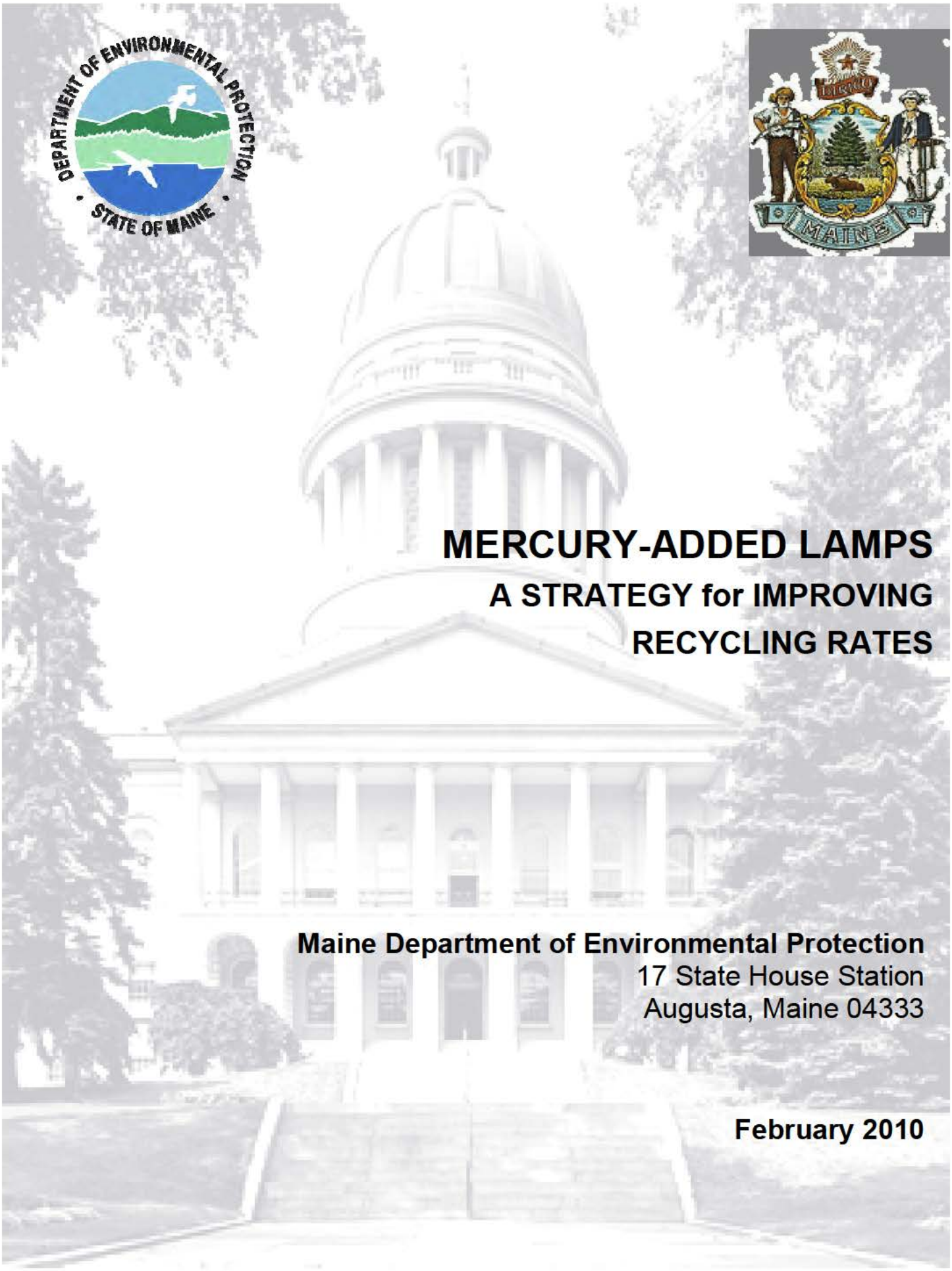
MAINE STATE LEGISLATURE



MERCURY-ADDED LAMPS

A STRATEGY for IMPROVING RECYCLING RATES

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I. About this report

This report follows our January 2008 report[1] in which we estimated that only about 25% of fluorescent lamps discarded by Mainers are recycled. The 2008 report, co-authored with the Public Utilities Commission, describes in detail the decade long effort in this State to promote the recycling of fluorescent and other mercury-added lamps. Yet, though it is illegal to do so,[2] most waste fluorescent lamps still are dumped in the trash, with the consequence that mercury inevitably is released into the environment when the lamps are broken and crushed during waste handling.

The problem is not due to a lack of lamp recycling capacity or collection services. The technology to reclaim mercury from spent lamps was commercialized in the 1990s, spurred by the gradual realization that the lamps qualify as hazardous waste due to their mercury content and the subsequent enactment of state regulations making recycling mandatory. A now robust commercial lamp recycling industry serves all areas of Maine and has the capacity to handle 100% of the waste lamps estimated to be available for recycling.

So why aren't these services more widely used? Despite long-standing outreach efforts, most of the public and regulated community appear to be unaware of the requirement to recycle waste mercury lamps, or where they can take them for recycling. Convenience and cost also may be significant factors. It is widely supposed that improved lamp recycling rates demand a collection system that is easy to access and devoid of drop-off charges or other fees that can be a disincentive to participation. Handling and storage issues pose yet another challenge as the fragile lamps must be protected from breakage until they reach the recycling facility and the mercury can be safely recovered.

As directed by the Legislature,[3] this report sets forth a strategy to improve lamp recycling rates. The report recommendations build on the substantial existing lamp recycling infrastructure already in place in Maine, suggesting workable enhancements to maximize the number of lamps diverted from the trash for proper collection and recycling.

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[1] Maine Department of Environmental Protection (DEP) and Maine Public Utilities Commission (PUC), *Report Regarding the Recycling of Fluorescent Lamps and Consumer Education*, January 2008.

[2] See 38 MRSA §§1663 and 1666, banning the disposal of mercury-added products, including lamps, in a solid waste disposal facility.

[3] See *An Act to Provide for the Safe Collection and Recycling of Mercury-Containing Lighting*, PL 2009, c.272, §§3 and 4. A copy of the Act is reproduced in Appendix 1 of this report.

II. Background information on fluorescent lamps

> **The Problem:** Fluorescent lamps are an environmental paradox: they use a fraction of the energy and last longer than incandescent lamps, but they also contain a small amount of mercury. This harmful neurotoxin should not be disposed of in landfills or incinerators.
>
> **The Solution:** Fluorescent lamps should be recycled at the end of their life to prevent the release of mercury into the environment.
>
> *Product Stewardship Institute*

Fluorescent lamps are universal. They come in many shapes and sizes and are used for both general illumination as well as specialty applications ranging from photocopying to UV disinfection to bug zappers. Perhaps most familiar are the 4-foot linear fluorescent lamps (LFLs) that have long been used in schools, office buildings, warehouses and stores. LFLs also have been used to illuminate some residential spaces such as home workshops, kitchens and basements.

Widespread use of fluorescent lighting in the living area of homes was constrained until recently by the fact that fluorescent lamps have not been available in sizes that fit in traditional home lighting fixtures designed for screw-based incandescent bulbs. That has changed over the last decade with technological advances in compact fluorescent lamps (CFLs). CFLs are screw-based fluorescent lamps that can be used in any fixture that accepts an incandescent bulb. They have rapidly gained a significant share of home residential lighting due to their superior energy efficiency compared to incandescent bulbs.[4]

All fluorescent lamps contain mercury. Lamp manufacturers have been working to reduce the amount of mercury they use and have, for example, reduced the average mercury content of 4-foot fluorescent lamps by 75% since 1985. However, it has not yet proven feasible under current technology to eliminate the mercury altogether.

Mercury-free lighting technologies now under development could compete with fluorescent lighting in the future. The most promising of these emerging technologies is light emitting diodes or LEDs (see Appendix 2 to this report). LEDs have a small presence in the marketplace at the moment but seem poised to become common in street lighting and commercial buildings.[5]

Concerns about global warming may hasten the transition as LED technology has

[4] The Department of Energy estimates that in states like Maine, where CFL use has been aggressively promoted, about 25% of screw-based sockets contain CFLs. See L. Vestel, *As C.F.L. Sales Fall, More Incentives Urged*, N.Y. Times, September 28, 2009. The Maine Public Utilities Commission (PUC) has aggressively promoted the use of CFLs by homeowners since 2002. The PUC estimates that Maine households have seven CFLs in use on average. See Maine DEP and PUC *supra* n 1 at 8. A report on fluorescent lighting in Ontario suggests that households have an average of 25 lighting sockets. See Kelleher Environmental, *Fluorescent Lighting in Ontario: Lifespan Model and Research*, Waste Diversion Ontario, (August, 2007), p 4.

[5] E. Rosenthal and F. Barringer, "Green Promise Seen in Switch to LED Lighting", *NY Times*, May 30, 2009.

"considerable potential to reduce electricity consumption and the associated green house gas emissions."[6] Studies suggest that a complete conversion from incandescent and fluorescent lamps to LEDs could decrease carbon emissions associated with lighting by up to 50%.[7]

Until recently, light color has been a barrier to adoption of LEDs for general purpose lighting but that limitation appears to have been overcome. A number of LED products capable of producing "warm" white light suitable for general illumination have become commercially available in the last several years. These new products include linear LED lamps designed as a drop-in replacement for LFLs and screw-based LEDs designed to replace CFLs and incandescent bulbs.

As LED technology continues to improve, the main impediment to wide adoption likely will be purchase price. Screw-based LED lamps designed to replace the standard 60-watt incandescent bulbs currently are priced from $40 to $50, while 4-foot linear LEDs are listed online at over $100 each. This upfront cost makes LEDs seem expensive compared to incandescent and fluorescent lighting even though the lifecycle cost of LED lighting is significantly lower due to superior energy savings and avoided lamp replacement costs.

Residential consumers in particular may be put off by high LED lamp prices, unwilling to tolerate a payback of up to 5 or more years. As a consequence, commercial adoption of LEDs can be expected to precede residential use.[8]

Businesses already are beginning to realize the superior cost benefits of the technology. For example, when Sentry Equipment Company built a new factory in Wisconsin in 2008, it decided to use LEDs for all of the building's exterior and much of its interior lighting.[9] The system cost $18,000—three times more than the projected cost of the original lighting design—but is saving the company $7,000 a year in energy costs.[10] Sentry recouped the additional cost of installing LEDs within two years. Company president Michael Farrell said the decision to use LEDs was a "no brainer."[11]

> "LED light bulbs will eventually be what we use to replace incandescent bulbs—CFLs are a temporary solution to energy efficient lighting."
>
> Greg Seaman, www.eartheasy.com

[6] G. Gereffi, K. Dubay and M. Lowe, *Manufacturing Climate Solutions*, Duke University, November 2008, p 10.
[7] Rosenthal and Barringer *supra* n 5. An LED consumes about 12% of the energy an incandescent uses and lasts more than 40 times longer; by comparison, CFLs use about 30% of the power consumed by incandescents and last 8 to 10 times longer. McKinsey & Company, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*, December 2007, p. 35.
[8] McKinsey *supra* n 7 at 36.
[9] See Cree, Inc., "LED Workplace: Sentry Equipment Company", weee.ledworkplace.org.
[10] See Eric Taub, "Fans of LEDs Say This Bulb's Time Has Come," *NY Times*, July 28, 2008.
[11] *Id*.

III. Maine's lamp recycling infrastructure

A. Lamps from businesses

More than 80% of the waste fluorescent lamps estimated to be available for recycling each year come from industrial, commercial and institutional (IC&I) facilities. The vast majority of these are LFLs, which typically contain more mercury than CFLs.

Under the Universal Waste Rules (UWRs),[12] facility operators are responsible for keeping spent lamps intact and safely storing them until they are shipped for recycling or, in some cases, transported to a municipal collection point. Eighty Maine municipalities offer lamp collection services to local businesses and institutions.

Where municipal lamp collection services are not available, compliance with Maine's disposal ban depends on each IC&I facility making contractual arrangements with a third party to pick up the lamps and transport them to a lamp recycling facility. Numerous companies offer lamp collection services in Maine. They include waste management companies, recyclers and universal waste transporters.[13] Large volume users often retain a full-service lighting service contractor to supply, install, remove and recycle fluorescent lamps.

Businesses, both large and small, also can buy lamp recycling kits for shipping waste lamps to a recycling facility by common carrier. The purchase price includes a shipping container, a prepaid shipping label and the required regulatory paperwork. Shipping containers are available for all sizes and shapes of fluorescent lamps and double as a convenient UWR-compliant storage box for safely accumulating spent lamps until they are shipped. When the container is full, the user simply seals it and uses the prepaid label to ship the lamps to the recycling facility.

Lamp recycling kits with pre-paid shipping make it relatively easy for small businesses, especially in rural areas, to meet the UWR requirements. Three companies have received approval from the department to offer mail-back service in Maine.

B. Lamps from households

Maine householders have two types of drive-and-drop options for recycling fluorescent lamps. They can take CFLs to any of the more 200 retail stores that participate in a recycling program operated by the PUC Efficiency Maine program.[14] Or they can drop off

[12] The Universal Waste Rules refer to those provisions in the Hazardous Waste Management Rules that apply specifically to the handling of mercury-added lamps and other universal wastes. See 06-096 CMR 850(3)(A)(13). The Universal Waste Rules were adopted in 2001 to streamline and simplify handling requirements for certain commonly generated (universal) waste products such as fluorescent lamps that have hazardous constituents and therefore require special handling at end of life.

[13] For a list of lamp recycling companies in Maine and the services they offer, go to: www maine.gov/dep/rwm/hazardouswaste/pdf/uwrecyclingcompanies.pdf.

[14] Efficiency Maine is a PUC program promoting the more efficient use of electricity. On July 1, 2010, the responsibilities of the Efficiency Maine program will be transferred to the Efficiency Maine Trust, a new independent state agency established to operate energy efficiency and renewable energy programs. See PL 2009, c. 372.

both CFLs and LFLs—or any other type of mercury added lamp[15]—at a municipal collection point.

Most Maine municipalities collect fluorescent lamps at the local transfer station, or have made arrangements for their residents to take the lamps to a collection facility in a nearby town. Presently, 164 of the approximately 280 municipal transfer stations and recycling centers in Maine are equipped to collect lamps. Most charge a drop-off fee, typically $1 per lamp, to offset their costs.

The retail stores participating in the PUC program do not charge drop-off fees. The PUC fully funds the program for now through its Efficiency Maine budget, although the commission plans to phase out this subsidy in the near future.

Recycling by mail also is an option for household lamps. Lamp recycling kits specifically designed to safely ship spent CFLs to a recycling facility can be purchased online from several companies, including Northeast Lamp Recyclers, Osram-Sylvania, Veolia and Waste Management. The kits cost about $20, typically fit up to 15 CFLs and can be shipped by U.S. mail.

IV. Lamp recycling costs

To ensure funding continues for the PUC and municipal collection efforts, the Maine Legislature last year passed and Governor Baldacci signed into law *An Act to Provide for the Safe Collection and Recycling of Mercury-Containing Lighting.*[16] The key feature of the Act is a requirement that lamp manufacturers either: 1) establish a program to collect household lamps at no cost; or 2) take over funding of the existing municipal and PUC collection programs.

For the purpose of this part of the report—an assessment of the costs of manufacturer recycling to consumers, municipalities and manufacturers—we have assumed manufacturers will choose to fund operation of the existing PUC / municipal collection infrastructure. They are, however, free to propose an altogether new system for lamp recycling.

Cost to consumers

The intended effect of Maine's new lamp recycling law is to reduce the financial burden of recycling on local taxpayers and PUC ratepayers by transferring lamp recycling costs to lamp manufacturers, and ultimately to consumers as manufacturers adjust their lamp prices upward to cover their recycling-related costs. On the other hand, the law ensures that consumers will no longer have to pay a fee when they drop off spent fluorescent lamps for recycling. The law explicitly requires manufacturers to provide "convenient collection

[15] Other types of mercury-added lamps include U-tube fluorescent lamps, tanning lamps and high intensity discharge lamps. Maine law requires manufacturers of mercury-added lamps sold after January 1, 2006 to affix a label disclosing that the lamp contains mercury. The label must be sufficiently durable to remain legible for the life of the lamp. See 38 MRSA §1662, sub-§1 and 06-096 CMR 870. The label currently used by manufacturers to meet this requirement consists of the letters "Hg" in a circle.

[16] PL 2009, c. 272; see Appendix 1 of this report.

locations located throughout the State where residents can drop off their household lamps without cost."[17]

It is too early to know the exact magnitude of increases in lamp purchase prices as a result of Maine's law. Manufacturers will need to increase the price of their lamps to cover the costs of collection, recycling, education and outreach, and administrative overhead. In the case of CFLs, manufacturers themselves predict a 50-75% increase in their product costs[18] and an increase in the price of a single bulb by as much as 150%.[19] In the case of 4-foot LFLs, manufacturers predict a more modest cost increase of 33% per lamp assuming large quantities of lamps are recycled.[20]

For now, Maine is the only state that requires manufacturers to assume responsibility for lamp recycling. Given our relatively modest market share (Maine's population is less than ½ of one percent of the U.S. population), the immediate impact of Maine's law on national lamp pricing likely will be modest.

If most other states eventually follow our lead, manufacturers could eventually be forced to raise CFL prices by as much as a quarter to a third.[21] Manufacturers observe this would widen the price gap between inexpensive incandescent bulbs and CFLs, and could dissuade consumers from buying them, thereby slowing the transition to more energy efficient-lighting.[22] Yet that price gap already is wide and largely has been overcome through consumer education.

It is now common knowledge that the lifecycle cost of fluorescent lighting is much lower than incandescent lighting. Over the life of a typical light fixture the greatest expense by far is the electricity it consumes not the purchase price. Even if CFL prices were to increase by 150% as speculated by some in the industry, that higher price still will represent only a small portion of lifecycle cost of the lamp when energy costs are factored in. Arguably, the higher price, by capturing the costs of recycling fluorescent lamps at the front end, will more accurately reflect the true cost of fluorescent lamps compared to mercury-free LED lamps and other emerging energy-efficient lighting technologies that do not require special handling at end of life. See Appendix 2, page 29.

Cost to municipalities

While it seems likely that consumers ultimately will pay more for CFLs as the costs of recycling increasingly are assumed by lamp manufacturers, the recycling costs currently incurred by Maine municipalities will be reduced or eliminated. Municipal costs include the labor costs to collect, handle and safely store the lamps, and the cost of arranging for the lamps to be picked up for recycling.

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[17] 38 MRSA §1672(4)(A)(1).
[18] Alexandra Behringer, "Maine's new CFL recycling program: should manufacturers pay?" www.energycentral.com, November 3, 2009.
[19] National Electrical Manufacturers Association (NEMA), *Recycling Household CFLs*, September 2007, p. 4.
[20] National Electrical Manufacturers Association, *Manufacturer Take-Back of Lamps*, September 2007, p.3.
[21] Cascadia Consulting Group, *Fluorescent Lamp Recycling in Washington State: Recycling Levels, Stakeholder Analysis and Policy Options*, Washington State Department of Ecology, June 2007, p. 78.
[22] NEMA *supra* n 19.

Table 1 below shows the range of prices currently charged for onsite pick-up and mail-back of spent fluorescent lamps. The prices were obtained from our phone and internet survey of companies doing business in Maine.

In FY 2009 (July 1, 2008 through June 30, 2009), Maine municipalities shipped almost 221,000 fluorescent lamps for recycling.[23] The vast majority of these were 4-foot LFLs according to shipping records. Assuming that municipalities pay the lower prices reported in Table 1[24] and that their average recycling cost therefore is no more than 40¢ per lamp, the total cost of recycling all fluorescent lamps collected by Maine municipalities in FY 2009 was less than $90,000. The municipal labor costs associated with recycling the lamps are unknown.

As previously mentioned, most of the 164 municipal waste facilities that currently provide lamp collection services charge a drop off fee to cover their costs. These facilities, for the most part, serve the State's larger cities and towns. Smaller towns, on the other hand, often do not have the staffing to collect fees and oversee the safe handling of the lamps. When lamp manufacturers begin picking up these costs in 2011, some of these towns may elect to add the service.

Table 1: Low and high per lamp recycling prices

Lamp type	Price per bulb*			
	Onsite pickup		Prepaid mail in	
Linear (LFL)	**Low price**	**High price**	**Low price**	**High price**
4' T12	$0.24	$1.04	$1.19	$4.68
4' T8	$0.24	$1.04	$0.59	$2.27
U-tube T12	$0.40	$1.50	$2.25	$7.70
U-tube T-8	$0.40	$1.50	$1.12	$3.75
8' T12	$0.48	$2.08	$3.79	$6.40
8' T8	$0.48	$2.08	$1.89	$3.20
Compact (CFL)	$0.40	$1.50	$0.63 - $0.79	$1.25 - $2.50
Pick-up fee	None	$35	N/A	N/A

*assumes storage containers are full when shipped

Cost to manufacturers

The recycling costs currently incurred by municipalities and the PUC to collect spent fluorescent lamps from homeowners are indicative of the costs lamp manufacturers can expect to pay when they assume financial responsibility for those programs. The PUC experience perhaps gives us the best gauge of the possible magnitude of those costs.

[23] Compiled from Uniform Bills of Lading submitted to the department as required under the Universal Waste Rules, 06-096 CMR 850(3)(A)(13)(e)(iii).

[24] A phone conversation with the Solid Waste Manager for the City of Augusta, confirmed this was the case for lamps collected at the city's Hatch Hill landfill. Leslie Jones, personal communication, January 21, 2010.

The PUC's current annual operating budget for its retailer CFL collection program is about $70,000. This includes about $6,500 (or about $1 per lamp collected) to provide storage buckets to participating stores and ship full buckets to a lamp recycling plant operated by Veolia Environmental Services, Inc. (Veolia). Other costs include an estimated $6,000 to $10,000 in staff costs to deliver buckets and train store clerks;[25] and about $54,000 for the portion of the Efficiency Maine CFL marketing costs attributed to getting out the recycling message.[26]

By comparison, a Lighting Task Force convened by the California Department of Toxic Substances Control to make recommendations on collection and recycling of residential fluorescent lamps assumed collection and recycling costs of 60¢ per lamp and outreach costs of $5 million per year.[27] The members of that task force included representatives of lamp manufacturers Philips Electronics, GE Lighting, and Osram Sylvania.

One reason for shifting responsibility for lamp recycling from government to manufacturers is the assumption that the lighting industry will be able to bring their market presence and entrepreneurial skills to bear in reducing the cost of lamp recycling. The private sector presumably has far greater capacity to design a cost effective collection program than local or state government.[28] Manufacturers not government are the actors in the product life cycle with the greatest leverage over environmental improvement.[29] They have the expertise as designers, marketers and distributors that government lacks and, as a consequence, they are in a better position than government to find the most inexpensive approach to capturing the mercury in lamps.

By assigning responsibility for recycling waste lamps to the companies that make money by selling them, Maine has brought market forces to bear in streamlining and reducing the cost of lamp collection and recycling, and in driving innovation in lighting design that could eliminate the need for recycling by eliminating the use of mercury.

[25] The PUC projects that it will need the equivalent of one full time staff position to operate its CFL recycling program if public education and marketing to retailers is greatly expanded as recommended in the USM study report discussed in section VI of this report. Personal communication with PUC staff.
[26] Personal communication with PUC staff.
[27] California Department of Toxics Substances Control, *AB 1109: Lighting Task Force Report*, September 1, 2008, pp 23, 25.
[28] Product Policy Institute, *Manufacturer Take Back: The Next Step for Energy Efficient Lighting Products*, May 2007, p 2.
[29] R. Lifset, *Extending Producer Responsibility in North America: Progress, Pitfalls and Prospects in the Mid-1990s*," Proceedings of the Symposium on Extended Produce Responsibility, November 14-15, 1995, p 38.

V. Education and outreach

Since the mid-1990s, the Department of Environmental Protection has undertaken an extensive education and outreach campaign to make fluorescent lamp users aware of the disposal ban and their recycling options. This ongoing effort has included the distribution of educational material through our website, mass mailings, frequent training sessions on universal waste handling, and on-site compliance inspections.

Initially, we focused our efforts on the business community because, at the time, Maine's ban on disposal of the lamps in the municipal waste stream only applied to business. Further, until CFL technology was widely commercialized, the use of fluorescent lighting predominated in industrial, commercial and institutional buildings and still accounts for 80% or more of fluorescent lamp sales.

In the year 2000, as CFLs began to be widely promoted for their energy-saving benefits, the Legislature extended the disposal ban to fluorescent lamps and other mercury-added products from households.[30] The ban on these household items was set to take effect prospectively beginning January 1, 2005 in order to give the department and the State Planning Office (SPO) time to prepare municipalities to safely collect these items at their solid waste handling facilities.

SPO addressed the local infrastructure needs, disbursing about $750,000 to municipalities between 2001 and 2006 to pay for collection sheds and signage like that at the right encouraging residents to recycle mercury products. The department, for its part, has focused on training and education. We have had an on-going training program for municipal solid waste facility operators in place since 2001, and have provided thousands of informational brochures to towns and cities for distribution to their residents.

The department also has adopted mercury product labeling rules that require fluorescent lamp manufacturers to label the lamp packaging. The label must, at a minimum, inform the purchaser that the lamp contains mercury and that it cannot be placed in the trash.[31] Recognizing that the original packaging is not likely to be around when the lamp eventually is replaced, the rules also require the lamp itself to be labeled, a requirement that lamp manufacturers currently meet by stamping each lamp with the letters "Hg," the international symbol for mercury. The idea is that consumers can be taught to look for the symbol, which is their signal that spent lamps should be recycled.

[30] See PL 1999, c. 779, §2, eff. August 11. 200, enacting 38 MRSA §1665.
[31] 06-096 CMR 870, effective October 29, 2006.

Efficiency Maine mentions the recycling requirement in all of its print and some of its television advertising promoting the use of CFLs. Its print advertising includes the phrase "CFLs contain trace amounts of mercury and must be recycled at the end of their life." The print materials also refer consumers to the Efficiency Maine website. There visitors can find a county-by-county list of the retail stores where CFLs can be dropped off for recycling, and links to DEP informational materials on the proper handling of mercury-added products.

Obviously, consumers cannot be expected to fulfill their obligation to recycle fluorescent lamps unless they know the lamps contain mercury. Indeed, they have a right to know. While the amount of mercury in an individual lamp is small, and there is no risk of human exposure to the mercury as long as the lamp remains intact, the possibility of exposure at levels of concern cannot be dismissed if the lamp is broken.

When a bulb is broken on carpet, it is very difficult to recover all the mercury containing particles without removing the carpet.[32] Thus, while we encourage people to use fluorescents because their superior energy efficiency makes them a wise environmental choice, they may not be the best choice in places where they could be easily broken or in carpeted areas frequented by infants, young children and pregnant women.[33]

[32] Maine Department of Environmental Protection, *Maine Compact Fluorescent Lamp Study*, February 2008.
[33] See Maine Department of Environmental Protection, *Frequently Asked Questions Regarding CFLs*, February 25, 2008.

VI. USM survey of CFL users

In 2009, Dr. Travis Wagner at the University of Southern Maine conducted a survey to identify factors that contribute to the low recycling rate for CFLs.[34] Most respondents (77%) knew CFLs contained mercury but most (63%) did not know that recycling of CFLs is required. Most (64%) also did not know where to take CFLs for recycling or that CFL collection and recycling is offered in some locations at no cost (73%). Respondents were fairly evenly split on the three main factors that would encourage them to recycle—a sense of environmental responsibility, free or reduced recycling fees and convenience.

Based on the survey findings, Dr. Wagner recommends reorienting the outreach message to focus on the specific locations where CFLs can be recycled for free. The following specific steps are suggested:

1. Create a dedicated, simplified website specifically for CFL recycling information to include a user-friendly map and list of drop-off locations rather than the current Excel spreadsheet format. The drop-off locations should be kept current and should include contact information and hours of operations.

2. Select a simple, short, and memorable URL (i.e., web address) such as www.recyclecfls or www.mainecfl.

3. Label each CFL package with a vibrant sticker that includes the phrases "Must be Recycled" and "Maine CFL Recycling Information – www.xxx.xxx" and include the CFL recycling URL.

4. Post and continuously distribute the CFL URL at all municipal transfer stations, though utility bills, Efficiency Maine ads, and on the front of Efficiency Maine CFL in-store coupons (or on a tear-off section of the coupon that could be retained by the purchaser); and

5. Using the print media, periodically list specific locations of participating stores that will accept CFLs for free.

Dr. Wagner also recommends significantly increasing the number of collection locations to make recycling more convenient for homeowners. For example, given that 73% of the survey respondents purchased CFLs at home improvement and big box stores, Dr. Wagner suggests that these point-of-sale locations should be required or encouraged to provide free CFL collection. He further recommends that free collection be made available at every municipal solid waste transfer station.

The department has provided Dr. Wagner's study to lamp manufacturers for consideration as they prepare to implement their new responsibilities under Maine law. The law requires the manufacturer programs to include effective "education and outreach, including, but not

[34] T. Wagner, *Household Compact Fluorescent Light (CFL) Recycling in Maine*, University of Southern Maine, September 2009. The executive summary is attached to this report as Appendix 4; the full report available at www.ecomaine.org/recycling/index.shtm.

limited to, point-of-purchase signs and other materials provided to retail establishments without cost."[35]

The department will work with manufacturers to put these recommendations into practice. However, education alone will not necessarily produce significant change. Even with a convenient and free collection system for collection lamps for households in place, the recovery of spent lamps ultimately will depend on each individual's willingness to participate. For lamp recycling to work, homeowners still will need to set spent lamps safely aside and eventually get in their cars and take them to a collection point. Although most people are likely to combine lamp drop-off with other errands, the cost in gas and time cannot be dismissed and poses on-going challenge in our effort to boost the lamp recycling rate.

[35] See 38 MRSA §1672(4)(A)(3), effective September 12, 2009.

VII. Maine's lamp recycling rate

The recovery rate for spent mercury lamps from Maine businesses and households has remained disappointingly low. Well below half of the lamps estimated to be available for recycling are diverted from the waste stream. In our 2008 report, we calculated lamp recycling rates of 24%, 27% and 22% for 2004, 2005 and 2006 respectively.[36] Our latest calculations suggest the recycling has risen only modestly to about 30% in the last two years.

Table 2. Recycling rate for mercury-added lamps in Maine

Year	Estimated number of lamps available for recycling in ME	Number of lamps shipped for recycling by ME generators	Recycling rate
2004	3,000,000	732,645	24%
2005	3,000,000	819,689	27%
2006	3,000,000	671,349	22%
2007	3,000,000[37]	962,685	32%
2008	3,250,000[38]	988,574	30%

[36] Maine DEP and PUC *supra* n 1 at fn 6.

[37] A trade association representing the lamp recycling industry estimated that 670 million mercury lamps were available for recycling in the United States in 2002 and 2003. Maine's population-based share of that total is about 3 million. We have used this figure to calculate recycling rates for 2004 through 2007 in the absence of other industry estimates of lamps available for recycling in those years. See Association of Lighting and Mercury Recyclers, "National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.", November 2004.

[38] This number was derived by extrapolating from and then averaging two separate estimates of the number of mercury lamps available for recycling in the U.S. in 2008. See Massachusetts Department of Environmental Protection, *2008 Massachusetts Lamp Recycling Rate Calculation: Draft for Public Comment* (October 19, 2009); see also Elizabeth Saunders, *Comments of Massachusetts Clean Water Action and Mercury Policy Project on the October 2009 Proposed Massachusetts Mercury Lamp Recycling Rate Calculation*," December 2009.

VIII. Recommended strategy for improving lamp recycling rates

Recommendation 1: The State should focus its efforts on non-residential generators.

80% or more of the mercury-added lamps available for recycling come from industrial, commercial and institutional buildings.[39]

Recommendation 2: Among non-residential generators, the State should focus on large industrial, commercial and institutional facilities in light of their presumably sizeable generation of spent lamps.

Maine law already requires lamp vendors to clearly inform anyone who purchases more 200 fluorescent lamps at a time that the lamps contain mercury and may not be placed in the solid waste stream.[40] More should be done to ensure the message is being received. Specifically, the department should encourage the largest generators of waste lamps to integrate take back and recycling provisions into their lamp purchase and sales agreements.

The *Take Back the Light* program in Ontario (see Appendix 3) offers a template for a market-driven outreach program based on this premise. The program uses its website to link lamp buyers with sellers willing to provide take-back and recycling. Participation is voluntary but those who decide to participate must register on-line and prepare a lamp management plan. Participants are guaranteed the lowest available price for recycling.

An alternate approach would be to adopt rules requiring large generators to develop lamp management plans that include arrangements for recycling.[41] As with *Take Back the Light*, lamp management plans should link lamp purchases with recycling.

Recommendation 3: The manufacturer recycling program for household lamps should be expanded to cover fluorescent and other mercury-added lamps from small businesses.

Small businesses often buy their fluorescents at retail outlets, and lack the bulk buying power that their larger brethren can bring to bear in negotiating with lamp vendors and recyclers for take back and recycling. We think Maine's lamp recycling rate could be significantly improved if small businesses can recycle their fluorescent lamps at no charge through the municipal collection system. Eighty of the 164 municipal solid waste collection facilities currently equipped to collect spent fluorescent lamps from households also collect lamps from businesses and institutions for a fee. The definition of "small universal waste generator" would provide a convenient regulatory threshold. That term as used in the DEP Hazardous Waste Management Rules means "a person or entity that generates…no more than 200 universal waste items...at a time…"[42]

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[39] Solid Waste Association of North America, "Biggest Bang for Your Buck," *Promoting Mercury-Containing Lamp Recycling: A Guide for Waste Managers*, p 2.

[40] See 38 MRSA §1662, sub-§2 requiring lamp vendors to provide notice to purchasers of lamps for use in industrial, commercial or office buildings, but exempting retailers who "incidentally' sell to such purchasers. The department considers retail sales of less than 200 lamps to be incidental.

[41] Cascadia *supra* n 21 at 70.

[42] See 06-096 CMR 850(3)(A)(13)(a)(xiii).

<u>Recommendation 4</u>: The department should work with lamp manufacturers, municipalities and retailers to: 1) increase the number of locations where householders can drop off spent fluorescent lamps; and 2) effectively inform the public of these locations as well as the prohibition on putting fluorescents in the trash.

Dr. Wagner's survey confirms that effective public education combined with free, convenient collection opportunities will be critical to the success of efforts to increase lamp recycling rates from households. The Legislature recognized these critical factors when it enacted the law requiring lamp manufacturers to implement a department–approved program for recycling household lamps.

The law specifically requires that the program include:

- Convenient locations throughout the State where residents can drop off their household lamps without cost, including but not limited to municipal collection sites and participating retail establishments;[43] and
- Effective education and outreach, including, but not limited to, point-of-purchase signs and other materials provided to retail establishments without cost.[44]

As a prerequisite to its approval, the department should require that the program include, at a minimum, provision to maintain and expand retailer participation in the CFL collection program established by the Maine Public Utilities Commission. Moreover, the department should work with manufacturers to ensure that their proposed education and outreach steps complement the efforts of other players, including the department, the PUC and municipalities.

<u>Recommendation 5:</u> As resources allow, the department should work toward improving its website to make it more user friendly for persons seeking information on recycling of fluorescent lamps.

At a minimum, the department will seek to develop a user-friendly map of fluorescent lamp drop-off locations as recommended in the USM report, and will explore the possibility of using the Google Earth application to provide users with driving instructions to the nearest drop-off location.

The website Earth911.com already has this feature as does lamp recycler Veolia Environmental Services (www.recycleabulb.com). All a visitor to these websites need do is enter their zip code, specific the distance they are willing to travel (e.g. 5 miles, 10 miles) and they are presented with a list of drop-off locations with a click of the mouse. The National Electrical Manufacturers Association recently added the Earth911 feature to its lamprecycle.org site.[45] Lamp manufacturers include the lamprecyle.org URL on the packaging of all mercury-added lamps sold in the U.S.(see Recommendation 6, next page).

[43] 38 MRSA §1672, sub-§4, ¶A, sub-¶1.
[44] 38 MRSA §1672, sub-§4, ¶A, sub-¶3.
[45] National Electrical Manufacturers Association, "NEMA's LampRecycle.org Gets a Fresh Face," press release, August 2009.

<u>Recommendation 6:</u> The department should work with lamp manufacturers to improve lamp labeling and bring the industry into full compliance with Maine's labeling rules for mercury-added products.

Mercury-added lamps sold in Maine currently are labeled in accordance with a plan approved by the Vermont Agency of Natural Resources. Lamp manufacturers have yet to seek formal approval to use this same labeling in Maine.

Department rules allow manufacturers to comply with Maine's mercury product labeling law[46] by labeling lamps in the same manner as approved in another state provided they file documentation declaring their intent to do so and provided that documentation describes the state-specific adjustments, if any, that will be made to implement the plan in Maine.[47] Submittal of the required documentation constitutes compliance with Maine law unless the department notifies the manufacturer within 30 days that the proposed label violates Maine law.[48]

Maine's labeling law, as made specific under department rules, requires that the packaging label clearly inform the purchaser that the product contains mercury and may not be disposed of in solid waste. The rule does not specify the exact wording that must be used but gives the following example of acceptable wording:

> Contains Mercury. Don't Put in Trash. Recycle or Manage as Hazardous Waste.[49]

Vermont, on the other hand, allows the following wording:

> Hg LAMP CONTAINS MERCURY, Manage in Accord with Disposal Laws. See www.lamprecyle.org or 1-866-666-6850

The Vermont-approved label on its face falls short of what Maine law requires by failing to clearly convey the message that disposal is prohibited or that the lamp must be recycled. The words "manage in accord with disposal laws" are especially problematic in that they could easily be interpreted to condone disposal. A Maine purchaser must visit the website listed on the lamp label or call the toll free number to learn that disposal is prohibited. We believe phone numbers and web addresses are an uncertain and ineffective way to convey that information.

IX. Implementing legislation

The manufacturer responsibility provisions enacted last year must be amended to implement Recommendation 3 above. Suggested bill language follows on the next page.

[46] 38 MRSA 38 MRSA §1662, sub-§1.
[47] See 06-096 CMR 870(8), eff. October 29, 2006.
[48] *Id.*
[49] 06-096 CMR 870(5)(a), effective October 29, 2006.

An Act to Make it Easier for Small Business to Recycle Fluorescent Lamps

Proposed by the Department of Environmental Protection for consideration by the Joint Standing Committee on Natural Resources
124th Maine Legislature, Second Regular Session—2010

Be it enacted by the People of the State of Maine as follows:

Sec. 1. 38 MRSA §1672, sub-§4, as enacted by PL 2009, c. 272, §1, is amended to read:

4. Manufacturer recycling programs for household mercury-added lamps. Effective January 1, 2011, each manufacturer of mercury-added lamps sold or distributed for household use in the State on or after January 1, 2001 shall individually or collectively implement a department-approved program for the recycling of mercury-added lamps from households and mercury-added lamps collected by municipalities from small businesses. For the purpose of this subsection, a small business is an entity that qualifies as a small universal waste generator under the department hazardous waste management rules.

A. The recycling program required under this subsection must include:

(1) Convenient collection locations located throughout the State where residents can drop off their household lamps without cost, including but not limited to municipal collection sites and participating retail establishments;

(2) Handling and recycling equipment and practices in compliance with the universal waste rules adopted pursuant to section 1319-O, subsection 1, paragraph F and all other applicable requirements;

(3) Effective education and outreach, including, but not limited to, point-of-purchase signs and other materials provided to retail establishments without cost; and

(4) An annual report to the department on the number of mercury-added lamps recycled under the manufacturer's program, the estimated percentage of mercury-added lamps available for recycling that were recycled under the program and the methodology for estimating the number of mercury-added lamps available for recycling, an evaluation of the effectiveness of the recycling program, recommendations for increasing the number of lamps recycled under the recycling program and an accounting of the costs associated with administering and implementing the recycling program.

B. A manufacturer required to implement a recycling program under this subsection shall submit its proposed recycling program for department review and approval. The department shall solicit public comment on the proposed program before approving or denying the program.

C. Beginning April 1, 2011, a manufacturer not in compliance with this section is prohibited from offering any mercury-added lamp for final sale in the State or distributing any mercury-added lamp in the State. A manufacturer not in compliance with this section shall provide support to retailers to ensure the manufacturer’s mercury-added lamps are

not offered for sale, sold at final sale or distributed in the State.

D. Beginning April 1, 2011, a retailer may not offer for final sale a mercury-added lamp produced by a manufacturer not in compliance with this section. The department shall notify retailers of the manufacturers of mercury-added lamps not in compliance with this section.

E. Beginning April 15, 2013, and biennially thereafter, the department shall calculate the percentage of mercury-added lamps recycled ~~from households~~ and report to the joint standing committee of the Legislature having jurisdiction over natural resources matters on any modifications to the manufacturer recycling programs it intends to make to improve mercury-added lamp recycling rates and any recommendations for statutory changes needed to facilitate mercury-added lamp collection and recycling.

F. The department may determine that a manufacturer's recycling program is in compliance with paragraph A, subparagraphs (1), (2) and (4) ~~for the collection of compact fluorescent lamps from households~~ if the manufacturer provides adequate financial support to:

(1) Municipalities for the collection and recycling of ~~such~~ mercury-added lamps from households and small businesses ~~to municipalities~~; and

(2) A ~~a~~ conservation program for recycling of compact fluorescent lamps established pursuant to Title 35-A, section 3211-A and implemented by the Public Utilities Commission.

SUMMARY

The bill would require manufacturers of mercury added lamps to assume costs incurred by municipalities to collect and recycle lamps from small businesses

REFERENCES

California Department of Toxic Substances Control, *AB 1109: Lighting Task Force Report*, September 1, 2008.

Cascadia Consulting Group, *Fluorescent Lamp Recycling in Washington State*, report to the Washington State Department of Ecology, June 2007.

Gereffi, G., Dubay, K. and Lowe, M., *Manufacturing Climate Solutions: Carbon-Reducing Technologies and U.S. Jobs*, Center on Globalization, Governance & Competitiveness, November 2008.

Hilkene, C. and Friesen, K., *Background Study on Increasing Recycling of End-of-life Mercury-containing Lamps from Residential and Commercial Sources in Canada*, Pollution Probe, October 31, 2005.

Interstate Mercury Education and Reduction Clearinghouse, *IMERC Fact Sheet: Mercury Use in Lighting*, Northeast Waste Management Officials Association, August 2008.

Kelleher Environmental, *Fluorescent Lighting in Ontario, Canada: Lifespan Model and Research*, report to Waste Diversion Ontario, August, 2007.

Maine Department of Environmental Protection and Maine Public Utilities Commission, *Report Regarding the Recycling of Fluorescent Lamps and Consumer Education*, January 2008.

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Northeast Waste Management Officials Association, *Review of Compact Fluorescent Recycling Initiatives in the U.S. & Internationally*, July 23, 2009.

OSRAM Opto Semiconductors and Siemens Corporate Technology, *Life cycle assessment of illuminants: a comparison of light bulbs, compact fluorescent lamps and LED lamps*, November 2009.

Product Stewardship Institute, *Product Stewardship Action Plan for Fluorescent Lighting*, June 30, 2008.

Wagner, T., *Household Compact Fluorescent Light (CFL) Recycling in Maine*, University of Southern Maine, September 2009.

APPENDIX 1

An Act to Provide for the Safe Collection and Recycling of Mercury-containing Lighting

Public Laws 2009, chapter 272, effective September 12, 2009

Be it enacted by the People of the State of Maine as follows:

Sec. 1. 38 MRSA §1672 is enacted to read:

§ 1672. Mercury-added lamps

1. Definitions. As used in this section, unless the context otherwise indicates, the following terms have the following meanings.

A. "Manufacturer" means a person who manufactures a mercury-added lamp and has a presence in the United States or a person who imports a mercury-added lamp manufactured by a person who does not have a presence in the United States.

B. "Mercury-added lamp" means an electric lamp to which mercury is intentionally added during the manufacturing process, including, but not limited to, linear fluorescent, compact fluorescent, black light, high-intensity discharge, ultraviolet and neon lamps.

C. "Municipal collection site" means a solid waste disposal facility, transfer station, storage facility or recycling facility at which mercury-added lamps from households are collected for recycling that is municipally owned or operated or operated by a regional association.

D. "Person" means any individual, corporation, partnership, cooperative, association, firm, sole proprietorship, government agency or other entity.

2. Mercury content standards. The following provisions govern mercury content standards.

A. The department shall adopt rules establishing mercury content standards for lamps sold or manufactured in the State on or after January 1, 2012. The standards must be based on mercury content standards for lamps established in California. If one or more categories of lamps are not covered by the mercury content standards established in California, the department may adopt standards minimizing the mercury content of lamps within those categories, including adoption of a no-mercury standard if a nonmercury alternative is available at a cost comparable to a mercury alternative. Rules adopted pursuant to this paragraph are routine technical rules as defined in Title 5, chapter 375, subchapter 2-A.

B. The rules adopted under paragraph A must provide that:

(1) A manufacturer of mercury-added lamps sold or being offered for sale in the State

shall prepare and, at the request of the department, submit within 28 days of the date of the request technical documentation or other information showing that the manufacturer's mercury-added lamps sold or offered for sale in the State comply with the rules. If the manufacturer of a mercury-added lamp being sold or offered for sale does not provide the documentation requested, that manufacturer may not be allowed to sell or offer for sale mercury-added lamps in the State; and

(2) A manufacturer of mercury-added lamps sold or being offered for sale in the State shall provide upon request a certification to a person who sells or offers for sale a mercury-added lamp of that manufacturer. The certification must attest that the mercury-added lamp does not contain levels of mercury that would result in the prohibition of that lamp being sold or offered for sale in the State. If the manufacturer of a mercury-added lamp being sold or offered for sale does not provide the certification requested, that manufacturer may not be allowed to sell or offer mercury-added lamps for sale in the State.

3. Mercury-added lamp purchasing. When making purchasing decisions on mercury-added lamps and ballasts, the Department of Administrative and Financial Services, in consultation with the department and the Public Utilities Commission, shall request information on mercury content, energy use, lumen output and lamp life from potential suppliers and shall issue specifications and make purchasing decisions that favor models at comparable cost with high energy efficiency, lower mercury content and longer lamp life. Information obtained on mercury content, energy use and lamp life must be made available by the Department of Administrative and Financial Services to other purchasers who purchase a large number of mercury-added lamps. This information must also be posted on the State's publicly accessible website.

4. Manufacturer recycling programs for household mercury-added lamps. Effective January 1, 2011, each manufacturer of mercury-added lamps sold or distributed for household use in the State on or after January 1, 2001 shall individually or collectively implement a department-approved program for the recycling of mercury-added lamps from households.

A. The recycling program required under this subsection must include:

(1) Convenient collection locations located throughout the State where residents can drop off their household lamps without cost, including but not limited to municipal collection sites and participating retail establishments;

(2) Handling and recycling equipment and practices in compliance with the universal waste rules adopted pursuant to section 1319-O, subsection 1, paragraph F and all other applicable requirements;

(3) Effective education and outreach, including, but not limited to, point-of-purchase signs and other materials provided to retail establishments without cost; and

(4) An annual report to the department on the number of mercury-added lamps recycled under the manufacturer's program, the estimated percentage of mercury-added lamps available for recycling that were recycled under the program and the

methodology for estimating the number of mercury-added lamps available for recycling, an evaluation of the effectiveness of the recycling program, recommendations for increasing the number of lamps recycled under the recycling program and an accounting of the costs associated with administering and implementing the recycling program.

B. A manufacturer required to implement a recycling program under this subsection shall submit its proposed recycling program for department review and approval. The department shall solicit public comment on the proposed program before approving or denying the program.

C. Beginning April 1, 2011, a manufacturer not in compliance with this section is prohibited from offering any mercury-added lamp for final sale in the State or distributing any mercury-added lamp in the State. A manufacturer not in compliance with this section shall provide support to retailers to ensure the manufacturer's mercury-added lamps are not offered for sale, sold at final sale or distributed in the State.

D. Beginning April 1, 2011, a retailer may not offer for final sale a mercury-added lamp produced by a manufacturer not in compliance with this section. The department shall notify retailers of the manufacturers of mercury-added lamps not in compliance with this section.

E. Beginning April 15, 2013, and biennially thereafter, the department shall calculate the percentage of mercury-added lamps recycled from households and report to the joint standing committee of the Legislature having jurisdiction over natural resources matters on any modifications to the manufacturer recycling programs it intends to make to improve mercury-added lamp recycling rates and any recommendations for statutory changes needed to facilitate mercury-added lamp collection and recycling.

F. The department may determine that a manufacturer's recycling program is in compliance with paragraph A, subparagraphs (1), (2) and (4) for the collection of compact fluorescent lamps from households if the manufacturer provides adequate financial support for the collection and recycling of such lamps to municipalities and a conservation program established pursuant to Title 35-A, section 3211-A and implemented by the Public Utilities Commission.

5. Applicability. The requirements of this section do not apply to motor vehicles as defined in Title 29-A, section 101, subsection 42 or watercraft as defined in Title 12, section 13001, subsection 28 or their component parts.

Sec. 2. Recycling program submission date for existing manufacturers. A manufacturer subject to the Maine Revised Statutes, Title 38, section 1672 and in existence on the effective date of this Act shall submit its proposed recycling program pursuant to Title 38, section 1672, subsection 4, paragraph B by January 1, 2010.

Sec. 3. Report on recycling of mercury-added lamps from businesses. The Department of Environmental Protection shall submit a report by January 1, 2010 to the Joint Standing Committee on Natural Resources on the recycling of mercury-added lamps from businesses,

including, but not limited to, linear fluorescent lamps. The report must include:

1. An estimate of the number of mercury-added lamps recycled and the recycling rate for mercury-added lamps from businesses over each of the last 3 years;

2. A comprehensive strategy for improving lamp recycling rates;

3. Any legislation necessary to implement the strategy proposed in the report; and

4. The availability of nonmercury lamps to replace mercury-added lamps.

The Joint Standing Committee on Natural Resources may submit legislation to the Second Regular Session of the 124th Legislature to implement recommendations included in the report.

Sec. 4. Report on recycling of mercury-added lamps from households. The Department of Environmental Protection shall submit a report by January 1, 2010 to the Joint Standing Committee on Natural Resources on the recycling of mercury-added lamps from households pursuant to the Maine Revised Statutes, Title 38, section 1672. The report must include, but is not limited to:

1. An assessment of the costs of the manufacturer recycling programs for mercury-added lamps to manufacturers, consumers, municipalities and others;

2. After consultation with manufacturers of mercury-added lamps, recommendations for streamlining the recycling of mercury-added lamps from households; and

3. A review and assessment of education and outreach alternatives.

The Joint Standing Committee on Natural Resources may submit legislation to the Second Regular Session of the 124th Legislature to implement recommendations included in the report.

Effective September 12, 2009

APPENDIX 2

Nonmercury Alternatives to Fluorescent Lamps

Light emitting diodes

The most promising, emerging lighting alternative to fluorescent lamps is light emitting diodes or LEDs. LED lamps are more energy-efficient[50] and longer lasting than fluorescent lamps, and do not contain mercury or other hazardous components that require special handling at end of life.[51]

LEDs are made from semiconductor materials that emit light when an electrical current flows through them. LED lighting is also called "solid state lighting" because the light is emitted from a solid object—the semiconductor material—rather than from a vacuum or gas tube as in incandescent or fluorescent lighting.[52]

The market for general purpose LED lighting currently is very small—less than 1% of the global lighting market—but growing rapidly as the performance of LED lighting has improved much more rapidly than anticipated.[53] Sales of LED lighting products have grown 40 to 60% annually in recent years and are expected to reach $1.6 billion by 2012.[54] The U.S. Department of Energy (DOE) estimates that rapid development of LED lighting in the U.S. over the next 20 years could reduce electricity demand by 33% and deliver over $200 billion in savings.[55] According to DOE, LED lighting already is beginning to surpass the quality and efficiency of fluorescent and incandescent lighting.

The DOE Energy Star program, which DOE operates in partnership with the U.S. Environmental Protection Agency, initiated labeling standards for LED products in 2008. The program, which has long set energy efficiency standards for consumer products, assesses the efficiency and quality of LEDs, and has awarded its ENERGY STAR label to several LED products that can be used for general lighting in both residential and commercial settings.[56] To qualify for the ENERGY STAR label, the LED light must pass a variety of tests demonstrating that it has the following characteristics:

- Brightness equal to or greater than incandescent or fluorescent lamps;
- Light that is well distributed in the area illuminated by the fixture;

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[50] McKinsey *supra* n 7 at 35.
[51] OSRAM Opto Semiconductors GmBH and Siemens Corporate Technology, *Life Cycle Assessment of Illuminants: A Comparison of Light Bulbs, Compact Fluorescent Lamps and LED Lamps*, Executive Summary, November 2009. See also: United Nations Environment Program, *Report on the major mercury-containing products and processes, their substitutes and experience in switch to mercury for products and processes*, July 14, 2008, p. 80; Rosenthal and Barringer *supra* n. 5.
[52] Gereffi, Dubay and Lowe *supra* n 6 at 10.
[53] *Id.* at 16.
[54] *Id*.
[55] U.S. Department of Energy, *Learn about LEDs*, http://www.energystar.gov.
[56] For a list of ENERGY STAR qualified commercial LED lighting, go to: http://www.energystar.gov/index.cfm?fuseaction=ssl.display_products_com_html.

- Excellent color quality, producing a shade of white that is clear and consistent over time;
- Efficiency good or better than fluorescent lighting;
- Light that comes on instantly when the lamp is turned on; and
- No flicker when dimmed.

The number and type of available LED products is growing along with the technology. A variety of LED lamps are made for use in many different lighting applications including under-cabinet lighting for kitchens, recessed downlights (ceiling fixtures from which the light is directed downward) and outdoor lighting for streets and parking lots.

Electronics manufacturers Sharp and Panasonic have launched sales of screw-base LED lamps in Japan. The lamps are shaped like traditional incandescent lamps and can be used in an incandescent socket. Sharp offers nine models, available in seven different shades of white, "for use in ordinary lamps."[57] The Panasonic lamp is equivalent in light output to the common 60-watt incandescent bulb.[58] It can last up to 19 years if used an average of five and half hours per day and uses a tenth of the energy of its incandescent counterpart, but costs $40.

Philips Electronics North America also has developed, manufactured and soon will bring to market a 6 watt LED replacement for the 60-watt incandescent bulb.[59] According to Philips, its new lamp meets the demanding performance requirements established by the U.S. Department of Energy for its Bright Tomorrow Lighting Prize (L Prize).

The L Prize competition, authorized under the Energy Independence and Security Act of 2007, challenges industry to develop LED replacement technologies for 60-watt incandescent bulbs, the most widely used and inefficient lighting product. Philips previously announced that it had developed an LED replacement for the 40-watt incandescent bulb, scheduled to be commercially available in North America by late 2010.[60] In the meantime, screw-based LED lamps equivalent to 40 and 60 watt incandescent bulbs already can be purchased online in the U.S. Available models include those made by Sharp and a dimmable bulb made by Lemnis Lighting, a Dutch company.

Firms engaged in the design, manufacture and selling of LEDs include General Electric, OSRAM and Philips, the three largest players in the traditional lighting market,[61] as well

[57] Sharp Corporation, "Sharp Introduces Nine New LED Lamps for Home Use", June 11, 2009.
[58] T. Hornyak, "Panasonic: New LED bulbs shine for 19 Years", *CNET News*, September 10, 2009.
[59] Philips Electronics, "Philips first to submit to Department of Energy competition with development of LED replacement for common household bulb", September 24, 2009.
[60] Philips Electronics, "Philips Lighting unveils 600 lumen dimmable A-shape LED bulb for incandescent replacement", May 4, 2009.
[61] See Taub *supra* n 10 ["These companies face a tough problem. Their businesses were built on customers who regularly replaced light bulbs. How do you a profit when new lighting may commonly last 50 to 100 times as long as a standard bulb?"].

as new companies specializing in LED technology. North Carolina based LED manufacturer Cree, Inc. has quadrupled its work force to over 3,000 workers since 2002.[62] The Bird's Nest Stadium, built for the 2008 Olympics in Beijing, is illuminated by Cree LEDs.[63] Cree also makes LED lamps for general illumination, including fixtures for dormitories, office, restaurants and hotels, and has partnered with several U.S. cities—including Ann Arbor, Michigan, and Raleigh, North Carolina—to put LEDs in street lights and parking garages. Anchorage, Los Angeles, San Francisco and Toronto also have embarked on LED conversions.[64]

Businesses too are increasingly realizing the energy-savings benefits of LED technology.[65] Wal-Mart, for example, recently installed LED parking lot lights at one of its stores in Kansas.[66] The lights meet DOE specifications and are expected to reduce energy needs by 50% and maintenance costs by 80% compared to traditional, mercury-added lamps used to illuminate parking lots.

Wal-Mart also has decided to use LED lighting products in the refrigerators and freezers of all 4,200 of its stores.[67] Hannaford Supermarkets in New England is doing the same. The freezers and cold cases at Hannaford's new store in Augusta are lit with LEDs controlled by motion sensors. As someone nears the case, the lights turn on; they turn off again when there's no foot traffic.[68]

The bottom line is that LED technology has progressed more rapidly than was predicted two years ago when we last reported to you. LEDs already are competitive with CFLs,[69] which lighting executives now view as an interim technology.[70] They expect LEDs to win out in the race to replace the inefficient incandescent bulb. "Its fit-and-forget lighting that is essentially there for as long as you live."[71]

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[62] Gereffi, Dubay and Lowe *supra* n 6 at 19.
[63] *Id*.
[64] Rosenthal and Barringer *supra* n 5.
[65] Environmental Leader, "LEDs Make Inroads into Commercial and Home Applications," envronmentalleader.com, July 16, 2009.
[66] *Id*.
[67] Gereffi, Dubay and Lowe *supra* n 6 at 13.
[68] GreenerBuildings, "New Hannaford Supermarket is First to Achieve LEED-Platinum Green Rating", greenerbuildings.com, July 22, 2009.
[69] Osram and Siemens *supra* n 51 at 22.
[70] Taub *supra* n 10; see also Environmental Leader, "Will LED's Light the Future?" environmentalleader.com, July 30, 2008.
[71] Rosenthal and Barringer *supra* n 5, quoting Colin Humphrey, a researcher at Cambridge University.

High efficiency incandescent

In February 2007, GE announced that it was working to double the efficiency of incandescent bulbs, and hoped to introduce a high efficiency incandescent (HEI) lamp as non-mercury alternative to CFLs by 2010. GE has since suspended that effort, choosing instead to focus on what it believes will be the ultimate in energy-efficient lighting—LEDs.[72]

Others are still plugging away on HEI technology, however. Scientists at the University of Rochester are reported to have developed a method for doubling the efficiency of incandescent bulbs, although the technology is still in the early stages of development.[73] And researchers at Deposition Sciences in Santa Rosa, California are using reflective coatings to improve bulb efficiency by converting waste heat to visible light.[74]

Philips Lighting's Halogena line of incandescent bulbs uses an earlier version of these coatings to boost energy efficiency.[75] Philips touts its halogen bulbs as 30% more energy efficient than the traditional 60-watt and 100-watt incandescents they are designed to replace. The bulbs have a life expectancy of 2 years and cost about $5 each. In Europe, Philips has introduced another line of incandescents called EcoClassic that it touts as 50% more efficient than traditional bulbs.[76] Neither of the Philips bulbs has been certified by the Energy Star program.

LED, Incandescent, CFL

[72] Environmental Leader, "GE Suspends Development of High-Efficiency Incandescent Bulbs", envormenttalleader.com, December 1, 2008.
[73] L. Vestel, "Can Incandescent Bulbs Compete on Efficiency", *NY Times*, May 29, 2009.
[74] *Id*.
[75] *Id*.
[76] Philips Lighting, "Halogena Energy Saver bulbs combine the benefits of energy saving with high-quality halogen light," www.lighting.philips.com, downloaded December 12, 2009. A halogen lamp is a type of incandescent lamp in which a small amount of halogen gas is used to increase the lamp life and prevent darkening of the glass. See Wikipedia, "Halogen lamp," en.wkipedia.org; see also GE Lighting, "Frequently Asked Questions — Halogen," www.geligtining.com.

Electron stimulated luminescence (ESL)

A Seattle company called Vu1 ("view one") hopes to soon bring to market a new type of screw-based light bulb to compete with CFLs and LEDs as an alternative to incandescent bulbs.[77] The technology—electron stimulated luminescence (ESL)—works by firing electrons at phosphor, which then glows. The technology is similar to that used in cathode ray tubes and TVs.

According to the company, ESLs don't contain hazardous substances and are expected to be introduced in 2010 at a price of $20, or about half the current cost of a screw-based LED lamp. ESLs reportedly use about 65% less energy than incandescent bulbs and last four times longer. They also are said to give off a "warm" light similar to incandescents, can be turned on instantly and are fully dimmable.

ESL lamp

Photoluminescent nanofibers (PLN)

The research institute RTI International recently announced that it has developed a mercury-free lighting technology five times more energy efficient than incandescent light bulb.[78]

The technology, funded in part by the Department of Energy's Solid-State Lighting program, centers around advancements in the nanoscale properties of materials to create high-performance, nanofiber-based reflectors and photoluminescent nanofibers (PLN).[79] Nanofibers are materials with diameters measured in nanometers (a nanometer is one billionth of a meter). In nanofibers in the RTI technology are much smaller than human hair but with comparable lengths.[80]

According to the press release, the technology produces an aesthetically pleasing light with better color properties than is typically found in CFLs. RTI is continuing development of this technology and is actively pursuing commercialization. The company anticipates that commercial PLN products will be available in three to five years.[81]

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[77] Impact Lab, "Future of Light Bulbs May Be ESL's", www.impactlab.com, September 17, 2009.
[78] RTI International, "RTI International develops technology to make energy-efficient lighting," press release, February 8, 2010.
[79] *Id.*
[80] *Id.*
[81] *Id.*

APPENDIX 3

Take Back the Light — Lamp Recycling in the Province of Ontario

In June 2008, the Recycling Council of Ontario (RCO)[82] launched *Take Back the Light*, a program to increase the recycling of fluorescent lamps sold to the industrial, commercial and institutional (IC&I) sector.[83] The program accomplishes this goal mainly by working with lamp buyers to integrate take back provisions into their lighting supply contracts.

The core idea of *Take Back the Light* is to connect users of mercury-added lamps with suppliers that are to willing to provide recycling. The program targets larger IC&I lamp users because they can use their bulk buying power to get the best possible price for lamp recycling. Competition for their business, in turn, presumably will entice lamp vendors to routinely offer take back services.

Participation in the market-driven program is voluntary. To participate, lamp users register online at www.takebackthelight.ca. A program administrator then contacts the registrant to provide information about the recycling process. Each registrant is visited and provided a handbook that includes sample contract language they can use when procuring lamps.

Participants also enjoy preferential pricing. Because of the large volume of lamps collected through the program, RCO has negotiated preferred pricing on lamp recycling for all participants.

Lamp sellers who are willing to provide take back and recycling services also can actively participate in the program by registering online. They pay a registration fee ranging from $500 to $2,000 per year depending on their gross sales, and their services in turn are promoted thorough the program website. [84]

Take Back the Light was started with $160,000 in seed money from the Ontario Ministry of the Environment but eventually expects to be self-sustaining with income from royalties paid by lamp recyclers.[85] The program has two full time positions serving a jurisdiction with a population about 10 times that of Maine.[86]

The program has had modest success to date but growth projections based on current collection rates suggest the program will increase lamp recycling in Ontario from its current 7% rate to 30% by 2012.[87] The program still targets the large IC&I sector, but is capturing small businesses as well.

Jo-Anne St. Godard, Executive Director of RCO, says the program is "templatable." RCO is willing to license the program for use in other jurisdictions.

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[82] The Recycling Council of Ontario is a not-for-profit, membership-based organization whose mission is to inform and educate society about the avoidance of waste and the efficient use of resources.
[83] Recycling Council of Ontario, "Take Back the Light Launches in Ontario", press release, June 18, 2008.
[84] Recycling Council of Ontario, "Registration", www.takebackthelight.ca.
[85] Jo-Anne St. Godard, personal communication, December 2009.
[86] *Id.*
[87] Jo-Anne St. Godard, personal communication, January 26, 2010.

APPENDIX 4

USM Survey — Household CFL Recycling in Maine

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EXECUTIVE SUMMARY

Because of increased energy costs and a successful campaign by Efficiency Maine, compact fluorescent lights (CFLs) are now used in a majority of Maine homes. Although CFLs provide many benefits, they contain small amounts of mercury which, given the large number of CFLs in use, can become an environmental contaminant of concern unless recycled in an environmentally sound manner.

Despite a ban on disposing of CFLs, availability of free CFL recycling, and a statewide CFL recycling education campaign, indicators suggest that the CFL recycling rate remains very low. A study was undertaken to identify factors contributing to the low recycling rate by surveying 520 Maine residents who use CFLs.

Based on the survey, 48.3% of respondents have 10 or more CFLs currently in use and the primary impetus cited (59.6%) for purchasing CFLs was energy conservation. While 23.5% stated they recycle their CFLs, 28.9% of respondents disposed of CFLs, 16.2% did not know what they did with their CFLs, and 7.6% placed them into storage even though 76.8% of respondents knew CFLs contained mercury. The survey responses indicate that the lack of knowledge is likely the primary factor in low recycling participation; 63.2% did not know that CFLs are required to be recycled and an additional 9.7% said recycling is not required. As to locations for CFL drop-off, 64.2% said they did not know where CFLs could be brought for recycling. Finally, 72.9% of the respondents said they were unaware that CFL collection and recycling can be free. Regarding factors that would prompt CFL recycling, respondents were fairly even in selecting environmental responsibility, free or reduced recycling fees, and convenience.

Another influential factor in recycling is convenience. An analysis of the state-sponsored free CFL recycling program identified insufficient coverage of municipalities. Only 22.9% of Maine's municipalities have a participating location and the 10 municipalities with the highest population, representing 20.4% of the state's population, collectively have only 24 locations. Indicative of this situation is that the 204 participating locations have collected only 8,768 CFLs since 2007.

In light of the requirements for CFL manufacturers in the recently enacted LD 973, "An Act to Provide for the Safe Collection and Recycling of Mercury-containing Lighting," this study recommends: (1) modifying the educational focus and (2) expanding free CFL collection. Based on the results, education efforts should be reoriented from highlighting the need to recycle CFLs to focus on educating the public on the specific locations for free CFL drop-off

including periodic listings of specific locations in the local media. To increase convenience, CFL collection locations should be expanded specifically to include more home improvement, warehouse, mass merchant, and chain grocery stores to coincide with primary CFL purchase locations. Efforts should be made to increase substantially the number of free drop-off locations in Maine's population centers. Finally, free CFL collection should be made available at every municipal solid waste transfer station.

APPENDIX 5

DEP rulings on applicability of the manufacturer responsibility provisions of the Maine fluorescent lamp recycling law

Section 4 of *An Act to Provide for the Safe Collection and Recycling of Mercury-containing Lighting* (Appendix 1 of this report) directs the Department of Environmental Protection, after consultation with manufacturers of mercury added lamps, to make recommendations for streamlining the recycling of lamps from households. Manufacturers have not put yet forward any such recommendations, perhaps because their statutory obligation to assume responsibility for recycling does not begin until next year. In the meantime, at the request of lamp manufacturers, the department has made two rulings on the applicability of the law.

Ruling 1: Manufacturers that sell or have sold lamps exclusively to lighting wholesalers, large corporations, original equipment manufacturers and governmental entities are not subject to the requirements of 38 MRSA §1672, sub-§4.

The law by its terms applies only to a manufacturer who made mercury-added lamps that were "sold or distributed for household use in the State on or after January 1, 2001" [emphasis added]. Manufacturers that make and distribute lamps exclusively for use in non-household settings are not required to provide collection and recycling services in Maine. Conversely, lamp manufacturers whose products have been or are sold to discount, department, food, hardware, drug and big box retail establishments or to utilities will be presumed to have sold or distributed lamps to households in Maine.

Ruling 2: If a manufacturer ceases selling and distributing mercury-added lamps for household use, that manufacturer should be relieved of its responsibility to provide lamp collection and recycling services at the point when it is reasonable to conclude that all lamps made by the manufacturer have been replaced.

The department is still in discussion with lamp manufacturers as to the appropriate length of time that manufacturers who have ceased selling lamps should remain responsible for collection and recycling. A cut-off could be derived from industry predictions of lamp life (generally reported in hours) and assumptions about the average hours per day household lamps are likely to be use, with an allowance to ensure the manufacturer remains responsible during the time its lamps could be entering the waste stream.

Based on lamp mortality curves published by the Illuminating Engineering Society of North America,[88] all fluorescent lamps fail within 130% of rated life. The rated life is the number of hours, declared by the manufacturer, at which 50% of a large test group of

[88] Illuminating Engineering Society of North America, *Lighting Handbook*, p 6-30.

lamps failed. The rated life for most CFLs is between 6,000 and 15,000 hours.[89] A lamp must have a rated life of 6,000 hours to qualify for the Energy Star label.[90]

Assuming CFLs are used 3 hours per day on average, all those with a rated life of 15,000 hours could be expected to fail within 18 years after the manufacturer ceased sales [15,000 x 1.3 ÷ (3 x 365)]. All CFLs with a rated life of 6,000 could be expected to fail within 7 years after sales end [6,000 x 1.3 ÷ (3 x 365)].

LFLs typically last longer CFLs, with reported rated life ranging from 20,000 to 36,000 hours.[91] Again assuming 3 hours of use per day in a household setting, all LFLs with a rated life on the low end of this range could be expected to have failed within 24 years [10,000 x 1.3 ÷ (3 x 365)] after a manufacturer ceases sales to the retail market. An LFL at the high end of the range can be expected to have failed within 43 years [36,500 x 1.3 ÷ (3 x 365)].

Actual lamp life will be influenced by several factors including the rated life, the manufacturer, the location of the lamp (indoors or out) and how it is used. If a fluorescent lamp is installed where it is frequently switched on and off, it will age rapidly.[92] Scenarios where the time on is less than one hour followed by 5 or 10 minutes off significantly decrease lamp life.[93]

[89] Wikipedia, "Compact fluorescent lamp: comparison with incandescent lamps," en.wkipedia.org, downloaded August 20, 2009; see also R. Marquardt, *Compact Fluorescent Lamp Recycling Project Phase I Draft Report*, Zero Waste Alliance, September 10, 2002, p 8.
[90] U.S. Department of Energy, *Energy Star Program Requirements for CFLs, Final Version*, March 7, 2008.
[91] Kelleher Environmental *supra* n 4 at 9.
[92] Wikipedia, "Fluorescent lamp – disadvantages – frequent switching," en.wikipedia.org, downloaded February 12, 2010; see also U.S. Department of Energy, "Energy Savers: When to Turn off Your Lights," www.energysavers.gov, February 24, 2009.
[93] Marquardt *supra* n 89 at 9.