Incandescent Reflector Lamps Study of Proposed Energy Efficiency Standards for New York State

Final Report 06-07
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New York State
Energy Research and
Development Authority

NYSERDA

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ABSTRACT

Article 16, Section 16-106, 2, (a) (iv) of the New York State statutes authorizes a study to be conducted to determine whether an energy efficiency standard for incandescent reflector lamps should be established, taking into account factors including the potential impact on electricity usage, product availability, and consumer and environmental benefits.[1] This report presents the findings of that study.

Data was collected from the U.S. Department of Energy, U.S. Census Bureau, New York utilities websites, National Electrical manufacturers Association, California Energy Commission, and other states developing incandescent reflector lamps standards and from manufacturers in the preparation of this report. Discussions also occurred between the author and energy efficiency advocates and lamp manufacturers in the development of additional data and to discuss potential recommendations. The data allowed for complete energy, environmental, economic and financial analyses to determine the validity of all recommendations.

This report recommends New York adopting the following standards. These recommended standards match standards being promulgated in other states.

Rated Lamp Wattage	Minimum Average Lamp Efficacy (lm/W)
40 – 50	10.5
51 – 66	11.0
67 – 85	12.5
86 – 115	14.0
116 – 155	14.5
156 – 205	15.0

It is recommended that the following lamp types and wattages be exempted from the minimum average lamp efficacy requirements for the reasons stated with each lamp.

- PAR38, BR38, R40 and BR40, greater than 205 watts. No replacement lamp is available that will provide similar light output and produce energy savings.
- R20, 45 watts and less. No replacement lamp is available that will produce energy savings.
- BR30 and ER30, 45 watts and less. No replacement lamp is available that will produce energy savings.
- BR40 and ER40, 45 watts and less. No replacement lamp is available that will produce energy savings.

- BR30's and 40's and ER30's and 40's, 50 watts. Consumer buying behavior issues produce a high probability that net energy savings caused by the replacement of these lamp types and wattage will be negative.
- BR30's and 40's and ER 40's, 65 watts. Consumer buying behavior issues produce a moderate to high probability that net energy savings caused by the replacement of these lamp types and wattage will be negative.

Product testing and certification is required to ensure compliance with the recommended standards. The federal guidelines for testing incandescent reflector lamps are recommended. Certification of the testing results must be provided by the manufacturer to a New York state agency or the state's designee.

KEY WORDS

Incandescent Reflector Lamps
Lamp Exemptions to Minimum Average Lamp Efficacy Standards
Minimum Average Lamp Efficacy Standards
New York Incandescent Reflector Lamp Legislation
Recommended Efficiency Standards for Incandescent Reflector Lamps Regulated by New York State

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SUMMARY

Article 16, Section 16-106, 2, (a) (iv) of the New York State statutes authorizes a study to be conducted to determine whether an energy efficiency standard for incandescent reflector lamps should be established, taking into account factors including the potential impact on electricity usage, product availability, and consumer and environmental benefits.[1] This report presents the findings of that study.

New York State is proposing the enactment of appliance efficiency standards for incandescent reflector lamps exempted from federal incandescent reflector standards. A law was passed by the New York legislature, Article 16, Section 16-102, 21[1], that defines incandescent reflector lamps covered by the law as a lamp which is not colored or designed for rough or vibration service applications; has an inner reflector coating on the outer bulb to direct the light; has a E26 medium screw base; has a rated voltage or voltage range that lies at least partially within one hundred fifteen to one hundred thirty volts; and falls into one of the following categories:

(a) a bulged reflector or elliptical reflector bulb shape and which has a diameter which equals or exceeds 2.25 inches, or
(b) a reflector, parabolic aluminized reflector, or similar bulb shape and which has a diameter of 2.25 to 2.75 inches.

The summary table, Table 1, below provides the number of incandescent reflector lamps in use in New York State, the number of incandescent reflector lamps that the proposed standards would regulate, and the annual energy usage of these lamps for the consumer market and for the business market.

Table 1. Summary Table

	Residential	Business
New York State Total IR Lamps in Use	13,460,000	6,650,000
Total IR Lamps to be Regulated by State	10,768,000	5,320,000
Energy Use All IR Lamps in Use (kWh)	1,202,700,000	1,681,600,000
Energy Use IR Lamps being Regulated (kWh)	962,142,000	1,348,701,000

Lamp manufacturers and their trade association, National Electrical Manufacturer Association, have expressed concerns that individual states will enact standards that are different from other states. This would cause a distribution problem as to which products get shipped to which state since a central warehouse ships to multiple states. Their wish is to have consistency between individual state regulations.

This report recommends New York State adopt the following standards (see Table 2). These recommended standards match standards being promulgated in other states. This is required to address the primary concern of the lamp manufacturers that states adopt the same incandescent reflector lamp standards to eliminate distribution roadblocks.

Table 2. Recommended Minimum Average Lamp Efficacy Standards.

Rated Lamp Wattage	Minimum Average Lamp Efficacy (lm/W)
40 – 50	10.5
51 – 66	11.0
67 – 85	12.5
86 – 115	14.0
116 – 155	14.5
156 – 205	15.0

There are replacement lamps available that meet these recommended minimum average lamp efficacy standards, with the exception of the recommended exempted lamps listed below. For a lamp meeting the minimum average lamp efficacy standards to be a replacement for a lamp that does not meet the standards, it must provide similar light output (lumens), be able to fit into the same light fixture (same diameter), and have a lower rated lamp wattage so it will produce energy savings. Multiple manufacturers have indicated the availability of these replacement products.

It is recommended that the following lamp types and wattages be exempted from the minimum average lamp efficacy requirements for the reasons stated with each lamp. The recommended minimum average lamp efficacy standards and exemptions allow New York State to essentially match standards being promulgated in other states and to meet the needs of manufacturers.

- PAR38, BR38, R40 and BR40, greater than 205 watts - No replacement lamp is available that will provide similar light output and produce energy savings.
- R20, 45 watts and less - No replacement lamp is available that will produce energy savings.
- BR30 and ER30, 45 watts and less - No replacement lamp is available that will produce energy savings.
- BR40 and ER40, 45 watts and less - No replacement lamp is available that will produce energy savings.
- BR30’s and 40’s and ER30’s and 40’s, 50 watts - Consumer buying behavior issues produce a high probability that net energy savings caused by the replacement of these lamp types and wattage will be negative.

- BR30's and 40's and ER 40's, 65 watts - Consumer buying behavior issues produce a moderate to high probability that net energy savings caused by the replacement of these lamp types and wattage will be negative.

Product testing and certification is required to ensure compliance with the recommended standards. The federal guidelines for testing incandescent reflector lamps are recommended. Certification of the testing results must be provided by the manufacturer to a New York State agency or the State's designee. These recommendations are consistent with the intent of the law for the establishment of incandescent reflector lamp standards. Implementation of the recommended standards will provide significant electricity reductions in both use and peak demand. More efficient incandescent reflector lamps are readily available and there are positive consumer and environmental benefits.

The following table compares the recommended New York State incandescent reflector lamps standards with other states that have, or are developing standards for this product.

Table 3. Comparison by State

	California, Massachusetts and Rhode Island[2]	**Proposed New York**
Minimum average Lamp efficacy	Adopted DOE standard	Adopt DOE standard
Lamps exempted		
R20, 45 watts and less	Yes	Yes
R20, 50 watts	No	No
R20, 100 watts	No	No
IR lamps over 205 watts	Silent on these lamps	Yes
BR30, 50 watts and less	Yes	Yes
ER30, 50 watts and less	Yes	Yes
BR30, 65 watts	Yes	Yes
BR40, 50 watts and less	Yes	Yes
ER40, 50 watts and less	Yes	Yes
BR40, 65 watts	Yes	Yes
ER40, 65 watts	Yes	Yes
Testing procedures	Adopted DOE standard	Adopt DOE standard

It should be noted that consumer education is paramount for successful adoption of the proposed incandescent reflector lamp regulation in New York State.

The potential demand and energy savings, and environmental and economic impacts are substantial if the recommended incandescent reflector lamp standards are enacted. The following provides information on these positive impacts.

Permanent demand reduction: ..... 137.0 MW

Annual energy savings: ..... 617.2 million kWh

Environmental benefits

SO_2 Annual Reduction.....925.9 tons

Greenhouse Gas Annual Reductions

NO_x .....462.9 tons

CO_2.....337,012.0 tons

Life cycle positive economic impact:.....$208.1 million

Section 1
HISTORY OF INCANDESCENT REFLECTOR LAMP REGULATIONS

The Energy Policy Act of 1992 required the U.S. Department of Energy (DOE) to establish energy efficiency standards for certain appliances.[3] One of the identified appliances was incandescent reflector lamps. DOE developed proposed standards and testing standards, held a series of hearings and public comment periods and published standards for incandescent reflector lamps. These standards and testing procedures were published in the Federal Register and made part of the U.S. Code. The standards exempted certain incandescent reflector lamps.

Language taken directly from the U.S. Code defines incandescent reflector lamps as any lamp (commonly referred to as a reflector lamp) which is not colored or designed for rough or vibration service applications, that contains an inner reflective coating on the outer bulb to direct the light, an R, PAR, or similar bulb shapes (excluding ER or BR) with E26 medium screw bases, a rated voltage or voltage range that lies at least partially within 115 and 130 volts, a diameter which exceeds 2.75 inches, and is either:

(I) a low(er) wattage reflector lamp which has a rated wattage between 40 and 205 watts; or

(II) a high(er) wattage reflector lamp which has a rated wattage above 205 watts.[4]

Bulged reflector (BR) and elliptical reflector (ER) lamps were excluded from the definition and from regulations because they were considered a specialty lamp rather than a general service lamp. One must remember these regulations were developed in the mid-1990s when few BR and ER lamps were in use. Since the regulations were adopted, BR and ER lamps have gained popularity at the expense of R lamps which could not meet the minimum federal efficacy standards. Between the date of enactment of the IR requirements and today, the halogen PAR lamps have also gained in popularity. Halogen lamps, in general, are more efficacious than standard incandescent lamps.

Since the popularity of BR and ER lamps has grown and DOE has not updated its incandescent reflector lamp standards since 1997, states have instituted legislation and/or standards to adopt minimum efficiency standards for incandescent reflector lamps exempted from or not included in federal standards such as the BR and ER lamps. New York, California, Rhode Island and Massachusetts are some of the states that have passed such legislation/standards and either have adopted or are in the process of adopting standards.

Section 2

THE NEW YORK INCANDESCENT REFLECTOR LAMP LEGISLATION

Article 16, Section 16-102, 21 of New York State law defines incandescent reflector lamps covered by the law as a lamp which is not colored or designed for rough or vibration service applications, that has an inner reflector coating on the outer bulb to direct the light, an E26 medium screw base, and a rated voltage or voltage range that lies at least partially within one hundred fifteen to one hundred thirty volts, and that falls into one of the following categories:

(c) a bulged reflector or elliptical reflector bulb shape and which has a diameter which equals or exceeds 2.25 inches, or

(d) a reflector, parabolic aluminized reflector, or similar bulb shape and which has a diameter of 2.25 to 2.75 inches.

This definition enables New York State to regulate incandescent reflector lamps that are exempt from federal regulation. The lamps by category that are included in the State's regulations are R20 and PAR 20 lamps and BR and ER 20's, 30's, and 40's lamps.

Section 3
INCANDESCENT REFLECTOR LAMP INFORMATION

DETERMINING THE NUMBER OF INCANDESCENT REFLECTOR (IR) LAMPS IN USE IN NEW YORK STATE

Two methodologies were used, adjusted and compared to develop the number of IR lamps in use in New York State. The first method for this study, called the "Census Method", examined the total number of IR lamps in use in the United States as developed by the U. S. Department of Energy in its report *U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and Energy Consumption Estimate, September 2002*[5], and U.S. Census data for the population of the country and New York[6]. This method states that since 6.7% of the population of the U.S. lives in New York, 6.7% of the IR lamps operate within New York State. Because halogen lamps are the most likely energy-efficient replacement for IR lamps, this examination of the number of lamps within New York State also looked at the number of halogen lamps in use. See Table 2 for the number of lamps for residential use and business use this method predicts.

The second primary methodology used for this study, called the "Electric Customer Method", included determining the number of electric customers within New York State and the average number of lamps per business customer and residential dwelling unit (as provided in the above referenced DOE report). The number of electric customers was determined through research on utility websites and on the New York Department of Public Service website. The total number of electric customers in New York State is approximately 6,700,000 residential and 995,000 businesses. The residential customer count must be adjusted for master metered apartment complexes where one electric customer may be equivalent to a few hundred residential dwelling units. An adjustment for master metered apartments would bring the total number of residential dwelling units to 7,500,000. The number of dwelling units and businesses are multiplied by the number of lamps per unit as specified in the DOE report (2 IR lamps and 0.2 halogen lamps per dwelling unit and 17 IR lamps and 0.2 halogen lamps per business). See Table 2 for the number of lamps for residential use and business use this method predicts.

Adjustments were made to the estimated number of IR and halogen lamps within the State in order to account for unique residential and business density characteristics in New York City (NYC). For instance, dwelling units within NYC, on average, are smaller than the average size dwelling unit nationally. Therefore, the number of IR lamps per dwelling unit will also be less than the U.S. average as reported by DOE (2 lamps per dwelling unit U.S. average; 1.8 IR lamps per dwelling unit assumed for New York State). NYC also has more businesses per population than the U.S. Census would predict, therefore there

should be a higher total of IR lamps than the Census method of 6.7% would predict. It is expected the population of IR and halogen lamps would be more like 8% of the total IR and halogen lamps in use within the U.S. Spread sheets detailing numerical calculations for Table 2 are included in Appendix A: New York Customers.

Table 4. Number of IR Lamps[5,6]

	Residential	**Business**
U.S. Total Lamps		
IR lamps	262,471,000	82,480,000
Halogen	14,219,000	17,663,000
NY State Total Lamps		
Census Method		
IR lamps	17,586,000	5,526,000
Halogen	953,000	1,183,000
Electric Customer Method		
IR lamps	14,959,000	16,785,000
Halogen	1,496,000	208,000
NY State Total Lamps Used for Remainder of Report		
IR lamps	13,460,000[a]	6,650,000[b]
Halogen	900,000[c]	1,400,000[b]

Notes: [a] The electric customer method was used adjusted for less (1.8) IR lamps per dwelling unit.
[b] The census method was used adjusted to reflect a higher (8% vs 6.7%) businesses per population.
[c] The electric customer method was used adjusted for less (0.12) halogen lamps per dwelling unit.

Some New York State IR lamps already meet the proposed standards or are regulated under the federal standards. It is estimated that 20%, based on DOE average wattage per lamp[5], of the total IR lamps in New York will not be affected by the proposed state standards. Therefore, the number of lamps to be included in any calculations regarding the benefits of the proposed New York State IR standards is:

Residential: 10,768,000

Business: 5,320,000

DETERMINING ENERGY USE OF INCANDESCENT REFLECTOR (IR) LAMPS IN USE IN NEW YORK STATE

The energy use is a function of the number of lamps in use in New York State or the number of IR lamps that fall under the proposed state standards developed from the above discussion; the average wattage of IR and halogen lamps as reported by U. S. DOE in the above referenced report; and the daily average operating hours reported in the same DOE report[5]. No adjustments were made to these numbers for New York State because there is no state-by-state data available. To develop annual energy usage, it was assumed the average daily operating hours for residences would occur 365 days per year and 250 days per year for businesses. Spread sheets detailing numerical calculations for Table 3 are included in Appendix A: New York Customers.

Table 5. IR Lamp Energy Consumption

	Residential	**Business**
Average Lamp Wattage		
IR Lamps	102 watts	104 watts
Halogen	205 watts	64 watts
Average Daily Operating Hours		
IR Lamps	2.4 hours	9.6 hours
Halogen	2.5 hours	9.7 hours
Annual Energy Consumption, All IR Lamps (kWh)		
IR Lamps	1,202,700,000	1,681,600,000
Halogen	168,356,000	233,235,000
Annual Energy Consumption, IR Lamps under Proposed State Regulation (kWh)		
IR Lamps	962,142,000	1,348,701,000

DETERMINING THE NUMBER OF INCANDESCENT REFLECTOR (IR) LAMPS REPLACED AND ADDED ANNUALLY IN NEW YORK STATE

The National Electrical Manufacturers Association (NEMA) has provided information on the shipment of different types of incandescent reflector lamps, including halogen, for 2002 for the entire United States. The numbers reported represent 78.8% of all incandescent reflector lamps shipped that year. Census data was used to estimate the number of lamps sold in New York State, i.e., 6.7% of the lamps was sold in New York State. Based on the number of lamps reported by NEMA as shipped and the percentage of total IR lamps this represents, an additional 39,447,000 IR lamps were shipped nationally but are not included in any of the NEMA reported categories of IR lamps. For this report, it is assumed these additional lamps can

be assigned to the different NEMA categories based on the weighting of lamps reported in each category. An additional assumption was made for blown glass PAR (BPAR38) lamps below 121 watts. Since no data was reported for 2002 for this category, the 2001 data of 466,000 lamps shipped was used.[7]

Table 6 below presents the number of IR lamps shipped nationally and sold within New York State including those lamps not categorized by NEMA. Spread sheets detailing numerical calculations for Table 4 are included in Appendix A: New York Customers.

Table 6. Lamp Replacement by Type[7]

Type of Lamp	U.S. Lamps Shipped	NY Lamps Replaced/Added	NY Lamps (Including Unclassified)
BR30, 85W & <66W	65,890,000	4,414,600	5,584,800
BR40, 120W or less	14,915,000	999,300	1,264,200
ER30 or ER40	1,454,000	97,400	123,200
Blown Glass PAR38, 150W	2,121,000	142,100	179,800
Blown Glass PAR38,less than 121W	466,000	31,200	39,500
Total IR non-halogen	84,846,000	5,684,700	7,191,500
Halogen PAR38	49,460,000	3,313,800	4,192,200
Halogen PAR30	14,516,000	972,600	1,230,300
Total IR Halogen	63,976,000	4,286,400	5,422,500
Unclassified by NEMA	39,447,000	2,642,900	
Total IR Lamps Sold	**188,269,000**	**12,614,000**	**12,614,000**

Section 4
MINIMUM AVERAGE LAMP EFFICACY STANDARDS

The DOE minimum efficacy standards for IR lamps were established in 1997. These minimum efficacy standards have been utilized by California, Massachusetts and other states establishing state standards for IR lamps exempted from the DOE standards. Table 7 below provides the DOE minimum efficacy standards expressed in terms of lumens per watt of rated lamp wattage.

Table 7. DOE Minimum Lamp Efficacy Standards[3]

Rated Lamp Wattage	Minimum Average Lamp Efficacy (Lm/W)
40 – 50	10.5
51 – 66	11.0
67 – 85	12.5
86 – 115	14.0
116 – 155	14.5
156 – 205	15.0

The table does not cover all IR lamps that are included in the New York State legislation. IR lamps with wattages less than 40 watts and greater than 205 watts exist but are not included in the efficacy table above. The New York State legislation is silent on which wattages should be covered by regulation. It is recommended that lamps below 40 watts and above 205 watts be specifically exempted from the New York State regulations for the following reasons.

- There are no higher energy efficiency alternatives for IR lamps less than 40 watts.
- There are no IR lamps above 205 watts that meet the minimum average lamp efficacy requirements of 15.0 lumens per watt and have sufficient lumen light output to replace these higher wattage (250-watt and 300-watt) IR lamps.
- The amount of IR lamps in use with wattages below 40 watts and above 205 watts is minuscule.

The average efficacies for lamps that do not meet the minimum average lamp efficacy requirements and are included in the New York State legislation are shown in Table 8 below. Development of these numbers can be found in Appendix B: Incandescent Reflector Lamp Data.

Table 8. Average Efficacy of Existing Non-qualifying IR Lamps

Rated Lamp Wattage	Average Lamp Efficacy (lm/w)
40 – 50	7.6
51 – 66	10.1
67 – 85	9.2
86 – 115	10.2
116 – 155	10.7
156 – 205	11.0

AVAILABILITY OF IR LAMPS THAT MEET THE MINIMUM AVERAGE LAMP EFFICACY REQUIREMENTS

This section attempts to determine if the federally regulated minimum average lamp efficacies, as presented in Table 8 above, should be adopted by New York State for lamps it intends to regulate by examining the availability of lamps that meet these standards. Data for this analysis is included in Appendix B: Incandescent Reflector Lamp Data of this report.

Rated Lamp Wattage: 40 – 50 watts

There are two non-halogen IR lamps that will meet the minimum average lamp efficacy of 10.5 lumens per watt set forth in the federal standards. They are a 45-watt BR30 and a 50-watt ER30. All halogen 50-watt PAR 20; 40-, 45-, and 50-watt PAR 30's; and 40-, 45-, and 50-watt PAR 38's have efficacies higher than the federal standard for this wattage range.

Rated Lamp Wattage: 51 – 66 watts

There are four non-halogen IR lamps that will meet the minimum average lamp efficacy of 11.0 lumens per watt set forth in the federal standards. They are a 60-watt R30 and 65-watt BR30, PAR38, and R40. All halogen 60-watt BR30 and BR 40, 60-watt PAR30, and 60-watt PAR38s have efficacies higher than the federal standard for this wattage range.

Rated Lamp Wattage: 67 – 85 watts

There are no non-halogen lamps that meet the minimum average lamp efficacy of 12.5 lumens per watt set forth in the federal standards. However, all halogen 75-watt PAR30, and 70-, 75-, and 80-watt PAR38s have efficacies higher than the federal standard for this wattage range.

Rated Lamp Wattage: 86 – 115 watts

There are no non-halogen lamps that meet the minimum average lamp efficacy of 14.0 lumens per watt set forth in the federal standards. However, all halogen 90- and 100-watt PAR38s have efficacies higher than the federal standard for this wattage range.

Rated Lamp Wattage: 116 – 155 watts

There are no non-halogen lamps that meet the minimum average lamp efficacy of 14.5 lumens per watt set forth in the federal standards. However, all halogen 120-watt PAR38s have efficacies higher than the federal standard for this wattage range.

Rated Lamp Wattage: 156 – 205 watts

There is only one lamp still manufactured within this wattage range, a non-halogen 200-watt BR40. It does not meet the federal minimum average lamp efficacy standard of 15.0 lumens per watt.

There are lamps of varying wattages, shapes, and sizes that meet the federal minimum average lamp efficacy standards and that meet the New York State definition for IR lamps (with the exception of lamps in the 156- to 205-watt range). However, there are halogen replacements of lower wattage that meet the federal regulations with a light output (lumens) slightly less than the non-halogen 200-watt BR40 lamp in this category. It is believed these 120-watt PAR 38 halogen lamps could effectively replace the 200-watt BR40.

There are multiple manufacturers of each replacement lamp type and wattage that meet the proposed minimum average lamp efficacy requirements. These products are currently in the marketplace.

Based on these findings, it is recommended that New York State adopt the federal regulations of minimum average lamp efficacy for the different bins of rated lamp wattage as set forth in Table 8 for its proposed standards.

ARE THERE REPLACEMENT LAMPS FOR IR LAMPS THAT DO NOT MEET THE EFFICIENCY REQUIREMENTS AND WILL THESE REPLACEMENT LAMPS SAVE ENERGY?

Answering this question will assist in determining where, if any, exemptions to the minimum average lamp efficacy standards should be recommended. For a lamp meeting the minimum average lamp efficacy standards to be considered a replacement for a lamp that does not meet the standards, it must provide similar light output (lumens), be able to fit into the same light fixture (same diameter), and have a lower rated lamp wattage so it will produce energy savings. For example, a 50-watt R20 non-halogen lamp that does not meet the efficiency standards can be physically replaced with a 50-watt PAR20 halogen lamp. The lamp would provide more light, but no energy savings would occur. For this analysis, this lamp would not be considered a replacement because it did not save any energy. Data to conduct this analysis can be found in Appendix B: Incandescent Reflector Lamp Data.

The following lists lamp types and wattages and makes a determination for each if there is a replacement that meets the above criteria of light output, size, and energy savings and the standard for minimum average lamp efficacy for lamps covered under the New York State legislation.

- R20, 30-watt non-halogen: No replacement available that saves energy.
- R20, 45-watt non-halogen: No replacement available that saves energy.
- R20, 50-watt non-halogen: Can be replaced with the R20, 45-watt lamp although this lamp does not meet the minimum average lamp efficacy of 10.5 lumens per watt.
- R20, 75-watt non-halogen: Can be replaced with PAR20, 50-watt halogen.
- R20, 100-watt non-halogen: Can be replaced with a 75-watt, PAR16 halogen lamp. While this lamp is slightly smaller in diameter than the R20, it will fit into existing R20 fixtures.
- BR30, 45-watt non-halogen: One manufacturer's lamp meets the minimum average lamp efficacy standard and would not have to be replaced. Only one PAR30, 40-watt halogen lamp that is classified as short length by its manufacturer would meet the replacement criteria.
- BR30, 50-watt non-halogen: Can be replaced with PAR30, 40- and 45-watt halogen lamps that save energy.
- BR30, 65-watt non-halogen: One manufacturer's lamp meets the minimum average lamp efficacy standard and would not have to be replaced. Other non-qualifying lamps can be replaced with a PAR 30, 50-watt halogen lamp.
- BR30, 75-watt non-halogen: Can be replaced with a 50-watt, PAR30 halogen or with the BR30, 65-watt non-halogen lamp that passes the efficiency standards.
- BR30, 85-watt non-halogen: Can be replaced with a 60-watt or 75-watt, PAR30 halogen lamp.
- BR30, 110-watt non-halogen: Can be replaced with a 75-watt, PAR30 halogen lamp.
- ER30, 50-watt non-halogen: One manufacturer's lamp meets the minimum average lamp efficacy standard and would not have to be replaced. Other non-qualifying lamps can be replaced with PAR 30, 40-watt short length or 45-watt halogen lamp.
- ER30, 75-watt non-halogen: Can be replaced with a 50- or 60-watt, PAR30 halogen lamp.
- PAR 38, 150-watt non-halogen: Can be replaced with a 100- or 120-watt, PAR38 halogen lamp.
- PAR38, 250-watt non-halogen: No replacement available provides an equivalent amount of light.
- OPAR BR38, 75-watt non-halogen: Can be replaced with a 50-, 60-, 65-, or 70-watt, PAR38 halogen lamp.
- OPAR BR38, 150-watt non-halogen: Can be replaced with an 80-, 90-, 100-, or 120-watt, PAR38 halogen lamp.
- BR38, 250-watt non-halogen: No replacement available that provides an equivalent amount of light.
- BR38, 300-watt non-halogen: No replacement available that provides an equivalent amount of light.

- BR40, 65-watt non-halogen: Can be replaced with a 50-watt, PAR38 halogen lamp.
- BR40, 75-watt non-halogen: Can be replaced with a 50-watt, PAR38 halogen lamp.
- BR40, 85-watt non-halogen: Can be replaced with a 60-, 70-, or 75-watt, PAR38 halogen lamp.
- BR40, 90-watt non-halogen: Can be replaced with a 60-, 70-, or 75-watt, PAR38 halogen lamp.
- BR40, 100-watt non-halogen: Can be replaced with a 60-, 70-, or 75-watt, PAR38 halogen lamp.
- BR40, 120-watt non-halogen: Can be replaced with an 80- or 90-watt, PAR38 halogen lamp.
- BR40, 200-watt non-halogen: Can be replaced with a 120-watt, PAR38 halogen lamp.
- BR40, 300-watt non-halogen: No replacement available that provides an equivalent amount of light.
- ER40, 120-watt non-halogen: Can be replaced with a 90-watt or 100-watt, PAR38 halogen lamp.

Based on the availability of lamps that meet the efficacy standards, fits into the same light fixture, provides similar light output and saves energy, the following lamps should be exempt from the recommended New York State minimum average lamp efficacy standards. This recommendation for exemptions is based on the technical ability to replace a less-efficient lamp, and does not include any economic analysis or consumer buying behaviors.

Recommended Exemptions Based on Lamp Replacement Availability:

- R20, 45 watts or less, no replacements available
- BR30, 45 watts and less, very limited replacement
- PAR38, 250 watt, no replacements available
- BR 38, 250 watts or greater, no replacements available
- BR40, above 200 watts, no replacements available

Section 5
ECONOMIC ANALYSIS, LIFE CYCLE COST TEST

Appendix C: Life Cycle Economic Analysis provides the details for each replacement IR lamp. The study is separated into a consumer section and a business section. The cost of the IR lamps is less for a business than a consumer because of the volume purchased by businesses. The annual operating hours for IR lamps in businesses are much higher, 2,425 hours vs. 876 hours for a consumer.[5] This data is provided by DOE in its above referenced report. The energy cost $0.1458 per kWh for consumers and $0.1203 per kWh for businesses and discount rate of 3% were provided by the New York State Energy Research and Development Authority (NYSERDA). The energy costs are a weighted average for New York State and the business kWh cost is weighted for commercial and industrial use. No energy escalators were to be used.

Lamp costs were developed through surveying stores in the Albany area where consumers would normally go to purchase IR lamps, and searching the internet for sites that sell IR lamps[12]. To set the consumer cost included in Appendix C, the average of all prices obtained for a specific lamp type and wattage was used. The cost for a business used the lowest cost from any source. If only one price was available for a specific type and wattage lamp, the business price was assumed to be 10% below this price. Businesses have the added cost of labor to replace lamps. Labor cost was added to the lamp costs when determining life cycle costs. It was estimated it would take a maintenance person being paid at $40 per hour, with benefits, 10 minutes to replace an IR lamp.

The life cycle is equivalent to the life of the existing IR lamp or the IR lamp that would replace it, whichever is longer, divided by the annual operating hours for either consumers or businesses. This expresses the life cycle in years. Since all life cycles are greater than one year, present value analysis is used for energy cost savings and lamp costs/replacement to reflect the cost of money. Negative net benefits to either the consumer or business are expressed as a negative number.

All replacement IR lamps that meet the federal minimum average lamp efficacy standards were found to be cost effective with the exception of the R20 45-watt non-halogen lamp replacing a R20, 50-watt non-halogen lamp. For both the consumer and business, this lamp produced a negative net benefit to the customer. Based on the financial analysis alone, the R20 50-watt non-halogen lamp should be exempted from the standards.

Section 6
CONSUMER BEHAVIOR

Many consumers are uneducated regarding lighting issues and many more are under-educated. Market research conducted by the LRC for a number of sponsors confirms this statement. The research points out consumers equate the amount of light a bulb emits to the wattage of the lamp. The higher the wattage the more light output, especially within a technology class such as incandescent or fluorescent. Price of the lamp is a major consideration in making buying decisions for consumers.

Because of these issues, consumers may very well replace IR lamps that no-longer can be sold according to the proposed New York State regulations with a standard incandescent "A" lamp, instead of the more efficient halogen or other alternative IR lamp. The A lamp fits the light fixture, it will have the same or higher wattage (in the mind of the consumer, it must provide the same or greater light output) and it only costs $0.50 as compared to the halogen alternative at $7.00.

Consumer education is paramount if the adoption of the proposed IR lamp regulation within New York State is going to be successful. Consumers must be taught to compare light output (lumens) rather than wattage when selecting a replacement IR lamp. In addition, an explanation of the energy savings and the longer life of the replacement lamp must be communicated to overcome any pricing issues. Education must also ensure consumers understand IR lamps project light in a certain direction. As a result of this projection, they are more efficient in delivering light to a specific area than a standard incandescent lamp. Therefore, IR lamps should only be replaced with more efficient IR lamps and not standard incandescent.

Lack of information pertaining to light output per given unit of energy consumed on packaging material confounds the needs for consumers to make rational purchasing decisions. Since certain lamps such as the BR and ER incandescent reflector lamps are exempted from federal energy efficiency regulations, they are also not covered in the federal package labeling requirements. For covered IR lamps, the federal labeling requirements include the wattage of the lamp, its light output expressed in lumens and the life of the lamp. In examining lamp labels of some non-federally regulated IR lamps, it was noted the lumens (light output) was not included on the packaging. Without this information, it will be difficult for the consumer to select an energy efficient alternative for IR lamps.

Therefore, it is recommended that if New York State enacts IR lamp regulations, a consumer education program be developed and executed to ensure consumers have the necessary knowledge to make informed choices regarding the replacement of less efficient IR lamps.

CONSUMER BEHAVIOR AND POTENTIAL ENERGY SAVINGS

In many cases consumers are likely to choose non-energy saving alternative IR, or standard incandescent lamps, to replace the IR lamps that would no longer be available due to New York regulations. Therefore, it is appropriate to examine potential energy savings under different consumer buying scenarios to determine if IR lamp exemptions to the regulations are needed.

Appendix D: BR/ER 30 & 40 Incandescent Reflector Lamp Scenarios: Energy Savings – New York provides the detail analysis for each scenario examined for 65-watt, 50-watt, and 85-watt BR and ER incandescent reflector lamps and their potential replacements including standard incandescent lamps. Four scenarios were developed. Each attempts to predict slightly different consumer buying behaviors. These scenarios are similar to what was used in California to examine potential energy savings under different consumer buying behaviors. The California study was used to recommend exemptions of certain lamps from the State's regulations. The scenarios are:

- Scenario 1 – Perfect Replacement – This scenario says consumers will act rational and examine light outputs and wattages. They will choose a replacement that will save energy even if it costs more to purchase or they will choose a replacement of equal wattage but with a higher efficacy that meets the New York State regulations.

- Scenario 2 – Halogen Replacement – In this scenario, the consumer will select from the more expensive halogen choices including the possible use of higher wattage halogen lamps. An alternative is to use an IR lamp of equal wattage that qualifies under the New York State regulations.

- Scenario 3 – A Lamp Replacement – This scenario allows the consumer to replace the IR lamp with standard A incandescent lamps of varying wattages. Only 10% of the consumers will use the A lamp. Others will continue to select from halogen or qualified IR lamps.

- Scenario 4 – Lots of A Lamps – The percentage of consumers selecting "A" lamps in this scenario increases to 20%. All else is according to other scenarios.

Table 9. Scenario Results

	Total kW Savings			
Baseline	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Lamp to be Replaced	Perfect Replacement	Halogen Replacement	A Lamp Replacement	Lots of A Lamps
65-watt, BR/ER 30/40	39,000 kW	6,500 kW	780 kW	(5,200 kW)
50-watt, BR/ER 30/40	750 kW	(750 kW)	(1,380 kW)	(1,800 kW)
85-watt, BR/ER 30/40	10,000 kW	10,000 kW	8,875 kW	7,750 kW

The 65-watt BR/ER category shows positive energy savings for most of the replacement lamp scenarios. Energy savings will become negative when consumers replace 12–13% of existing 65-watt BR and ER lamps with A lamps. A statistically significant fielded survey of residential lighting in California, conducted by RLW Analytics in 2005, indicated that 8.1% of recessed light fixtures (fixture type most likely to use reflector lamps) utilized non-reflector incandescent lamps[8]. This survey was conducted prior to the new efficiency standards for IR lamps being in place.

It can be expected that the percentage of non-reflector incandescent lamps used in recessed fixtures will increase when the current BR and ER 65-watt lamps are no longer sold in California because of the new IR lamp regulations. The energy-efficient alternatives to the incandescent reflector lamp for the 65-watt BR and ER lamps are halogen PAR lamps. The RLW survey indicates that only 3.2% of recessed light fixtures in California currently use a halogen lamp. Given that significantly more consumers use non-reflector incandescent lamps in their recessed fixtures than halogen PAR lamps, it is reasonable to expect the percentage of non-reflector incandescent lamps to increase significantly, and may very well exceed the 12% to 13% threshold that would cause energy savings to be negative. There is no reason to believe New York State homes have a significantly different mix of lamp types in recessed light fixtures than what RLW Analytics found in California. In fact, if anything, one can argue there should be higher percentages of non-reflector incandescent lamps in recessed fixtures in New York than California because of California energy issues in recent years, energy pricing increases, and the emphasis that the State of California, California utilities and California consumers have placed on energy conservation.

Based on the above, it is recommended that the 65-watt BR30, the BR40, and the 65-watt ER40 be exempted. Consumer behavior with the purchase of non-reflector incandescent lamps to replace the 65-watt BR and ER lamps could likely cause energy savings to become negative.

Based on this analysis of consumer buying behaviors, it is recommended that 50-watt BR 30 and BR 40, and 50-watt ER 30 and ER 40 be exempted from proposed New York State energy efficiency regulations.

A small percentage of consumers purchasing either A lamps or the 65-watt non-halogen IR lamps that meet the proposed minimum efficacy standards cause the possible energy savings of replacing the 50-watt BR 30 or 40 or ER 30 or 40 lamps to be negative. Therefore, it is recommended that the 50 watt BR 30, 50-watt BR40, 50-watt ER30 and 50-watt ER40 be exempted from the minimum average lamp efficacy regulations.

Conversely, the 85-watt BR/ER 30 and BR/ER 40 show positive energy savings even with 20% of the replacement lamps being of the A lamp variety. Therefore, these lamps should not be exempted.

Section 7
MANUFACTURERS' CONCERNS

Discussions occurred between the LRC, three major IR lamp manufacturers, and their association representative, the National Electrical Manufacturer Association (NEMA). The primary concern of the manufacturers is that each state will set different regulations regarding IR lamp standards. This would cause a distribution problem as to which products are shipped to which state since a central warehouse ships to multiple states. Their wish is to have consistency between individual state regulations.

The manufacturers have stated IR lamps that meet the minimum average lamp efficacy as set forth by DOE regulation are readily available to replace less efficient R, BR and ER lamps. They believe states should concentrate their efforts to set minimum average efficacy standards for replacing the higher wattage (above 65 watts) IR lamps as this is where the greatest energy savings can be achieved.

The manufacturers would prefer the regulation language set the effective date for implementation of the standards based on the products manufactured after the effective date rather than products sold after the effective date. They feel there will be more control in providing qualifying products if states use a manufacturing date. This would also allow retailers to sell any inventory of non-qualifying products without incurring any losses. A discussion between the New York Department of State (DOS), the LRC and the Advisory Committee ensued at the May 19, 2006 Advisory Committee meeting regarding this issue. DOS indicated the legislation was clear, and could not be changed without further legislation, and that the effective date will be based on the sales date.

Section 8
PRODUCT TESTING PROCEDURES/CERTIFICATION

DOE has established product testing and certification procedures for IR lamps it regulates. These procedures are included in 10 CFR Part 430, subparts 430.22, 430.23, 430.24, 430.25 and Appendix R to subpart 430.23[9]. By reference, the following standards are incorporated into the DOE product testing procedures:

- ANSI C78.21-1989 "Incandescent Lamps – PAR and R Shapes"
- Illuminating Engineering Society of North America (IESNA) LM-20-1994 "IESNA Approved Method for Photometric Testing of Reflector-Type Lamps"

These standards essentially require the following:

- The lamp efficacy shall be equal to the average lumen output of lamps tested divided by the average lamp wattage as determined in section 4 of Appendix R, with the resulting quotient rounded off to the nearest tenth of a lumen per watt.
- For each basic model of IR lamp, samples of production lamps shall be tested and the results of all samples shall be averaged for a 12-month period. A minimum sample of 21 lamps shall be tested over the 12-month period.
- The laboratory conducting the testing must be accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) or by an accrediting organization recognized by NVLAP.
- The manufacturer shall report the results to DOE within one month of completing the 12-month testing cycle.

These testing procedures are rigorous, are accepted by lamp manufacturers, and can be applied to the IR lamp classifications that New York State legislation wishes to regulate. They have also been adopted by California. The certification requirements would have to be modified to require the manufacturers report their findings to New York State or some other entity collecting the certifications for multiple states.

Based on the above, it is recommended that New York State use the DOE testing procedures as presented in 10 CRF Part 430 for IR lamps it wishes to regulate and modify the certification requirements to have the manufacturers report the test results to an agency of the State government or its representative.

Section 9

RECOMMENDED EFFICIENCY STANDARDS FOR INCANDESCENT REFLECTOR LAMPS REGULATED BY NEW YORK STATE

- Recommended that New York State adopt the DOE minimum average lamp efficacy (lumens per watt) requirements for incandescent reflector lamps it proposes to regulate according to its legislative definition of incandescent reflector lamps. These requirements are:

Table 10. Recommended Minimum Average Lamp Efficacy Standards.

Rated Lamp Wattage	Minimum Average Lamp Efficacy (lm/w)
40 – 50	10.5
51 – 66	11.0
67 – 85	12.5
86 – 115	14.0
116 – 155	14.5
156 – 205	15.0

Lamps exist that meet these minimum average efficacy requirements and can be considered a replacement lamp for less efficient IR lamps. A lamp is considered a replacement when it provides similar light output (lumens), is able to fit into the same light fixture (same diameter) and has a lower rated lamp wattage so it will produce energy savings. The availability of these replacement lamps is good and multiple manufacturers produce the qualifying products.

- Recommended that the following lamp types and wattages be exempt from the minimum average efficacy requirements. Rationale for each exemption is given with each recommendation. These recommendations are based solely on the data presented above.
  - PAR38, BR38, R40 and BR40, greater than 205 watts. No replacement lamp is available that will provide similar light output and produce energy savings.
  - R20, 45 watts and less. No replacement lamp is available that will produce energy savings.
  - R20, 50 watts. The replacement of this lamp was not found to be cost effective based on life cycle analysis for either consumers or businesses.
  - BR30 and ER30, 45 watts and less. No replacement lamp is available that will produce energy savings.
  - BR40 and ER40, 45 watts and less. No replacement lamp is available that will produce energy savings.
  - BR30 and BR40 and ER30 and ER40, 50 watts. Consumer buying behavior issues produce a high probability that net energy savings caused by the replacement of these lamp types and wattage will be negative.

    - BR30 and BR40 and ER 40, 65 watts. Consumer buying behavior issues produce a moderate to high probability that net energy savings caused by the replacement of these lamp types and wattage will be negative.
- Recommended that a consumer educational program be conducted in conjunction with the issuance of the IR lamp standards. Consumers should be taught to examine light output (lumens) rather than wattage when selecting replacement IR lamps.
- Recommended that New York State adopt the DOE IR lamp testing procedures for IR lamps it proposes to regulate and that the manufacturers are required to certify the results of these tests directly to New York State or its designee.
- Notwithstanding the above, it is recommended that New York State modify these recommendations to match IR lamp standards promulgated by other states. This is required to address the primary concern of the manufacturers that states adopt the same IR lamp standards to eliminate distribution roadblocks.

These recommendations are consistent with the intent of the law for the establishment of incandescent reflector lamp standards. Implementation of the recommended standards will provide significant electricity reductions in usage and peak demand, more efficient incandescent reflector lamps are readily available and there are positive consumer and environmental benefits.

Table 11. Comparison of Recommended New York IR Lamp Standards to Other States.

	California, Massachusetts and Rhode Island[2]	**Proposed New York**
Minimum average lamp efficacy	Adopted DOE standard	Adopt DOE standard
Lamps exempted		
R20, 45 watts and less	Yes	Yes
R20, 50 watts	No	No
R20, 100 watts	No	No
IR lamps over 205 watts	Silent on these lamps	Yes
BR30, 50 watts and less	Yes	Yes
ER30, 50 watts and less	Yes	Yes
BR30, 65 watts	Yes	Yes
BR40, 50 watts and less	Yes	Yes
ER40, 50 watts and less	Yes	Yes
BR40, 65 watts	Yes	Yes
ER40, 65 watts	Yes	Yes
Testing procedures	Adopted DOE standard	Adopt DOE standard
Consumer education	Nothing mentioned	Recommended

Section 10

POTENTIAL DEMAND AND ENERGY SAVINGS AND ENVIRONMENTAL IMPACT FROM ADOPTING THE RECOMMENDED IR LAMP STANDARDS

Potential demand and energy savings from implementing the recommendations above are substantial. If all non-qualifying IR lamps were replaced with more efficient IR lamps and with a small percentage of non-reflector incandescent lamps, the potential total energy savings is 617.2 million kWh per year or 21.4% of the energy used for all IR lamps currently. The peak electrical demand reduction would exceed 137 megawatts. See Appendix E: Energy Savings from Full Replacement of Non-Qualifying IR Lamps for New York State for detailed calculations.

Calculations to determine demand and energy savings are included in Appendix E: Energy Savings from Full Replacement of Non-Qualifying IR Lamps for New York State. Demand reductions utilize a coincident peak for the IR lighting of 10.3% for residential use and 77% for business use[10]. This data was provided by NYSERDA based on current evaluation reports. The total number of IR lamps to be regulated by the proposed standards within New York was developed as part of Appendix A. An estimate as to the percentage of lamps by wattage and type that would replace non-qualifying IR lamps was developed utilizing the best knowledge of personnel at the LRC and NEMA supplied data. Purchasing decisions as to the type and wattage lamp that would replace the non-qualifying lamp was based on the lighting knowledge of each class of customer and the available lamps to replace the non-qualifying lamp as developed above.

For New York it is expected that the demand reduction and energy savings can be achieved within three years of the effective date of the standards for incandescent reflector lamps. This is achievable because of the relatively short life (approximately 2,000 hours) of IR lamps.

Emission reductions occur due to less electric generation. NYSERDA provided commonly used environmental pollution factors per megawatt hour of electric consumption. They are: [11]

SO_2 ..... 3.0 pounds per MWh
NO_x ..... 1.5 pounds per MWh
CO_2 ..... 1,092 pounds per MWh

The enactment of the proposed standards for IR lamps, when fully implemented, will reduce the following environmental pollutants by:

SO_2 ..... 925.9 tons annually
Greenhouse Gases:
NO_x ..... 462.9 tons annually
CO_2 ..... 337,012.0 tons annually

ECONOMIC IMPACT AND BENEFIT/COST ANALYSIS

What is the total economic impact to New York State consumers and businesses if the IR lamp standards are enacted? This section answers this question by examining the net present value of replacing all non-qualifying IR lamps with lamps that meet the proposed state standard from an energy and lamp replacement cost perspective.

There are positive net present value economic benefits to consumers and businesses from both an energy savings perspective and lamp replacement cost perspective. Lamp replacement costs are lower for the more efficient lamps because of the extended life of these products (replaced less often). The details of this analysis are included in Appendix C: Life Cycle Economic Analysis.

Table 11. Life Cycle Economic Impact

	Residential	Businesses
Reduction of Energy Costs	$125,527,000	$52,278,000
Reduction in Lamp Costs	$11,211,000	$19,099,000
Total Net Economic Benefit	$136,738,000	$71,377,000

The benefit/cost ratio is infinite because the cost component is negative. The lamp replacement costs, for the more efficient lamps, are less than the lamp replacement costs for the current lamps in use.

Appendix A

NEW YORK CUSTOMERS

Total Number of Lamps by Type & Customer

Lamps and Energy Use
Source: US DOE, US Lighting Market Characterization, Volume 1: Nat. Ltg Inventory, Sept. 2002

Avg. # of lamps per bldg/dwelling unit

	Residential	Commercial	Industrial
Gen. Svc Incandescent	34	53	7
Std. _Reflector	2	17	6
Halogen	0.2	0.2	1.0
Halogen, low voltage		9	
CFL - pin base		21	6
CFL - screw base	1	10	6
CFL - screw base reflect		1	1
MH		4	47
Total Number of Customers	7,479,313	983,210	11,820

Total Number of Lamps by Type

	Residential	Commercial	Industrial
Gen. Svc Incandescent	254,296,632	52,110,132	82,740
Std. _Reflector	14,958,625	16,714,571	70,920
Halogen	1,495,863	196,642	11,820
Halogen, low voltage		8,848,890	
CFL – pin base		20,647,411	70,920
CFL – screw base	7,479,313	9,832,100	70,920
CFL – screw base reflect		983,210	11,820
MH		3,932,840	555,540

Based on US Census data, 6.7% of population lives in NYS.

Total Number Lamps Nationally from DOE Study

	Residential	Commercial	Industrial
Gen. Svc Incandescent	3,653,336,000	244,924,000	1,501,000
Std. _Reflector	262,471,000	81,229,000	1,251,000
Halogen	14,219,000	17,496,000	167,000
Halogen, low voltage		39,733,000	2,000
CFL - pin base		96,973,000	1,371,000
CFL - screw base	73,473,000	47,437,000	1,442,000
CFL - screw base reflect	559,000	5,563,000	189,000
MH		19,378,000	10,706,000

Total Number Lamps NYS from Census Data

	Residential	Commercial	Industrial
Gen. Svc Incandescent	244,773,512	16,409,908	100,567
Std. _Reflector	17,585,557	5,442,343	83,817
Halogen	952,673	1,172,232	11,189
Halogen, low voltage		2,662,111	134
CFL - pin base		6,497,191	91,857
CFL - screw base	4,922,691	3,178,279	96,614
CFL - screw base reflect	37,453	372,721	12,663
MH		1,298,326	717,302

Adjusted Number of Lamps based on NYC apt. size and number of C/I

	Residential	Commercial	Industrial
Gen. Svc Incandescent	235,000,000	46,000,000	500,000
Std. _Reflector	13,460,000	6,600,000	50,000
Std. _Reflector Under NY Regulations	10,768,000	5,280,000	40,000
Halogen	900,000	1,400,000	11,840
Halogen, low voltage		6,000,000	
CFL - pin base		12,000,000	75,000
CFL - screw base	6,000,000	8,000,000	75,000
CFL - screw base reflect	30,000	372,721	12,663
MH		1,700,000	700,000
MH > 150w and <500w		1,800,000	

Energy Used by Lamp Type
Source: US DOE, US Lighting Market Characterization, Volume 1: Nat. Ltg Inventory, Sept. 2002

Avg. Lamp Wattage

	Residential	Commercial	Industrial
Gen. Svc Incandescent	63	83	126
Std. _Reflector	102	104	102
Halogen	205	64	452
Halogen, low voltage		48	58
CFL - pin base		17	31
CFL - screw base	18	16	14
CFL - screw base reflect	11	16	14
MH		472	438

Operating hours per day by light source

Gen. Svc Incandescent	1.9	9.4	14.2
Std. _Reflector	2.4	9.7	13.4
Halogen	2.5	9.6	13.6
Halogen, low voltage		10.3	12.4
CFL - pin base		10.7	14.9
CFL - screw base	2.3	10.6	14.4
CFL - screw base reflect	1.7	10.3	9.6
MH		10.1	14.4

Energy Use by Lamp Type and Customer Type (kWh)

	Residential	Commercial	Industrial
Gen. Svc Incandescent	10,267,267,500	8,972,300,000	223,650,000
Std. _Reflector	1,202,677,920	1,664,520,000	17,085,000
Std. _Reflector Under NY Regulations	962,142,336	1,331,616,000	17,085,000
Halogen	168,356,250	215,040,000	18,195,712
Halogen, low voltage		741,600,000	0
CFL - pin base		545,700,000	8,660,625
CFL - screw base	90,666,000	339,200,000	3,780,000
CFL - screw base reflect	140,250	15,356,105	425,477
MH		2,145,240,000	

Lamp Replacement
Source: Lamp Catalogs for lamp life

	Hours
Gen. Svc Incandescent	750
Std. _Reflector	2000
Halogen	3000
Halogen, low voltage	3000
CFL - pin base	6000
CFL - screw base	6000
CFL - screw base reflect	6000
MH	17500

Operating Hours per Year by Lamp Type
Source Table 5-6 DOE

	Residential	Commercial	Industrial
Gen. Svc Incandescent	693.5	2350	3550
Std. _Reflector	876	2425	3350
Halogen	912.5	2400	3400
Halogen, low voltage		2575	3100
CFL - pin base		2675	3725
CFL - screw base	839.5	2650	3600
CFL - screw base reflect	620.5	2575	2400
MH		2525	3600

Number of Lamps Replaced per Year by Lamp Type

Gen. Svc Incandescent	217,296,667	144,133,333	2,366,667
Std. _Reflector	5,895,480	7,755,000	887,500
Halogen	273,750	1,120,000	13,419
Halogen, low voltage		5,150,000	
CFL - pin base		5,350,000	46,563
CFL - screw base	839,500	3,533,333	45,000
CFL - screw base reflect	3,103	159,959	5,065
MH		245,286	144,000

Number of Years to Lamp Replacement

Gen. Svc Incandescent	1.081	0.319	0.211
Std. _Reflector	2.283	0.825	0.563
Halogen	3.288	1.250	0.882
Halogen, low voltage		1.165	0.968
CFL - pin base		2.243	1.611
CFL - screw base	7.147	2.264	1.667
CFL - screw base reflect	9.670	2.330	2.500
MH		6.931	4.861

Number of Lamps Shipped per Year NEMA Data & Census

Source: 2002 NEMA data and 2000 Census population

	National	NYS	"Other" Distributed by Weighting of Each Category
BR 30	65,890,000	4,414,630	5,584,779
BR 40, 120 w or less	14,915,000	999,305	1,264,182
ER 30 & ER 40	1,454,000	97,418	123,240
BPAR 38, 150 watt	2,121,000	142,107	179,774
BPAR 38, below 121 watt	466,000	31,222	39,498
Total Non-halogen	84,846,000	5,684,682	7,191,473
Halogen PAR 38	49,460,000	3,313,820	4,192,186
Halogen PAR 30	14,516,000	972,572	1,230,364
Total Halogen	63,976,000	4,286,392	5,422,550
Other	39,447,000	2,642,949	
Total	188,269,000	12,614,023	12,614,023

Appendix B

INCANDESCENT REFLECTOR LAMP DATA

Lamp data from manufacturers' lamp catalogs
Cost data from home improvement, retail and lighting distributors

Lamp type	Wattage	Halogen (Y/N)	Mfr	Initial Lumens	Lumens per watt	Life (hours)	Cost
R 20	30	N	GE	200	6.667	2000	$6.88
	30	N	Syl	140	4.667	2000	$2.91-$6.45
	45	N	GE	450	10.000	2500	$11.57
	50	N	West	380	7.600	2000	$5.32
	50	N	Bulbrite				$1.88
	50	N	Syl	330	6.600	2000	$2.16-$7.25
	50	N	GE	410	8.200	2000	$2.97-$4.39
	50	N	Phil	385	7.700	2500	$3.97
	75	N	GE	650	8.667	2000	$8.58
	75	N	Syl	500	6.667	2000	$6.85
	75	N	West	700	9.333	2000	$2.84
	100	N	Phil	935	9.350	2000	$4.69
	100	N	West	1050	10.500	2000	$3.67
PAR 20	50	Y	Syl	550	11.000	2500	$4.47-$9.95
	50	Y	GE	570	11.400	2500	$8.36
R 30	60	N	West	715	11.917	1000	$6.95
BR 30	45	N	GE	485	10.778	2000	$3.97
	45	N	Syl	350	7.778	2000	$6.09
	45	N	Syl	400	8.889	2000	$8.00
	45	N	Phil	340	7.556	2500	
	50	N	Valubrand				$2.99
	50	N	West				$4.20
	50	N	Phil	360	7.200	2000	$8.29
	60	Y	Phil	700	11.667	3000	$3.49-$5.99
	65	N	GE	725	11.154	2500	$4.97-$5.44
	65	N	Syl	620	9.538	2000	$1.55-$3.95
	65	N	Phil	635	9.769	2500	$3.04-$4.27
	65	N	West	650	10.000	2000	$3.28
	75	N	Phil	700	9.333	2000	
	85	N	Phil	855	10.059	2500	$3.19-$4.27
	85	N	West	920	10.824	2000	$4.35
	110	N	GE	1080	9.818	2000	$12.80

Lamp type	Wattage	Halogen (Y/N)	Mfr	Initial Lumens	Lumens per watt	Life (hours)	Cost
ER 30	50	N	GE	525	10.500	2000	$6.12
	50	N	Phil	400	8.000	2000	$4.49
	50	N	Syl	350	7.000	2000	$7.55-$8.54
	75	N	Syl	580	7.733	2000	$4.11-$9.42
	75	N	GE	850	11.333	2000	$6.43
	75	N	Phil	570	7.600	2000	$4.49
	75	N	West				$4.30
PAR 30	40	Y	Phil	720	18.000	4200	$5.97
	45	Y	GE	620	13.778	3000	$8.44
	50	Y	GE	825	16.500	4000	$8.44
	50	Y	GE	630	12.600	3000	$7.47-$8.44
	50	Y	Phil	970	19.400	4200	$5.97
	50	Y	Syl	660	13.200	2500	$4.47-$7.49
	60	Y	GE	800	13.333	3000	$8.44
	75	Y	GE	1030	13.733	3000	$7.47-$8.33
	75	Y	Syl	1130	15.067	2500	$4.47-$7.49
PAR 38	40	Y	Phil	720	18.000	4200	$7.97
	45	Y	Phil	530	11.778	3000	$7.97
	45	Y	Syl	560	12.444	2500	$4.47-$7.49
	45	Y	GE	540	12.000	2500	$7.74-$8.44
	50	Y	Syl	650	13.000	2500	$9.95
	50	Y	Phil	860	17.200	4200	$7.97
	50	Y	GE	800	16.000	3000	$14.48
	50	Y	GE	600	12.000	2000	$7.73-$8.44
	60	Y	GE	1050	17.500	3000	$14.94
	60	Y	GE	800	13.333	3000	$8.44
	60	Y	Phil	1120	18.667	4200	$7.97
	65	N	Syl	715	11.000	1750	$6.06
	70	Y	GE	1250	17.857	3000	$13.67
	70	Y	Phil	1550	22.143	4200	$7.97
	75	Y	Phil	1050	14.000	3000	$7.97
	75	Y	GE	1050	14.000	2500	$7.96-$8.29
	75	N	Syl	1060	14.133	2500	$4.47
	80	Y	GE	1500	18.750	3000	$18.16
	90	Y	Syl	1310	14.556	2500	$4.47-$6.95
	90	Y	Phil	1350	15.000	3000	$7.97
	90	Y	GE	1350	15.000	2500	$7.99-$8.44
	100	Y	Syl	1500	15.000	2250	$12.59
	100	Y	Phil	2200	22.000	4200	$7.97
	100	Y	GE	2030	20.300	3000	$17.66
	100	Y	GE	1500	15.000	2000	$7.35-$8.44
	120	Y	Syl	1800	15.000	2000	$7.04-$8.95

Lamp type	Wattage	Halogen (Y/N)	Mfr	Initial Lumens	Lumens per watt	Life (hours)	Cost
PAR 38	120	Y	GE	1900	15.833	2500	$13.19
	150	N	GE	1700	11.333	2000	$5.97
	250	N	Phil	3100	12.400	4000	
OPAR BR 38	75	N	Syl	650	8.667	2000	$7.97
	150	N	Syl	1350	9.000	2000	$7.97
BR 38	250	N	Syl	3100	12.400	4000	Krypton
	300	N	Syl	3030	10.100	2000	
ER 39	120	N	GE	1425	11.875	2000	$11.95
R 40	65	N	West	715	11.000	1000	$8.40
	250	N	GE	2200	8.800	5000	$6.87
	300	N	GE	3700	12.333	2000	$20.30
	300	N	Phil	3240	10.800	2000	
BR 40	60	Y	Phil	750	12.500	3000	$5.99
	65	N	Phil	685	10.538	2000	$3.49-$4.97
	65	N	GE	700	10.769	2000	$5.69-$6.77
	65	N	Eiko				$4.35
	75	N	Syl	610	8.133	4000	
	75	N	Syl	680	9.067	2000	$2.69-$5.95
	75	N	West	800	10.667	2000	$3.63
	85	N	Phil	925	10.882	2000	$3.49-$4.97
	85	N	West	780	9.176	5000	$5.98
	90	N	GE	1000	11.111	2000	$7.97
	100	N	Syl	935	9.350	2000	$7.63
	100	N	West	1050	10.500	2000	$3.63
	120	N	Syl	1150	9.583	2000	$2.41-$7.63
	120	N	GE	1600	13.333	2000	$6.77-$10.14
	120	N	Syl	960	8.000	4000	
	120	N	Phil	1225	10.208	2000	$3.51-$4.97
	120	N	West	1350	11.250	2000	$3.63
	200	N	Phil	2200	11.000	2000	$16.99
	300	N	Phil	2480	8.267	2000	$23.49
	300	N	Syl	3030	10.100	2000	$15.17
ER 40	120	N	Phil	1190	9.917	2000	$4.89
	120	N	Syl	1370	11.417	2000	$9.70
	120	N	GE	1425	11.875	2000	$7.72
	120	N	West	1085	9.042	2000	$6.66

Average Efficacy for Non-Qualifying Lamps

40-50 watt	7.6
51-66 watts	10.1
67- 85 watts	9.2
86-115 watts	10.2
116-155 watts	10.7
156-205 watts	11.0

Appendix C

LIFE CYCLE ECONOMIC ANALYSIS

Existing Lamps					Replacement Lamps					Annual	Life	Discount	Energy Cost	Annual Energy	Lamp Cost over Life Cycle		PV Energy	PV Lamp Cost	Net Consumer
Type	Wattage	Life (hrs)	Cost		Type	Wattage	Life	Cost		Burn Hours	Cycle (yrs)	Rate	(per kWh)	Cost Savings	Existing	Replacement	Cost Savings	Differential	Benefit
R20	50	2000	$3.99		R20	45	2500	$11.57		876	2.85	3%	$0.1458	$0.64	$4.99	$11.57	$1.40	$6.39	($4.99)
R20	75	2000	$6.09		PAR20	50	2500	$7.59		876	2.85	3%	$0.1458	$3.19	$7.61	$7.59	$7.03	($0.02)	$7.05
BR30	50	2000	$5.16		PAR30	45	3000	$8.44		876	3.42	3%	$0.1458	$0.64	$7.74	$8.44	$1.67	$0.68	$0.99
BR30	65	2000	$3.79		PAR30	50	3425	$7.05		876	3.91	3%	$0.1458	$1.92	$6.49	$7.05	$5.68	$0.54	$5.13
BR30	75	2000	$3.28		PAR30	50	3425	$7.05		876	3.91	3%	$0.1458	$3.19	$5.62	$7.05	$9.50	$1.39	$8.10
BR30	85	2250	$3.94		PAR30	60	3000	$8.44		876	3.42	3%	$0.1458	$3.19	$5.25	$8.44	$8.36	$3.09	$5.27
BR30	110	2000	$12.80		PAR30	75	2750	$6.94		876	3.14	3%	$0.1458	$4.47	$17.60	$6.94	$10.78	($10.35)	$21.13
ER30	50	2000	$6.68		PAR30	45	3000	$8.44		876	3.42	3%	$0.1458	$0.64	$10.02	$8.44	$1.67	($1.53)	$3.20
ER30	65	2000	$6.68		PAR30	50	3450	$7.05		876	3.94	3%	$0.1458	$1.92	$11.52	$7.05	$5.72	($4.34)	$10.06
ER30	75	2000	$6.11		PAR30	50	3450	$7.05		876	3.94	3%	$0.1458	$3.19	$10.54	$7.05	$9.56	($3.39)	$12.95
PAR38	150	2000	$5.97		PAR38	100	2863	$10.80		876	3.27	3%	$0.1458	$6.39	$8.55	$10.80	$16.00	$2.19	$13.81
OPAR BR38	75	2000	$7.97		PAR38	50	3425	$7.05		876	3.91	3%	$0.1458	$3.19	$13.65	$7.05	$1.40	($6.41)	$7.81
OPAR BR38	150	2000	$7.97		PAR38	90	2667	$7.16		876	3.04	3%	$0.1458	$7.66	$10.63	$7.16	$1.40	($3.37)	$4.77
BR40	65	2000	$5.05		PAR38	50	3425	$7.05		876	3.91	3%	$0.1458	$1.92	$8.65	$7.05	$5.68	($1.55)	$7.23
BR40	75	2667	$4.09		PAR38	50	3425	$7.05		876	3.91	3%	$0.1458	$3.19	$5.25	$7.05	$9.50	$1.75	$7.75
BR40	85	3500	$4.81		PAR38	60	3400	$10.45		876	3.88	3%	$0.1458	$3.19	$4.67	$10.45	$9.43	$5.61	$3.82
BR40	90	2000	$7.97		PAR38	70	3600	$10.82		876	4.11	3%	$0.1458	$2.55	$14.35	$10.82	$7.93	($3.42)	$11.35
BR40	100	2000	$5.63		PAR38	70	3600	$10.82		876	4.11	3%	$0.1458	$3.83	$10.13	$10.82	$11.94	$0.67	$11.27
BR40	120	2400	$5.58		PAR38	90	2667	$7.16		876	3.04	3%	$0.1458	$3.83	$6.20	$7.16	$8.97	$0.93	$8.04
BR40	200	2200	$16.99		PAR38	120	2250	$9.73		876	2.57	3%	$0.1458	$10.22	$17.38	$9.73	$20.34	($7.42)	$27.76
ER40	120	2000	$7.24		PAR38	90	2667	$7.16		876	3.04	3%	$0.1458	$3.83	$9.65	$7.16	$8.97	($2.42)	$11.39
Average Life		2,144			Average Life		3,071												
	Average lamp Cost		$6.56			Average lamp Cost		$8.33	Average Life Cycle		3.51								
Net Comsuner Benefits																			
Total Annual Energy Savings (kWh)			262,396,024		$38,257,340.30							3%	$0.1458						
Total Number of Lamps			10,768,000																Net Consumer Benefit
															$9.40	$8.33	$125,526,608.03	($11,211,438.57)	$136,738,046.60

Appendix D

BR/ER 30 & 40 INCANDESCENT REFLECTOR LAMP SCENARIOS: ENERGY SAVINGS–NY

Base Case			Scenario 1 - Perfect Replacement			Scenario 2 - Halogen Replacement			Scenario 3 - A Lamp Replacement			Scenario 4 - Lots of A Lamps		
Baseline Lamp	Watts per Lamp	Est. Installed Lamp Base, NY	% People Choosing Alternatives	Watts Saved per Lamp	Total KW Savings	% People Choosing Alternatives	Watts Saved per Lamp	Total KW Savings	% People Choosing Alternatives	Watts Saved per Lamp	Total KW Savings	% People Choosing Alternatives	Watts Saved per Lamp	Total KW Savings
BR/ER30 & 40	**65**	7,000,000												
Alternate Lamp														
PAR30/38	50		50%	15	52,500	25%	15	26,250	30%	15	31,500	10%	15	10,500
PAR30/38	75					25%	(10)	(17,500)	20%	(10)	(14,000)	20%	(10)	(14,000)
65BR30 plus	65		50%	0	0	50%	0	0	40%	0	0	50%	0	0
CFL	20													
A-line	60								1%	5	350	10%	5	3,500
A-line	75								3%	(10)	(2,100)	10%	(10)	(7,000)
A-line	100								6%	(35)	(14,700)	0%	(35)	0
			100%		52,500	100%		8,750	100%		1,050	100%		(7,000)
Baseline Lamp														
BR/ER30 & 40	**50**	500,000												
Alternate Lamp														
PAR30/38	45		50%	5	1250	25%	5	625	30%	5	750	10%	5	250
PAR30/38	50		50%	0	0	50%	0	0	40%	0	0	50%	0	0
65BR30 plus	65					25%	(15)	(1,875)	20%	(15)	(1,500)	20%	(15)	(1500)
CFL	15													
A-line	60								1%	(10)	(50)	10%	(10)	(500)
A-line	75								6%	(25)	(750)	10%	(25)	(1250)
A-line	100								3%	(50)	(750)			
			100%		1250	100%		(1,250)	100%		(2,300)	100%		(3,000)
Baseline Lamp														
BR/ER30 & 40	**85**	800,000												
Alternate Lamp														
PAR30/38	60		50%	25	10,000	50%	25	10,000	45%	25	9,000	40%	25	8,000
PAR30/38	70		50%	15	6,000	50%	15	6,000	45%	15	5,400	40%	15	4,800
CFL														
A-line	75								5%	10	400	10%	10	800
A-line	100								5%	(15)	(600)	10%	(15)	(1,200)
			100%		16,000	100%		16,000	100%		14,200	100%		12,400

Appendix E

ENERGY SAVINGS FROM FULL REPLACEMENT

OF NON-QUALIFYING IR LAMPS FOR NY

IR Lamp Stock by Type and Wattage

Total IR Lamp Stock Under NY Regulation		Peak Coincidence	Hours of Operation per Yr.
Residential	10,768,000	10%	876
Business	5,320,000	77%	2425

Lamps to be Replaced

	Residential	Business
R 20, 75W	538,400	532,000
BR 30 & 40, 85W	2,692,000	1,330,000
BR 30 & 40 & ER 40, 120W	4,307,200	2,394,000
ER 30, 75W	538,400	532,000
PAR 38, 150W	1,615,200	
BR 40, 90W	1,076,800	532,000
Total	10,768,000	5,320,000

Energy Savings by Lamp and Customer Type

	Residential				Business				Total	
	% of Replace-ment	Watts Saved	Annual kWh Saved	Peak kW Saved	% of Replace-ment	Watts Saved	Annual kWh Saved	Peak kW Saved	Annual kWh Saved	Peak kW Saved
Replacements for R20, 75 watt										
PAR20, 50 W halogen	90%	25	10,611,864	1,248	97%	25	31,284,925	9,934	41,896,789	11,182
Incandescent "A" 75 W	2%	0	0	0	2%	0	0	0	0	0
Incandescent "A" 100 W	8%	-25	(943,277)	(111)	1%	-25	(322,525)	(102)	(1,265,802)	(213)
Replacements for BR30 & 40, 85 watt										
PAR30, 60 W halogen	45%	25	26,529,660	3,119	48%	25	38,703,000	12,289	65,232,660	15,409
PAR30, 75 W halogen	45%	10	10,611,864	1,248	48%	10	15,481,200	4,916	26,093,064	6,163
Incandescent "A" 75 W	2%	10	471,638	55	2%	10	645,050	205	1,116,688	260
Incandescent "A" 100 W	8%	-15	(2,829,830)	(333)	2%	-15	(967,575)	(307)	(3,797,405)	(640)
Replacements for BR30 & 40 & ER40, 120 watt										
PAR30, 75 W halogen	45%	45	76,405,421	8,984	50%	45	130,622,625	41,476	207,028,046	50,460
PAR30, 90 W halogen	50%	30	56,596,608	6,655	50%	30	87,081,750	27,651	143,678,358	34,305
Incandescent "A" 100 W	5%	20	3,773,107	444	0%	20	0	0	3,773,107	444
Replacements for ER30, 75 watt										
PAR30, 50 W halogen	45%	25	5,305,932	624	48%	25	15,481,200	4,916	20,787,132	5,540
PAR30, 60 W halogen	45%	15	3,183,559	374	48%	15	9,288,720	2,949	12,472,279	3,324
Incandescent "A" 75 W	2%	0	0	0	2%	0	0	0	0	0
Incandescent "A" 100 W	8%	-25	(943,277)	(111)	2%	-25	(645,050)	(205)	(1,588,327)	(316)
Replacements for PAR38, 150 watt										
PAR38, 100 W halogen	49%	50	34,665,422	0					34,665,422	0
PAR38, 120 W halogen	49%	30	20,799,253	0					20,799,253	0
Incandescent "A" 150 W	2%	0	0	0					0	0
Replacements for BR40, 90 watt										
PAR30, 60 W halogen	45%	30	12,734,237	1,497	49%	30	18,964,470	6,022	31,698,707	7,519
PAR30, 75 W halogen	45%	15	6,367,118	749	49%	15	9,482,235	3,011	15,849,353	3,759
Incandescent "A" 100 W	10%	-10	(943,277)	(111)	2%	-10	(258,020)	(82)	(1,201,297)	(193)
TOTAL			262,396,024	24,331			354,842,005	112,671	617,238,029	137,002
							Energy Cost Savings		$80,944,833	

Energy/Demand/Cost Savings by Implementation Year

Year 1

	kWh	Demand	Cost Savings
Consumer	107,100,418	9,931	$15,615,241
Business	354,842,005	112,671	$42,687,493
Total	461,942,423	122,602	$58,302,734

Year 2

	kWh	Demand	Cost Savings
Consumer	214,200,836	19,862	$31,230,482
Business	354,842,005	112,671	$42,687,493
Total	569,042,841	132,533	$73,917,975

Year 3

	kWh	Demand	Cost Savings
Consumer	262,396,024	24,331	$38,257,340
Business	354,842,005	112,671	$42,687,493
Total	617,238,029	137,002	$80,944,833

Year 4

	kWh	Demand	Cost Savings
Consumer	262,396,024	24,331	$38,257,340
Business	354,842,005	112,671	$42,687,493
Total	617,238,029	137,002	$80,944,833

Lamp Replacement Costs Savings
The cost of lamps both existing style and more efficient based on avg. lamp life

Year 1

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	4,395,102	$4.91	$21,579,951
Efficient Replacement	4,395,102	-$6.21	($27,293,584)
Net Lamp Cost Benefit			($5,713,633)

Year 2

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	4,395,102	$4.91	$21,579,951
Efficient Replacement	4,395,102	-$6.21	($27,293,584)
Net Lamp Cost Benefit			($5,713,633)

Year 3

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	6,372,898	$4.91	$31,290,929
Efficient Replacement	1,977,796	-$6.21	($12,282,113)
Net Lamp Cost Benefit			$19,008,816

Year 4

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	4,395,102	$4.91	$21,579,951
Efficient Replacement	4,395,102	-$6.21	($27,293,584)
Net Lamp Cost Benefit			($5,713,633)

Year 5

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	6,372,898	$4.91	$31,290,929
Efficient Replacement	4,395,102	-$6.21	($27,293,584)
Net Lamp Cost Benefit			$3,997,345

Year 6

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	4,395,102	$4.91	$21,579,951
Efficient Replacement	1,977,796	-$6.21	($12,282,113)
Net Lamp Cost Benefit			$9,297,838

Year 7

	# of lamps	Avg. Cost	Total Cost
Consumer			
Existing Lamp	1,977,796	$4.91	$9,710,978
Efficient Replacement	0	-$6.21	$0
Net Lamp Cost Benefit			$9,710,978

Total Net Lamp Benefit over Time: $24,874,080

REFERENCES

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