REGULATORY IMPACT ANALYSIS FOR PROPOSED ENERGY CONSERVATION STANDARDS FOR DISTRIBUTION TRANSFORMERS

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REGULATORY IMPACT ANALYSIS FOR PROPOSED ENERGY CONSERVATION STANDARDS FOR ELECTRICAL DISTRIBUTION TRANSFORMERS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REGULATORY IMPACT ANALYSIS FOR PROPOSED ENERGY CONSERVATION STANDARDS FOR ELECTRICAL DISTRIBUTION TRANSFORMERS

1.0 INTRODUCTION

The Department of Energy (Department, or DOE) has determined that distribution transformer energy-efficiency standards constitute an "economically significant regulatory action" under Executive Order (E.O.) 12866 "Regulatory Planning and Review." 58 FR 51735, October 4, 1993. Therefore, the proposed energy-efficiency standards require a regulatory impact analysis (RIA), which involves an evaluation of non-regulatory alternatives to the proposed standards. This document evaluates several possible alternatives to the proposed standards, and compares the costs and benefits of each to the proposed standards. As described in section 2.0 of this report, the proposed standards are those in trial standard level (TSL) 2 for liquid-immersed distribution transformers and TSL 2 for medium-voltage, dry-type distribution transformers.[a]

Under the Process Rule (*Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products*, 10 CFR 430, Subpart C, Appendix A), DOE is committed to continually explore non-regulatory alternatives to standards. 62 FR 54817. The Department has prepared this draft regulatory analysis pursuant to E.O. 12866, which is subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA). 58 FR 51735.

The Department identified six major, non-regulatory alternatives to standards as representing feasible policy options to achieve potentially similar improvements in distribution transformer energy efficiency. Table RIA.1 lists the six alternatives. The Department evaluated each of those alternatives that apply to the distribution transformers covered by this notice of proposed rulemaking (NOPR) in terms of its ability to achieve significant energy savings at a reasonable cost, and compared the effectiveness of each one to the effectiveness of the proposed standards. As discussed in section 2.2 below, DOE found that some of these policy alternatives would not have an impact on those transformers for which there are proposed standards and therefore did not further analyze them.

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[a] Because the Energy Policy Act of 2005 established energy conservation standards for low-voltage, dry-type distribution transformers, the Department has removed this type of transformer from the NOPR stage of its analysis.

Table RIA.1 Policy Alternatives to Proposed National Distribution Transformer Standards

No New Regulatory Action
Consumer Rebates
Consumer Tax Credits
Manufacturer Tax Credits
Voluntary Energy-Efficiency Targets
Early Replacement
Bulk Government Purchases

2.0 NON-REGULATORY POLICIES

2.1 Methodology

This section describes the approach DOE used to analyze non-regulatory policies for the appropriate distribution transformer product classes. The Department assumed that each policy would apply to one or both of the two transformer types: liquid-immersed and medium-voltage, dry-type.

2.1.1 Modeling Method

To calculate the national energy savings (NES) and the net present value (NPV) corresponding to each policy alternative, the Department used the national impact analysis (NIA) Spreadsheet Model. (See Chapter 10 of the technical support document (TSD)[1] for a description of the NIA Spreadsheet Model.) To compare each alternative to the proposed standards, the Department quantified the effect of each alternative on the purchase of distribution transformers meeting efficiency levels equivalent to those in the proposed standards. This report refers to these levels as *target levels*. Once it had made the quantitative assumptions for each alternative, DOE made the appropriate revisions to the inputs in the NIA Spreadsheet Model. The main model inputs that DOE revised were the market shares of equipment at the target efficiencies.

The shipments for any given year comprise a distribution of efficiency levels. The Department assumed that the proposed standards would affect 100 percent of the shipments, while the non-regulatory policies affect a smaller percentage of the shipments. In each policy case, DOE made particular assumptions about the percentage of shipments (market shares) impacted by the policy under analysis. In the base case and the policy case, the impacted shipments enter the stock each year. Using the estimates of transformer losses from the life-cycle cost analysis (Chapter 8 of the TSD), the Department calculated the annual total energy use by the stock of transformers. For each year analyzed, the difference in source energy use between the proposed standards case and the policy case is the annual energy savings.

A shift in market share to higher-efficiency transformers may increase the average installed cost of distribution transformers. Operating costs will generally decrease due to a decline in energy consumption. Therefore, DOE was able to calculate an NPV for non-regulatory alternatives in the same way as for the proposed standard. In some scenarios, total installed cost increases are partially mitigated by government rebates or tax credits. The Department assumed that credits and rebates would be paid for by consumers in another form (such as additional taxes), and therefore did not include them as a benefit for the purposes of calculating the national NPV.

The key measures of the impact of each alternative are:

- National energy savings in quadrillion British thermal units (quads): Cumulative national primary energy savings for equipment bought in the period from the effective date of the policy case (2010) to the year 2038.

- Net present value: The value of net monetary savings from equipment bought in the period from the effective date of the policy case (2010) to the year 2038. The Department calculated the NPV as the difference between the present value of equipment and operating expenditures (including energy) in the base case, and the present value of expenditures in each alternative policy case. The Department calculated capacity and operating cost savings through the year 2073 for transformers purchased in the period 2010 to 2038.[a]

2.1.2 Policy Assumptions

The impacts of non-regulatory policies are by nature uncertain, since they depend on program implementation and marketing efforts and the subsequent consumer behavior response. The projected impacts depend on the assumptions about the consumer participation rate and are therefore subject to more uncertainties than the impacts of mandatory standards, which the Department assumed would have full compliance. To increase the robustness of the analysis, the Department conducted a literature review on each non-regulatory policy and consulted with key experts to gather information on similar incentive programs that have been implemented in the U.S. By studying field experience with sample programs of each type, DOE sought to make credible assumptions of their potential market impacts. Section 2.2 below reports the conclusions from this research as they apply to the policy modeling assumptions and includes the corresponding literature citations.

Each of the policy alternatives to the proposed standards that DOE considered improves the average efficiency of new distribution transformers relative to the base case (no new regulatory action). The analysis considered that each alternative policy would induce consumers to purchase units at the target levels, the same efficiency levels as required by the proposed

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[a] The Department used the same time period for NPV in the RIA as it did for the NIA in the advance notice of proposed rulemaking.

standards. In contrast to the proposed standards, however, the penetration rate in the alternative policy cases may not be 100 percent.

The proposed standards are those in TSL 2, as shown in Table RIA.2. Section II of the NOPR shows the efficiency levels for the proposed standard levels by product class and kilovolt-ampere (kVA) size.

The size of the eligible market for the policies varies among the product classes. Table RIA.2 shows the percentages of the distribution transformer market that the Department projects will be below the target levels in 2010 (in the column labeled “Percent Non-Compliant”). Therefore, policies that aim for the target level will impact the non-complying portion of the distribution transformer market for each product class. Non-regulatory policies would thus impact some fraction of these portions of the market.

The Department assumed that the non-regulatory policy impacts last from the effective date for proposed distribution transformer standards, 2010, through the end of the analysis period, 2038.

Table RIA.2 Proposed Standard Levels for Distribution Transformers

Distribution Transformer Type	TSL	Percent Non-Compliant
Liquid-Immersed	2	43.6
Medium Voltage, Dry-Type	2	31.2

The Department did not consider administrative costs for any of the non-regulatory policies in its analysis. Inclusion of such costs would decrease their NPV by a small amount.

2.1.3 Policy Interactions

The Department calculated the impacts of each regulatory policy separately from those of the other policies. In actual practice, certain policies are often most effective when implemented in combination to provide incentives. The Department attempted to make conservative assumptions to avoid double-counting policy impacts. Therefore, the policy impacts reported below are not additive; the combined impact of several or all of the policies may not be inferred from adding the results together.

Section 2.3 below presents the results of the analysis of the non-regulatory policies for distribution transformers.

2.2 Non-Regulatory Policy Assumptions

2.2.1 No New Regulatory Action

The case in which no new regulatory action is taken with regard to distribution transformer efficiency constitutes the base case scenario described in Chapter 10 of the TSD. This case defines the basis of comparison for all other scenarios. By definition, no new regulatory action yields zero energy savings and a net present value of zero dollars.

2.2.2 Financial Incentives Policies

The Department considered scenarios in which the Federal government would provide two types of financial incentives: rebates and tax credits. The government could provide consumers with a cash rebate at the time of purchase. Tax credits could be granted to consumers who purchased target-level distribution transformers, or the government could issue tax credits to manufacturers to offset costs associated with producing such equipment.

The Department's evaluation of financial incentive policies used a comprehensive study of the potential for energy efficiency in California performed by Xenergy, Inc., which summarizes experience with various utility rebate programs.[2] Xenergy developed a re-parameterized, mixed-source, information-diffusion model to estimate market impacts induced by financial incentives for energy-efficient appliances. The basic premise of this mixed-source model is that information diffusion drives technology adoption. The model is formulated to characterize the influences of both internal and external sources of information on consumer behavior by superimposing two components in the equation, each capturing the effect of one of two different types of information source. The effects of these two types of information-diffusion mechanisms are different. *Internal* sources of information influence consumers to purchase new products, due mainly to word-of-mouth from early adopters, while *external* information sources influence consumers to change their adoption decisions as a result of marketing efforts and information coming from outside the consumer group. The mixed-source model describes a combined impact of the two information-source types, and specific parameterization determines consumer adoption behavior. (Appendix RIA.A contains further details.)

Xenergy's model combined these two information diffusion mechanisms and generated a set of "implementation curves," which Xenergy calibrated using evaluation data from utility rebate programs conducted in the 1990s. Consumer response to rebate incentives appears to result from a combination of the two information-source types. The implementation curves illustrate the increased penetration of efficient equipment (i.e., increased market share) as a result of consumer response to benefit/cost (B/C) ratio changes induced by a specific rebate program. The implementation curves are used to depict various diffusion patterns based on perceived barriers to consumer purchase of high-efficiency equipment. There are implementation curves for varying levels of market barriers, from "no barriers" to "extremely high barriers." These curves provide a means to study the impact on the consumer participation rate of changing the B/C ratio by reducing the initial equipment cost through financial incentives.

To further understand the impacts of financial incentives policies, the Department used studies on forecasting the impact of consumer tax credits.[3, 4] This research differentiated the impact of tax credits into the "direct price effect," which arises from the incremental equipment cost savings, and the "announcement effect," which is independent of the rebate amount. The announcement effect derives from the credibility that a particular technology receives from its inclusion in an incentive program, as well as changes in product marketing strategy and the resulting modifications in markups and pricing. The Department assumed that the direct price effect and the announcement effect would also apply to rebate programs. It assumed that half of the increases in market penetration associated with rebates would be due to the direct price effect and half to the announcement effect.

Consumer Rebates. The Department modeled the impact of the consumer rebate policy by determining the increase in market penetration of target-level equipment relative to the base case. It assumed that this policy would apply to medium-voltage, dry-type transformers.

For medium-voltage, dry-type distribution transformers, the Department estimated the impact of increasing the B/C ratio via a rebate that paid 70 percent of the incremental equipment cost between a distribution transformer meeting the base case efficiency level[a] and a unit meeting the target efficiency. The Department based the 70 percent rebate amount on existing utility rebate programs for low-voltage, dry-type distribution transformers that require TP1-2002 efficiency levels to qualify.[5, 6, 7, 8] The Department studied each of these programs and found that the average rebate amounted to about 70 percent of the incremental equipment cost for low-voltage, dry-type transformers. It then assumed that the consumer rebate policy would reduce the incremental equipment costs for medium-voltage, dry-type transformers during the analysis period by the same percentage.

The Department assumed the rebates would remain in effect until they had transformed the market, so that the shift in market share efficiencies seen in the first year of the program would be maintained throughout the forecast period (2010–2038). Section 2.3 below presents the results of the analysis for the consumer rebate policy.

To estimate the B/C ratios, the Department first calculated the B/C ratio for each design line with an efficiency meeting the target level relative to the base case design line with no rebate (see Ch.8 of the TSD for details on transformer design lines). It then calculated another B/C ratio for each design line meeting the target level, with a rebate reducing its incremental equipment cost, relative to the base case unit. Because of the incremental cost reduction due to the rebate, the B/C ratio for the rebate policy unit is larger. Table RIA.3 shows the inputs to these calculations and the resulting B/C ratios for each design line (DL). See Chapter 8 of the TSD for a detailed discussion of design lines.

[a] The base case is a market weighted-average of units at several efficiency levels.

Table RIA.3 Benefit/Cost Ratios for Proposed Standard and Rebate Policy Cases

Design Line[a]	Benefit (Lifetime Operating Cost Savings) ($)	Incremental Installed Cost ($)	B/C Ratio with No Rebate	Rebate Amount ($)	Incremental Equipment Cost after Rebate ($)	B/C Ratio for Rebate Policy Case
DL 1	375	364	1.0	186	178	2.1
DL 2	255	51	5.0	47	4	59.2
DL 3	8,310	632	13.2	493	139	59.8
DL 4	2,134	1,191	1.8	712	480	4.5
DL 5	18,706	2,934	6.4	1,870	1,064	17.6
DL 9	3,758	396	9.5	270	126	29.9
DL 10	18,441	6,350	2.9	4,220	2,130	8.7
DL 11	6,432	1,352	4.8	900	452	14.2
DL 12	15,868	3,433	4.6	2,311	1,122	14.1
DL 13	11,087	3,599	3.1	2,426	1,174	9.4

Note: Design lines 1 though 5 represent liquid-immersed transformers. Design lines 9 though 13 represent medium-voltage, dry-type transformers.

The Department then used the implementation curves discussed above to estimate the increased percentage of consumers who would purchase units that meet the policy target levels if given a rebate incentive. The Department assumed that medium-voltage, dry-type transformers would fit the "moderate barriers" curve, since they are typically purchased by industrial entities that analyze the economics of the purchase and, therefore, have some incentive for energy efficiency.

Figure RIA.1 shows an implementation curve with the penetration rates (market shares) of target-level units for an example design line of medium-voltage, dry-type transformers as a function of B/C ratios. Using this method, DOE estimated that, for design line 13 (one of the medium-voltage, dry-type design lines), the penetration rate increase, as shown, would be about 32 percent.

To estimate the impacts of this rebate policy on medium-voltage, dry-type transformers, DOE calculated the weighted average of the resulting market share increases by product class, using the market shares of the design lines. The Department applied these market share increases to the portion of shipments affected by the standards (non-compliant) in each product class, generating effective market share increases of distribution transformers meeting the target levels

[a] Because the Energy Policy Act of 2005 established energy conservation standards for low-voltage, dry-type distribution transformers, the Department has removed from this NOPR its analysis of design lines 6, 7, and 8.

by product class. In the RIA model, DOE adjusted the base case shipments projection to reflect these percentage increases in effective market share.

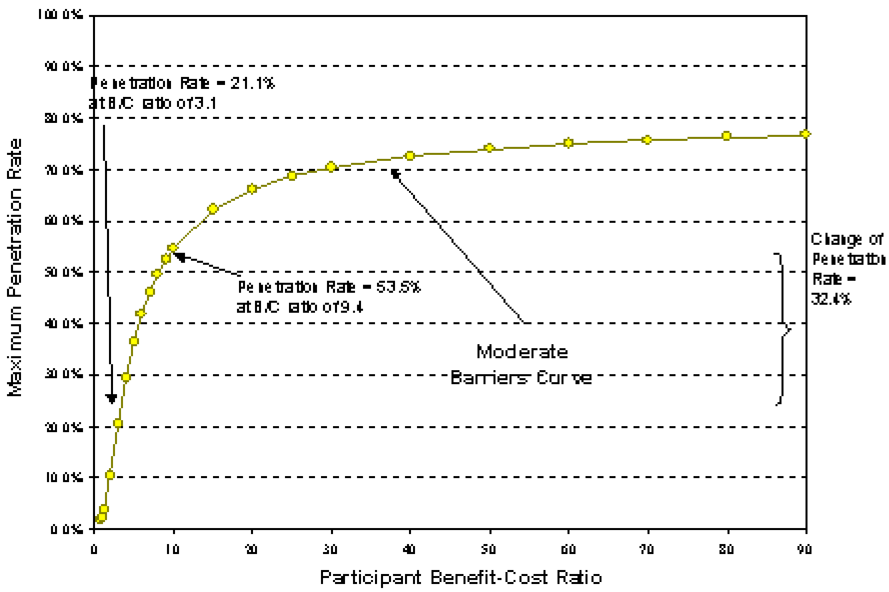

Figure RIA.1 Market Penetration Curve for Design Line 13 of Medium-Voltage, Dry-Type Transformers

Table RIA.4 lists the market share increases of the affected shipments, the percentage of the product class (PC) affected by the standards, and the effective PC market share increases, for each medium-voltage, dry-type transformer product class.

Table RIA.4 Market Share and Effective Market Share Increases for Consumer Rebates Policy Case by Medium-Voltage, Dry-Type Product Class

Product Class	Increased Market Share (Percentage of Affected Market Segment) (%)	Percent Affected by Proposed Standard (%)	Increased Effective Market Share (%)
PC 5	30.8	43.3	13.5
PC 6	30.8	43.3	13.5
PC 7	27.3	28.3	7.9
PC 8	27.3	28.3	7.9
PC 9	32.4	27.1	8.8
PC 10	32.4	27.1	8.8

Although the Department assumed that the rebate policy would not apply to utilities, and therefore liquid-immersed transformers, it did analyze the impacts of consumer and manufacturer tax credits on liquid-immersed transformers. Therefore, DOE needed to calculate the impacts of a hypothetical rebate-type incentive for liquid-immersed transformers, assuming that such rebates would reduce the incremental installed cost of these transformers by the same percentage as they would for the medium-voltage, dry-type transformers. Using this assumption, DOE calculated the changes in B/C ratios for the liquid-immersed representative units, as shown above in Table RIA.3.

The Department assumed liquid-immersed transformers would fit the "low barriers" curve, because the utilities that purchase them usually evaluate the economics of the purchase. In 1996, Oak Ridge National Laboratory (ORNL) stated in its determination analysis that 90 percent of the liquid-immersed transformer purchases were evaluated.[9] Data submitted by the National Electrical Manufacturers Association (NEMA) for years after 1996 showed that about 65 percent of utilities still evaluated their distribution transformer purchases.

For liquid-immersed transformers, DOE estimated the market-weighted averages of the penetration rates from the design line at the product class level. The Department then used implementation curves to estimate the increased percentage of consumers who would purchase units that meet the policy target levels, if given hypothetical rebates covering 70 percent of incremental costs. For example, as shown in Figure RIA.2, for design line 1 the penetration rate (market share) would increase by almost 17 percent. Table RIA.5 lists the market share increases of the affected shipments, the percentage of the product class impacted by the proposed standards, and the effective product class market share increases, for each liquid-immersed transformer product class. The Department used these values to calculate the impacts of the tax credit policies on liquid-immersed transformers, as explained in the sections below.

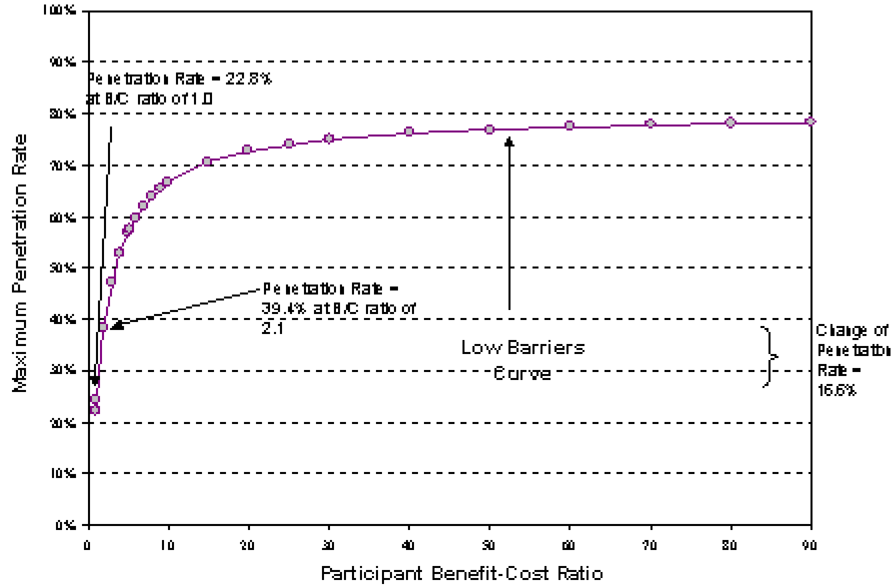

Figure RIA.2 Market Penetration Curve for Design Line 1 of Liquid-Immersed Transformers

Table RIA.5 Market Share and Effective Market Share Increases for Consumer Rebates Policy Case by Liquid-Immersed Product Class

Product Class	Increased Market Share (Percentage of Affected Market Segment)	Percent Impacted by Proposed Standard	Increased Effective Market Share (Percentage of Product Class)
PC 1	19.2	40.2	7.7
PC 2	14.3	46.5	6.6

Consumer Tax Credits. The Department assumed that a tax credit policy would apply to medium-voltage, dry type transformers, as well as those liquid-immersed transformers that are purchased by investor-owned utilities (IOUs).

The Department assumed a consumer tax credit equivalent to the amount covered by rebates (i.e., 70 percent of the incremental cost between distribution transformer base case equipment and equipment meeting the policy target levels).

The Department estimated that, for both transformer types, the consumer participation rate would be lower than that for consumer rebates. Research on tax credits has shown that the time delay to the consumer in receiving a reimbursement via tax credit, plus the added transaction costs in tax-return preparation, make the tax credit incentive less effective than a rebate received at the time of purchase. Based on previous analysis,[10] DOE assumed that only 60 percent as many consumers would take advantage of the tax credit as would take advantage of a rebate.

Using a similar approach as for the rebate policy, DOE estimated that the market share of target efficiency distribution transformers would increase due to consumer tax credits over the base case by the percentages shown in Table RIA.6. For both transformer types, these percentage market share increases are 60 percent of the market increases estimated for the rebate policy (which are shown in Tables RIA.4 and RIA.5). For liquid-immersed transformers product classes 1 and 2, DOE adjusted the effective market shares to reflect the percentage of those transformers owned by IOUs, as shown in Table RIA.6. The Department used data on transformer ownership by design line to estimate the percentage of liquid-immersed transformers owned by IOUs. Refer to Chapter 8 of the TSD for more information.

The Department assumed the impact of this policy would be to permanently transform the market so that the shipment-weighted efficiency gain seen in the first year of the program would be maintained throughout the forecast period. Section 2.3 below presents the results of the analysis for the consumer tax credit policy.

Table RIA.6 Effective Market Share Increases for Consumer Tax Credits Policy Case by Product Class

Product Class[a]	Percent Owned by IOUs (%)	Increased Effective Market Share (Percentage of Product Class) (%)
PC 1	72.3	3.4
PC 2	50.7	2.0
PC 5	0	8.1
PC 6	0	8.1
PC 7	0	4.8
PC 8	0	4.8
PC 9	0	5.3
PC 10	0	5.3

Manufacturer Tax Credits. The Department assumed that tax credits could be given to manufacturers of liquid-immersed and medium-voltage, dry-type transformers. It assumed that this incentive policy would help reimburse manufacturers for retooling costs. Because these tax credits would go to manufacturers instead of consumers, DOE assumed that manufacturers would pass on the reduced costs, causing a direct price effect. However, DOE assumed that the announcement effect would not occur because the program would not be visible to owners of distribution transformers. Since the direct price effect is approximately equivalent to the announcement effect,[3] the Department assumed that half of the consumers assumed to take advantage of consumer tax credits would purchase more-efficient products with a manufacturer tax credit program. As a result, DOE estimated the percentage by which market shares of efficient distribution transformers would increase due to manufacturer tax credits over the base case, as shown in Table RIA.7.

[a] Because the Energy Policy Act of 2005 established energy conservation standards for low-voltage, dry-type distribution transformers, the Department has removed from this NOPR its analysis of product class 3 (low-voltage, dry-type, single-phase) and product class 4 (low-voltage, dry-type, three-phase).

Table RIA.7 Effective Market Share Increases for Manufacturer Tax Credits Policy Case by Product Class

Product Class	**Increased Effective Market Share (Percentage of Product Class) (%)**
PC 1	1.7
PC 2	1.0
PC 5	4.1
PC 6	4.1
PC 7	2.4
PC 8	2.4
PC 9	2.6
PC 10	2.6

The Department assumed that the impact of this policy would be to permanently transform the market so that the shipment-weighted efficiency gain seen in the first year of the program would be maintained throughout the forecast period. Section 2.3 below presents the results of the analysis for the manufacturer tax credit policy.

2.2.3 Voluntary Energy-Efficiency Targets

The Department assumed that this policy would apply only to low-voltage, dry-type distribution transformers. For the RIA, DOE would model the voluntary efficiency target policy assuming some form of enhancement of the existing Energy Star program conducted by the Environmental Protection Agency (EPA) and the Department.[11] The Energy Star program sets minimum energy-efficiency specifications for various products. Energy Star encourages consumer adoption of these products through marketing to promote consumer label recognition, adoption of the specifications by various efficiency incentive programs, and manufacturer production and promotion of Energy Star-compliant appliances.

Energy Star has a modest program for low-voltage, dry-type transformers, with efficiency specifications at the NEMATP 1-2002 standard level. Energy Star does not have specifications for medium-voltage, dry-type transformers.[a] While the Energy Star website states that "utility transformers" (i.e., liquid-immersed) are included in its program, EPA staff indicate that there

[a] The only programs that DOE found that include medium-voltage, dry-type transformers are Oregon's equipment standard and Minnesota's building code.

has been very little program activity on liquid-immersed transformers in recent years.[12] Thus, DOE concluded that there is no historical basis to project the impact of a voluntary efficiency program on the market for medium-voltage, dry-type or liquid-immersed transformers, and assumed that voluntary programs would have no impact during the forecast period. The flat or declining market share of TP 1-compliant medium-voltage, dry-type transformers observed in the shipment data is consistent with this conclusion.

Therefore, since this policy would apply only to low-voltage, dry-type transformers, which are no longer part of this rulemaking, DOE did not analyze the impacts of this policy.

2.2.4 Early Replacement

Early replacement refers to the replacement of distribution transformers before the end of their useful lives. The purpose of this policy is to replace old, inefficient equipment with higher-efficiency units.

In 1995, ORNL performed a study of savings potential for early replacement of distribution transformers.[13] This study found that early replacement would be practical only at the time of routine transformer maintenance and would be cost-effective for just 13 percent of transformers as an alternative to refurbishment. As discussed in Chapter 10 of the TSD, in discussions with DOE, transformer owners stated that refurbishment was uncommon in current practice. Thus, the RIA analysis assumed that owners would replace their transformers rather than refurbishing them. Therefore, the Department concluded that an early replacement policy for this equipment would have minimal impact and did not further analyze it.

2.2.5 Bulk Government Purchases

The Department assumed that this policy would apply only to low-voltage, dry-type distribution transformers. For the RIA, DOE assumed that a bulk government purchase policy would encourage Federal, State, and local governments to purchase distribution transformers meeting the target levels. Aggregating public sector demand could provide a market signal to manufacturers and vendors that some of their largest customers seek suppliers with products that meet an efficiency target at competitive prices. This program could also induce “market pull” impacts through the effects of manufacturers and vendors achieving economies of scale for high-efficiency products. The Department assumed that government agencies, such as the U.S. General Services Administration (GSA), would administer such a program. A bulk purchasing program could impact government purchases of low-voltage, dry-type transformers. However, while government entities own medium-voltage, dry-type and liquid-immersed transformers, they are typically purchased on a custom basis rather than for inventory. Thus, DOE concluded that a bulk purchasing program would not be appropriate for MV dry-type or liquid-immersed distribution transformers.

Therefore, because low-voltage, dry type transformers are no longer part of this rulemaking, DOE did not analyze the impacts of this policy.

2.3 Results Summary for Non-Regulatory Alternatives

Table RIA.8 shows the NES and NPV of each of the applicable non-regulatory alternatives. The results are reported for liquid-immersed and medium-voltage, dry-type transformers, as well as in total. The case in which no regulatory action is taken with regard to distribution transformers constitutes the base case (or "No Action") scenario. Since this is the base case, energy savings and NPV are zero by definition. For comparison, the table includes the impacts of the proposed energy conservation standards. The NPV amounts shown in Table RIA.8 refer to the NPV based on two discount rates (seven percent and three percent real). Note that, for three of the policy alternatives, no results are reported; as discussed above, DOE found that those policies would not impact the distribution transformers covered by this NOPR.

None of the alternatives DOE examined would save as much energy or have an NPV as high as the proposed standards. Also, several of the alternatives would require new enabling legislation, such as consumer or manufacturer tax credits, since authority to carry out those alternatives does not presently exist.

Table RIA.8 Non-Regulatory Alternatives and the Proposed Standard

Policy Alternatives	Type	Primary Energy Savings (quads)	Net Present Value* (billion $2004)	
			7% discount rate	3% discount rate
No New Regulatory Action		0.0	0.0	0.0
Consumer Rebates	Liquid	0.0	0.0	0.0
	MV** Dry	0.007	0.013	0.042
	Total	**0.007**	**0.013**	**0.042**
Consumer Tax Credits	Liquid	0.058	0.058	0.218
	MV Dry	0.004	0.008	0.025
	Total	**0.06**	**0.07**	**0.24**
Manufacturer Tax Credits	Liquid	0.029	0.028	0.108
	MV Dry	0.002	0.004	0.013
	Total	**0.03**	**0.03**	**0.12**
Voluntary Energy-Efficiency Targets		NA	NA	NA
Early Replacement		NA	NA	NA
Bulk Government Purchases		NA	NA	NA
Proposed Standards at TSL 2	Liquid	2.28	2.31	8.78
	MV Dry	0.113	0.207	0.683
	Total	**2.40**	**2.52**	**9.47**

* The Department determined the NPV discounted to 2004 in billion 2004$.

** MV = medium-voltage

APPENDIX RIA.A: USING IMPLEMENTATION CURVES TO ESTIMATE MARKET PENETRATION OF NON-REGULATORY POLICIES

There is extensive economic literature on the diffusion process of new products as technologies evolve. Some of the literature focuses primarily on the development of analytical models of diffusion patterns of new products for individual consumers or for technologies from competing firms.[14, 15, 16, 17] One study records researchers' attempts to investigate underlying factors that drive diffusion processes.[16] Because of distinct characteristics of the diverse new products, few studies are conclusive in terms of developing a universally applicable model. Some key findings, however, seem to have gained wide recognition in academia and industry.

First, new technologies may not be adopted by all potential users, regardless of their economic benefits and technological merits. Therefore, a ceiling of adoption rate exists for many products. Second, not all adopters purchase new products at the same time; some act earlier to purchase new products, while others respond slowly, waiting for products to become more mature. Third, diffusion processes can be approximately characterized by asymmetric S-curves, depicting three stages of the diffusion: starting, accelerating, and decreasing as the adoption ceiling is being reached.

An important diffusion model, the *epidemic model*, is widely used in marketing and social studies on diffusion. It assumes a) that consumers value the benefits of a new product identically, and b) that the cost of a new product is constant or declines monotonically over time. What induces a consumer to purchase the new product is information about the availability and the benefits of the product. In other words, it is information diffusion that drives new product adoption by individual consumers.[16] The model embraces information diffusion from both internal sources (news spread by word of mouth from early adopters) and external sources (the announcement effect by government or commercial advertising programs) by superimposing a logistic function with an exponential function.[14, 17]

The degree of relative dominance of influence by internal or external sources will determine the general shape of the diffusion curve of a specific product.[14, 17] For instance, if the adoption of one particular product is more influenced by external sources of information diffusion (announcement effect) than by internal sources (word of mouth among earlier adopters to prospective adopters), the rate of diffusion at the beginning stage of the diffusion process is much higher. This reflects the immediate information exposure to a significant number of prospective adopters brought about by external sources, in contrast to the more gradual exposure to internal sources such as news propagation by earlier adopters, a small proportion of the population, to other prospective adopters.

Graphically speaking, a relatively dominant external source of information diffusion will give an immediate jump-start to the adoption of a new product in the first years, forming a concave curve with respect to the Y axis (see the exponential curve in Figure RIA.A.1). Adoption of a new product with a stronger influence by internal sources of information diffusion (such as a socially tightened network formed by prospective adopters) may start with a few early adopters and gradually increase as the number of adopters grows Once a critical mass accumulates, the growth appears to accelerate very rapidly and thus forms a convex curve with respect to the Y-axis during the starting and acceleration stages (see the logistic curve in Figure RIA.A.1).

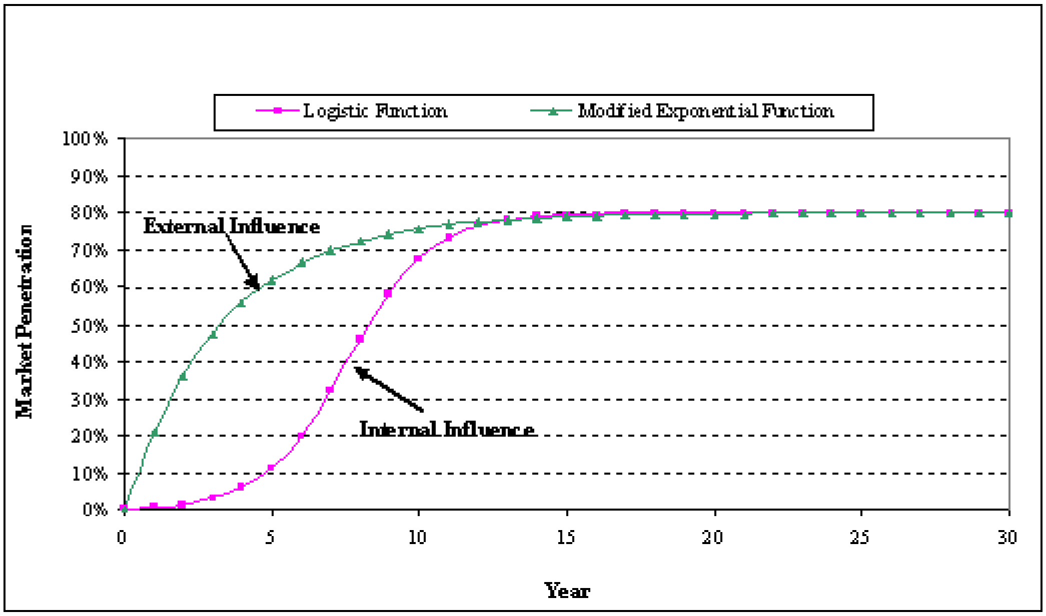

Figure RIA.A.1 Comparison of Exponential and Logistic Curves Showing External and Internal Influences on Consumers

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