 at p. 2) CA IOUs noted they had provided sufficient data indicating the LED industry will be able to comfortably support the EL at TSL 3, for a standard requiring compliance in 2019. (See section IV.C.4 and IV.D for a summary of data provided by CA IOUs) (CA IOUs, No. 118 at p. 7) PG&E stated that there was less innovation and R&D in CFL technology and more in LED and therefore, the largest benefit to the consumer would be a standard that can be met only by LED lamps (*i.e.,* TSL 3). (PG&E, Public Meeting Transcript, No. 112 at p. 129)

ASAP added that regarding both energy savings and performance characteristics, LED technology will replace CFLs in CFLKs. (ASAP, Public Meeting Transcript, No. 112 at pp. 129–130) The Joint Comment and CA IOUs stated that while manufacturers commented that TSL 3 or TSL 4 would reduce consumer choice because the CFLs commonly found in CFLKs today would no longer meet the standard, no unique utility has been defined that distinguishes CFLKs that use CFLs from ones that use LED lamps. (Joint Comment, No. 117 at p. 2; CA IOUs, No. 118 at p. 2) The Joint Comment and CA IOUs asserted that adopting TSL 3 would improve performance without loss of utility. (Joint Comment, No. 117 at p. 2; CA IOUs, No. 118 at p. 2) According to the Joint Comment, CA IOUs, and ASAP, the primary distinguishing characteristic of CFLKs that use CFLs appears to be lower cost. (Joint Comment, No. 117 at p. 2; CA IOUs, No. 118 at p. 2; ASAP, Public Meeting Transcript, No. 112 at pp. 129–130) ASAP warned that experience with low-priced CFLs had not been good and, therefore, maintaining CFLs would negatively impact consumer satisfaction, while adopting TSL 3 would maintain long-term health of the product category. ASAP stated that while DOE's methodology was sound, the rapid pace of technology called for an ambitious approach in setting standards. (ASAP, Public Meeting Transcript, No. 112 at pp. 129–130)

On the other hand, Hunter stated that the market for CFLKs was aesthetically-driven and because they were not driving innovation in LED technology, they could not ensure that the base types and associated product offerings would be there at levels higher than the proposed TSL 2. (Hunter, Public Meeting Transcript, No. 112 at p. 131) ALA stated that TSL 2 would allow manufacturers to continue to offer CFLKs with CFLs, which consumers value for their unique combination of performance and price. (ALA, No. 115 at p. 2) Further, it would allow manufacturers to continue offering

[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 email to *dipsweb@bls.gov*.

[67] U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II).* 1992. U.S. Government Printing Office: Washington, DC (Last accessed October 23, 2015.) *https://ia801602.us.archive.org/5/items/regionalmultipl00unit/regionalmultipl00unit.pdf.*

[68] Scott, M., J. Roop, O. Livingston, R. Schultz, and P. Balducci. *ImSET 3.1: Impact of Sector Energy Technologies Model Description and User's Guide.* 2009. Pacific Northwest National Laboratory,: Richland, WA. (Last accessed October 15, 2015.) *http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf.*

[69] *http://www.eceee.org/all-news/press/2014/rapid-development-LED-lamps.*

consumers nearly all CFLK models currently on the market at or near current market prices. (ALA, No. 115 at p. 2)

Further, ALA stated that manufacturers would have limited flexibility to comply with TSLs 3 or 4, which would negatively impact consumers. Westinghouse stated that while the main barrier to adoption of CFLs had been features, for LED lamps it is cost and size. (Westinghouse, Public Meeting Transcript, No. 112 at pp. 44–45) ALA stated that at TSL 3 manufacturers would need to redesign CFLKs with small base sockets and high lumen outputs and at TSL 4 manufacturers would need to redesign the most common, least efficacious CFLKs at significant cost, or else discontinue them, limiting the range of CFLKs available to consumers. (ALA, No. 115 at pp. 2–3) According to ALA, redesigning CFLKs to comply with TSL 3 or TSL 4 would, in many cases, adversely impact aesthetic appeal, a significant part of the utility CFLKs offer to consumers. (ALA, No. 115 at p. 3)

Lamps Plus stated that adopting TSL 2 does not limit potential CFLK designs and, at the same time, allows more efficient SSL technology to continue to develop. (Lamps Plus, Public Meeting Transcript, No. 112 at p. 132) ALA noted that the market is already moving towards more energy-efficient products. (ALA, Public Meeting Transcript, No. 112 at p. 131) PG&E agreed that the market was moving towards more efficient products, however, PG&E contended that this trend indicated that a higher standard (*i.e.,* TSL 3 or TSL 4) would just push the market in the direction it is already headed. (PG&E, Public Meeting Transcript, No. 112 at p. 129)

In its evaluation of TSLs, DOE assessed which products would be available at the time manufacturers would need to comply with standards. As TSL 4 corresponding to EL 4 is based on a modeled product, a lamp suitable for direct replacement that complies with EL 4 is not currently commercially available. DOE learned through interviews that most CFLK manufacturers do not manufacture lamps, but rather purchase lamps from another supplier or manufacturer to package in CFLKs. Because lamp manufacturers are not required to comply with standards promulgated by this rulemaking, DOE is uncertain as to whether such a lamp meeting EL 4 would be commercially available at the time CFLK manufacturers would need to comply with any amended standards.

DOE determined that EL 4 can be met by other methods available to CFLK manufacturers; however, most of these options require redesigns of existing fixtures. Some commercially available lamps with smaller base types meet EL 4, but these are available with low lumen outputs and would therefore require several lamps to be incorporated into a new CFLK to provide the same amount of light. Some commercially available lamps with the same base type as the baseline lamp are available at EL 4, but these have higher lumen outputs such that a CFLK would have to be redesigned with fewer sockets to maintain the same light output. Alternatively, LED modules and drivers with a similar lumen output as the baseline lamp could be incorporated as consumer replaceable parts in CFLKs. However, all of these methods of meeting EL 4 reflect the fact that, for most situations, direct lamp replacement would not be a means of meeting the EL.

At TSL 3 which corresponds to EL 3, the representative lamp unit is the most efficacious commercially available LED lamp that could be considered an adequate substitute for the baseline lamp (*i.e.,* has a non-reflector shape, a lumen output within 10 percent of the baseline lamp, a CCT around 2,700 K, a CRI greater than or equal to 80, a lifetime greater than or equal to that of the baseline, and a medium screw base). Small base lamps are available only with low lumen outputs, consumer replaceable LED modules and drivers in limited lumen ranges, and a few integrated LED modules and drivers systems are available at EL 3.

At TSL 2, which corresponds to EL 2, the representative lamp units are a commercially available LED lamp and CFL and at TSL 1, which corresponds to EL 1, the representative lamp unit is a commercially available CFL, all of which are considered adequate substitutes for the baseline lamp (*i.e.,* have a non-reflector shape, a lumen output within 10 percent of the baseline lamp, a CCT around 2,700 K, a CRI greater than or equal to 80, a lifetime greater than or equal to that of the baseline, and a medium screw base). At EL 2 and EL 1, CFLK manufacturers can choose from a large number of suitable options for direct lamp replacements, as well as fixture redesigns to meet this level. In particular, both consumer replaceable as well as integrated LED modules and drivers are available with lumen outputs that are not an option at higher ELs.

DOE also received comments regarding the energy savings as well as costs and benefits to consumers, manufacturers, and the nation resulting from the TSLs evaluated. ASAP recommended that DOE adopt TSL 3 given the potential energy savings estimated for that level. (ASAP, Public Meeting Transcript, No. 112 at pp. 129–130) The Joint Comment and CA IOUs stated that TSL 3 would generate significantly more energy savings than TSL 2. (Joint Comment, No. 117 at p. 1; CA IOUs, No. 118 at p. 2) On the other hand, Westinghouse commented that by proposing TSL 2, DOE had appropriately chosen a level that results in maximum energy savings. (Westinghouse, Public Meeting Transcript, No. 112 at p. 133) Lutron supported the proposal of TSL 2, stating that it would result in significant energy savings, well beyond that analyzed from the baseline. (Lutron, No. 113 at p. 2)

The Joint Comment and CA IOUs stated that DOE's analysis shows that adopting TSL 3 would result in CFLKs that are competitive on a first cost basis and superior on an LCC basis. (Joint Comment, No. 117 at p. 2; CA IOUs, No. 118 at p. 2) Further, the Joint Comment and CA IOUs noted that DOE's analysis shows that TSL 3 and TSL 4 with NPVs of $0.70 billion and $0.71 billion, respectively, at a 7% discount rate, are more cost effective than TSL 2 with NPV at $0.50 billion. (Joint Comment, No. 117 at p. 1; CA IOUs, No. 118 at p. 2)

Westinghouse appreciated that DOE factored INPV in its decision, an element Westinghouse stated is sometimes outweighed by other factors in some rulemakings. (Westinghouse, Public Meeting Transcript, No. 112 at p. 133) ALA stated that the MIA indicates that the economic impacts of TSLs 3 and 4 on manufacturers would be grave. ALA added that if TSL 3 or TSL 4 were adopted, CFLK manufacturers would be forced to significantly raise their prices in order to comply with the standard, which would be an untenable burden for industry to bear. (ALA, No. 115 at p. 3)

ALA stated that relative to TSL 2, the incremental burdens imposed on manufacturers by TSLs 3 and 4 are much larger than the corresponding incremental benefits in terms of national energy savings and consumer benefits. (ALA, No. 115 at p. 3) ALA and Lutron agreed that TSL 2 ensures the standard is economically justified while TSLs 3 and 4 do not. (ALA, No. 115 at pp. 2–3; Lutron, No. 113 at p. 2)

When selecting a TSL, DOE weighs the benefits and burdens of each TSL, considering to the extent practicable factors such as national energy savings and costs to the consumer, industry, and the nation. DOE first considers the max tech level, and then less-stringent levels until DOE determines the maximum increase in energy efficiency that is technologically feasible and economically justified. In the NOPR analysis and in this final rule DOE determined that TSL 2 is the highest TSL for which the benefits outweigh the burdens. (See section V.C.1 for further details.)

2. Regulatory Text

ALA commented that DOE should clarify that 10 CFR 430.32(s)(2) and 10 CFR 430.32(s)(3) are inapplicable to CFLKs subject to DOE's amended CFLK efficiency standards by replacing the phrase ''manufactured on or after January 1, 2007'' in each paragraph with ''manufactured on or after January 1, 2007, and before January 7, 2019.'' (ALA, No. 115 at p. 7)

Paragraphs (2) and (3) of 10 CFR 430.32(s) specify the current standards for respectively, CFLKs with medium screw base sockets and CFLKs with pin-base sockets for fluorescent lamps. Paragraph (4) of 10 CFR 430.32(s) specifies the current standards for CFLKs with other socket types. Once the amended standards established in this final rule require compliance, the efficacy and energy consumption requirements in 10 CFR 430.32(s)(2) through (s)(4) will be superseded by the amended standards. DOE notes that only the efficacy and energy consumption requirements are amended by this rulemaking. The other requirements in paragraphs (2)–(4) of 10 CFR 430.32(s) will remain in effect after the compliance date of this rule. Specifically, the following requirements will remain in effect: (1) The requirement for CFLKs to be packaged with lamps to fill all sockets; (2) lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, rapid cycle stress test, and lifetime for CFLKs with medium screw base sockets packaged with compact fluorescent lamps; and (3) use of an electronic ballast for CFLKs with pin-base sockets for fluorescent lamps.

The proposed regulatory language would have codified amended standards from this rulemaking in 10 CFR 430.32 (s)(5). As proposed, the efficacy and energy consumption standards in paragraphs (2) and (3) of 10 CFR 430.32(s) would no longer have been applicable to CFLKs subject to the amended standards by specifying an exception in paragraphs (2) and (3) for the minimum efficacy requirement provided in paragraph (s)(5) and specifying an exception in paragraph (4) for the requirements provided in paragraph (s)(5). This text was intended to indicate that the efficacy standards established in this rulemaking would supersede current efficacy and energy consumption requirements. Taking into consideration stakeholder suggestions, in this final rule, DOE modified the proposed regulatory language in paragraph (s)(2), (3), and (4) to state that the standards in those paragraphs are applicable to ceiling fan light kits manufactured on or after January 1, 2009 and prior to 3 years after date of final rule publication in the **Federal Register**. Further, in paragraph (s)(5), DOE has specified all of standards to which CFLKs will be subject at the compliance date of amended standards adopted in this final rule. For clarity, the references to paragraph (s)(5) in paragraphs (s)(2)–(s)(4) were eliminated, and all of the non-efficacy and energy consumption requirements were reiterated in paragraph (s)(5).

Philips expressed concern over the use of the term ''lifetime'' in the table of requirements, recommending that the term ''rated life'' be used instead. Philips referred DOE to the Philips and NEMA comments on the CFL test procedure rulemaking for further suggestions and background. (Philips, No. 119 at p. 3)

The certification values for compliance with the lifetime requirement in 10 CFR 430.32(s)(2) should be determined according to definitions and procedures specified in applicable DOE test procedures. Lifetime is a statutory definition, and DOE has proposed related definitions when necessary in test procedures for products included in this rulemaking (*i.e.,* CFLs and LED lamps). See *http://www.regulations.gov/#!docketDetail;D=EERE-2015-BT-TP-0014* and *http://www.regulations.gov/#!docketDetail;D=EERE-2011-BT-TP-0071* for further details.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for CFLKs. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for CFLKs, and the standards levels that DOE is adopting in this final rule. Additional details regarding DOE's analyses are contained in the final rule TSD supporting this document.

A. Trial Standard Levels

DOE analyzed the benefits and burdens of four TSLs for CFLKs. These TSLs were developed by combining specific ELs for each of the product classes analyzed by DOE. DOE presents the results for the TSLs in this document, while the results for all ELs that DOE analyzed are in the final rule TSD. Table V.1 presents the TSLs and the corresponding ELs for CFLKs. TSL 4 represents the maximum technologically feasible (''max-tech'') energy efficiency for the CFLK product class.

TABLE V.1—CFLK TRIAL STANDARD LEVELS

All CFLKs efficacy level	Trial standard level
1	1
2	2
3	3
4	4

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on CFLK consumers by looking at the effects potential amended standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on consumer subgroups. These analyses are discussed below.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) Purchase price increases, and (2) annual operating costs decrease. As discussed in section IV.D, however, DOE projects that higher-efficiency CFLKs will have a lower purchase price than less efficient products. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.,* product price plus installation costs), and operating costs (*i.e.,* annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the final rule TSD provides detailed information on the LCC and PBP analyses.

Table V.2 and Table V.3 show the LCC and PBP results for the TSL efficacy levels considered for the All CFLKs product class. In the first table, the simple payback is measured relative to the least efficient product on the market. In the second table, the LCC savings are measured relative to the no-new-standards efficacy distribution in the compliance year (see section IV.F.10 of this document).

TABLE V.2—AVERAGE LCC AND PBP RESULTS BY EFFICACY LEVEL FOR ALL CFLKS

EL	Average costs (2014$)				Simple payback (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
Residential Sector						
Sub *	2.8	17.4	70.3	71.3		13.8
0	5.5	3.6	40.4	45.6	0.2	13.8
1	8.8	3.4	40.0	48.4	0.4	13.8
2	19.4	2.9	33.4	51.8	1.2	13.8
3	10.5	2.0	23.4	32.8	0.5	13.8
4	9.3	1.9	22.0	30.3	0.4	13.8
Commercial Sector						
Sub *	2.8	76.9	194.5	196.7		13.8
0	5.5	15.8	136.9	142.9	0.0	13.8
1	8.8	14.9	157.2	167.3	0.1	13.8
2	19.4	12.8	140.8	160.6	0.3	13.8
3	10.5	9.0	107.7	117.8	0.1	13.8
4	9.3	8.5	104.9	113.8	0.1	13.8

* "Sub" corresponds to the sub-baseline (*i.e.,* lamps that have efficacies below the baseline set for the new product class structure set forth in this rulemaking).

Note: The results for each EL are calculated assuming that all consumers use products at that efficacy level. The PBP is measured relative to the least efficient product currently available on the market.

TABLE V.3—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS-CASE EFFICACY DISTRIBUTION FOR ALL CFLKS

TSL	Life-cycle cost savings	
	% of Consumers that experience	Average savings *
	Net cost	2014$
Residential Sector		
—	0.6	23.0
1	0.6	23.0
2	9.7	24.3
3	7.6	30.9
4	7.6	30.9
Commercial Sector		
—	10.5	28.7
1	10.5	28.7
2	1.9	53.4
3	0.3	67.7
4	0.3	67.8

* The LCC savings calculation excludes consumers with zero LCC savings (no impact).

Note: The results for each TSL represent the impact of a standard set at that TSL, based on the no-new-standards-case and standards-case efficacy distributions calculated in the shipments analysis. The calculation excludes consumers with zero LCC savings (no impact).

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households and small businesses that purchase CFLKs. Table V.4 and Table V.5 compare the average LCC savings for each TSL and the simple PBP at each efficacy level for the two consumer subgroups to the average LCC savings and the simple PBP for the entire sample. In most cases, the average LCC savings and the simple PBP for low-income households and small businesses that purchase CFLKs are not substantially different from the average LCC savings and simple PBP for all households and all buildings, respectively. Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.4—COMPARISON OF LCC SAVINGS AND PBP FOR LOW-INCOME HOUSEHOLDS AND ALL HOUSEHOLDS

TSL	Average LCC savings (2014$)		Simple payback period (years)	
	All	Low-income	All	Low-income
—	23.0	23.0	0.2	0.2
1	23.0	23.0	0.4	0.4
2	24.3	24.1	1.2	1.2
3	30.9	30.6	0.5	0.5
4	30.9	30.7	0.4	0.4

TABLE V.5—COMPARISON OF LCC SAVINGS AND PBP FOR SMALL BUSINESSES AND ALL BUSINESSES

TSL	Average LCC savings (2014$)		Simple payback period (years)	
	All	Low-income	All	Low-income
—	28.7	31.7	0.0	0.0
1	28.7	31.7	0.1	0.1
2	53.4	51.9	0.3	0.3
3	67.7	65.4	0.1	0.1
4	67.8	65.5	0.1	0.1

c. Rebuttable Presumption Payback

As discussed in section IV.F.12, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for CFLKs. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V.6 presents the rebuttable presumption payback periods for the considered TSLs. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, nation, and environment. The results of that analysis serve as the basis for DOE to evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

TABLE V.6—REBUTTABLE-PRESUMPTION PAYBACK PERIOD RESULTS

TSL	Residential sector	Commercial sector
—	0.2	0.4
1	0.4	0.1
2	1.1	0.2
3	0.5	0.1
4	0.4	0.1

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of CFLKs. Section V.B.2.a describes the expected impacts on manufacturers at each TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash-Flow Analysis Results

DOE examined the financial impacts (represented by changes in INPV) of today's adopted standards on CFLK manufacturers as well as the conversion costs that DOE estimates CFLK manufacturers would incur at each TSL. To evaluate the range of cash-flow impacts on the CFLK industry, DOE used the preservation of gross margin markup scenario to estimate the impacts on manufacturers. The preservation of gross margin markup scenario assumes that in the standards cases, manufacturers would be able to pass along any potential higher production costs required for more efficacious products to their consumers. Specifically, the industry would be able to maintain its average no-new-standards case gross margin (as a percentage of revenue) despite any potential higher production costs in the standards cases.

DOE also modeled a low investment scenario and a high investment scenario for manufacturers that corresponds to the range of potential investments manufacturers must make to comply with amended standards. Each investment scenario results in a unique set of cash flows and corresponding industry values at each TSL.

In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and the standards cases that result from the sum of discounted cash flows from the reference year (2015) through the end of the analysis period (2048). The results also discuss the difference in cash flows between the no-new-standards case and the standards cases in the year before the compliance date for the adopted standards. This difference in cash flow represents the size of the required conversion costs relative to the cash flow generated by the CFLK industry in the absence of amended energy conservation standards.

To assess the upper (less severe) end of the range of potential impacts on CFLK manufacturers, DOE modeled a low investment conversion cost scenario and to assess the lower (more severe) end of the range of potential impacts on CFLK manufacturers, DOE modeled a high investment conversion cost scenario.

In both the high and low investment scenarios, DOE expects that most manufacturers will not incur conversion costs at any of the TSLs in the lamp replacement scenario as a result of amended CFLK standards. Conversion costs in the lamp replacement scenario at each of the TSLs are attributed to complying with the EISA 2007 45 lm/W backstop rather than the standards adopted in this final rule. For the light kit replacement scenario, as efficacy levels increase with each TSL, product conversion costs will increase incrementally in proportion with the increasing amount of R&D needed to design more efficacious CFLKs. Manufacturers will incur capital conversion costs in the light kit replacement scenario as a result of amended CFLK standards requiring retooling costs to produce fixtures using LEDs. The product and conversion costs incurred by complying with today's CFLK standard in the light kit replacement scenario are additive to conversion costs incurred by complying with the EISA 2007 45 lm/W backstop. In the following results, DOE expresses conversion costs in terms of the conversion cost investment scenarios, which aggregate the conversion costs incurred by complying with the EISA 2007 backstop and the incremental conversion costs incurred at each TSL.

Table V.7 and Table V.8 present the projected range of potential results for CFLK manufacturers for the low investment and high investment scenarios.

TABLE V.7—MANUFACTURER IMPACT ANALYSIS FOR CEILING FAN LIGHT KITS—LOW INVESTMENT SCENARIO

	Units	No-new-standards case	Trial standard levels			
			1	2	3	4
INPV	2014$ millions	174.9	175.2	169.9	166.2	166.0
Change in INPV	2014$ millions		0.3	(5.0)	(8.7)	(8.9)
	%		0.2	(2.8)	(5.0)	(5.1)
Product Conversion Costs	2014$ millions	4.5	4.5	5.1	5.3	5.3
Capital Conversion Costs	2014$ millions	10.6	10.6	11.9	12.2	12.3
Total Conversion Costs	2014$ millions	15.1	15.1	17.0	17.5	17.7

TABLE V.8—MANUFACTURER IMPACT ANALYSIS FOR CEILING FAN LIGHT KITS—HIGH INVESTMENT SCENARIO

	Units	No-new-standards case	Trial standard levels			
			1	2	3	4
INPV	2014$ millions	174.9	175.2	168.5	164.3	164.0
Change in INPV	2014$ millions		0.3	(6.4)	(10.6)	(10.9)
	%		0.2	(3.7)	(6.0)	(6.2)
Product Conversion Costs	2014$ millions	4.5	4.5	5.6	6.0	6.1
Capital Conversion Costs	2014$ millions	10.6	10.6	13.3	13.9	14.1
Total Conversion Costs	2014$ millions	15.1	15.1	18.9	20.0	20.3

For the no-new-standards case, DOE typically assumes conversion costs are zero because manufacturers typically do not need to make additional investments beyond their normal capital expenditures and investments in research and development if no standards are prescribed by a rulemaking. However, DOE included conversion costs in the no-new-standards case since manufacturers would have to make significant investments to comply with the EISA 2007 45 lm/W backstop. DOE estimates CFLK manufacturers will incur product conversion costs of $4.5 million and capital conversion costs of $10.6 million to comply with the efficacy requirements prescribed by the EISA 2007 backstop. Product conversion costs include investments in research, development, testing, and marketing that manufacturers must make redesigning CFLKs to accommodate lamps that meet the EISA 2007 backstop efficacy requirements. Capital conversion costs include investments in production equipment that CFLK manufacturers would be required to make in order to significantly expand their CFLK manufacturing capacity to meet expected market demand for CFLKs that accommodate more efficacious CFL and LED lamps to comply with the EISA 2007 backstop.

TSL 1 sets the efficacy level at EL 1 for all CFLKs. At TSL 1, DOE estimates the impact on INPV to be $0.3 million or a change in INPV of 0.2 percent. At TSL 1, industry free cash flow (operating cash flow minus capital expenditures) is expected to decrease by approximately 12 percent to $9.3 million, compared to the no-new-standards case value of $10.5 million in 2018, the year leading up to the energy conservation standards.

The percentage impact on INPV is slightly positive at TSL 1. DOE anticipates that most manufacturers would not be significantly impacted at this TSL. DOE projects that in 2019, 100 percent of shipments that meet the efficacy level required by the no-new-standards case would also meet or exceed the efficacy level required at TSL 1.

At TSL 1, the shipment-weighted average MPC increases by 11 percent relative to the no-new-standards case MPC in 2019, the expected year of compliance. In both the high and low investment scenarios, manufacturers are able to recover their conversion costs through a moderate increase in MPC over the course over of the analysis period, resulting in a slightly positive INPV impact at TSL 1.

TSL 2 sets the efficacy level at EL 2 for all CFLKs. At TSL 2, DOE estimates impacts on INPV range from −$6.4 million to −$5.0 million, or a change in INPV of −3.7 percent to −2.8 percent. At TSL 2, industry free cash flow is expected to range from $7.8 million to $8.5 million, which represents a decrease of approximately 26 percent to 19 percent respectively, compared to the no-new-standards case value of $10.5 million in 2018, the year leading up to the energy conservation standards.

Percentage impacts on INPV are slightly negative at TSL 2. DOE anticipates that most manufacturers would not lose a significant portion of their INPV at TSL 2 because the ELs at this TSL can be met by purchasing replacement lamps that are currently available on the market. DOE projects that in 2019, 40 percent of shipments that meet or exceed the efficacy level required by the no-new-standards case would also meet or exceed the efficacy level required at TSL 2.

DOE expects product conversion costs will rise from $4.5 million at TSL 1 to $5.1 million at TSL 2 in the low investment scenario and from $4.5 million at TSL 1 to $5.6 million at TSL 2 in the high investment scenario. Manufacturers will incur product conversion costs, primarily driven by increased R&D efforts needed to redesign CFLKs to use LED lamps that meet the efficacy level at TSL 2. Capital conversion costs will increase from $10.6 million at TSL 1 to $11.9 million at TSL 2 in the low investment scenario and from $10.6 million at TSL 1 to $13.3 million at TSL 2 in the high investment scenario.

At TSL 2, the shipment-weighted average MPC increases by 25 percent relative to the no-new-standards case MPC in 2019. Manufacturers are not able to recover the $17.0 million in conversion costs in the low investment scenario or the $18.9 million in conversion costs in the high investment scenario through the increase in MPC over the course of the analysis period, resulting in slightly negative INPV impacts at TSL 2.

TSL 3 sets the efficacy level at EL 3 for all CFLKs. At TSL 3, DOE estimates impacts on INPV range from −$10.6 million to −$8.7 million, or a change in INPV of −6.0 percent to −5.0 percent. At this level, industry free cash flow is expected to range from $7.4 million to $8.3 million, which represents a decrease of approximately 30 percent and 21 percent respectively, compared to the no-new-standards case value of $10.5 million in 2018, the year leading up to the energy conservation standards.

Percentage impacts on INPV range are moderately negative at TSL 3. TSL 3 sets the first efficacy level that can be met only by LED lamps. DOE projects that in 2019, 17 percent of shipments that meet or exceed the efficacy level required by the no-new-standards case would also meet or exceed the efficacy level required at TSL 3.

DOE expects product conversion costs will rise from $5.1 million at TSL 2 to $5.3 million at TSL 3 in the low investment scenario and from $5.6 million at TSL 2 to $6.0 million at TSL 3 in the high investment scenario. Product conversion costs are driven primarily by increased R&D efforts needed to redesign CFLKs to accommodate the more efficacious LED lamps. DOE expects capital conversion costs to increase from $11.9 million at TSL 2 to $12.2 million at TSL 3 in the low investment scenario and from $13.3 million at TSL 2 to $13.9 million at TSL 3 in the high investment scenario as a result of retooling costs necessary to produce redesigned CFLK fixtures that use LEDs at TSL 3.

At TSL 3, the shipment-weighted average MPC increases by 27 percent relative to the no-new-standards case MPC in 2019. Manufacturers are not able to recover the $17.5 million in conversion costs in the low investment scenario or the $20.0 million in conversion costs in the high investment scenario through the increase in MPC over the course of the analysis period, resulting in moderately negative INPV impacts at TSL 3.

TSL 4 sets the efficacy level at EL 4 for all CFLKs, which represents max-tech. At TSL 4, DOE estimates impacts on INPV to range from −$10.9 million to −$8.9 million, or a change in INPV of −6.2 percent to −5.1 percent. At this level, industry free cash flow is expected to range from $7.2 million to $8.3, which represents a decrease of approximately 31 percent and 21 percent respectively, compared to the no-new-standards case value of $10.5 million in 2018, the year leading up to the energy conservation standards.

Percentage impacts on INPV are moderately negative at TSL 4. DOE projects that in 2019, 9 percent of shipments that meet or exceed the efficacy level required by the no-new-standards case would also meet or exceed the efficacy level required at TSL 4.

DOE expects product conversion costs will rise by less than $50 thousand dollars from TSL 3 to TSL 4 in the low investment scenario and slightly rise from $6.0 million at TSL 3 to $6.1 million at TSL 4 in the high investment scenario. DOE estimates manufacturers will incur slightly higher product conversion costs as they allocate more capital to R&D efforts necessary to redesign CFLKs that meet the max-tech EL. DOE expects capital conversion costs to increase slightly from $12.2 million at TSL 3 to $12.3 million at TSL 4 in the low investment scenario and from $13.9 million at TSL 3 to $14.1 million at TSL 4 in the high investment scenario due to retooling costs associated with the high number of models that will be redesigned in the light kit replacement scenario at TSL 4.

At TSL 4, the shipment-weighted average MPC increases by 26 percent relative to the no-new-standards case MPC in 2019. Manufacturers are not able to recover the $17.7 million in conversion costs in the low investment scenario or the $20.3 million in conversion costs in the high investment scenario through the increase in MPC over the course of the analysis period, resulting in moderately negative INPV impacts at TSL 4.

b. Impacts on Employment

DOE determined that there was only one CFLK manufacturer with domestic production of CFLKs, and this manufacturer's sales of ceiling fans packaged with CFLKs represents a very small portion of their overall revenue. During manufacturer interviews, manufacturers stated that the vast majority of manufacturing of the CFLKs they sell is outsourced to original equipment manufacturers located abroad. These original equipment manufacturers produce CFLKs based on designs from domestic CFLK manufacturers. Because of this feedback, DOE did not quantitatively assess any potential impacts on domestic production employment due to amended energy conservation standards on CFLKs.

c. Impacts on Manufacturing Capacity

CFLK manufacturers stated that they did not anticipate manufacturing capacity constraints as a result of amended energy conservation standards. If manufacturers redesign their CFLK fixtures to comply with amended standards, the original equipment manufacturers of CFLKs would be able to make the changes necessary to comply with standards in the estimated three years from the publication of this final rule to the compliance date. Additionally, at the standard levels adopted in this final rule, manufacturers have a range of options to comply with standards for a significant portion of the CFLKs by replacing the lamps with existing products that are sold on the market today. DOE does not anticipate any impact on manufacturing capacity as a result of this rulemaking. See section V.C.1 for more details on the standard adopted in this rulemaking.

d. Impacts on Subgroups of Manufacturers

Using average cost assumptions to develop an industry cash-flow estimate may not be adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche product manufacturers, and manufacturers exhibiting cost structures substantially different from the industry average could be affected disproportionately. DOE identified small business manufacturers as a subgroup that would require a separate analysis in the MIA. DOE analyzes the impacts on small businesses in section VI.B of this final rule. DOE did not identify any other adversely impacted manufacturer subgroups for CFLKs for this rulemaking based on the results of the industry characterization.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of recent or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducted a cumulative regulatory burden analysis as part of this rulemaking.

DOE identified a number of requirements, in addition to amended energy conservation standards for CFLKs, that CFLK manufacturers could face for products they manufacture approximately three years prior to and three years after the estimated compliance date of these amended standards. The following section addresses key concerns that manufacturers raised during interviews regarding cumulative regulatory burden.

Manufacturers raised concerns about existing regulations and certifications separate from DOE's energy conservation standards that CFLK manufacturers must meet. These include California Title 20, which has energy conservation standards identical to DOE's existing CFLK standards, but requires an additional certification, and Interstate Mercury Education and Reduction Clearinghouse (IMERC) labeling requirements, among others.

DOE discusses these and other requirements in chapter 12 of the final rule TSD, which lists the estimated compliance costs of those requirements when available. In considering the cumulative regulatory burden, DOE evaluates the timing of regulations that impact the same product because the coincident requirements could strain financial resources in the same profit center and consequently impact capacity. DOE identified the upcoming ceiling fan standards rulemaking and the GSLs standards rulemaking, as well as the 45 lm/W standard for GSLs in 2020, as potential sources of additional cumulative regulatory burden on CFLK manufacturers.

DOE has initiated a rulemaking to evaluate the energy conservation standards of ceiling fans by publishing a notice of availability for a framework document (78 FR 16443; Mar. 15, 2013) and preliminary analysis TSD. (79 FR 64712; Oct. 31, 2014) The CFLK standards adopted in this rulemaking affect many of the same manufacturers as the ongoing ceiling fan standards rulemaking and have a similar projected compliance date. Due to these similar projected compliance dates, manufacturers could potentially be required to make investments to bring CFLKs and ceiling fans into compliance during the same time period. Additionally, redesigned CFLKs could also require adjustments to ceiling fan redesigns separate from those potentially required by the ceiling fan rulemaking.

DOE has also initiated a rulemaking to evaluate the energy conservation standards of GSLs by publishing notices of availability for a framework document (78 FR 73737; Dec. 9, 2013) and preliminary analysis TSD. (79 FR 73503; Dec. 11, 2014) In addition, if standards from the GSL standards rulemaking do not produce savings greater than or equal to the savings from a minimum efficacy standard of 45 lm/W, sales of GSLs that do not meet the minimum 45 lm/W standard would be prohibited as of January 1, 2020. (42 U.S.C. 6295(i)(6)(A)(v)) Any potential standards established by the GSL rulemaking are also projected to require compliance in 2020. Potential standards promulgated from the GSL standards rulemaking and/or the operation of the GSL 45 lm/W provision will impact GSLs available to be packaged with CFLKs. Therefore, regardless of the standards in this rulemaking, CFLK manufacturers will likely need to package more efficacious lamps with CFLKs.

In addition to the amended energy conservation standards on CFLKs, several other existing and pending Federal regulations may apply to other products produced by lamp manufacturers and may subsequently impact CFLK manufacturers. These lighting regulations include the finalized metal halide lamp fixture standards (79 FR 7745; Feb. 10, 2014), the finalized general service fluorescent lamp standards (80 FR 4041; Jan. 26, 2015), and the ongoing high-intensity discharge lamp standards (80 FR 6016; Feb. 4, 2015). DOE acknowledges that each regulation can impact a manufacturer's financial operations. Multiple regulations affecting the same manufacturer can strain manufacturers' profit and possibly cause them to exit particular markets. Table V.9 lists the other DOE energy conservation standards that could also affect CFLK manufacturers in the three years leading up to and after the estimated compliance date of amended energy conservation standards for these products.

TABLE V.9—OTHER DOE REGULATIONS POTENTIALLY AFFECTING CFLK MANUFACTURERS

Regulation	Approximate compliance date	Estimated industry total conversion expenses
Metal Halide Lamp Fixtures	2017	$25 million (2012$).[70]
General Service Fluorescent Lamps	2018	$26.6 million (2013$).[71]
High-Intensity Discharge Lamps	* 2018	N/A.†
Ceiling Fans	* 2019	N/A.†
General Service Lamps	* 2019	N/A.†
Candelabra-Base Incandescent Lamps and Intermediate-Base Incandescent Lamps.	β N/A	N/A.†
Other Incandescent Reflector Lamps	β N/A	N/A.†

* The dates listed are an approximation. The exact dates are pending final DOE action.

† For energy conservation standards for rulemakings awaiting DOE final action, DOE does not have a finalized estimated total industry conversion cost.

β These rulemakings are placed on hold due to the Continuing Appropriations Act, 2016 (Pub. L. 114–53, Sept. 30, 2015).

Note: For minimum performance requirements prescribed by the Energy Independence and Security Act of 2007 (EISA 2007), DOE did not estimate total industry conversion costs because an MIA was not completed as part of the final rule codifying these statutorily-prescribed standards.

3. National Impact Analysis

a. Significance of Energy Savings

Toestimate the energy savings attributable to potential standards for CFLKs, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2019–2048). Table V.10 presents DOE's projections of the NES for each TSL considered for CFLKs. The savings were calculated using the approach described in section IV.H of this document.

TABLE V.10—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CFLKS SHIPPED IN 2019–2048

	Trial standard level (quads)			
	1	2	3	4
Primary Energy	0.008	0.047	0.066	0.067
FFC Energy	0.008	0.049	0.069	0.070

OMB Circular A–4 [72] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using nine, rather than 30, years of product shipments. The choice of a nine-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[73] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to CFLKs. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a nine-year analytical period are presented in Table V.11. The impacts are counted over the lifetime of CFLKs purchased in 2019–2027.

TABLE V.11—CUMULATIVE NATIONAL ENERGY SAVINGS FOR CFLKS; NINE YEARS OF SHIPMENTS
[2019–2027]

	Trial standard level (quads)			
	1	2	3	4
Primary Energy	0.008	0.047	0.064	0.065
FFC Energy	0.008	0.049	0.067	0.068

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for CFLKs. In accordance with OMB's guidelines on regulatory analysis,[74] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.12 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2019–2048.

TABLE V.12—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CFLKS SHIPPED IN 2019–2048

Discount rate	Trial standard level (billion 2014$)			
	1	2	3	4
3%	0.21	0.66	0.95	0.97
7%	0.21	0.50	0.70	0.71

[70] Estimated industry conversion expenses were published in the TSD for the February 2014 Metal Halide Lamp Fixtures final rule. 79 FR 7745. The TSD for the 2014 Metal Halide Lamp Fixture final rule can be found at *https://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/16.*

[71] Estimated industry conversion expenses were published in the TSD for the January 2015 general service fluorescent lamps final rule. 80 FR 4042. The TSD for the 2015 general service fluorescent lamps final rule can be found at *https://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/24.*

[72] U.S. Office of Management and Budget. *Circular No. A–4, Regulatory Analysis.* 2003. Washington, DC (Last accessed October 23, 2015.) *http://www.whitehouse.gov/sites/default/files/omb/assets/regulatory_matters_pdf/a-4.pdf.*

[73] Section 325(m) of EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6 year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some consumer products, the compliance period is 5 years rather than 3 years.

[74] U.S. Office of Management and Budget, ''Circular A–4: Regulatory Analysis,'' section E, (Sept. 17, 2003) (Available at: *http://www.whitehouse.gov/omb/circulars_a004_a-4/*).

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.13. The impacts are counted over the lifetime of products purchased in 2019–2027. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.13—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR CFLKS; NINE YEARS OF SHIPMENTS
[2019–2027]

Discount rate	Trial standard level (billion 2014$)			
	1	2	3	4
3%	0.21	0.66	0.92	0.93
7%	0.21	0.50	0.68	0.69

The above results reflect the use of a default trend to estimate the change in price for CFLKs over the analysis period (see section IV.G of this document). DOE also conducted a sensitivity analysis that considered a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the final rule TSD. In the high-price-decline case, the NPV is lower than in the default case. This is due the faster adoption of LED CFLKs in the no-new-standards case, which results in consumers moving to CFLKs that already meet or exceed potential standards. Therefore in this scenario, setting a standard does not move as many consumers to a higher efficacy level, resulting in lower energy savings from the standard.

c. Indirect Impacts on Employment

DOE expects energy conservation standards for CFLKs to reduce energy bills for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered in this rulemaking. DOE understands that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2019–2024), where these uncertainties are reduced.

The results suggest that the adopted standards are likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

DOE has concluded that the standards adopted in this final rule would not reduce the utility or performance of the CFLKs under consideration in this rulemaking. Manufacturers of these products currently offer units that meet or exceed the adopted standards.

5. Impact of Any Lessening of Competition

As discussed in section III.E.1.e, the Attorney General of the United States (Attorney General) to determine the impact, if any, of any lessening of competition likely to result from an amended standard and to transmit such determination in writing to the Secretary within 60 days of the publication of a final rule, together with an analysis of the nature and extent of the impact. To assist the Attorney General in making such determination, DOE provided the Department of Justice (DOJ) with copies of the NOPR and the TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for CFLKs are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

6. Need of the Nation To Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. As a measure of this reduced demand, chapter 15 of the final rule TSD presents the estimated reduction in generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from amended standards for CFLKs is expected to yield environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases. Table V.14 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The table includes both power sector emissions and upstream emissions. The emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

TABLE V.14—CUMULATIVE EMISSIONS REDUCTION FOR CFLKS SHIPPED IN 2019–2048

	Trial standard level			
	1	2	3	4
Power Sector Emissions				
CO_2 (*million metric tons*)	0.65	3.28	4.50	4.59
SO_2 (*thousand tons*)	0.71	2.56	3.40	3.46

TABLE V.14—CUMULATIVE EMISSIONS REDUCTION FOR CFLKS SHIPPED IN 2019–2048—Continued

	Trial standard level			
	1	2	3	4
NO_X (*thousand tons*)	0.52	3.25	4.53	4.63
Hg (*tons*)	0.00	0.01	0.01	0.01
CH_4 (*thousand tons*)	0.09	0.35	0.47	0.47
N_2O (thousand tons)	0.01	0.05	0.07	0.07
Upstream Emissions				
CO_2 (*million metric tons*)	0.02	0.14	0.20	0.20
SO_2 (*thousand tons*)	0.00	0.03	0.04	0.04
NO_X (*thousand tons*)	0.23	1.98	2.82	2.89
Hg (*tons*)	0.00	0.00	0.00	0.00
CH_4 (*thousand tons*)	1.32	10.88	15.54	15.92
N_2O (thousand tons)	0.00	0.00	0.00	0.00
Total FFC Emissions				
CO_2 (*million metric tons*)	0.66	3.42	4.70	4.79
SO_2 (*thousand tons*)	0.71	2.59	3.44	3.50
NO_X (*thousand tons*)	0.75	5.23	7.36	7.53
Hg (*tons*)	0.00	0.01	0.01	0.01
CH_4 (*thousand tons*)	1.42	11.23	16.01	16.39
CH_4 (thousand *tons* CO_2eq)*	39.62	314.42	448.21	458.92
N_2O (thousand tons)	0.01	0.05	0.07	0.07
N_2O (*thousand tons* CO_2eq)*	3.58	13.67	18.23	18.56

* CO_2eq is the quantity of CO_2 that would have the same GWP.

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the considered TSLs for CFLKs. As discussed in section IV.L of this document, for CO_2, DOE used the most recent values for the SCC developed by an interagency process. The four sets of SCC values for CO_2 emissions reductions in 2015 resulting from that process (expressed in 2014$) are represented by $12.2/metric ton (the average value from a distribution that uses a 5-percent discount rate), $40.0/metric ton (the average value from a distribution that uses a 3-percent discount rate), $62.3/metric ton (the average value from a distribution that uses a 2.5-percent discount rate), and $117/metric ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). The values for later years are higher due to increasing damages (public health, economic and environmental) as the projected magnitude of climate change increases.

Table V.15 presents the global value of CO_2 emissions reductions at each TSL. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values; these results are presented in chapter 14 of the final rule TSD.

TABLE V.15—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR PRODUCTS SHIPPED IN 2019–2048

TSL	SCC Case* (million 2014$)			
	5% Discount rate, average	3% Discount rate, average	2.5% Discount rate, average	3% Discount rate, 95th percentile
Power Sector Emissions				
1	8.7	29.5	43.3	83.2
2	33.1	128.3	196.0	379.4
3	43.9	172.9	265.3	513.6
4	44.6	176.1	270.4	523.5
Upstream Emissions				
1	0.3	0.9	1.2	2.4
2	1.4	5.4	8.3	16.1
3	1.9	7.6	11.7	22.6
4	2.0	7.8	11.9	23.1

TABLE V.15—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR PRODUCTS SHIPPED IN 2019–2048—Continued

TSL	SCC Case* (million 2014$)			
	5% Discount rate, average	3% Discount rate, average	2.5% Discount rate, average	3% Discount rate, 95th percentile
Total FFC Emissions				
1	9.0	30.3	44.5	85.5
2	34.5	133.7	204.4	395.5
3	45.8	180.5	277.0	536.2
4	46.6	183.9	282.3	546.6

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.2, $40.0, $62.3, and $117 per metric ton (2014$). The values are for CO_2 only (*i.e.,* not CO_{2eq} of other greenhouse gases).

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

DOE also estimated the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from the considered TSLs for CFLKs. The dollar-per-ton value that DOE used is discussed in section IV.L of this document. Table V.16 presents the cumulative present values for NO_X emissions for each TSL calculated using 7-percent and 3-percent discount rates. This table presents values that use the low dollar-per-ton values, which reflect DOE's primary estimate. Results that reflect the range of NO_X dollar-per-ton values are presented in Table V.18.

TABLE V.16—ESTIMATES OF PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR CFLKS SHIPPED IN 2019–2048

TSL	Million 2014$	
	3% Discount rate	7% Discount rate
Power Sector Emissions		
1	3.49	3.44
2	15.73	10.88
3	21.20	13.98
4	21.59	14.18
Upstream Emissions		
1	1.75	1.85
2	9.51	6.52
3	13.08	8.51
4	13.34	8.64
Total FFC Emissions		
1	5.25	5.29
2	25.24	17.40
3	34.27	22.49
4	34.93	22.82

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) No other factors were considered in this analysis.

8. Summary of National Economic Impacts

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V.17 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL for CFLKs considered in this rulemaking, at both a 7-percent and 3-percent discount rate. The CO_2 values used in the columns of each table correspond to the four sets of SCC values discussed above.

TABLE V.17—NET PRESENT VALUE OF CONSUMER SAVINGS COMBINED WITH PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS

TSL	Billion 2014$ Consumer NPV at 3% discount rate added with:			
	SCC Case $12.2/metric ton and 3% low NO_X values	SCC Case $40.0/metric ton and 3% low NO_X values	SCC Case $62.3/metric ton and 3% low NO_X values	SCC Case $117/metric ton and 3% low NO_X values
1	0.22	0.25	0.26	0.30
2	0.72	0.82	0.89	1.08
3	1.03	1.16	1.26	1.52

TABLE V.17—NET PRESENT VALUE OF CONSUMER SAVINGS COMBINED WITH PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS—Continued

TSL	Billion 2014$ Consumer NPV at 3% discount rate added with:			
	SCC Case $12.2/metric ton and 3% low NO_X values	SCC Case $40.0/metric ton and 3% low NO_X values	SCC Case $62.3/metric ton and 3% low NO_X values	SCC Case $117/metric ton and 3% low NO_X values
4	1.05	1.19	1.28	1.55
	Consumer NPV at 7% discount rate added with:			
TSL	SCC Case $12.2/metric ton and 7% low NO_X values	SCC Case $40.0/metric ton and 7% low NO_X values	SCC Case $62.3/metric ton and 7% low NO_X values	SCC Case $117/metric ton and 7% low NO_X values
1	0.22	0.25	0.26	0.30
2	0.55	0.65	0.72	0.91
3	0.76	0.90	0.99	1.25
4	0.78	0.91	1.01	1.28

In considering the above results, two issues are relevant. First, the national operating cost savings are domestic U.S. monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and the SCC are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2019 to 2048. Because CO_2 emissions have a very long residence time in the atmosphere,[75] the SCC values in future years reflect future climate-related impacts that continue beyond 2100.

C. Conclusion

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

For this final rule, DOE considered the impacts of amended standards for CFLKs at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest EL that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of: (1) A lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a regulatory option decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the final rule TSD. However, DOE's current analysis does not explicitly control for heterogeneity in consumer preferences, preferences across subcategories of products or specific features, or

[75] The atmospheric lifetime of CO_2 is estimated of the order of 30–95 years. Jacobson, MZ, "Correction to 'Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming,'" *J. Geophys. Res.* 110. pp. D14105 (2005).

consumer price sensitivity variation according to household income.[76]

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy conservation standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[77] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

1. Benefits and Burdens of TSLs Considered for CFLK Standards

Table V.18 and Table V.19 summarize the quantitative impacts estimated for each TSL for CFLKs. The national impacts are measured over the lifetime of CFLKs purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2019–2048). The energy savings, emissions reductions, and value of emissions reductions refer to FFC results. The ELs contained in each TSL are described in section V.A of this document.

TABLE V.18—SUMMARY OF ANALYTICAL RESULTS FOR CFLK TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4
Cumulative FFC National Energy Savings (quads):				
quads	0.008	0.049	0.069	0.070
NPV of Consumer Costs and Benefits (2014$ billion):				
3% discount rate	0.21	0.66	0.95	0.97
7% discount rate	0.21	0.50	0.70	0.71
Cumulative FFC Emissions Reduction (Total FFC Emission):				
CO_2 *(million metric tons)*	0.66	3.42	4.70	4.79
SO_2 *(thousand tons)*	0.71	2.59	3.44	3.50
NO_X *(thousand tons)*	0.75	5.23	7.36	7.53
Hg *(tons)*	0.00	0.01	0.01	0.01
CH_4 *(thousand tons)*	1.42	11.23	16.01	16.39
CH_4 *(thousand tons CO_2eq)* *	39.62	314.42	448.21	458.92
N_2O *(thousand tons)*	0.01	0.05	0.07	0.07
N_2O *(thousand tons CO_2eq)**	3.58	13.67	18.23	18.56
Value of Emissions Reduction (Total FFC Emissions):				
CO_2 *(2014$ billion)***	0.009 to 0.086	0.034 to 0.396	0.046 to 0.536	0.047 to 0.547
NO_X—3% discount rate *(2014$ million)*	5.2 to 12.4	25.2 to 58.3	34.3 to 78.9	34.9 to 80.4
NO_X—7% discount rate *(2014$ million)*	5.3 to 11.6	17.4 to 38.4	22.5 to 49.7	22.8 to 50.4

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
** Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

TABLE V.19—SUMMARY OF ANALYTICAL RESULTS FOR CFLK TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1 *	TSL 2 *	TSL 3 *	TSL 4 *
Manufacturer Impacts:				
Industry NPV (2014$ million) (No-new-standards case INPV = 174.9)	175.2	168.5–169.9	164.3–166.2	164.0–166.0
Industry NPV *(% change)*	0.2	(3.7)–(2.8)	(6.0)–(5.0)	(6.2)–(5.1)
Residential Sector				
Consumer Average LCC Savings (2014$):				
All CFLKs	23.0	24.3	30.9	30.9
Consumer Simple PBP ** (years):				
All CFLKs	0.4	1.2	0.5	0.4
% of Consumers that Experience Net Cost:				
All CFLKs	0.6	9.7	7.6	7.6
Commercial Sector				
Consumer Average LCC Savings (2014$):				
All CFLKs	28.7	53.4	67.7	67.8
Consumer Simple PBP ** (years):				
All CFLKs	0.1	0.3	0.1	0.1
% of Consumers that Experience Net Cost:				
All CFLKs	10.5	1.9	0.3	0.3

* Parentheses indicate negative (−) values.
** Simple PBP results are calculated assuming that all consumers use products at that efficacy level. The PBP is measured relative to the least efficient product currently available on the market

[76] P.C. Reiss and M.W. White, Household Electricity Demand, Revisited, *Review of Economic Studies* (2005) 72, 853–883.

[77] Alan Sanstad, Notes on the Economics of Household Energy Consumption and Technology Choice. Lawrence Berkeley National Laboratory (2010) (Available online at: *https://www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf*).

DOE first considered TSL 4, which represents the max-tech EL. TSL 4 would save 0.07 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $0.71 billion using a discount rate of 7 percent, and $0.97 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 4.79 Mt of CO_2, 3.50 thousand tons of SO_2, 7.53 thousand tons of NO_X, 0.01 tons of Hg, 16.4 thousand tons of CH_4, and 0.07 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reduction at TSL 4 ranges from $46.6 million to $546.6 million.

At TSL 4, the average LCC impact is a savings of $30.9 in the residential sector and a savings of $67.8 in the commercial sector. The simple payback period is 0.4 years in the residential sector and 0.1 years in the commercial sector. The fraction of consumers experiencing a net LCC cost is 7.6 percent in the residential sector and 0.3 percent in the commercial sector.

At TSL 4, the projected change in INPV ranges from a decrease of $10.9 million to a decrease of $8.9 million, which corresponds to decreases of 6.2 percent and 5.1 percent, respectively.

The Secretary concludes that at TSL 4 for CFLKs, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the reduction in manufacturer industry value and the potentially limited availability of compliant CFLKs discussed in section IV.O.1. Consequently, the Secretary has concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, which would save an estimated 0.069 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.70 billion using a discount rate of 7 percent, and $0.95 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 4.70 Mt of CO_2, 3.44 thousand tons of SO_2, 7.36 thousand tons of NO_X, 0.01 tons of Hg, 16.0 thousand tons of CH_4, and 0.07 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reduction at TSL 3 ranges from $45.8 million to $536.2 million.

At TSL 3, the average LCC impact is a savings of $30.9 in the residential sector and a savings of $67.7 in the commercial sector. The simple payback period is 0.5 years in the residential sector and 0.1 years in the commercial sector. The fraction of consumers experiencing a net LCC cost is 7.6 percent in the residential sector and 0.3 percent in the commercial sector.

At TSL 3, the projected change in INPV ranges from a decrease of $10.6 million to a decrease of $8.7 million, which corresponds to decreases of 6.0 percent and 5.0 percent, respectively.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that at TSL 3 for CFLKs, the benefits of energy savings, positive NPV of consumer benefits, and the estimated monetary value of the emissions reductions would be outweighed by the reduction in manufacturer industry value and by the potential limited availability of compliant CFLKs discussed in section IV.O.1. Consequently, the Secretary has concluded that TSL 3 is not justified.

DOE then considered TSL 2, which would save an estimated 0.049 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $0.50 billion using a discount rate of 7 percent, and $0.66 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 3.42 Mt of CO_2, 2.59 thousand tons of SO_2, 5.23 thousand tons of NO_X, 0.01 tons of Hg, 11.2 thousand tons of CH_4, and 0.05 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reduction at TSL 2 ranges from $34.5 million to $395.5 million.

At TSL 2, the average LCC impact is a savings of $24.3 in the residential sector and a savings of $53.4 in the commercial sector. The simple payback period is 1.2 years in the residential sector and 0.3 years in the commercial sector. The fraction of consumers experiencing a net LCC cost is 9.7 percent in the residential sector and 1.9 percent in the commercial sector.

At TSL 2, the projected change in INPV ranges from a decrease of $6.4 million to a decrease of $5.0 million, which corresponds to decreases of 3.7 percent and 2.8 percent, respectively.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that at TSL 2 for CFLKs, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, the estimated monetary value of the emissions reductions, and positive average LCC savings would outweigh the reduction in manufacturer industry value.

Accordingly, the Secretary has concluded that TSL 2 would offer the maximum improvement in efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy.

Therefore, based on the above considerations, DOE is adopting the energy conservation standards for CFLKs at TSL 2. The amended energy conservation standards for CFLKs, which are expressed as minimum lm/W, are shown in Table V.20.

TABLE V.20—AMENDED ENERGY CONSERVATION STANDARDS FOR CFLKS

Product class	Lumens [1]	Minimum required efficacy (lm/W)
All CFLKs	<120	50
	≥120	$74.0 - 29.42 \times 0.9983^{lumens}$

[1] Use the lumen output for each basic model of lamp packaged with the basic model of CFLK or each basic model of integrated SSL in the CFLK basic model to determine the applicable standard.

2. Summary of Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is the sum of: (1) The annualized national economic value (expressed in 2014$) of the benefits from operating products that meet the adopted standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, and (2) the annualized monetary value of the benefits of CO_2 and NO_X emission reductions.[78]

[78] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2014, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated

Table V.21 shows the annualized values for CFLKs under TSL 2, expressed in 2014$. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reductions (for which DOE used a 3-percent discount rate along with the average SCC series corresponding to a value of $40.0/ton in 2015 [2014$]), the estimated cost of the adopted standards for CFLKs is $6.0 million per year in increased equipment costs, while the estimated benefits are $55 million per year in reduced equipment operating costs, $7.5 million per year in CO_2 reductions, and $1.7 million per year in reduced NO_X emissions. In this case, the net benefit amounts to $59 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series corresponding to a value of $40.0/ton in 2015 (in 2014$), the estimated cost of the adopted standards for CFLKs is $4.0 million per year in increased equipment costs, while the estimated annual benefits are $41 million in reduced operating costs, $7.5 million in CO_2 reductions, and $1.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $46 million per year.

TABLE V.21—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS (TSL 2) FOR CFLKS

	Discount rate	Million 2014$/year		
		Primary estimate *	Low net benefits estimate *	High net benefits estimate *
Benefits				
Consumer Operating-Cost Savings	7%	55	36	59
	3%	41	24	43
CO_2 Reduction Value ($12.2/t) **	5%	2.6	1.4	2.7
CO_2 Reduction Value ($40.0/t) **	3%	7.5	3.9	7.9
CO_2 Reduction Value ($62.3/t) **	2.5%	11	5	11
CO_2 Reduction Value ($117/t) **	3%	22	12	24
NO_X Reduction Value †	7%	1.7	1.0	4.0
	3%	1.4	0.7	3.4
Total Benefits ††	7% plus CO_2 range	60 to 79	38 to 48	66 to 86
	7%	65	40	71
	3% plus CO_2 range	45 to 64	26 to 36	50 to 70
	3%	50	28	55
Costs				
Consumer Incremental Product Costs	7%	6.0	3.5	6.4
	3%	4.0	2.3	4.2
Total ††	7% plus CO_2 range	54 to 73	34 to 44	59 to 80
	7%	59	37	65
	3% plus CO_2 range	41 to 60	24 to 33	45 to 66
	3%	46	26	51

* This table presents the annualized costs and benefits associated with CFLKs shipped in 2019 − 2048. These results include benefits to consumers which accrue after 2048 from the products purchased in 2019 − 2048. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary Estimate assumes the reference case electricity prices and housing starts from *AEO 2015* and decreasing product prices for LED CFLKs, due to price learning. The Low Benefits Estimate uses the Low Economic Growth electricity prices and housing starts from *AEO 2015* and a faster decrease in product prices for LED CFLKs. The High Benefits Estimate uses the High Economic Growth electricity prices and housing starts from *AEO 2015* and the same product price decrease for LED CFLKs as in the Primary Estimate.

** The CO_2 values represent global monetized values of the SCC, in 2014$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series incorporate an escalation factor.

† The $/ton values used for NO_X are described in section IV.L. DOE estimated the monetized value of NO_X emissions reductions using benefit per ton estimates from the Regulatory Impact Analysis titled, "Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants," published in June 2014 by EPA's Office of Air Quality Planning and Standards. (Available at: *http://www3.epa.gov/ttnecas1/regdata/RIAs/111dproposalRIAfinal0602.pdf*.) See section IV.L.2 for further discussion. For DOE's Primary Estimate and Low Net Benefits Estimate, the agency is presenting a national benefit-per-ton estimate for particulate matter emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski *et al.,* 2009). For DOE's High Net Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele *et al.,* 2011), which are nearly two-and-a-half times larger than those from the ACS study. Because of the sensitivity of the benefit-per-ton estimate to the geographical considerations of sources and receptors of emissions, DOE intends to investigate refinements to the agency's current approach of one national estimate by assessing the regional approach taken by EPA's Regulatory Impact Analysis for the Clean Power Plan Final Rule.

†† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with a 3-percent discount rate ($40.0/t case). In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating-cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

with each year's shipments in the year in which the shipments occur (2020, 2030, *etc.*), and then discounted the present value from each year to 2015. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year that yields the same present value.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that the adopted standards for CFLKs are intended to address are as follows:

(1) Insufficient information and the high costs of gathering and analyzing relevant information leads some consumers to miss opportunities to make cost-effective investments in energy efficiency.

(2) In some cases the benefits of more efficient equipment are not realized due to misaligned incentives between purchasers and users. An example of such a case is when the equipment purchase decision is made by a building contractor or building owner who does not pay the energy costs.

(3) There are external benefits resulting from improved energy efficiency of appliances that are not captured by the users of such equipment. These benefits include externalities related to public health, environmental protection and national energy security that are not reflected in energy prices, such as reduced emissions of air pollutants and greenhouse gases that impact human health and global warming. DOE attempts to qualify some of the external benefits through use of social cost of carbon values.

The Administrator of the Office of Information and Regulatory Affairs (OIRA) in the OMB has determined that the regulatory action is not a significant regulatory action under section (3)(f) of Executive Order 12866. Section 6(a)(3)(A) of the Executive Order states that absent a material change in the development of the planned regulatory action, regulatory action not designated as significant will not be subject to review under section 6(a)(3) unless, within 10 working days of receipt of DOE's list of planned regulatory actions, the Administrator of OIRA notifies the agency that OIRA has determined that a planned regulation is a significant regulatory action within the meaning of the Executive order. Accordingly, DOE did not submit this final rule to OIRA for review.

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

DOE emphasizes as well that Executive Order 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, OIRA has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, DOE believes that this final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of a final regulatory flexibility analysis (FRFA) 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 (*http://energy.gov/gc/office-general-counsel*). DOE has prepared the following FRFA for the products that are the subject of this rulemaking.

1. Description of the Need For, and Objectives of, the Rule

A description of the need for, and objectives of, the rule is set forth elsewhere in the preamble and not repeated here.

2. Description of Significant Issues Raised by Public Comment

DOE received no comments specifically on the initial regulatory flexibility analysis prepared for this rulemaking. Comments on the economic impacts of the rule are discussed elsewhere in the preamble and did not necessitate changes to the analysis required by the Regulatory Flexibility Act.

3. Description of Comments Submitted by the Small Business Administration

The Small Business Administration did not submit comments on DOE's proposed rule.

4. Description on Estimated Number of Small Entities Regulated

For manufacturers of CFLKs, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. See 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description available at: *https://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf*. CFLK manufacturing is classified under NAICS code 335210, ''Small Electrical Appliance Manufacturing.'' The SBA sets a threshold of 750 employees or less for an entity to be considered as a small business for this category.

To estimate the number of companies that could be small businesses that sell CFLKs covered by this rulemaking, DOE conducted a market survey using publicly available information. DOE's research involved information provided by trade associations (*e.g.*, ALA[79]) and information from previous rulemakings, individual company Web sites, SBA's database, and market research tools (*e.g.*, Hoover's reports[80]). DOE also asked stakeholders and industry representatives if they were aware of any small businesses during manufacturer interviews and DOE public meetings. DOE used information from these sources to create a list of companies that potentially manufacture or sell CFLKs and would be impacted by this rulemaking. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a ''small business,'' or are completely foreign owned and operated.

For CFLKs, DOE initially identified a total of 67 potential companies that sell CFLKs in the United States. Of these, DOE identified only one manufacturer that also manufactures the lamps sold with their CFLKs. All other CFLK manufacturers source the lamps packaged with their CFLKs. After reviewing publicly available information on these potential small businesses, DOE determined that 40 were either large businesses or businesses that were completely foreign owned and operated. DOE determined that the remaining 27 companies were small businesses that either manufacture or sell covered CFLKs in the United States. The one CFLK manufacturer that also sells lamps that DOE identified is also a small business. Based on manufacturer interviews, DOE estimates that these small businesses account for approximately 25 percent of the CFLK market. One small business accounts for approximately five percent of the CFLK market, while all other small businesses account for one percent or less of the CFLK market individually.

5. Description and Estimate of Compliance Requirements

At TSL 2, the adopted standard in this final rule, DOE projects that impacts on small businesses as a result of amended standards would be consistent with the overall CFLK industry impacts presented in section V.B.2. Small businesses are not expected to experience differential impacts as a result of the amended CFLK standards due to the majority of large and small businesses sourcing the lamps used in their CFLKs from lamp manufacturers; small and large CFLK businesses typically outsourcing the manufacturing of the CFLKs they sell to original equipment manufacturers located abroad; and the range of available options to replace non-compliant lamps with lamps on the market that can meet the adopted standards.

DOE identified only one CFLK small business that is also a lamp manufacturer. For this analysis, DOE refers to lamp manufacturers as entities that produce and sell lamps, as opposed to purchasing lamps from a third party. The majority of lamps packaged in CFLKs are purchased from lamp manufacturers, then inserted into a CFLK or packaged with a CFLK. Therefore, CFLK businesses will typically not be responsible for the costs associated with producing more efficacious lamps packaged with CFLKs that comply with the adopted standards (though CFLK manufacturers would shoulder any increase in purchase price of a more efficacious lamp).

At the adopted standard level, CFLK businesses have the option to replace the lamps used in their CFLKs with more efficacious lamps available on the market. This lamp replacement option allows most CFLK businesses to comply with the adopted CFLK standards without redesigning their existing CFLKs. However, these more efficacious lamps could be more expensive for CFLK manufacturers to purchase and could require CFLK manufacturers to increase the sale price of their CFLKs to recover these higher production costs. DOE's shipments analysis found that approximately 50 percent of CFLKs sold at TSL 2 will follow this lamp replacement option, allowing these CFLK businesses to avoid redesign and conversion costs. Based on manufacturer interviews, small businesses are just as likely to pursue the lamp replacement option as large businesses.

DOE expects that CFLK businesses that meet amended CFLK standards by redesigning CFLK fixtures instead of replacing lamps are expected to incur conversion costs driven by retooling costs, increased R&D efforts, product certification costs, and testing costs. DOE learned during manufacturer interviews that the majority of the manufacturing of CFLKs by small and large CFLK businesses is outsourced to a limited number of original equipment manufacturers located abroad. CFLK businesses typically pay retooling costs to these original equipment manufacturers located abroad, who operate and maintain machinery used to produce the CFLKs that those businesses then sell.

DOE also learned from manufacturer interviews that, in some cases, multiple CFLK businesses, including small and large CFLK businesses, are outsourcing production to the same original equipment manufacturer located abroad. Small businesses are currently competing against large businesses despite purchasing components at lower volumes, and DOE expects that they will continue to compete after the adoption of standards, because the adopted standards will not significantly disrupt most CFLK manufacturers' supply chain. DOE does not expect that small businesses would be disadvantaged compared to large businesses if they redesign their CFLKs. Total estimated conversion costs for the industry at TSL 2 range from $17.0 million in the low investment scenario to $18.9 million in the high investment scenario.

As stated in section V.B.2.a, DOE estimates that CFLK manufacturers may experience a decrease in INPV ranging from a decrease of 3.7 percent to a decrease of 2.8 percent at TSL 2. For the reasons outlined previously, DOE has determined that most small businesses would not be disproportionally impacted by the adopted CFLK energy conservation standard compared to industry average impacts previously stated. DOE estimates that the overall percent change in INPV for the CFLK industry is reflective of the range of potential impacts for small businesses as well.

DOE notes that because lamp manufacturers typically test and certify their lamps, CFLK businesses can use the testing and certification data provided by the lamp manufacturer to comply with the CFLK standards. By using existing testing and certification data, both large and small CFLK businesses can significantly reduce their own testing and certification costs associated with complying with amended CFLK standards. DOE emphasizes, however, that CFLK manufacturers are ultimately responsible for demonstrating compliance with applicable CFLK standards.

6. Description of Steps Taken To Minimize Impacts to Small Businesses

The discussion in the previous section analyzes impacts on small businesses that would result from DOE's final rule. In reviewing alternatives to the final rule, DOE examined energy conservation standards set at higher and lower ELs.

[79] American Lighting Association Company Information Industry Information Lists, *http://www.americanlightingassoc.com/*) (Last accessed Nov 13, 2015).

[80] Hoovers Company Information Industry Information Lists, *http://www.hoovers.com/*) (Last accessed Nov 13, 2015).

With respect to TSL 4, DOE estimated that while there would be significant consumer benefits from the projected energy savings of 0.07 quads (ranging from $0.71 billion using a 7-percent discount rate to $0.97 billion using a 3-percent discount rate), along with emissions reductions, the overall impacts would result in an INPV reduction of 5.1–6.2 percent. DOE determined that this INPV reduction, along with the potential limited availability of compliant CFLKs, would outweigh the potential benefits. For TSL 3, DOE estimated that while there would be significant consumer benefits from the projected energy savings of 0.069 quads (ranging from $0.70 billion using a 7-percent discount rate to $0.95 billion using a 3-percent discount rate), along with emissions reductions, the overall impacts would result in an INPV reduction of 5.0–6.0 percent. DOE determined that this INPV reduction, along with the potential limited availability of compliant CFLKs, would outweigh the potential benefits. In addition, while TSL 1 would reduce the impacts on small business manufacturers, it would come at the expense of a significant reduction in energy savings and NPV benefits to consumers, achieving 83 percent lower energy savings and 58 percent less NPV benefits to consumers compared to the energy savings and NPV benefits at TSL 2.

EPCA requires DOE to establish standards at the level that would achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. Based on its analysis, DOE concluded that TSL 2 achieves the maximum improvement in energy efficiency that is technologically feasible and economically justified. Therefore, DOE did not establish standards at the levels considered at TSLs 3 and 4 because DOE determined that they were not economically justified. DOE's analysis of economic justification considers impacts on manufacturers, including small businesses. While TSL 1 would reduce the impacts on small business manufacturers, EPCA prohibits DOE from adopting TSL 1.

In summary, DOE concluded that establishing standards at TSL 2 balances the benefits of the energy savings and the NPV benefits to consumers at TSL 2 with the potential burdens placed on CFLK manufacturers, including small business manufacturers. Accordingly, DOE does not adopt any of the other TSLs considered in the analysis, or the other policy alternatives detailed as part of the regulatory impacts analysis included in chapter 17 of the final rule TSD.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. Additionally, Section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of CFLKs must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for CFLKs, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including CFLKs. *See generally* 10 CFR part 429. The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that the rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR part 1021, App. B, B5.1(b); 1021.410(b) and App. B, B(1)–(5). The rule fits within this category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this rule. DOE's CX determination for this rule is available at *http://energy.gov/nepa/categorical-exclusion-cx-determinations-cx*.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism.'' 64 FR 43255 (Aug. 10, 1999) imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this 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 as to energy conservation for the products that are the subject of this final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf*.

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

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

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

I. Review Under Executive Order 12630

Pursuant to Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights'' 53 FR 8859 (March 18, 1988), DOE has determined that this rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed this final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

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

L. Review Under the Information Quality Bulletin for Peer Review

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

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

M. Congressional Notification

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

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects

10 CFR Part 429

Confidential business information, Energy conservation, Household appliances, Imports, Reporting and recordkeeping requirements.

10 CFR Part 430

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

Issued in Washington, DC, on December 17, 2015.

David T. Danielson,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, DOE amends parts 429 and 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

■ 2. Section 429.33 is amended by revising the introductory text of paragraph (a)(3) to read as follows:

§ 429.33 Ceiling fan light kits.

(a) * * *

(3) For ceiling fan light kits that require compliance with the January 7, 2019 energy conservation standards:

* * * * *

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 3. The authority citation for part 430 continues to read as follows:

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

■ 4. Section 430.23 is amended by revising the introductory text of paragraph (x)(2) to read as follows:

§ 430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(x) * * *

(2) For each ceiling fan light kit that requires compliance with the January 7, 2019 energy conservation standards:

* * * * *

■ 5. Section 430.32 is amended by:

■ a. Revising the introductory text of paragraphs (s)(2) and (3);

■ b. Revising paragraph (s)(4); and

■ c. Adding paragraph (s)(5).

The addition and revisions read as follows:

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

* * * * *

(s) * * *

(2) Ceiling fan light kits manufactured on or after January 1, 2007, and prior to January 7, 2019, with medium screw base sockets must be packaged with medium screw base lamps to fill all sockets. These medium screw base lamps must—

* * * * *

(3) Ceiling fan light kits manufactured on or after January 1, 2007, and prior January 7, 2019, with pin-based sockets for fluorescent lamps must use an electronic ballast and be packaged with lamps to fill all sockets. These lamp ballast platforms must meet the following requirements:

* * * * *

(4) Ceiling fan light kits manufactured on or after January 1, 2009, and prior to January 7, 2019, with socket types other than those covered in paragraphs (s)(2) or (3) of this section, including candelabra screw base sockets, must be packaged with lamps to fill all sockets and must not be capable of operating with lamps that total more than 190 watts.

(5) Ceiling fan light kits manufactured on or after January 7, 2019 must be packaged with lamps to fill all sockets, and each basic model of lamp packaged with the basic model of CFLK and each basic model of integrated SSL in the CFLK basic model shall meet the requirements shown in the table:

Lumens [1]	Minimum required efficacy (lm/W)
<120	50
≥120	$(74.0 - 29.42 \times 0.9983^{\text{lumens}})$

[1] Use the lumen output for each basic model of lamp packaged with the basic model of CFLK or each basic model of integrated SSL in the CFLK basic model to determine the applicable standard.

(i) Ceiling fan light kits with medium screw base sockets manufactured on or after January 7, 2019 and packaged with compact fluorescent lamps must include lamps that also meet the following requirements:

Lumen Maintenance at 1,000 hours	≥90.0%.
Lumen Maintenance at 40 Percent of Lifetime	≥80.0%.
Rapid Cycle Stress Test	Each lamp must be cycled once for every 2 hours of lifetime of compact fluorescent lamp as defined in § 430.2. At least 5 lamps must meet or exceed the minimum number of cycles.
Lifetime	≥6,000 hours for the sample of lamps.

(ii) Ceiling fan light kits with pin based sockets for fluorescent lamps, manufactured on or after January 7, 2019, must also use an electronic ballast.

* * * * *

Note: The following attachment will not appear in the Code of Federal Regulations.

U.S. DEPARTMENT OF JUSTICE

Antitrust Division

RFK Main Justice Building 950 Pennsylvania Avenue NW., Washington, DC 20530–0001, (202) 514–2401/(202) 616–2645 (Fax)

October 13, 2015

Anne Harkavy
Deputy General Counsel
For Litigation, Regulation and Enforcement

Department of Energy
Washington, DC 20585

Dear Deputy General Counsel Harkavy:

I am responding to your letter of October 2, 2015 seeking the views of the Attorney General about the potential impact on competition of proposed amended energy conservation standards for Ceiling Fan Light Kits. Your request was submitted under Section 325 (o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended (EPCA), 42 U.S.C. 6295(o)(2)(B)(i)(V), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the Assistant Attorney General for the Antitrust Division in 28 CFR 0.40(g).

In conducting its analysis, the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice or increasing industry concentration. A lessening of competition could result in higher prices to manufacturers and consumers.

We have reviewed the proposed standards contained in the Notice of Proposed Rulemaking published in the **Federal Register** (80 FR 156, at 48624–48682, August 13, 2015) (NOPR). We have also reviewed supplementary information submitted to the Attorney General by the Department of Energy, including the Technical Support Document, and reviewed industry source material.

Based on this review, our conclusion is that the proposed amended energy conservation standards set forth in the NOPR for Ceiling Fan Light Kits are unlikely to have a significant adverse impact on competition.

Sincerely,

William J. Baer

[FR Doc. 2015–33071 Filed 1–5–16; 8:45 am]

BILLING CODE 6450–01–P