REGULATORY IMPACT ANALYSIS

Energy Conservation Standards for Consumer Products

Covering: Fluorescent Lamp Ballasts

U.S. DEPARTMENT OF ENERGY
Energy Efficiency and Renewable Energy, Office of Building Technologies

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1. INTRODUCTION

Part B of Title III of the Energy Policy and Conservation Act (EPCA) (P.L. 94-163), as amended by the National Energy Conservation Policy Act (NECPA) (P.L. 95-619), by the National Appliance Energy Conservation Act (NAECA) (P.L. 100-12), by the National Energy Conservation Amendments of 1988 (NAECA 1988) (P.L. 100-357), and the Energy Policy Act of 1992 (EPAct) (P.L. 102-486) created the Energy Conservation Program for Consumer Products other than Automobiles. The consumer products covered by this program (often referred to hereafter as "covered products") are: refrigerators, refrigerator-freezers and freezers; dishwashers; clothes dryers; water heaters; central air conditioners and central air conditioning heat pumps; furnaces; direct heating equipment; television sets; kitchen ranges and ovens; clothes washers; room air conditioners; pool heaters; fluorescent lamp ballasts; and any other consumer product classified by the Secretary of Energy [Section 322]. To date, the Secretary has not so classified any additional products.

For 12 covered products, the Act prescribes an initial Federal energy conservation standard [Section 325 (b) - (h)]. The Act establishes effective dates for the standards in 1988, 1990, 1992, or 1993, depending on the product, and specifies that the standards are to be reviewed by the Department within three to ten years, also depending on the product [Section 325(b) - (h)]. After the specified three- to ten-year period, DOE may promulgate new standards for each product; however, the Secretary may not prescribe any amended standard which increases the maximum allowable energy use, or decreases the minimum required energy efficiency, of a covered product [Section 325 (1) (1)].

The Act required DOE to publish a final rule no later than January 1, 1992, to determine if the standards on fluorescent lamp ballasts should be amended. [Section 325(g) (4) (A) (i)] This product is the subject of the rulemaking for which this Regulatory Impact Analysis is being issued.

Any new or amended standard must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible, and economically justified [Section 325 (1) (2) (A)].

Section 325 (1) (2) (B) (i) provides that before DOE determines whether a standard is economically justified, it must first solicit comments on a proposed standard. After reviewing comments on the proposal, DOE must then determine that the benefits of the standard exceed its burdens, based, to the greatest extent practicable, on a weighing of the following seven factors:

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

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

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

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

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

(6) The need for national energy conservation; and

(7) Other factors the Secretary considers relevant.

In addition, the Act specifies criteria for petitions to DOE in regard to amendments to standards [Section 325 (k)]. Under the Act, any person may petition the Department to conduct a rulemaking to amend a Federal energy conservation standard for any covered product [Section 325 (k) (l)]. The Department must grant such a petition if it determines that an amended standard will result in significant conservation of energy, is technologically feasible and is cost-effective [Section 325 (k) (2)].

This Regulatory Impact Analysis describes the analyses performed by DOE to arrive at the proposed energy efficiency standards for the product types listed above.

Executive Order 12866 (58 FR 51735, October 4, 1993) directs that, in proposing a significant regulatory action, an agency perform a regulatory analysis. Such an analysis presents major alternatives to the regulation that could achieve substantially the same regulatory goal, as well as a description of the costs and benefits (quantified, to the extent feasible) of the proposed rule.

DOE has determined that this proposed rule is a "significant regulatory action".

Since Congress mandated that DOE promulgate performance standards, the only other alternative within the boundaries of the law is a no-standard alternative. However, in preparing this Regulatory Impact Analysis, the list of alternatives has been expanded to include alternatives that would require new enabling legislation or statutory amendments.

This Regulatory Impact Analysis is concerned with the projected economic impacts of the standards, and their major alternatives, on the nation as a whole.

In addition to examining possible alternatives to the proposed standards, this Regulatory Impact Analysis examines the way in which performance criteria and other factors are defined and measured for the proposed standards. The proposed alternatives are examined for reasonableness and possible biases which might affect the success of the standards in achieving the legislated goals of energy conservation and reduced demand for energy. The analysis briefly presents the results of the Technical Support Document (TSD)[1] and explains how these results were used to determine the relative impact of the proposed standards on the nation.

2. DESCRIPTION AND ANALYSIS OF MAJOR ALTERNATIVES

There are many methods to achieve energy conservation through the increased energy efficiency of consumer products. This section describes and analyzes various regulatory and non-regulatory alternatives and their effectiveness in conserving energy.

The alternatives examined in this analysis ranged from the no-action alternative or the "base case" against which the benefits of other alternatives were measured to alternatives requiring new legislation for implementation.

Each alternative has been analyzed in comparison to the other alternatives in terms of potential energy savings, net present value, and other impacts that differ among the alternatives. A summary of this comparative analysis is presented in the following section. A detailed discussion and quantitative description of each alternative is presented in the remaining sections of this chapter.

2.1 Comparative Analysis of the Alternatives

To compare each alternative quantitatively to the proposed conservation standards in terms of energy savings and the net present value (or cost savings), it was necessary to quantify the effect of each alternative on the purchase and use of energy-efficient fluorescent ballasts. Each alternative to the proposed regulation was quantified so that inputs to the Lawrence Berkeley National Laboratory model (LBNL-NES v.4) could be determined. The NES model was used to calculate the energy use and the net present value corresponding to each alternative. The key inputs to the forecasting model were:

- national shipments forecasts;
- electricity price projections;
- ballast system characteristics;

- percentages of different ballast types in fixtures;
- percentages of ballasts converted to different ballast types under standards;
- years of standards implementation; and
- social discount rate.

The price and energy consumption inputs to the forecasting model are shown in Table R.1. Only those parameters that were needed to specify the alternatives were changed from the base case. Otherwise, all aspects of the base case remained constant throughout the analysis to permit a quantitative comparison of the alternatives without extraneous effects.

Note that for this regulatory impact analysis, the alternative policies assumed that for four-foot electronic systems, T8 electronic ballasts are used. The lamp/ballast systems were assumed to operate in commercial sector buildings, except for eight-foot HO ballasts, which were assumed to operate in the industrial sector.

The results from the forecasting model are summarized in the first two columns of Table R.2 for each alternative evaluated. All results are reported relative to the base or no-action case so that the energy savings resulting from each alternative can be assessed readily. Most alternatives would result in some energy savings and in positive net present value compared to the base case. As the comparison shows, the proposed approach resulted in appreciably higher energy savings and a greater national net present value than the other alternatives.

Table R.1 Ballast Price vs Energy Consumption

Technology Option	Incremental Ballast Price (1997$)	Unit Energy Savings kWh/a
1-lamp F32T8 (Commercial)	6.69	52
2-lamp F32T8 (Commercial)	8.37	62
3-lamp F32T8 tandem-wired (Commercial)	12.56	92
3-lamp F32T8 non-tandem-wired (Commercial)	-4.03	116
4-lamp F32T8 (Commercial)	-1.45	122
2-lamp F96T12/ES (Commercial)	17.37	49
2-lamp F96T12HO/ES (Industrial)	12.05	108

The impacts of measures of each program were:

- Commercial and Industrial Energy Savings (Quads, exajoules = 10^{18} joule). Cumulative energy use from the base case projection minus the alternative case projection. Cumulative from 2003-2030 or 2005-2030. Electricity consumption reported as primary energy.

- Net Present Value. Value of future savings from ballasts bought in the period 2003-2030 or 2005-2030. Calculated as the present value of the equipment and energy expenditures in the base case minus the present value of expenditures in the alternative case. Future fuel and equipment expenditures discounted to 1997 using a 7 percent real discount rate. Electricity cost savings associated with any ballasts purchased by 2030 and occurring in years after 2030, as well as the costs of replacement lamps purchased after 2030 to be used in ballasts purchased before 2030, were included in the total for the NPV calculations.

The additional columns presented in Table R.2 focus on other aspects of each alternative that are pertinent to the regulatory analysis, including:

- equity impacts (or effects on the well-being of the nation);

- whether legislative authority exists for implementing the alternative;

- major barriers to implementation and enforcement (other than legislative);

- impact of the alternative on competition; and

- compliance and reporting requirements of each alternative.

These factors for each alternative were compared to the proposed standards. None of the alternatives showed energy or economic savings comparable to the proposed program. The proposed approach appeared to be less favorable than some of the other program alternatives in competition and reporting/compliance requirements. (See Table R.2, Expected Impacts of Program Alternatives) Those program alternatives (voluntary targets, enhanced labeling/consumer education, government purchases, lighting research) that involve non-mandatory methods for achieving more energy-efficient consumer products fared better in these two areas. However, the reporting/compliance requirements and the potential effects on competition of the performance standards must be weighed against the greater and more certain energy savings of the proposed approach compared to what the alternatives could achieve in this area.

2.2 No-Action Alternative

This alternative was analyzed as the "base case" and assumed that the proposed standards were not implemented. The no-action alternative did not imply that no energy savings would be realized; some energy savings would be achieved because of higher energy costs, the continuation of other Federal and private sector energy conservation activities, and state adoption of building energy codes. These programs include the deregulation of energy prices, the Environmental Protection Agency's (EPA) Energy Star Buildings/Green Lights program, the National Electrical Manufacturers Association's (NEMA) Energy Cost Savings Council, the Federal Energy Management Program's activities, and the Energy Policy Act of 1992 (EPAct) voluntary luminaire efficacy rating program.

2.2.1 Energy Prices

In recent years, the prices of natural gas and oil have been deregulated. Projected energy prices to the year 2020 for the commercial and industrial sectors were developed by the Energy Information Agency in the Annual Energy Outlook 1999 (AEO 99). Prices after the year 2020 were assumed to be constant at the 2020 price. The AEO 99 Reference case electricity price projection was adjusted to represent marginal prices for each sector.

The results in Table R.2 show energy savings and NPV for the Decreasing Shipments to 2027 base case. The savings are in source Quads, with source Exajoules in parentheses and italics. These are the savings in lighting electricity use; savings including net HVAC interactions are about 6 percent higher (see Appendix B). For most of the alternative cases, the savings shown are from 2003 to 2030. For the Voluntary Energy Efficiency Targets and the Performance Standards, the savings shown are from 2005 to 2030 (as discussed below, those scenarios were assumed to begin in 2005).

Table R.2 Expected Impacts of Program Alternatives

Alterative Programs		Fluorescent Lamp Ballasts: Energy Savings Quad (EJ)	Fluorescent Lamp Ballasts: NPV*** (billion 1997$)	Equity Impacts*	Legislative Authority	Major Barriers to Implementation & Enforcement	Competition	Compliance & Reporting Requirements
No Action		0	None	None	**	None	None	None
Tax Credits (Consumers)		0.21 *(0.22)*	0.31	Some costs will be borne by all taxpayers regardless of purchase of energy efficient product	No	None, other than legislative	May favor large manufacturers	Could be unwieldy
Tax Credits (Manufacturers)		0	0	"	No	Enforcement problems likely	"	"
Rebates (Consumers)		0.36 *(0.38)*	0.53	"	No	Potential difficulties in administration	"	"
Voluntary Energy Efficiency Targets	10-yr delay	0.77 *(0.81)*	0.68	None	No	No assurance that participation will be widespread	None	None
	5-yr delay	1.54 *(1.62)*	1.52					
Consumer Education and Labeling	Current Tech.	0.09 *(0.09)*	0.12	None	Yes	None	None	Minimal (labeling)
	Advanced Tech. (Controls)	0.10 *(0.10)*	0.13					
Government Purchases		0.30 *(0.32)*	0.40	None	No	None	Not anti-competitive	None
Lighting Research		0.04 *(0.05)*	0.04	None	Yes	None	Technology transfer must be distributed	None

Building Codes	0.15 *(0.16)*	0.18	None	Yes	Compliance verification necessary	None	Extensive
Performance Standards	2.23 *(2.35)*	2.59	None	Yes	None	Not anti-competitive	Reasonable

Key: None = 0 or not significant
EJ = 10^{18} Joule
Quad = 10^{15} Btu of energy

Notes: * Economic well-being of nation as a whole.
** Yes, if no standard is justified
*** Net present value for fuel and equipment discounted to 1997 at 7percent real

2.2.2 Existing Consumer Information Programs

Congress mandated in the Energy Policy and Conservation Act (EPCA) (P.L. 94-163) both a labeling program and a complementary consumer education and information program. The labeling program took effect on May 21, 1980, implemented by the Federal Trade Commission (FTC); the public education and information program is being handled by DOE. In the Energy Policy Act of 1992 (EPAct, P.L. 102-486), Congress also stimulated the formation of a voluntary luminaire program to provide information on the efficacy of the fluorescent luminaire system. The luminaire efficacy rating (LER) is greatly improved with the use of an electronic ballast.

Under the labeling program, consumer awareness of the relative efficacies of luminaires available in the marketplace is expected to increase. That is, the basic information that consumers need to make a *rational* purchase decision would be more available to them.

The EPA's Energy Star Buildings program (including the Green Lights program), NEMA's Enegy Cost Savings Council, and the EPAct voluntary luminaire efficacy rating program, provide information and assistance to consumers on selecting efficient ballasts and upgrading lighting systems. The educational activities focus on steering the consumer away from the idea of minimizing first cost and on promoting the use of life-cycle costing as the primary factor in selecting a ballast for purchase.

There are several drawbacks to relying wholly on the education and labeling program above to achieve the desired results:

- Consumer education and labeling programs are directed only at the demand for consumer products; they will not guarantee the appropriate supply-side responses by manufacturers;
- In many cases, fluorescent lamp ballasts are installed by builders, and minimum first cost is an overriding consideration;
- Building tenants who pay the energy bills do not often make the decisions on ballast efficiency;
- Energy efficiency is only one factor in consumers' purchase decisions;
- There is a long lag before the effect of such educational activities is manifest in the marketplace.

As a means of achieving the level of energy savings believed possible under the proposed standards, the education and labeling effort, is expected to have only a moderate effect.

2.2.3 Existing Mandatory Standards

Before the passage of the National Appliance Energy Conservation Act of 1987 (NAECA), several states established programs that set minimum efficiency levels for certain consumer products. The National Appliance Energy Conservation Amendments of 1988 (NAECA 1988) brought fluorescent lamp ballasts under EPCA coverage. EPAct requires that states adopt building energy codes at least as strict as the ASHRAE/IES.90.1[1] code. These programs have changed the distribution patterns for ballasts which has impacts at the national level.

2.2.4 Base Case Description

The base case included the following assumptions about factors likely to increase commercial and industrial lighting energy efficiency:

- Commercial and industrial electricity prices were projected to decline until the year 2020. After 2020, prices were assumed to be constant at the 2020 level.
- The FTC labeling program for consumer products would continue;
- The U.S. Department of Energy's existing public information program would continue;
- Manufacturers would be able to produce the more energy-efficient equipment demanded by consumers;
- Magnetic ballast shipments would steadily decline;
- The electronic ballast standards scenarios were analyzed with the assumption that when four-foot T8 electronic ballasts were purchased, they were T8 electronic rapid start (ERS) ballasts. While this somewhat underestimated the savings vs. the T8 electronic instant start (EIS) ballasts that predominate the market, it retained the NES model's assumption that ERS ballasts were those proposed as the standard (rather than EIS ballasts). Eight-foot and eight-foot high output systems used electronic T12 ballasts.

The NES model does not calculate fluorescent lighting energy consumption. The cumulative consumption from 2003 to 2030 was estimated as 90.6 Quads (95.6 EJ) for the Decreasing Shipments to 2027 base case. For the same base case, the estimated cumulative consumption for 2005 to 2030 was 85 Quads (90 EJ). See Chapter 5, section 5.3.6, Energy Consumption for a

[1] ASHRAE=Association of Heating Refrigerating and Air Conditioning Engineers. IES=Illuminating Engineering Society (of North America).

description of the calculations.

For most of the alternative cases, the start year was assumed to be 2003. For the Voluntary Efficiency Targets cases, the start year was assumed to be 2005, as discussed below.

2.3 Tax Credits to Consumers

2.3.1 Discussion

Tax credits for ballasts would require new legislation that would include all covered products. The costs of such a program would be borne by all taxpayers because it would result in less tax revenues to the government.

Tax credits alone affect only the demand for consumer products. There is no guarantee that manufacturers will respond to consumer needs by producing more efficient products.

2.3.2 Quantitative description

A program offering a tax credit of 50 percent of the increased cost of more energy efficient ballasts was evaluated. This program might be more easily administered than a rebate program because it could be carried out through an existing organization, the IRS. The program as evaluated here would return to a participating consumer exactly the same amount of money as the rebate program described in Section 2.5 below. The most important difference to the consumer between rebate and tax credit programs is that a rebate can be obtained quickly whereas a tax credit is delayed until income taxes are filed or a tax refund is provided by the IRS.

To simulate this impact, DOE has assumed that only 7 percent of consumers would purchase more energy-efficient products as a result of the tax credit program. This percentage reflected the same proportion of consumer response to utility demand-side-management (DSM) rebate programs, with some adjustment for the tax credit time delay. As described in Appendix B, LBNL analyzed data for 1992 - 1997 from utility DSM programs representing over 15 percent of national energy-efficiency expenditures and extrapolated the results using EIA data on national energy-efficiency spending. We found that for the peak rebate years of 1993 - 1995, the average rebate was equivalent to the full incremental cost (100 percent) of an electronic ballast, and that rebates were received for a quantity of electronic ballasts representing about one-fourth the number of magnetic ballasts that would have been purchased without the rebate. We make the assumption that for half of this cost reduction, the consumer response would be about half that it was for the DSM rebates, or 12 percent. The 1994 refrigerator RIA assumed that 60 percent of consumers would take advantage of the credit vs. 100 percent for consumer rebates, since there is a time delay for reimbursement of expenditures with a tax credit. We assume that a similar impact would occur for ballasts, with a net 7 percent (12

percent times 60 percent) conversion rate[2] to electronic ballasts.

The forecast results showed energy savings of 0.21 Quads (0.22 EJ) for the tax credit program alternative. The net present value (in 1997 dollars), discounted at 7 percent real, was 0.31 billion.

2.4 Tax Credits to Manufacturers

2.4.1 Discussion

DOE examined the possibility of providing tax credits to manufacturers. This approach would allow manufacturers to recoup some of the costs of manufacturing more energy-efficient consumer products. In combination with tax incentives or rebates for consumers, manufacturer tax credits could correct some of the market imperfections resulting from focusing only on incentives to consumers. However, the timing of a dual program for manufacturers and consumers would have to be precise to ensure that maximum benefits are achieved.

In any event, the potential would exist that many manufacturers would not respond to tax incentives. The cost of a manufacturer tax credit program could be very high. A tax credit program that would attract a high manufacturer participation rate could have very large costs. Also, the strictness of energy efficiency requirements for receiving a tax credit would affect participation. Less stringent requirements would result in greater participation but limit the energy savings achieved by the program; more stringent requirements might result in reduced participation and, thus, also limit energy savings.

Therefore, although the tax credit program would have the potential for achieving energy savings, the many issues associated with optimizing the benefits would need to be analyzed carefully. Some of this analysis has been performed by DOE and indicates that the cost of achieving significant energy savings through a tax credit program would be very high.

2.4.2 Quantitative Description

Offering tax incentives to consumer product manufacturers was considered as an alternative to regulation. The tax incentive analyzed would be an investment tax credit for installation of machinery and tools required to produce more energy-efficient ballasts.

Production of energy-efficient consumer product requires investment in some new tools and machinery. The manufacturer tax credit considered by DOE provided a 20 percent credit for

[2]Conversion rate refers to the percentage of magnetic ballast shipments that would be magnetic in the base case and were instead electronic in the alternative case. The conversion rate was an annual average for the period and was applied in the NES model to each year's magnetic ballast shipments. Note that for the performance standards case, this rate was 100 percent (T8 or T12).

investment in tools and machinery required to produce energy-efficient ballasts. The credit would not apply to investments in other forms of tools and machinery, nor would it apply to other forms of investment such as acquisition of subsidiaries, financial instruments, i.e., stock, loans, or new construction of plants.

Because the tax credit only applied to the portion of investment going toward production of energy-efficient consumer products and not toward investment in replacement equipment, an enforcement mechanism would be needed to prevent abuse. Enforcement would probably be divided between DOE and the Internal Revenue Service (IRS). DOE would have to stipulate specific categories of investment subject to the credit. IRS would have principal responsibility for review of claims for the credit. Investigation of alleged violations would probably require joint action by DOE and IRS. The cost of the enforcement program was not investigated, but it was thought to be high; the program would probably not be cost effective.

The effect of the investment tax credit was to lower the cost of design options requiring new tooling and machinery. From the Manufacturer Impact Analysis (see Chapter 6), the additional conversion capital expenditures for electronic ballasts from 2001 - 2003 were about $2.78 per ballast[3]. (The expenditures in the base case for gradual electronic ballast conversion over the entire period were incurred in the alternative case primarily in the year 2002.) The depreciated value of these costs was equal to the cost divided by the useful life of 13.9 years (for electronic ballasts, assuming 3600 hours); this value was $0.20. A manufacturer tax credit of 20 percent of these values would be $0.04. Since not all of this manufacturer benefit would be passed on to the consumer, the impact on NPV would be negligible. This alternative would have no energy savings.

The results showed no energy savings and an NPV of 0.

2.5 Rebates to Consumers

2.5.1 Discussion

Providing rebates to consumers who purchase energy-efficient ballasts would be difficult to implement. As discussed under Consumer Tax Credits above, there has been widespread national experience with rebate programs, but these were implemented by electric utilities as part of DSM programs. The concept of government-mandated rebates would entail complex interference in the market place; decisions would need to be made on which products should qualify, amount of rebate, time period covered, etc.

The rebate concept could be coupled with a tariff, much like the proposed "gas-guzzler tax" for automobiles; consumers who purchased inefficient units would be charged a federally imposed tax. It would be a costly, unwieldy, and cumbersome program to implement. However, it might be

[3]The difference in electronic ballast shipments from base case to standards case for 2001 - 2003

more effective than the no-action alternative.

As with tax credits, the rebate alternative would affect only the demand for energy-efficient consumer products. There would be uncertainty about the manufacturers' ability and/or desire to respond to the demand, particularly if the rebate program is not continued over a long enough time period to account for manufacturers' lead time to produce energy-efficient products. Thus, as a separate alternative, rebates would have only a small and potentially short-term effect on energy consumption.

2.5.2 Quantitative Description

A Federal program that gave consumers a rebate to encourage the purchase of energy-efficient ballasts was analyzed. This program would apply to all new ballasts whether they are replacements or for new construction. The program was assumed to provide a rebate of 50 percent of the increased cost of electronic ballasts. The 50 percent cost reduction was chosen under the same rationale described above for consumer tax credits. The response was assumed to be greater than that for tax credits, with a 12 percent electronic ballast conversion rate, similar to the proportional response rate for DSM rebate programs (see section 2.3.2). No assumption was made regarding the means of implementing the rebate (for example, through the distributor or manufacturer with a refund from the Federal government or directly by the government).

The forecast results showed energy savings of 0.36 Quads (0.38 EJ) for the consumer rebate program alternative. The net present value (in 1997 dollars), discounted at 7 percent real, was 0.53 billion.

2.6 Voluntary Energy Efficiency Targets

2.6.1 Discussion

EPCA called for industry to meet voluntary energy-efficiency targets for the covered products. If industry did not meet the voluntary targets, provisions were made for establishing Federal standards. In amending the Act with the National Energy Conservation Policy Act, P.L.95-619 (NECPA), Congress specifically changed the legislation to provide for immediate establishment of Federal standards to ensure the timely manufacture of energy-efficient consumer products. Although it is possible that voluntary targets might be as effective as mandated performance standards in achieving the energy savings goals, there probably would be a considerable time lag because of the many uncertainties associated with a program requiring concurrence from so many participants as well as uncertainties about future consumer demand for energy-efficient products.

2.6.2 Quantitative Description

It was assumed for analysis purposes that the voluntary program would specify the

energy-efficiency levels of the performance standards as goals. A fully voluntary program was assumed to cause a 10-year delay in achieving the energy conservation goals of the proposed standards. A voluntary program that was made mandatory if the goals were not met was assumed to achieve the energy efficiencies of the performance standards with a 5-year delay. Thus, the effects of a voluntary program were bounded by the assumptions of a 5- to 10-year delay.

The start year for this alternative was assumed to be 2005, the same year the performance standards would take effect. Since these would be voluntary targets, we assumed that the alternative would apply to all ballasts without an additional 5-year delay for the replacement market.

The forecast results for the voluntary program with 10 year delay showed energy savings of 1.05 Quads (1.11 EJ). The net present value (in 1997 dollars), discounted at 7 percent real, was 0.96 billion.

The forecast results for the voluntary/mandatory program with 5 year delay showed energy savings of 1.91 Quads (2.02 EJ). The net present value (in 1997 dollars), discounted at 7 percent real, was 2.04 billion.

2.7 Enhanced Consumer Education and Labeling Programs – Current Technologies

2.7.1 Discussion

This alternative includes enhancing the efforts of programs such as the EPA Energy Star Buildings/Green Lights program, NEMA's Energy Cost Savings Council, DOE's Federal Energy Management Program, and the EPAct voluntary luminaire program. These efforts would encourage the use of existing efficient technologies, primarily the electronic ballast.

The Environmental Protection Agency's Green Lights program, now encompassed by the Energy Star Buildings program, has provided high-profile incentives and comprehensive information services for building owners and lighting decision-makers to perform cost-effective lighting upgrades. NEMA's Energy Cost Savings Council complements the EPA's programs and aims to influence company executives, emphasize cutting costs and increasing profits. These voluntary activities are educational for building owners, chief financial officers, specifiers including building maintenance personnel, and lighting designers in the commercial and industrial sectors.

The voluntary luminaire program, created by a group of lighting organizations following EPAct's mandate, is designed as a testing and rating method for fluorescent luminaires. It does not encourage luminaire labeling per se, but rather the publication of the Luminaire Efficacy Rating (LER) as part of manufacturer literature (catalogs and product specification sheets). This is more effective than labeling, as commercial and industrial consumers typically select products from literature rather than off the shelf. Fluorescent luminaires are recommended to be rated with both magnetic T12 lamp ballast systems and electronic T8 systems; the LER is significantly higher when

using the electronic system, giving consumers a clear signal of the relatively higher efficacy of this system type.

The impacts of the existing EPA, NEMA, and EPAct programs were assumed to be included in the base case. This alternative would provide incentive for more aggressive consumer education efforts. An enhanced education program could be expected to increase consumer demand in proportion to the amount of money spent on publicity and dissemination of information. This approach, as with the financial incentives to consumers, did not address the supply side of the marketplace equation, and, therefore, could result in less-than-optimal energy savings because of potential supply and demand inequalities.

2.7.2 Quantitative Description

Evaluating the combined impacts of the education and product information programs discussed above required that assumptions be made about the number of consumers reached by the expanded program and to what extent the information received would influence their purchase of more energy-efficient consumer products. The program was defined, for purposes of analysis, as being able to reach an average of 3 percent per year of the purchasers of fluorescent ballasts not already influenced by the programs at their existing levels. These purchasers would be encouraged to use life-cycle cost techniques for selecting products. Sources of information that would enable consumers to make life-cycle cost decisions would be identified.

In general, any reasonable expansion of these consumer information programs would likely reach a relatively small percentage of the purchasing public beyond those already reached by the programs.

The variables in determining whether a purchaser of consumer products would respond positively to information presented by the programs could not be assessed with any degree of confidence. Response is highly dependent on the purchaser's ability to comprehend the information, agree with the concepts that are presented, gather needed information, and want and afford to make the purchase. The quantitative description did not attempt to estimate this response. It merely assumed that those reached will respond positively by purchasing the most energy-efficient ballasts (in terms of life-cycle costs) for their particular needs. Thus, the energy savings identified by the NES model would often be overestimates of the response to the program because not all purchasers reached could be expected to respond positively.

The forecast results showed energy savings of 0.09 Quads (0.09 EJ) for this enhanced consumer education alternative. The net present value (in 1997 dollars), discounted at 7 percent real, was 0.12 billion.

2.8 Enhanced Consumer Education and Labeling Programs – Advanced Technologies

This alternative assumed that the same enhanced education and labeling programs promoted advanced technologies such as daylighting/dimming controls for fluorescent ballasts. Of the consumers affected by the program, some selected the advanced systems and others chose regular electronic ballasts.

2.8.1 Discussion

The same considerations described for the alternative promoting consumer education for current technologies applied to this alternative.

The fraction of consumers using the advanced controls in this alternative was small because the controls technologies are relatively new. While dimming ballasts are reliable, they still comprise a tiny percentage of the fluorescent ballast market, in part because there have been problems with the control systems that operate them. The Lighting Research alternative described in section 2.10 below assumed that research efforts developed daylight/dimming control systems that were more effective and therefore affected a larger number of buildings than they did with this alternative.

2.8.2 Quantitative Description

LBNL's Lighting Systems Research Group estimated the potential for daylighting (dimming ballasts) and other controls to be 5 - 10 percent using available technology over ten years[4]. Controls had a 40 percent energy savings potential and could be used in 15 percent of existing floorspace. We calculated a conversion rate of 0.6 percent per year (40 percent * 15 percent divided by 10 years).

According to LBNL, the current incremental price for dimming vs. non-dimming electronic ballasts of $25 was expected to fall to $5 by 2004 or earlier. PNNL[5] estimated that the additional cost of a photocontroller including labor was about $100, divided by 50 ballasts that it could control = $2 per ballast. We therefore assumed an additional cost per electronic ballast of $5 + $2 = $7. Note that additional costs for skylights and architectural features in new buildings were not included.

In the NES model, the savings from electronic ballasts were increased by 40 percent to account for energy use reduction from dimming, the incremental price for electronic ballasts was increased by $7, and a conversion rate to electronic ballasts of 0.6 percent was used.

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[4]Memo from Francis Rubinstein (LBNL Lighting Systems Research Group) memo to Dean MacCauley (FEMP), 1999, "Estimated national energy savings potential for lighting controls" and personal communication, 8/99.

[5]Eric Richman, PNNL, personal communication, 7/99. Estimates based on office building studies by LBNL, PNNL, and others.

These savings were added to those from an NES run using the assumptions described in section 2.7 with a smaller conversion rate of 2.4 percent. This assumed the same number of consumers would be affected as by the consumer education alternative, but that consumers not converting to dimming ballasts (0.6 percent conversion rate) would still convert to regular electronic ballasts due to consumer education (3 percent minus 0.6 percent = 2.4 percent).

The forecast results showed energy savings of 0.10 Quads (0.10 EJ) for this enhanced consumer education alternative. The net present value (in 1997 dollars), discounted at 7 percent real, was 0.13 billion.

2.9 Government Purchases

In this alternative, all Federal, State, and local government ballast purchases were electronic ballasts. FEMP's existing Procurement Guidelines that encourage the selection of electronic ballasts, with their anticipated partial compliance rates, were already included in the base case forecast. The incremental impact of full FEMP compliance was covered in this alternative. In addition to government purchases, there was assumed to be a "market-pull" impact influencing non-federal purchases.

2.9.1 Discussion

This alternative had significant impacts since it assumed that all ballasts purchased in the government sector became electronic ballasts. This would require substantial funding and implementation efforts. The government sector market was estimated to comprise 20 percent of all fluorescent ballast purchases; municipal and state floor space includes public school and institutional buildings.

"Market pull" impacts would most likely occur through the effects of manufacturers and vendors achieving scale economies with the high-efficiency products, and marketing them more effectively to consumers across the board (rather than through direct example to consumers).

2.9.2 Quantitative Description

We assumed that the CBECS floorspace comprised by government-owned buildings corresponded to the percentage of ballast sales to the federal, state, and municipal sector. In the Energy Information Administration's 1995 Commercial Buildings Energy Consumption Survey (CBECS 1995)[6], the government-owned floor space was 20 percent of the total floor space. The

[6]EIA/DOE. 1998. *A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures*, DOE/EIA-0625(95), Washington DC, October 1998.

percentage of federal ballast sales was estimated to be about 1 to 2 percent of the total ballast sales[7].

We assumed that federal purchases were 2 percent and that half (1 percent) were already in the base case. This left 19 percent to be influenced by this alternative. We estimated that 55 percent are already electronic ballasts, based on the general market share for electronic ballasts in 1998, yielding an 8.6 percent impact (19 percent * 55 percent = 8.6 percent). To this we added an estimated 1.4 percent market-pull impact, for an overall 10 percent conversion rate to electronic ballasts.

The forecast results showed energy savings of 0.30 Quads (0.32 EJ) for the massive government purchases alternative. The net present value (in 1997 dollars), discounted at 7 percent real, was 0.40 billion.

2.10 Lighting Research

This alternative involved lighting research and development adding more efficient alternatives to currently available systems.

2.10.1. Discussion

This alternative assumed that R&D expanded the implementation of controls, including daylighting with dimming ballasts (promoted by the Consumer Education for Advanced Technologies alternative described in section 2.8 above). Despite the large increase in savings potential due to controls, this alternative had a relatively small impact. Research and development would take time to have an impact, while many of the magnetic ballasts sold during the analysis period were sold in the earlier years.

2.10.2 Quantitative Description

From LBNL Lighting Systems Reseach Group[8], R&D could make control systems that are more effectively used in buildings. They would be easier to commission, maintain, and monitor and thus more appealing to consumers. We estimated that this would allow 40 percent penetration (as compared with 15 percent in the Consumer Education alternative, section 2. 8). This would occur over a ten year period; we calculated a conversion rate of 1.6 percent (40 percent * 40 percent divided by 10 years). Since R&D would take awhile to penetrate the marketplace, we assumed a time delay of 5 years for this alternative. The estimated incremental cost of $7 did not change, as it was already projected to fall under current conditions.

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[7]Jeff Harris, LBNL, personal communication, 6/99.

[8]Steve Johnson, LBNL, personal communication, 8/99.

In the NES model, we increased the kWh savings by 40 percent and increased the incremental ballast cost by $7 (these are the same assumptions made in section 2.8). The conversion rate was 1.6 percent, with a delay period of five years.

The forecast results showed energy savings of 0.04 Quads (0.05 EJ) for the lighting research alternative. The net present value (in 1997 dollars), discounted at 7 percent real, was 0.04 billion.

2.11. Building Codes

This alternative involved the increased adoption and aggressive enforcement of commercial building codes, particularly the ASHRAE/IES 90.1-1999 (upgraded) code and the Federal Commercial (FedCom) building code. The conversion rate for electronic ballasts represented additional ballasts purchased (beyond those in the base case) for new buildings or for substantially renovated spaces, both of which are subject to the codes.

2.11.1 Discussion

The EPAct required that by 1994 states would adopt building codes, including lighting provisions, that were at least as strict as those in the existing ASHRAE/IES 90.1-1989 standard. In addition, the Department would review any update to the ASHRAE/IES standard and consider whether to designate it the required code. The upcoming revision, ASHRAE/IES 90.1-1999, is based on an assumption that electronic ballasts are the state-of-the-art available fluorescent technology, and therefore the use of electronic ballasts would greatly facilitate compliance. Similarly, electronic ballasts would assist compliance with the FedCom federal building code currently under revision. ASHRAE/IES 90.1-1999 was anticipated to have full impact beginning in the year 2005.

Adoption of the ASHRAE/IES 90.1-1989 code by the states has been uneven; while some states already had building codes at least as strict, others had no legislative or institutional mechanisms in place for a building energy code. The Department has provided technical assistance, financial incentives, and code support materials to state energy offices and agencies to increase the adoption rate.

Even when a state building energy code is in place, compliance with its provisions by designers and builders has often been partial. Studies conducted in Washington, Minnesota, New York, Idaho, California, and other locations indicate that codes have not been fully enforced. However, the level of code compliance is not directly related to code enforcement. California studies showing code enforcement at 70 percent to 80 percent in the buildings surveyed also found that the level of compliance actually exceeded the code.[9]

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[9] "Quality Metrics Impact Assessment," prepared for (DOE) Building Standards and Guidelines Program by Pacific Northwest National Laboratory, 1995.

2.11.2 Quantitative Description

The estimated impacts of the ASHRAE/IES 90.1-1989 code and the revised 90.1-1999 code, including partial state adoption and compliance, were already included in the base case. Analysis by PNNL and LBNL estimated the impacts of the 90.1-1999 code from 2005 to 2020. The number of additional electronic ballasts sold instead of magnetic ballasts due to partial adoption and compliance of the new code version was projected. The percentage for each year was relatively steady, so we assumed that the impacts through 2030 would be similar.

This alternative assumed faster adoption and more aggressive enforcement, i.e. 100 percent adoption and full compliance beginning in 2005. Therefore it represented an upper bound of potential impacts of ASHRAE/IES 90.1-1999 on the ballast market. Using the PNNL model, we calculated that full adoption/compliance resulted in sales of electronic ballasts about twice those with partial adoption/compliance.

The 2027 base case had an implied 4 percent conversion rate, while the PNNL/LBNL analysis with full compliance showed a 7 percent conversion rate. We assumed that the alternative case causes a net conversion rate of 3 percent (7 percent minus 4 percent).

The forecast results showed energy savings of 0.15 Quads (0.16 EJ). The net present value (in 1997 dollars), discounted at 7 percent real, was 0.18 billion.

2.12 Performance Standards

2.12.1 Discussion

The only alternative that fully complies with the Act is the setting of energy-efficiency or performance standards. This alternative is being used in the proposed regulation.

The standards will establish the maximum energy consumption or minimum efficiency level permitted for each lamp-ballast combination but will not prescribe the means by which that level is to be achieved. The efficiencies are specified in ratios relating the output of a product to its energy use. The standards levels vary among lamp-ballast combinations, depending on the design characteristics of each class. The standards levels are based on test procedures developed by DOE, which it intends, on a continuing basis, to modify to accommodate new product designs.

2.12.2 Quantitative Description

Performance standards were quantified by assuming that all ballasts would comply with the standards as proposed. That is, all manufacturers would meet the deadlines for the 2005 efficiency levels, and, after existing stocks of nonregulated products are depleted, only products meeting the

proposed standards would be distributed in commerce. Maximum benefits will not accrue immediately, however, because the standards do not require retrofitting of existing lighting systems, so it will take some time to replace all nonregulated products with regulated products.

The implementation of performance standards resulted in a total estimated energy savings of 2.23 Quads (2.35 EJ) beyond the standards set forth in NAECA 1988 (for the 2027 base case). These additional savings had a net present value (in 1997 dollars, discounted at 7 percent real) of 2.59 billion.

3. ENERGY SAVINGS, COSTS, AND BENEFITS OF TRIAL STANDARDS LEVELS

This section presents a quantitative discussion of the energy savings and the costs and benefits of the consensus performance standard scenarios to the nation. More detail on these standards scenarios is found in Appendix E.

3.1 Energy Savings and Net Present Value of Standards

We estimated that the base case cumulative fluorescent lighting energy consumption for the period from 2005 to 2030 was approximately 85 Quads or 90 exajoules (source energy) for the Decreasing Shipments to 2027 base case. The savings from the consensus standards was about 2.6 percent of the total estimated consumption.

The NPV is the difference between fuel cost savings and equipment costs. Fuel cost savings were calculated by the NES model using annual site energy savings multiplied by each year's projected marginal electricity rate for the appropriate sector. Ballast and lamp equipment costs were calculated from the model inputs, as described in Appendices A and B. Both fuel cost savings and equipment costs were discounted to the year 1997 in $1997. Note that HVAC energy cost savings were not included in the NPV calculations.

Table R.3 displays the energy saved and the resulting net present value of standards to the nation for the consensus standards.

Table R.3 Energy Savings and Net Present Value to Society of Standards for Fluorescent Ballasts Purchased from 2005-2030

(1997 Billion Dollars, Discounted to 1997 at 7 percent Real)

Electronic Standards			
For Units Sold from 2005 to 2030 Discounted at 7% to 1997 (in billion 1997 $)			
SCENARIO	*Scen 7A* *Decr2015*	*Scen 7B* *Decr2027*	*Scen 7C* *Constant*
Total Quads Saved	1.09	2.23	4.84
Total Quads Saved w/HVAC*	1.16	2.36	5.15
Total Exajoules Saved	1.15	2.35	5.11
Total Exajoules Saved w/ HVAC*	1.22	2.49	5.43
Total Benefit	1.85	3.42	7.18
Total Equipment Cost	0.45	0.83	1.76
Net Present Value	1.40	2.59	5.42
*For energy savings only; Total Benefit and Net Present Value do not include HVAC savings.			

REFERENCE

1. U.S. Department of Energy, *Technical Support Document: Energy Efficiency Standards for Fluorescent Lamp Ballasts*