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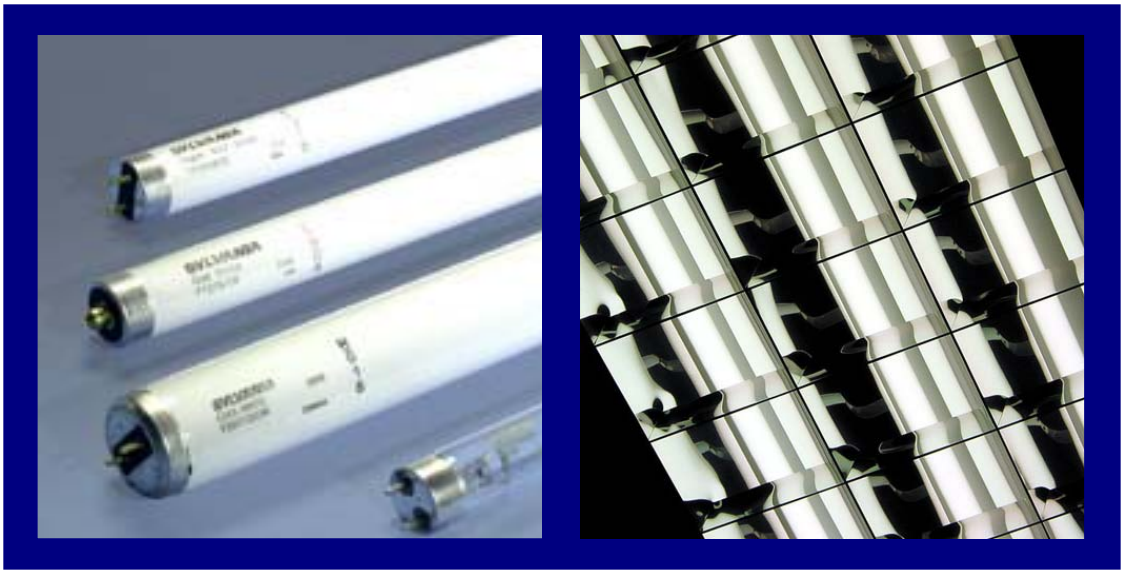
Fluorescent Lamp Recycling in Washington State

Recycling Levels, Stakeholder Analysis, and Policy Options



A report to

Washington State Department of Ecology

Prepared by

CASCADIA CONSULTING GROUP

June 2007

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Fluorescent Lamp Recycling in Washington State

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Executive Summary

Mercury is a persistent, bioaccumulative toxin (PBT) that can damage the central nervous and cardiovascular systems in humans. The 2003 *Washington State Mercury Chemical Action Plan* (CAP) established a state goal to "virtually eliminate the use and release of human-caused mercury in Washington State," including from mercury-added products. Mercury-added lamps have been identified as the product contributing to the largest quantity of mercury in disposed waste annually in Washington State.[1] Consequently, Ecology set a near term goal of increasing the lamp recycling rate from approximately 25% to 40% in Washington. Over the next eight years, Ecology seeks to achieve an 80% recycling rate by 2015, consistent with MCAP goals.

Mercury-added lamps, or light bulbs, include fluorescent lamps of all shapes, including linear tubes, circular or U-shaped bulbs, and compact fluorescents (CFLs); high intensity discharge (HID) lamps, including mercury vapor, metal halide, and high-pressure sodium lamps; and neon, ultraviolet (including germicidal, tanning, and "black" lights), and other specialty lamps. For brevity, in this report, the terms "fluorescent lamps," "mercury-containing lamps," and "mercury-added lamps" are used to refer collectively to this diverse group of lamp types. Standard incandescent light bulbs are *not* included in this group. The emphasis of this project is on lamps used in non-residential settings, primarily tubes, HIDs, and others; CFLs are often used in homes, and they are not a primary focus of this report.

In November 2006, the Washington State Department of Ecology hired Cascadia Consulting Group to conduct research with the ultimate purpose of determining an effective strategy leading to a significant increase in lamp recycling. Because commercial, industrial, and institutional users produce the large majority of spent fluorescent lamps, Ecology sought to focus on non-residential lamp users first. To reach 80% recycling, follow-up efforts may include more emphasis on homeowners and other residential users of fluorescent lamps.

The project and this report were organized into these major topic areas to accomplish Ecology's objectives:

- **Lamp Recycling and Generation in Washington** (Chapter 2). Determine the statewide annual lamp recycling rate, estimate cumulative mercury reduction achieved through lamp recycling, and estimate end-of-life (EOL) lamp generation.
- **Recommended Methodology for Recycling Rate** (Chapter 3). Develop a standard methodology to determine the statewide annual lamp recycling rate.
- **Stakeholder Practices, Barriers, and Opportunities** (Chapter 4). Gather stakeholder input to understand current attitudes, behaviors, barriers, and opportunities regarding increased lamp recycling.
- **Policy Options, Other States, and Strategies** (Chapter 5). Identify options, including through research on programs in other states, and make recommendations for increased fluorescent lamp recycling in Washington.

[1] Washington State Department of Ecology and Washington State Department of Health, *Mercury Chemical Action Plan*, page 1; *MCAP*, Table 2, page 5.

Lamp Recycling and Generation in Washington

Chapter 2 describes research to estimate the quantities of fluorescent lamps purchased, recycled, disposed, and reaching end-of-life each year. Quantities were estimated for the state as a whole and for a number of separate sectors of economy and population. This chapter also addresses estimation of mercury reduction achieved through recycling. Data gaps make it challenging to develop a robust methodology and assessment of recycling rates.

Key findings on lamp recycling and generation are:

- **Washington's state lamp recycling rate for 2004/2005 is in the ballpark of 20%** and comparable to ALMR's national estimate of 23% for 2003.[2]

- **An estimated 2½ million lamps are recycled annually from Washington State**; however, data gaps and inconsistencies hinder comparison of the results and may result in underestimation.

- **Approximately 14 million lamps reach end-of-life in Washington each year**.

- **About 8 million end-of-life lamps, 60% of the total, are estimated to come from commercial and institutional users**, while the industrial and residential sectors each account for about 20% of end-of-life lamps, or 3 million lamps from each sector.

- **Recycling is estimated to have prevented about 60 pounds of mercury each year** from entering landfills, incinerators, and the environment; the cumulative total for 2003 to 2005 is estimated at 150 to 200 pounds of mercury.

Recommended Methodology for Recycling Rate

Chapter 3 recommends approaches, data sources, and methods for future tracking of lamp generation and recycling. The recycling rate of any waste product is commonly defined as the quantity of product recycled divided by the quantity of product generated. In most cases, *generated* is defined as the quantity of the product reaching the end of its useful life and therefore ready to be disposed, recycled, or (in some cases) stored or stockpiled. Key aspects of the recommended methodology include:

- **To estimate the recycling rate in Washington, better data must be collected** on the quantities of lamps recycled and quantities of end-of-life lamps generated.

- **Lamp data should be tracked based on number of lamps**, rather than by weight, for ease of data collection and relevance to stakeholders and the public.

- **Mandated tracking and reporting of recycling and sales data would improve the accuracy** of recycling rate calculations, though enacting such policies would likely be unpopular with members of the lamp recycling and manufacturing industries.

[2] The two major data sources for the Washington State recycling rate calculation use recycling figures from two different years: 2005 for the data collected by King County and 2004 for the Ecology data. Accordingly, the "2004/2005" estimate covers this general time period. More current data available from Ecology did not include adjustments for some interstate transport of lamps; even with 2005 data provided, however, we do not expect that the recycling figures would shift dramatically in a single year.

- **The recommended method to estimate recycling quantities is a single annual survey of lamp recyclers** to tabulate the number of lamps recycled from Washington generators each year.

- **The recommended method involves scaling national data to Washington**, using appropriate metrics, to determine how many lamps will be generated in each year.

- **Estimates of recycling, sales, and lifespan should be developed using identical methods** in each year to enable tracking trends over time.

Stakeholder Practices, Barriers, and Opportunities

Chapter 4 summarizes input obtained from businesses and other stakeholders in Washington regarding their use of fluorescent lamps, management practices, and barriers to and opportunities for lamp recycling. The primary goal of gathering stakeholder input was to obtain information regarding current practices and attitudes with respect to fluorescent lamp usage and recycling and to help inform potential policy options. In addition, contacting stakeholders in key informant interviews and surveys initiated communication, identified potential participants for future stakeholder dialogues, and provided an opportunity to address the topic of lamp recycling.

Cascadia's key informant interview and surveys with more than 300 manufacturing and construction companies, government and military institutions, hospitals, hotels and restaurants, retailers and grocery stores, schools, warehouses, property managers, and lamp industry members produced the following results:

- **Roughly two-thirds of lamp users and all of the relampers contacted reported recycling at least some of their lamps.** Among companies that recycled, most reported recycling all or nearly all of their lamps.

- **More than a third of non-recycling companies said they needed more information**, the most common reason given for not recycling. Respondents also reported that they did not recycle because it was inconvenient or because they used low-mercury lamps**.**

- **Nearly three-quarters of lamp users reported that they have encountered no problems with recycling.** Difficulties with storage, cost, and other recycling logistics were the most commonly reported problems with lamp recycling.

- **The vast majority of respondents reported they were familiar with the health and environmental concerns** associated with mercury in fluorescent lamps.

- **A majority of respondents said that government should encourage lamp recycling by making it more convenient and less expensive** and by providing information.

- **Stakeholders demonstrated a strong willingness to participate in follow-up dialogues** on the topic of lamp recycling.

Policy Options, Other States, and Strategies

Chapter 5 outlines recommended approaches for increasing recycling rates, reducing mercury in the environment, and achieving Ecology's fluorescent lamp goals, based on analysis and input from key contacts in programs elsewhere working to reduce mercury in the environment. Potential options were developed through telephone interviews, in-person meetings, research,

and other communications with states, counties, other public agency staff members, and additional contacts.

Reaching an 80% fluorescent lamp recycling rate in the next eight years is an ambitious goal, and meeting the goal will require significant changes from the status quo. Model programs like Minnesota's, which achieved estimated 80% recycling in 2005, demonstrate that such success is possible. The options offered herein are intended to provide a path to 80% lamp recycling in Washington, though it should be recognized that the most effective approaches for dramatically increasing recycling are not likely those that are most easily feasible, convenient, or expedient. Successful implementation of these policies requires significant resource investments, commensurate with the degree of change desired. Though this project was designed to focus on commercial lamp generation, not residential, many of the policies needed to reach 80% recycling also involve approaches to increasing recycling among residents.

- **Achieving 80% lamp recycling likely requires a broad-based disposal ban**, which must be accompanied by convenient recycling options to be effective.
- **Ecology should actively support and participate in a product stewardship initiative** on fluorescent lamps as well as **partner with other states on lamp recycling policies.**
- **State and local government should lead by example**, purchasing low-mercury lamps, integrating recycling with lamp purchases and contracting, and recycling all of its spent fluorescent lamps.
- **Conduct inspections and actively enforce existing rules**; use any fines collected to support progress on lamp recycling. A disposal ban would also facilitate enforcement.
- **Support development of a reverse-distribution system**, particularly one in which costs of recycling are covered at the front end. Consider a **mercury or energy use fee or tax**.
- **Expand existing education and promotion efforts** on lamp recycling, **support local government efforts** to expand recycling, and **engage industry stakeholders** in developing solutions and effective outreach to non-recyclers.

Next Steps for Lamp Recycling in Washington

Ecology now has the opportunity to move forward on implementing strategies to increase lamp recycling significantly and to track that increase. The next steps are to:

- **Implement the recommended methodology to improve the estimation and tracking of the annual statewide lamp recycling rate**, as outlined in Chapter 3.
- **Follow up with stakeholders who agreed to participate in a lamp recycling dialogue** through focus groups, roundtable discussions, or additional interviews regarding development and implementation of policy options.
- **Pursue recommended policies**, including a disposal ban on mercury lamps, engagement in product stewardship initiatives, and development of a lamp take-back system.

1 Introduction and Project Overview

1.1 Purpose and Goals

Mercury is a persistent, bioaccumulative toxin (PBT) that can damage the central nervous and cardiovascular systems in humans. The 2003 Washington State Mercury Chemical Action Plan (CAP) established a state goal to "virtually eliminate the use and release of human-caused mercury in Washington State," including from mercury-added products.[3] Consequently, Ecology has set a goal of increasing the recycling rate for mercury-containing lamps to 80 percent by 2015.

Washington's Mercury Education and Reduction Act of 2003 established a timeline for the state to reduce its use of mercury-added products.[4] In 2004, all mercury-containing lamps and their packaging were required to be labeled with "Hg." In 2005, the state government was required to begin environmentally preferred purchasing by switching to products containing little or no mercury. In 2006, the act bans the sale of most thermometers, manometers, thermostats, novelties, toys, and jewelry, and new cars containing mercury. In addition, in 2006 primary and secondary schools were banned from purchasing elemental mercury or mercury compounds and were required to properly dispose of remaining bulk mercury. Executive Orders and directives from the Governor also called on State government to recycle all of its fluorescent lamps.[5]

Mercury-added lamps include fluorescent lamps of all shapes, including linear tubes, circular or U-shaped bulbs, and compact fluorescents; high intensity discharge (HID) lamps, including mercury vapor, metal halide, and high-pressure sodium lamps; and neon, ultraviolet (including germicidal, tanning, and "black" lights), and other specialty lamps. Fluorescent lamps have been identified as the product contributing to the largest quantity of mercury in disposed waste annually in Washington State.[6] Linear tubes are typically categorized by length and diameter. The standard tube length is four feet long, but tubes can range from one to eight feet long. The most common tube types are T12s (the oldest and largest in diameter, at 1.5 inches), T8s (smaller, 1" in diameter, and more common now), and T5s (the smallest in diameter, 5/8-inch, relatively uncommon but becoming more popular). For brevity, in this report, the terms "fluorescent lamps," "mercury-added lamps," and "mercury-containing lamps" are used to refer collectively to this diverse group of lamp types. Standard incandescent light bulbs are *not* included in this group. Standard incandescent light bulbs are *not* included in this group. The emphasis of this project is on lamps used in non-residential settings, primarily tubes, HIDs, and others; CFLs are often used in homes, and they are not a primary focus of this report.

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[3] Washington State Department of Ecology and Washington State Department of Health, *Mercury Chemical Action Plan*, page 1.

[4] A mercury-added product is a product, a commodity, a chemical, a product with one or more components, or a product that cannot function without the use of that component, that contains mercury or a mercury compound intentionally added to the product, commodity, chemical, or component in order to provide a specific characteristic, appearance, or quality, or to perform a specific function, or for any other reason. These products include formulated mercury-added products and fabricated mercury-added products. See http://www.newmoa.org/prevention/mercury/imerc/notification/#note.

[5] Governor's Directive Number 04-01, "Recycling Fluorescent Bulbs," January 28, 2004; Executive Order 02-03, "Sustainable Practices by State Agencies."

[6] Washington State Department of Ecology and Washington State Department of Health, *Mercury Chemical Action Plan*, Table 2, page 5.

In November 2006, the Washington State Department of Ecology hired Cascadia Consulting Group to conduct research with the ultimate purpose of determining an effective strategy leading to a significant increase in lamp recycling. Because commercial, industrial, and institutional users produce the large majority of spent fluorescent lamps, Ecology sought to focus on non-residential lamp users first. To reach 80% recycling, follow-up efforts may include more emphasis on homeowners and other residential users of fluorescent lamps.

The current project was divided into three main phases to accomplish Ecology's objectives:

I. **Lamp Recycling Rate Methodology.** Determine the statewide annual lamp recycling rate, estimate cumulative mercury reduction achieved through lamp recycling, and estimate end-of-life lamp generation. Develop a standard methodology to determine the statewide annual lamp recycling rate.

II. **Lamp Sector Analysis.** Gather stakeholder input to understand current attitudes, behaviors, barriers, and opportunities regarding increased lamp recycling.

III. **Develop Strategies.** Identify options, including through research on programs in other states, and make recommendations for increased fluorescent lamp recycling in Washington.

1.2 Project Background

Although mercury is a naturally occurring element, human activities have concentrated it in the environment to an extent that human and ecosystem exposure is a serious problem.[7] Mercury is used and released during mining and manufacturing as well as in and from products used by households, institutions, and businesses. In 2003, The Department of Ecology and Department of Health developed the Mercury Chemical Action Plan (CAP), making mercury the state's first priority pollutant. The Mercury CAP identified mercury-added lamps as a major source of mercury, which can be released during improper disposal. Mercury-added lamps include fluorescent lamps of all shapes (linear tubes, circular or U-shaped bulbs, compact fluorescents), high intensity discharge (HID) lamps (mercury vapor, metal halide, and high-pressure sodium) and neon lamps. In 2003, the Mercury CAP estimated that approximately 437 to 505 pounds of mercury are released annually by discarded fluorescent bulbs.[8] Using this estimate, lamps account for about 10 percent of the total estimated human-caused mercury releases in Washington.[9]

Because mercury-free fluorescent lamps are not currently available, the Mercury CAP recommended actions focused on increasing proper lamp disposal, primarily through recycling. Consequently, Ecology set a near term goal of increasing the lamp recycling rate from approximately 25% to 40% in Washington. For the longer term, Ecology is seeking to achieve an 80% recycling rate by 2015, consistent with MCAP goals.

The recommended actions in the Mercury CAP primarily involved education and outreach, although additional possible actions mentioned included conducting research on increasing the number of recycling facilities, banning landfilling of fluorescent lamps from households and small-

[7] Washington State Department of Ecology and Washington State Department of Health, *Mercury Chemical Action Plan*, pp. 1-2.

[8] Mercury CAP, page 55.

[9] Mercury CAP, page 6.

quantity generators, increasing the number of lamps that would be designated as "dangerous waste," and estimating the number of lamps currently landfilled.

Aside from developing the Mercury CAP, Washington State has taken several actions to reduce the generation and release of mercury from fluorescent lamps. These actions include making it easier for businesses to recycle lamps through the Universal Waste rule, directing state agencies to use lamps containing the lowest level of mercury, requiring state agencies and institutions to recycle used fluorescent lamps, requiring mercury-containing lamps sold in Washington to have a mercury warning label, and offering grants and free lamp recycling.

Prior to 2000, mercury-containing lamps generated by businesses were considered dangerous waste, and stringent regulatory requirements existed for storage and manifesting of off-site shipments of dangerous waste. In 2000, Ecology adopted the Universal Waste rule for lamps, which allows generators to manage dangerous-waste lamps under the less stringent Universal Waste rule, with a significantly reduced regulatory burden that is intended to facilitate recycling, particularly among smaller generators. Under the Universal Waste rule, however, lamp crushing is not allowed. Unless they designate as non-hazardous in toxicity testing, crushed lamps must be managed as hazardous waste.[10] National data suggest an increase in lamp recycling occurred following the U.S. Environmental Protection Agency's addition of lamps to the Universal Waste rule in 1999.[11]

Though several dozen companies produce fluorescent lamps, three major manufacturers – General Electric, Philips, and Osram Sylvania – account for the vast majority of lamps sold in the United States. Washington State contains a few companies reporting activities in the 335110 North American Industry Classification System (NAICS) code, *Electric Lamp Bulb and Part Manufacturing*, but none of the major manufacturers are located in the state. The "Big Three" manufacturers often have exclusive distribution arrangements for their lamps, such as General Electric at Wal-Mart, Philips at Home Depot, and Sylvania at Lowe's.

1.3 Report Overview and Outline

This report follows the structure of the Lamp Recycling project itself and is organized into the following major sections:

- **Lamp Recycling and Generation in Washington.** Chapter 2 describes research to estimate the quantities of fluorescent lamps purchased, recycled, disposed, and reaching end-of-life each year. Quantities were estimated for the state as a whole and for a number of separate sectors of economy and population. This chapter also addresses estimation of mercury reduction achieved through recycling. Data gaps make it challenging to develop an accurate assessment of recycling rates, but the next section recommends ways to make the recycling estimates more robust in the future.

- **Recommended Methodology for Recycling Rate.** Chapter 3 recommends approaches, data sources, and methods for future tracking of lamp generation and recycling.

[10] See http://www.ecy.wa.gov/pubs/98407c.pdf or http://www.ecy.wa.gov/pubs/0004020.pdf for more details. TCLP tests are the typical method used to determine if a waste is hazardous.

[11] Association of Lighting and Mercury Recyclers, *National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.*, Calistoga, Calif., November 2004, http://www.lamprecycle.org.

- **Stakeholder Practices, Barriers, and Opportunities.** Chapter 4 presents input from stakeholders regarding attitudes, current behaviors, barriers, and opportunities for increased fluorescent lamp recycling. Telephone interviews and online surveys were conducted with manufacturers, construction companies, government institutions, military facilities, hospitals, hotels, restaurants, retailers, grocery stores, schools, warehouses, and building and property managers. Additionally, we contacted industry associations, nongovernmental organizations, lamp manufacturers, lamp distributors, building maintenance professionals, relamping contractors, and others.

- **Policy Options, Other States, and Strategies.** Chapter 5 outlines recommended approaches for increasing recycling rates, reducing mercury in the environment, and achieving Ecology's lamp goals, based on analysis and input from key contacts in programs elsewhere working to reduce mercury in the environment. It also identifies potential impacts to stakeholders from implementing the recommended strategies. Approaches were gathered from telephone interviews, in-person meetings, and online surveys with counties, states, major local recyclers, other public agency staff members, and others.

1.4 Summary of Key Findings

The key findings from this lamp recycling project are presented below, organized by chapter.

Lamp Recycling and Generation in Washington (Chapter 2)

- **Washington's state lamp recycling rate for 2004/2005 is in the ballpark of 20%** and comparable to ALMR's national estimate of 23% for 2003.

- **An estimated 2½ million lamps are recycled annually from Washington State**; however, data gaps and inconsistencies hinder comparison of the results and may result in underestimation.

- **Approximately 14 million lamps reach end-of-life in Washington each year**.

- **About 8 million end-of-life lamps, 60% of the total, are estimated to come from commercial and institutional users**, while the industrial and residential sectors each account for about 20% of end-of-life lamps, or 3 million lamps from each sector.

- **Recycling is estimated to have prevented about 60 pounds of mercury each year** from entering landfills, incinerators, and the environment; the cumulative total for 2003 to 2005 is estimated at 150 to 200 pounds of mercury.

Recommended Methods for Future Recycling Rate Tracking (Ch. 3)

- **To estimate the recycling rate in Washington, better data must be collected** on the quantities of lamps recycled and quantities of end-of-life lamps generated.

- **Lamp data should be tracked based on number of lamps**, rather than by weight, for ease of data collection and relevance to stakeholders and the public.

- **Mandated tracking and reporting of recycling and sales data would improve the accuracy** of recycling rate calculations, though enacting such policies would likely be unpopular with members of the lamp recycling and manufacturing industries.

- **The recommended method to estimate recycling quantities is to administer a single annual survey to lamp recyclers** to tabulate the number of lamps recycled from Washington generators each year.

- **The recommended method involves scaling national data to Washington**, using appropriate metrics, to determine how many lamps will be generated in each year.

- **Estimates of recycling, sales, and lifespan should be developed using identical methods in each year.**

Stakeholder Practices, Barriers, and Opportunities for Recycling (Ch. 4)

- **Roughly two-thirds of lamp users and all of the relampers contacted reported recycling at least some of their lamps.** Among companies that recycled, most reported recycling all or nearly all of their lamps.

- **More than a third of non-recycling companies said they needed more information**, the most common reason given for not recycling. Respondents also reported that they did not recycle because it was inconvenient or because they used low-mercury lamps**.**

- **Nearly three-quarters of lamp users reported that they have encountered no problems with recycling.** Difficulties with storage, cost, and other recycling logistics were the most commonly reported problems with lamp recycling.

- **The vast majority of respondents reported they were familiar with the health and environmental concerns** associated with mercury in fluorescent lamps.

- **A majority of respondents said that government should encourage lamp recycling by making it more convenient and less expensive** and by providing information.

- **Stakeholders demonstrated a strong willingness to participate in follow-up dialogues** on the topic of lamp recycling.

Policy Options, Other States' Experience, and Strategy Development (Ch. 5)

- **Achieving 80% lamp recycling likely requires a broad-based disposal ban**, which must be accompanied by convenient recycling options to be effective.

- **Ecology should actively support and participate in a product stewardship initiative** on fluorescent lamps as well as **partner with other states on lamp recycling policies.**

- **State and local government should lead by example**, purchasing low-mercury lamps, integrating recycling with lamp purchases and contracting, and recycling all of its spent fluorescent lamps.

- **Conduct inspections and actively enforce existing rules**; use any fines collected to support progress on lamp recycling. A disposal ban would also facilitate enforcement.

- **Support development of a reverse-distribution system**, particularly one in which costs of recycling are covered at the front end. Consider a **mercury or energy use fee or tax**.

- **Expand existing education and promotion efforts** on lamp recycling, **support local government efforts** to expand recycling, and **engage industry stakeholders** in developing solutions and effective outreach to non-recyclers.

Next Steps for Lamp Recycling in Washington (Ch. 6)

Ecology now has the opportunity to move forward on implementing strategies to increase lamp recycling significantly and to track that increase. The next steps are to:

- **Implement the recommended methodology to improve the estimation and tracking of the annual statewide lamp recycling rate**, as outlined in Chapter 3.

- **Follow up with stakeholders who agreed to participate in a lamp recycling dialogue** through focus groups, roundtable discussions, or additional interviews regarding development and implementation of policy options.

- **Pursue recommended policies**, including a disposal ban on mercury lamps, engagement in product stewardship initiatives, and development of a lamp take-back system.

2 Lamp Recycling and Generation in Washington

The purpose of this chapter is to summarize the available data and estimates for the number of spent fluorescent lamps generated and recycled annually in Washington in total and for various sectors, such as commercial, industrial, and residential. This portion of the report also describes the methodology used to reach those estimates and the estimated quantity of mercury kept out of landfills, incinerators, and the environment due to increased lamp recycling between 2003 and 2005, since the adoption of Washington's *Mercury Chemical Action Plan* and passage of its Mercury Education and Reduction Act. The chapter focuses on summary information and key findings, and a separate appendix presents more information on data sources reviewed and used for the calculations on lamp recycling, generation and usage, and mercury content.

Following the summary of key findings, the next section of this chapter estimates the current recycling rate for fluorescent lamps in Washington using data to answer the following questions:

- How many mercury-added lamps are recycled each year in Washington State?
- How many lamps are purchased each year in Washington?
- What is the average lifespan of a typical fluorescent lamp?
- How many fluorescent lamps reach end-of-life each year in Washington?

The next major section estimates the quantity of mercury kept out of landfills, waste-to-energy facilities, and the environment. Calculations involve multiplying the number of lamps recycled by the average mercury content of lamps, which varies by lamp type, manufacturer, and year of manufacture. Data on mercury reduction can be used to estimate annual savings as well as cumulative mercury reduction due to recycling since 2003.

The final section discusses sector-specific generation and recycling rates for the commercial, industrial, and residential sector sectors. In addition, available data are presented regarding generation and recycling by state government, institutions, and K-12 schools; commercial property managers; the retail sector; and hospitals.

Data to support these estimates were gathered from a variety of sources, including:

- National industry associations, including the Association for Lamp and Mercury Recyclers (ALMR) and the National Electrical Manufacturers Association (NEMA);
- Associations in Washington state, including the Building Owners and Managers Association (BOMA), the Washington State Hospital Association (WSHA), the Washington Retail Association (WRA), and the Association of Washington Businesses (AWB);
- Nongovernmental organization efforts, including the Northeast Waste Management Officials' Association (NEWMOA); Product Stewardship Institute; Mercury Policy Project; Pacific Northwest Pollution Prevention Resource Center; and Northwest Product Stewardship Council;
- Information from the Department of Ecology, including existing databases and information sources used to develop the Mercury Chemical Action Plan;
- The U.S. Department of Energy and Bureau of the Census;

- Information from other U.S. states and intergovernmental efforts, such as the Interstate Mercury Education and Reduction Clearinghouse (IMERC) and the Quicksilver Caucus of the Environmental Council of the States. Data sources included IMERC's mercury-added product database, Maine's Fluorescent Lamp Study (2001) regarding quantities of mercury contained in different lamp types, and the Lane County (Oregon) Lamp Recycling Coalition Retail-based Pilot Program;

- Local city and county efforts in Washington, including King County's prior research efforts on mercury and fluorescent lamps; and

- Telephone interviews and online surveys conducted by Cascadia Consulting Group with Washington businesses and institutions.

The estimates presented in this chapter are constrained by the limited existing data available and existing resources. Due to limited availability of local data, most estimates for lamp generation in Washington State are extrapolated from national data sources. (The Northwest Energy Efficiency Alliance has done some regional-level tracking for its four-state area, but most of its quantification efforts to date have focused on compact fluorescent lamps.) Sector-specific data regarding lamp recycling are limited, though lamp usage, and thus generation, can be allocated more readily among sectors. The distribution between commercial and residential lamps is more reliable than more detailed sector breakdowns (e.g., retail, manufacturing, schools). Estimates presented in this chapter should be considered in light of these data limitations, as the need to consider and address these data limitations helped inform the choice of sources, methods, and calculations used in developing these estimates of lamp recycling in Washington State. Following this discussion of estimated lamp recycling in the state, Chapter 3 presents our recommended methodology for improving the tracking of generation and recycling of mercury-containing lamps in Washington in the future.

2.1 Key Findings on Lamp Recycling and Generation

- **Washington's state lamp recycling rate for 2004/2005 is in the ballpark of 20% and comparable to ALMR's national estimate of 23% for 2003.** For the recycling rate to exceed 25%, more than 1 million additional lamps would need to be added to the recycling totals, nearly a 50% increase from the quantities that are currently reported as recycled.

- **An estimated 2½ million lamps are recycled annually from Washington State**, based on data from King County (2005) and the Department of Ecology (2004). However, the surveys have several data gaps and inconsistencies that hinder comparison of the results and may result in underestimation.

- **Obtaining Washington-specific figures for lamp sales and spent lamp generation is problematic due to data gaps.** The lack of Washington-specific lamp sales data also complicates efforts to estimate lamp generation and recycling for each sector of the economy. Extrapolating from national, and sometimes regional, data sources is recommended in the absence of state-specific sales and generation figures.

- **An estimated 11 to 13 million tubes and 1 to 2 million CFLs were sold in Washington in 2004**, scaling from national data (NEMA). An alternate estimate, scaled from regional data (NEEA), estimates that 3.7 million CFLs were sold in Washington in 2005.

- **Approximately 14 million lamps reach end-of-life in Washington each year**, scaling from national data.

- **Approximately 60% of lamps are generated by the commercial sector, 20% by the industrial sector, and 20% by the residential sector**, based on national estimates. Applied to Washington's estimated 14 million lamps, the commercial sector (including government and institutions) generates approximately 8 million lamps annually; the industrial sector generates about 3 million lamps; and the residential sector generates approximately 3 million lamps.

- **Recycling is estimated to have prevented about 60 pounds of mercury each year** from entering landfills, incinerators, and the environment since the passage of the *Mercury Chemical Action Plan* in 2003. Cumulative mercury reduction for 2003 to 2005 is estimated 150 to 200 pounds, though uncertainties associated with both the number of lamps recycled and the mercury content of lamps impede exact accounting of mercury reductions.

2.2 Estimated Lamp Recycling in Washington

This section discusses the methods and findings for estimating the following quantities and rates related to fluorescent lamps:

- Quantities of mercury-added lamps recycled annually in Washington State;

- Quantities of fluorescent lamps sold each year in Washington State;

- Typical lifespans for fluorescent lamps and the quantities of lamps reaching their end-of-life each year in Washington; and

- Washington's recycling rate for fluorescent lamps.

2.2.1 Reported Quantities Recycled

Both King County and the Department of Ecology have conducted surveys to gather statewide lamp recycling data. Data from both agencies yield similar estimates in the ballpark of **2½ million lamps recycled annually from Washington State**; the King County estimate is for 2005, and the Ecology figure is for 2004. The surveys have several data gaps and inconsistencies that hinder comparison of the results, however, and may result in underestimation of the total amounts recycled. The following section presents more details on the existing data, and Chapter 3 makes recommendations for improving future data collection on recycling rate calculations.

King County Recycling Data

King County, Washington, has collected data from lamp recyclers for several years in order to track its own recycling rate. Under a recent agreement between King County and the Department of Ecology, the county assented to collect data from lamp recyclers for all of Washington State, in addition to lamp recycling figures for King County.

In 2006, King County contacted regional and national lamp recycling companies that serve the Pacific Northwest region, including Washington State, to obtain their statewide lamp recycling data for the 2005 calendar year. From the survey responses, King County calculated that six companies recycled 2.4 to 2.6 million lamps, primarily four-foot tubes, from Washington State in 2005. The seven lamp recyclers included in King County's lamp research are listed below. One company did not report for 2005, so its 2004 estimate was included in the higher estimate reported above. The data reported are not consistent across lamp recyclers; for example, one

recycler may be able to supply extensive tables of detailed data, while another provides a ballpark estimate over the telephone.

1. **EcoLights Northwest**, a local company headquartered in Seattle (www.ecolights.com);

2. **Veolia Environmental Services**, an international company, with Washington operations located in Kent and Vancouver; many of its North American operations were formerly known as **Onyx** until 2006, and they are sometimes still referenced by that name (www.veoliaes.com);[12]

3. **Earth Protection Services, Inc. (EPSI)**, a national company headquartered in Arizona, with its nearest consolidation facility in Oregon (www.earthpro.com);

4. **Environmental Protective Services (EPS)**, a regional company with its headquarters and a recycling facility both located near Portland, Oregon (www.enviroprotective.com);

5. **AERC**, a national company with its nearest location in northern California (www.aercrecycling.com);

6. **Mercury Technologies, Inc.**, headquartered in Minnesota (www.mercurytechnologies-mn.com); and

7. **Mercury Waste Solutions, Inc. (MWSI)**, with operations in Minnesota and a retort facility in Wisconsin (www.mwsi.com); MWSI was recently acquired by Waste Management, Inc.

Department of Ecology Recycling Data

The Department of Ecology's data were gathered as part of the Solid Waste Program's annual survey of recycling companies in Washington. Ecology's survey estimated that 748 tons of fluorescent lamps were recycled by Washington recyclers from in-state generators in 2004.[13] This weight translates to roughly 2½ million four-foot tube equivalents, mostly from two major lamp recyclers, EcoLights and Veolia/Onyx, the only two companies with a physical presence in Washington. In separate, informal phone contacts with Ecology, three lamp recyclers (EcoLights, EPSI, and Veolia/Onyx) reported estimates that totaled roughly 3 million lamps recycled from Washington in 2004, though one recycler later acknowledged a computer error that may have made its reported figure too high.[14]

Recycling Rate Summary

Based on data collected by King County and Ecology, fluorescent lamp recycling in Washington State is estimated at about 2½ million lamps. Because both surveys experienced significant non-reporting (of specific lamp data from reporting companies or from entire companies), we expect that this estimate is conservative and that the actual quantities recycled may be closer to 3 million lamps. The similarity of the two estimates lends confidence, however. For future improvement, we recommend in Chapter 3 a modified survey approach for more accurately estimating the quantity of lamps recycled in Washington State.

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[12] Veolia Environmental Services, "Onyx Is Now Veolia Environmental Services," July 7, 2006.

[13] Washington State Department of Ecology, Annual Solid Waste Recyclers' Survey for 2004, data compiled by Gretchen Newman. Imports from outside of Washington State were excluded from this total.

[14] Personal communication with Rob Rieck and Miles Kuntz, Department of Ecology. One of these lamp recyclers later revised its figures downward due to a computer error, though the original figures were not available for comparison purposes.

2.2.2 Estimated Lamp Generation

The recycling rate of any waste product is commonly defined as the quantity of product recycled divided by the quantity of product generated. In most cases, *generated* is defined as the quantity of the product reaching the end of its useful life and therefore ready to be disposed, recycled, or (in some cases) stored or stockpiled.

To calculate the annual recycling rate for fluorescent lamps in Washington State, one must therefore tabulate or estimate the quantity of lamps recycled (see section 2.2.1) and the quantity of lamps generated, or lamps that burn out, break, or are otherwise no longer used. A common method for estimating the quantity of waste lamps generated is to extrapolate the number of lamps that burn out in a given year based on the number of lamps sold in a prior year and their estimated burnout rate based on rated lifespan and typical usage. The Association of Lighting and Mercury Recyclers (ALMR), the Northwest Energy Efficiency Alliance (NEEA), and others have used this method.

ALMR has used national sales and import data to estimate generation figures. Their generation estimates are more available and current than the sales data. ALMR's figures allow direct application of the generation estimates, rather than deriving them from sales data.

Lamp Sales Data

National sales data. Since the Census Bureau stopped tracking lamp sales back in the early 1990s, national data on fluorescent lamp sales have relied on private data sources. Although it is possible to purchase some sales data, these data may not include important sales channels, such as Wal-Mart and Home Depot, wholesalers and distributors, and direct purchases by major relampers or property managers; regional lamp distribution systems also hinder state-level tracking. Private market research data more commonly focused on light fixtures and lamp ballasts, rather than the lamps (bulbs) themselves. In the past, the National Electrical Manufacturers Association (NEMA) has proven a better source for compiled sales data. Looking back to when the lamps recycled in 2004-2005 were likely purchased, the literature shows estimates of 500 to 600 million tubes and 50 to 85 million compact fluorescents in annual U.S. sales. CFL sales have risen significantly in recent years, though they represent a smaller share of the marketplace, while tube sales have generally increased more slowly. Combined figures of 550 to 685 million lamps correspond with estimates of production and generation cited elsewhere. Demand for fluorescent lamps is projected to continue growing about 2 percent annually for the next several years.[15]

Washington sales estimates. Estimates of lamp sales in Washington can be derived by scaling national data by Washington's share of total U.S. employment (2.17 percent) and households (2.15 percent). This approach yields an annual estimate of 11 to 13 million tubes and 1 to 2 million CFLs sold in Washington. Our recommended method uses employment figures to scale overall lamps and tube sales to Washington because the large majority of fluorescent tubes sold each year are sold into business and industry. We recommend using household data to scale the quantities for compact fluorescents, though the practical difference between the two scaling factors is negligible. For CFLs, the Northwest Energy Efficiency Alliance (NEEA) has both measured and estimated sales for the Pacific Northwest (Idaho, Montana, Oregon, and Washington). NEEA typically reports sales for the region as a whole but did quantify sales by state in 2001, with Washington accounting for 56% of non-coupon CFL sales (i.e., purchases that were not sponsored or subsidized by a utility or governmental jurisdiction). For 2005, NEEA estimates that 6.6 million CFLs were sold in the Pacific Northwest, so Washington's share is estimated at 3.7 million, a significant rise from previous years.

[15] Freedonia Group, *Lamps to 2009*, January 1, 2006.

Obtaining Washington-specific sales figures is problematic, except by extrapolating from national data. More recent estimates of waste lamps *generated* are available from ALMR and NEEA. Consequently, the generation data from ALMR described below are used in this report to estimate Washington's recycling rate.

Typical Lamp Lifespan

The lifespan of fluorescent lamps varies by lamp type, year of manufacture, use pattern, and individual lamp. Typical rated lifespans for four-foot tubes are commonly around 20,000 hours for both T8s and T12s, though modern T8s and T5s may have longer lifespans than T12s. Longer lamps such as eight-foot tubes usually have a similar or shorter lifespan. CFLs are often rated for a 10,000-hour life.[16]

However, translating rated life from rated hours to estimate actual years between purchase and disposal is not straightforward, as estimates must account for breakage, usage patterns, and early burnout. The U.S. Environmental Protection Agency reports that fluorescent lamp lifetimes range from 3 to 6 years and uses the average of 4 years, which includes bulbs that break before they burn out.[17] Although this four-year lifespan is commonly used, the lighting manufacturers prefer to use a 5-year estimate. Given that facilities conducting group relamping are likely to replace their fluorescent tubes more frequently and to help account for breakage that occurs with real-world use, we recommend using the 4-year figure, as discussed further in Chapter 3.

End-of-life Lamp Generation

Cascadia has found no existing estimates *that are based on Washington-specific data, rather than extrapolated from national information sources*, for the *total* number of mercury lamps that reach end-of-life annually in Washington State. Washington-specific estimates from NEEA exist only for CFLs. Commonly accepted estimates for the total number of fluorescent lamps that reach end-of-life each year in the United States range from 665 to 680 million lamps for 2001 through 2006.[18] ALMR conducts an annual survey of its approximately 25 member recyclers, supplemented by data from NEMA and the U.S. Department of Commerce, to estimate lamps recycled annually. ALMR estimated that 670 million lamps reached end-of-life in the U.S. in 2003. If this estimate is scaled by Washington's share of the U.S. employment (2.17%), then roughly 14½ million lamps reach end-of-life in the state annually. Since the ALMR figures are approximate, we recommend using the rounded figure of 14 million lamps as the appropriate estimate of Washington's annual lamp generation. Applying the rule of thumb that roughly 2.2 lamps reach end-of-life annually per person yields a similar estimate of 14 million lamps in Washington.[19] About 80%, or 11 million, are estimated to come from commercial, industrial, and institutional users, while the residential sector accounts for the remaining 20%, or 3 million.

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[16] Key data sources on the lifespan of fluorescent lamps include the *U.S. Lighting Market Characterization Study* (2002); *U.S. Lighting Market Sourcebook* (1993); U.S. Environmental Protection Agency (1999); and manufacturer data.

[17] U.S. Environmental Protection Agency, *Modification of the Hazardous Waste Program: Hazardous Waste Lamps – Final Economic Assessment*, March 11, 1999, E-5.

[18] National lamp disposal estimates have been made by the Association of Lighting and Mercury Recyclers (ALMR) (2004, 2006), the National Electrical Manufacturers Association (NEMA) (2000), the *Lighting Market Characterization Study* (LMC) (2002), and the U.S. Environmental Protection Agency (1997). We compared various figures and recommend using the data from the Association of Lighting and Mercury Recyclers for 2001-2006.

[19] U.S. Environmental Protection Agency, *Mercury Emission from the Disposal of Fluorescent Lamps: Final* Report, June 30, 1997, 2-21. Based on the 2006 population estimate of 6,375,600 residents in Washington (OFM).

These data are estimated, and Chapter 3 presents options for improving the underlying information and calculations.

2.2.3 Estimated Recycling Rate

Dividing the quantity of lamps recycled by the quantity of lamps generated yields an estimated recycling rate. King County's survey estimates that about 2.6 million lamps from Washington State were recycled in 2005 by seven major lamp recyclers operating in the region.[20] That estimate results in roughly a 19% recycling rate of a total of 14 million lamps that reached end-of-life in Washington State.[21] (In comparison, King County estimated its own lamp recycling rate at 37%, a reflection of the significant resources and efforts that the county has directed toward lamp recycling in recent years.[22]) The Department of Ecology estimated a recycling rate of 28% based on 748 tons of fluorescent lamps recycled by Washington recyclers from in-state generators in 2004. Waste characterization estimates for the state were used to estimate that 1,970 tons of fluorescent lamps were disposed in 2004, or 0.04% of the municipal solid waste stream.[23]

Waste composition studies are a valuable tool for understanding and managing solid waste flows. We must caution, however, against the application of these data for estimating recycling rates of physically small and infrequently occurring items such as fluorescent lamps. The estimate of 1,970 tons of fluorescent lamps disposed is a highly uncertain estimate for two primary reasons. First, the 2003 waste study draws on multiple county-level waste composition studies extrapolated to the entire state, rather than a single study with a consistent methodology and waste definitions. The 11 county studies show a range of incidence for fluorescent tubes from 0.0% to 0.08%. For example, using the higher end of this range would double lamp disposal to nearly 4,000 tons and lower the estimated recycling rate from 28% to 16%.[24]

Second, waste composition studies have additional uncertainties because they are based on a finite number of samples of a jurisdiction's refuse. Uncertainties in waste estimates can be as large as the estimate itself, especially for products that comprise an extremely small percentage of the waste stream. Therefore, even if an individual county's estimate of fluorescent tube incidence was 0.04%, the statistical uncertainty in that estimate could be high enough that the true incidence could reasonably be 0.00%, 0.08%, or even higher. Additionally, the waste composition report explains that the "fluorescent bulbs" estimate for five of the counties (King, Snohomish, Clark, Thurston, and Whitman, which together represent half of the state's population) was extracted from the estimates of "remainder/composite glass" based on Clallam County's relative amounts of these materials; such extrapolation can propagate uncertainty and widen error ranges. The accurate detection of low frequency, physically small (and breakable) materials, such as lamps, typically requires a large sample size and a research method designed specifically to track such items.

To estimate the recycling rate from the Ecology data, we recommend converting the tons into lamp units and using the 14 million lamp denominator derived from national lamp generation

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[20] This recycling rate includes a 2004 estimate for one firm that did not report in 2005.

[21] This recycling rate includes a 2004 estimate for one firm that did not report in 2005; omitting that firm reduces the recycling rate to 17%.

[22] King County lamp recycling data, compiled by Susan McDonald, Gail Savina, and Alexandra Thompson of the King County Solid Waste Division and Local Hazardous Waste Management Program in King County.

[23] Washington State Department of Ecology, *Waste Composition Analysis for the State of Washington: Final Report*, prepared by Green Solutions, June 2003.

[24] Sample alternate recycling rate calculation: (748 tons recycled) / (total generation = 4,688 tons = 748 tons recycled + 3,940 tons disposed if lamps are 0.08% of Washington's waste stream) = 16%.

figures. The 748 tons translate into approximately 2.5 million four-foot tube equivalents, and thus an estimated recycling rate of about 18%. Based on these figures and the King County data, we expect that Washington's state lamp recycling rate for 2004/2005 is in the ballpark of 20% and comparable to ALMR's national estimate of 23% for 2003.[25] ALMR has estimated the commercial recycling rate at about 29% and the residential rate at only about 2%.

We believe this is a conservative (low-end) estimate of Washington's lamp recycling rate. Some lamp data are missing from either or both the King County and Ecology data sources, including some lamp types, individual records, and some entire companies. For example, the two recycling companies that are included in both the King County and Ecology surveys appeared to report lower quantities of lamps to King County than to Ecology; however, direct comparison is complicated by the use of different units for reporting (counts vs. weights) and data confidentiality. Tracking by many lamp recyclers could also be improved. Several national recyclers were not included in either survey, and quantities from mail-back box programs (besides those of the recyclers surveyed) for fluorescent recycling that handle lamps from Washington were also untracked. Accordingly, we anticipate that the likely lamp recycling rate for Washington State is in the low 20s, near 20%, similar to the national rate. For the recycling rate to exceed 25%, more than 1 million additional lamps would need to be added to the recycling totals, nearly a 50% increase from the quantities that are currently reported to Ecology and King County as recycled.[26]

2.3 Cumulative Mercury Reduction from Lamp Recycling

This section estimates the quantity of mercury kept out of landfills because of lamp recycling in 2005, the year for which the most recent estimates of the quantity of lamps recycled in Washington are available. It also attempts to estimate the additional mercury reduction associated with lamp recycling since 2003, the year that Washington's *Mercury Chemical Action Plan* was released.

In 2003, the Mercury CAP set a state goal of virtually eliminating the use and release of mercury in Washington. In response, Ecology set a near term goal of increasing the lamp recycling rate from approximately 25% to 40% in Washington. For the coming years, Ecology is seeking to achieve an 80% recycling rate by 2015.

Mercury reduction is estimated by multiplying the number of lamps recycled by the mercury content of those lamps, ideally by type of lamp. Due to data limitations in both the quantity of lamps recycled by type and the quantity of mercury each type of lamp contains, the estimate will be rough.

2.3.1 Average Mercury Content in Lamps

The mercury content of fluorescent lamps varies by lamp type, model, manufacturer, and year of manufacture, making an accurate estimate of the amount of mercury collected by recycling or disposed in landfills difficult to calculate. Further complicating the problem is that there are at least two ways to measure and report mercury content: total content and content as measured

[25] Association of Lighting and Mercury Recyclers, *National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.*, Calistoga, Calif., November 2004, http://www.lamprecycle.org. ALMR also estimated that the government and business sector recycled 29% of lamps, while households recycled 2%.

[26] These estimates assume stable or increasing generation figures, a reasonable assumption given the relatively flat trend in these data for recent years and the fact that quantities from imports and non-reporting companies may be underestimated.

by the Toxicity Characteristic Leaching Procedure (TCLP), which measures the amount of mercury that leaches out of the bulbs under specific circumstances, intended to simulate how waste might react in a municipal solid waste landfill, rather than the total mercury content. To pass the TCLP test, the measurement must remain below 0.2 milligrams of mercury per liter. Because the test involves leaching, rather than total mercury content, additives that reduce the solubility of mercury in the testing procedure can enable lamps with higher mercury content to pass the test.

For the purposes of this project, we are most interested in the total mercury content of fluorescent lamps, not just the amount measured in TCLP testing. The State of California uses an alternate test known as Total Threshold Limit Concentration (TTLC), which measures total mercury content rather than TCLP leaching; the TTLC limit of 20 parts per million is equivalent to 3.8 mg of mercury in a four-foot T8 lamp.

This section of the report provides information on typical mercury content for fluorescent tubes, compact fluorescent lamps, and other mercury-containing lamps. Cascadia found mercury-content estimates from several sources with varying degrees of reliability. The mercury content of fluorescent lamps has decreased significantly over the past decades and may be continuing to decline. The difference in mercury content of lamps of different ages may outweigh other variations in the estimates; for example, manufacturers cite a 75% decrease in mercury content of average four-foot tubes from 1985 to 1999.[27] Some of the data were collected from primary sources in which the authors actually measured the mercury content (e.g., Maine), while others are from secondary sources that rely on estimates reported by manufacturers (e.g., USEPA and NEWMOA/IMERC) or compilations of existing published sources (e.g., Lane County, Oregon; Lighting Design Lab).[28]

Different manufacturers typically use different quantities of mercury in their lamps. For example, Philips pursued a strategy to make all of its standard lamps TCLP- and TTLC-compliant, while Sylvania and GE use additives in some of their lamps to make them TCLP-compliant. In 2002, Philips' standard four-foot T8 tubes (Alto lamps) contained about half as much mercury as their counterparts from Sylvania (Ecologic) and GE (Ecolux). Neither Philips nor GE manufactured a non-compliant four-foot T8, though Sylvania did.[29] Both Philips and Osram Sylvania offer online calculators to help meet LEED (Leadership in Energy and Environmental Design) standards for mercury reduction in existing buildings. Some claims have been made that lamps with lower mercury content burn out faster, and thus offset any mercury reductions because more lamps are needed. These claims are unsubstantiated, however; in fact, information collected for Washington's current Environmentally Preferable Purchasing effort indicate that some low-mercury lamps have longer rated life than their standard counterparts.

The data from Maine are based on independently measured data; however, the estimates show a wide range of values and are limited to specific lamp types. Because it draws on a larger, more current data set, we prefer the mercury content estimates that NEWMOA compiled from the IMERC mercury product database, which reflects lamp sales by NEMA member companies for 2004 and contains records for more than 650 separate lamp products. The data reflect actual sales, and thus they do not need to be adjusted by an estimate of the mix of lamp types (e.g.,

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[27] NEMA, *Fluorescent Lamps and the Environment: Mercury Use, Environmental Benefits, Disposal Requirements*, January 2001, 9.

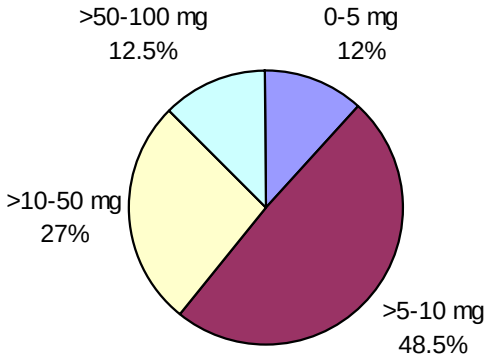
[28] Maine Department of Environmental Protection, *Maine Fluorescent Lamp Study Final Report,* December 2001.; U.S. Environmental Protection Agency, *Mercury Emissions from the Disposal of Fluorescent Lamps*, June 30, 1997; NEWMOA, *Mercury Use in Lighting*, 2004 (http://www.newmoa.org/prevention/mercury/imerc/FactSheets/lighting.cfm); Lane County Lamp Recycling Coalition, *Retail-based Pilot Program Final Report*, Lane County, Oregon, March 10, 2006;

[29] INFORM, *Purchasing for Pollution Prevention: Fact Sheet on Mercury in Fluorescent Lamps*, 2006.

T12, T8) sold. Because these data are reported in ranges (e.g., less than 5 mg, 5-10 mg), we lack sufficient information to calculate an accurate average.

Fluorescent tubes. Figure 1 shows the mercury content of typical fluorescent tubes as reportedly sold by NEMA member companies in 2004 and reported to the IMERC database.[30] Performing an extremely conservative estimate using the lower bound of each range (e.g., 0 for the less than 5 mg category), however, yields an estimate of 11.4 mg per average fluorescent tube. Because no zero mercury fluorescent tubes are currently available in the marketplace, however, we know that the true average lies higher. This figure is comparable to NEMA's industry average estimate of 11.6 mg per four-foot tube in 1999, the figure we will use as the basis of our mercury calculations.[31] Dividing the total mercury content of 9.4 tons in all lamps sold in 2001, as reported to IMERC, by estimated lamp sales in the range 600 to 670 million yields a slightly higher but generally comparable average of 13 to 14 mg of mercury per lamp.

Figure 1. Mercury Use in Fluorescent Tubes Sold by NEMA Companies in 2004[32]



As users switch from higher-mercury content T12 tubes to more energy-efficient and lower-mercury T8s (and eventually T5s), we anticipate that mercury content in lamps generated will decrease over time. T8s have composed the majority of the market share for new lamps in the Northwest since the late 1990s; T5s are small but growing, and T12s are being phased out in energy retrofits.[33] The mercury contained in the product itself represents only a portion of the total mercury used and emitted in mining and manufacturing lamps. Accordingly, future decreases in lamp mercury content of lamps should correlate with additional reductions in mercury generation from upstream parts of the lamp production process. Industry members and fluorescent lamp proponents also highlight the lamp lifecycle and actual usage to show the high energy-efficiency benefits of mercury use in fluorescent lamps. Mercury emissions from power generation associated with less efficient incandescent lamps can far outweigh the mercury content of fluorescents. Mercury emissions from electricity generation are significant concern at coal-fired power plants, though these represent only a minor portion of Washington State's energy portfolio.

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[30] NEWMOA, *IMERC Database*,

[31] NEMA, *Fluorescent Lamps and the Environment: Mercury Use, Environmental Benefits, Disposal Requirements*, January 2001, 9; NEMA, *Environmental Impact Analysis: Spent Mercury-containing Lamps*, January 2000 (4th edition), 3.

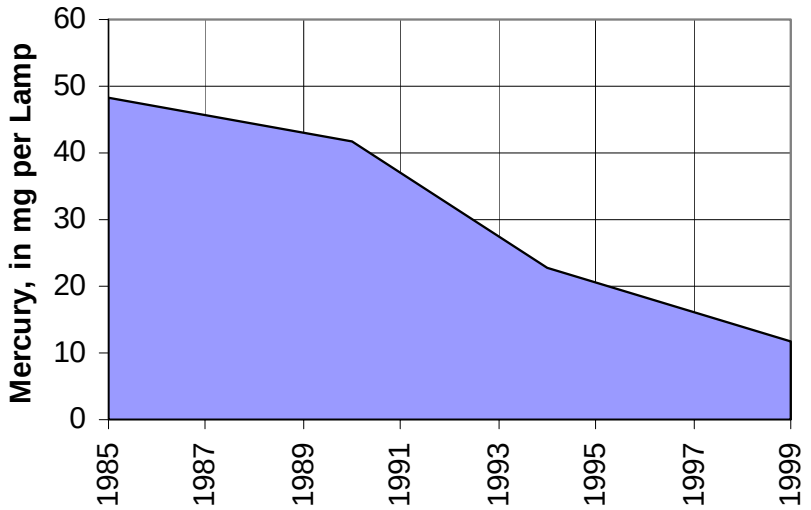
[32] NEWMOA/IMERC, *Mercury Use in Lighting*, May 2006.

[33] Northwest Energy Efficiency Alliance, *Commercial and Industrial Lighting Study, Volume 1*, prepared by Xenergy, Inc., report #00-072, December 2000, E-3.

Usage of green-cap lamps, or those that pass the Toxicity Characteristic Leaching Procedure (TCLP) test, should also result in reduced mercury levels. Please note that in its independent testing, however, the State of Maine could not differentiate TCLP-compliant lamps from "standard" lamps based on their tested mercury content. Accordingly, the state included TCLP-compliant lamps in its disposal ban, as several other states have also done.

Other lamp types. CFLs are the type of fluorescent with the lowest mercury content, with 66% of lamps containing less than 5 mg of mercury according to manufacturer data compiled in the IMERC database. Mercury content in high intensity discharge lamps varies greatly by wattage, and HID lamps generally contain more mercury per lamp than other lamp types. Among HIDs, metal halide lamps contain the most mercury, typically between 50 and 1,000 mg of mercury. Mercury short arc and mercury capillary lamps also contain high mercury levels, starting with at least 100 mg of mercury. Because we lack reliable data on lamp generation by type, we will apply the industry figures on mercury content for average tubes to our recycling estimates.

Table 1. Industry Average Mercury Content per Four-foot Fluorescent Tube, 1985-1999[34]
(mg per lamp)



2.3.2 Estimated Mercury Reduction from Recycling

Estimates of cumulative mercury reduction since the passage of the *Mercury Chemical Action Plan* are complicated by uncertainties associated with both the recycling data and the estimates of mercury content. Multiplying the number of lamps of various types recycled in Washington by their estimated mercury content would yield estimates of the total mercury content diverted through recycling. Because mercury content varies by lamp type (including length, diameter, model, manufacturer, and age), and estimates of recycling by lamp type are often missing or less reliable than figures for total lamp quantities, the data sets for both recycling and mercury content contain significant uncertainty. Applying the industry average mercury content of 11.6 mg per four-foot tube to the estimated 2½ million lamps recycled in Washington in 2004/2005 yields an estimated annual savings of more than 60 pounds of mercury kept out of landfills, incinerators,

[34] NEMA, *Fluorescent Lamps and the Environment: Mercury Use, Environmental Benefits, Disposal Requirements*, January 2001, 9; NEMA, *Environmental Impact Analysis: Spent Mercury-containing Lamps*, January 2000 (4th edition), 3.

and the environment. The remaining 12 million lamps that are disposed, primarily in landfills, are estimated to contain about 300 pounds of mercury.

Better tracking of the models and sizes of lamps recycled could help yield improved estimates of the quantity of mercury diverted. For example, variations in the quantities and recycling rates for the lamps with the highest average mercury content, like HIDs, have a significant impact on the results. Lack of comparable data and companies reporting from year to year hinders our ability to differentiate significant changes in recycling levels for 2003, 2004, and 2005. The Ecology data collected from recyclers show that quantities of lamps recycled increased by about 10% from 2003 to 2005. Based on the 2004/2005 recycling figure of 2½ million lamps, we roughly estimate cumulative mercury reduction from lamp recycling in Washington in the range of 150 to 200 pounds across the three-year period. Given current figures for lamp generation and mercury, achieving the 80% recycling rate goal would keep more than 280 pounds of mercury out of the waste stream and the environment each year. The recommended methodology for estimating the state's lamp recycling rate, outlined in Chapter 3, would also support better estimates of annual and cumulative mercury reductions.

2.4 Estimated Lamp Generation and Recycling by Sector

As mentioned previously, end-of-life lamp generation figures based on Washington-specific sales data are not available, though some CFL sales have been tracked in the Pacific Northwest region. Scaling national data to Washington based on the state's share of U.S. employment yielded an estimate of roughly 14 million lamps reaching end-of-life in the state annually.

The lack of Washington-specific lamp sales data also complicates efforts to estimate lamp generation and recycling for each sector of the economy. Scaling national estimates to Washington is again a reasonable approach. NEMA and ALMR have estimated that non-residential users (business, government, and institutions) account for about 80% of lamps used and disposed or recycled, but more detailed sector breakdowns were not identified for lamp *generation*. Extensive national data do exist regarding lamp *use* in different sectors of the economy, however, and this information can form a basis for estimating relative lamp generation by sector. In addition, some data and previous estimates do exist at the state level regarding lamp generation from specific sectors. Relevant Washington-specific data sources include the State's Green Building Advisor, State procurement data, and information gleaned from stakeholder interviews and surveys as part of this project.

Ideally, all lamp recyclers would track and report their quantities recycled by sector of origin, but such a change is likely optimistic, given the current tracking practices and capabilities of some lamp recyclers.

2.4.1 Overall Sector Breakdown

The distribution of fluorescent lamps in the commercial, industrial, and residential sectors has been thoroughly documented in the U.S. Department of Energy's 2002 *Lighting Market Characterization* study. This study estimated that 663 million fluorescent tubes were in use in the residential sector, 1.5 billion in the commercial sector, and 320 million in the industrial sector. However, this distribution cannot be applied directly to calculating lamp generation because typical lamp usage and lifespan vary across the three sectors.[35]

[35] U.S. Department of Energy, *U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and Energy Consumption Estimate*, prepared by Navigant Consulting, Inc., September 2002.

Unfortunately, no reliable sector-specific estimates of lamp lifespan could be identified. As mentioned previously, we recommend using 4 years as the average lifespan across all sectors and lamp types. The actual lifespan in residences is expected to be longer than 4 years (due to less intensive use) while the expected lifespan in industrial facilities may be shorter (due to more intensive use), particularly in 24-hour-burn facilities where the lights are always on. Accordingly, we estimate the commercial and industrial lifespan to be 4 and 3 years, respectively, based on average daily use of 9.7 hours for commercial and 13.4 hours for industrial;[36] average rated life of 20,000 hours; and group relamping in these facilities slated to occur at an average of 75% of rated life.[37] For the residential sector, we use a lifespan estimate of 6 years, in accordance with the upper bound of the EPA's 1999 estimated range of 3 to 6 years.

Applying the estimated lifespan of 6 years for residential use, 4 years for commercial use, and 3 years for industrial use to the *Lighting Market Characterization's* estimates of current lamps in use yields a breakdown of relative lamp generation by sector of roughly 60% commercial, 20% industrial, and 20% residential. Most government and institutional lamp users, like schools, would be considered part of the commercial category in this classification.

Several national data sources can help with estimates of the distribution of lamp use and generation among the commercial, industrial, and residential sectors. The estimated sector breakdown derived above is generally comparable with national estimates from ALMR and NEMA. In 2004, ALMR's recycling rate study estimated that approximately 22% of lamps generated were from the residential sector, and 78% came from the combined commercial and industrial sectors.[38] Similarly, NEMA estimates that 15% of lamps are sold to the residential sector, 5% are sold on the retail market to businesses, and 80% are sold on the wholesale market, mostly to commercial, industrial, and institutional users but likely also for some residential installation.

Applying the 60% commercial, 20% industrial, and 20% residential generation estimates to Washington's estimated 14 million lamps yields the following estimates:

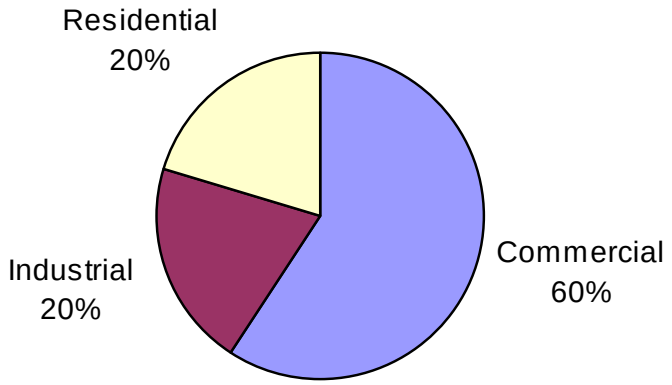
- The commercial sector (including government and institutions) generates approximately 8 million lamps each year in Washington;
- The industrial sector generates about 3 million lamps each year in Washington; and
- The residential sector generates approximately 3 million lamps each year in Washington.

[36] Daily usage estimates from the Department of Energy *Lighting Market Characterization* study, 2002.

[37] Sample calculation for commercial sector: (20,000-hour rated life x 75% relamping multiplier) / (9.7 hours per day x 365 days per year) = 4.2 years, rounded to 4 years for report.

[38] Association of Lighting and Mercury Recyclers, *National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.*, Calistoga, Calif., November 2004, http://www.lamprecycle.org.

Figure 2. Estimated Overall Sector Breakdown of Washington's Used Lamp Generation



These estimates assume that the industrial and commercial makeup of Washington is similar to that of the U.S., an assumption that may not be completely accurate. Nevertheless, the estimates above are reasonable and offer the best currently available estimates for lamp generation in Washington.

2.4.2 Commercial

Data from the *Lighting Market Characterization* study can also help estimate lamp generation from more specific types of commercial establishments. In particular, the study examined 20 subsectors within the commercial sector. By applying the relative electricity use for fluorescent and HID lamps from each of these sectors to the overall commercial sector estimate of 8 million lamps, we can produce the estimates shown in Table 2. Keep in mind that these estimates have significant uncertainty, and they assume that the relative makeup of commercial establishments in Washington is similar to the United States as a whole.

Retailers. Cascadia surveyed 10 retail/grocery businesses, in addition to the BOMA members who manage retail/grocery properties. Of these respondents, only three reported that they currently recycle lamps.

Hospitals. Commercial subsector estimates for inpatient health care facilities suggest that hospitals in Washington generate approximately 400,000 lamps each year. Cascadia surveyed 38 hospitals who participate in the P2 program or are members of the Washington State Hospital Association. Of these hospitals, two-thirds reported recycling at least some of their lamps, though the reported quantities recycled ranged as low as 10 to 30%.

Commercial property managers. Much of the commercial property is leased by businesses and managed by property managers rather than owned directly. Therefore, lamp replacement and recycling choices are made primarily by property managers. Cascadia surveyed 49 members of Washington's BOMA, the Building Owners and Managers Association. The property managers reported managing property primarily for offices, but also for some warehouses, retail/grocery, and manufacturing establishments. The majority of these respondents reported that they recycle fluorescent lamps.

Table 2. Estimated Annual Lamp Generation by Commercial Subsector

Commercial Subsector	Estimated Annual Lamp Generation	Percent
Vacant	300,000	3%
Office/professional	1,600,000	20%
Laboratory	100,000	1%
Warehouse (non-refrigerated)	1,000,000	13%
Food sales	200,000	3%
Public order/safety	100,000	1%
Health care (outpatient)	100,000	2%
Warehouse (refrigerated)	100,000	1%
Religious worship	200,000	2%
Public assembly	300,000	4%
Education	900,000	11%
Food service	200,000	3%
Health care (inpatient)	400,000	4%
Skilled nursing	100,000	1%
Hotel/motel/dorm	300,000	4%
Strip shopping	600,000	8%
Enclosed shopping center/mall	300,000	3%
Retail (excluding mall)	700,000	9%
Service (excluding food)	400,000	5%
Other	100,000	1%
Total Commercial in Washington	**8 million**	**100%**

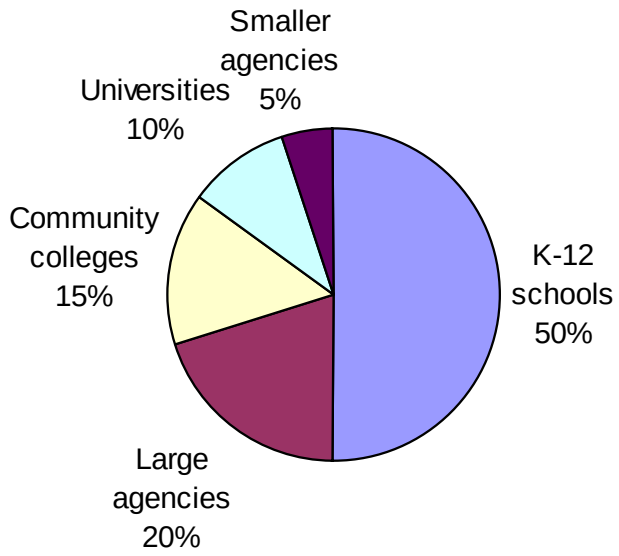
2.4.3 Industrial

An estimated 3 million fluorescent lamps are generated each year from Washington's industrial sector. Of the 123 businesses in the industrial sector that Cascadia surveyed, 70% reported that they recycle their fluorescent lamps, though not all businesses recycled all of their lamps. The survey data suggest that these businesses recycle, on average, about two-thirds of their lamps.[39] Note that the regulated hazardous waste generators surveyed may be more likely to recycle their mercury-added lamps than other businesses that are not already managing other regulated waste streams besides lamps.

2.4.4 State Government, Institutions, and K-12 Schools

For State government and institutions, we have several data sources. First, the State Green Building Advisor, Stuart Simpson, estimates that the State owns or leases 55 million square feet of building space for agencies and institutions. Assuming this space is illuminated to 1.6 watts per square foot with 40-watt fluorescent lamps, lighting that area requires approximately 2.2 million lamps. Assuming each lamp lasts 4 years, 550,000 lamps reach end-of-life annually. Simpson further breaks down this figure down among K-12 schools, large state agencies, smaller agencies, community colleges, and universities, as rounded to the nearest 5%. In addition, K-12 school districts in Washington add 60 million square feet, translating to an estimated 600,000 spent lamps per year.[40] Figure 3 shows the distribution of the approximately 1 million lamps estimated to be generated annually from Washington's government and schools.

Figure 3. Estimated Breakdown of Lamp Generation from Government and Schools



[39] Calculated using a weighted average and the midpoint of each reported recycling range.

[40] K-12 schools are discussed along with state governments and institutions because they purchase and recycle using the same state contract. Efforts to reach the Washington Association of Maintenance and Operations Administrators (WAMOA) and the Council of Educational Facility Planners (CEFPI) were not successful.

The State has contracts for purchasing and recycling lamps that can be used by state agencies, institutions, and other local governmental jurisdictions. In 2003, fluorescent lamps purchased under the State contract with Consolidated Electrical Distributors (CED), which carries the Osram Sylvania brand, totaled approximately 650,000 to 700,000 lamps.[41] In late 2006, Osram Sylvania and Veolia Environmental Services announced a partnership to promote lamp recycling through sales of Veolia's "RecyclePak" mail-back boxes alongside lamp sales from Sylvania. This partnership may provide an opportunity for increasing lamp recycling in conjunction with the State's current contract for the purchase of fluorescent lamps.[42] In the future, lamp recycling opportunities are expected to grow as other lamp manufacturers and recyclers follow suit with partnerships of their own.

In 2003, about 55,000 lamps were reportedly recycled through the State's separate contract with EcoLights Northwest for lamp *recycling*, for an estimated recycling rate of 8%. That figure nearly tripled to 160,000 lamps in the first three quarters of 2004; extrapolating these data for the rest of the year results in a public agency recycling rate of nearly 30%. Because the State has a convenience contract, state entities are not required to recycle with the designated contractor, EcoLights Northwest. Recycling may also occur through CED, the lamp distributor, which partners with EPSI for recycling. Grainger also offers mail-back boxes for recycling as part of its general contract with the state for miscellaneous supplies. Accordingly, the actual figures may be higher, though likely much improvement is needed to reach the Governor's lamp recycling goals.

Based on an informal survey that Ecology conducted with Sustainability Coordinators at 14 state agencies and 14 community and technical colleges, all but one institution recycles its lamps. The majority of respondents recycled their lamps through EcoLights and the State recycling contract. Two organizations reported that they recycled lamps through Consolidated Electrical Distributors (which partners with EPSI for lamp recycling services), holder of the state contract for lamp *purchases*. Three groups used other recyclers outside of either state contract. Improved reporting of quantities through the state contractors or via public agencies would enable more reliable tracking of state agency recycling rates and help measure progress toward the Governor's lamp recycling goals. In light of the currently reported recycling levels, state agencies likely still need significant progress in order to achieve the Governor's goal of recycling all of their fluorescent lamps.

2.4.5 Residential

An estimated 3 million lamps are generated each year from Washington's residential sector, as discussed above. This estimate is about the same as national estimates from ALMR applied to Washington's population. ALMR estimated that national generation of spent lamps from residences was 146 million lamps for 2006. Scaling ALMR estimates by Washington's household population yields an estimate of 3.1 million lamps reaching end-of-life for the residential sector in 2006. ALMR calculated a national recycling rate for the residential sector of approximately 2% of the total spent lamps from homes. Residential lamp recycling was not a focus of this current project, though recycling rates for the household sector could be estimated in the future using collection data from lamp recyclers as well as local government initiatives like the Take It Back Network.

[41] Two different figures were provided, depending on which types of lamps are included (Steve Krueger).

[42] Veolia Environmental Services and Osram Sylvania, "Veolia Environmental Services Launches Recycling Partnership with Osram Sylvania: Industry-first Business Association to Provide Environmentally Responsible Recycling Alternative," Denver, Colorado, November 15, 2006.

2.5 Data Summary and Future Enhancements

This chapter has reviewed data sources and other estimates in order to prepare calculations of fluorescent lamp recycling in Washington State, mercury reduction, and sector breakdowns of lamp generation and recycling. These data and estimates provide a useful starting point for Washington State's analysis of fluorescent lamp recycling. In the next chapter, we make recommendations and present a proposed methodology for future tracking of Washington's lamp recycling rate.

3 Recommended Methodology for Recycling Rate

The recycling rate of any waste product is commonly defined as the quantity of product recycled divided by the quantity of product generated. In most cases, *generated* is defined as the quantity of the product reaching the end of its useful life and therefore ready to be disposed, recycled, or (in some cases) stored or stockpiled.

To calculate the annual recycling rate for fluorescent lamps in Washington State, one must therefore tabulate or estimate the quantity of lamps recycled and the quantity of lamps generated – that is, lamps that burn out, break, or are otherwise no longer used, which are also known as "end-of-life" (EOL) lamps.

This section presents the consultant's recommendations for a standard methodology for determining the recycling rate for fluorescent lamps in Washington on an annual basis.

The methodology is presented in three parts below:

- *3.2 Estimating Quantities of Lamps Recycled* describes how to estimate the "numerator" of the recycling rate equation, or the number of lamps recycled;
- *3.3 Estimating End-of-life Lamps Generated from Sales Data* discusses methods for estimating the "denominator" for the recycling rate, or the total number of lamps "generated," meaning reaching their end of life; and
- *3.4 Tracking the Recycling Rate in Washington* discusses how to calculate the recycling rate for Washington State and track results over time.

First, we recommend that lamp data be tracked based on number of lamps rather than by weight of lamps. Although recycling rates for other products are often calculated based on weight, data for lamps are generally more available as counts of units rather than measured weight. In addition, using counts is more intuitively meaningful to the public and other stakeholders, who think about installing and removing lamps in numbers, or discrete individual units, rather than by weight. Volume- and weight-based recycling rates are equivalent as long as the reasonable assumption is made that the average weight of a lamp recycled is the same as the average weight of a lamp generated or disposed.

The recommended methodology assumes a continuation of the existing policy and regulatory framework, in which reporting from lamp recyclers and data inputs from manufacturers are voluntary, not mandated. Mandated tracking and reporting of lamp recycling as well as sales data would improve the accuracy of recycling rate calculations, though enacting such policies would require an investment of political capital. Policy options are discussed further in Chapter 5.

3.1 Key Findings on Recycling Rate Methodology

- **To estimate the recycling rate in Washington, better data must be collected** on the quantities of lamps recycled and quantities of end-of-life lamps generated.
- **Lamp data should be tracked based on number of lamps**, rather than by weight, for ease of data collection and relevance to stakeholders and the public.
- **Mandated tracking and reporting of recycling and sales data would improve the accuracy** of recycling rate calculations, though enacting such policies would likely be unpopular with members of the lamp recycling and manufacturing industries.

- **The recommended method to estimate recycling quantities is to administer a single annual survey to lamp recyclers** to tabulate the number of lamps recycled from Washington generators each year.

- **The recommended method involves scaling national data to Washington**, using appropriate metrics, to determine how many lamps will be generated in each year.

- **Three significant assumptions support the proposed methodology for estimating fluorescent tube generation** and could benefit from further investigation: (1) that national sales or generation data from NEMA or ALMR are accurate; (2) that Washington sales are proportionally similar to national sales; and (3) that bulb failure patterns can be reasonably modeled using a single lifespan metric.

- **Estimates of recycling, sales, and lifespan should be developed using identical methods in each year.** If Ecology chooses to make improvements to the methodology or data inputs, that methodological change must be applied to each year's calculations (including those in the past) for year-to-year comparisons to be valid.

3.2 Estimating Quantities of Lamps Recycled

Calculations of recycling rates for most products nearly always rely on data from recyclers regarding the quantity of products recycled. The common approach for fluorescent lamps is no different. In fact, both the Washington State Department of Ecology and King County (Washington) have both previously surveyed recyclers regarding quantities of fluorescent lamps recycled. Our recommended approach builds on these past efforts and attempts to standardize the methodology to facilitate replication from year to year.

We recommend that a single annual survey be administered to lamp recyclers (and, if necessary, lighting contractors and suppliers) to tabulate the number of lamps recycled from Washington generators each year.

Steps needed to design and implement the survey include the following.

1. **Define the survey population.** In 2005, the King County analysis of lamp recyclers identified seven major lamp recyclers operating in Washington. These companies should be surveyed each year. Additional lamp handling companies operating in Washington, such as Clean Harbors, PSC Environmental Services, and Safety Kleen, have been identified as intermediaries that send the lamps they collect to another company, such as EcoLights or Veolia, for recycling and management. Accordingly, they were not included in the data collection from recyclers. The Ecology survey currently includes only the recyclers with physical locations in Washington – currently, EcoLights and Veolia. It also includes companies and public entities that send their lamps to separate recyclers. The seven major recyclers from previous data collection efforts are as follows:

    - **EcoLights Northwest**, a local company headquartered in Seattle (www.ecolights.com);

    - **Veolia Environmental Services**, an international company, with Washington operations located in Kent and Vancouver; the North American operations were formerly known as **Onyx** and are sometimes still referenced by that name (www.veoliaes.com);

    - **Earth Protection Services, Inc. (EPSI)**, a national company headquartered in Arizona, with its nearest consolidation facility in Oregon (www.earthpro.com);

- **Environmental Protective Services (EPS)**, a regional company with its headquarters and a recycling facility in Oregon (www.enviroprotective.com);

- **AERC**, a national company with its nearest locations in California (www.aercrecycling.com);

- **Mercury Technologies, Inc.**, headquartered in Minnesota (www.mercurytechnologies-mn.com); and

- **Mercury Waste Solutions, Inc. (MWSI)**, with operations in Minnesota and a retort facility in Wisconsin (www.mwsi.com).

In addition, any new entries to the recycling marketplace should be surveyed, including any companies that replace lamps and ship them out-of-state without passing through one of the existing recyclers. Informal, initial interviews with recyclers in the field can help identify any new firms with significant market share. Note that in 2005, the top three lamp recyclers handled over 95% of lamps reported recycled from Washington generators, so primary attention should be paid to obtaining accurate estimates from these recyclers.

The Association of Lighting and Mercury Recyclers publishes a list of its members that would be a useful list to consider in expanding the survey recipients.[43] The list denotes their locations and whether they provide regional or national recycling services. All but two of the seven companies listed above are ALMR members. Additional companies providing national lamp recycling services to consider for addition to future surveys include HTR-GROUP in Missouri (www.htr-group.com); Lighting Resources, Inc., headquartered in California (www.lightingresourcesinc.com); and Green Lights Recycling, Inc., headquartered in Minnesota (www.greenlightsrecycling.com). The Lamp Section of the National Electrical Manufacturers Association (NEMA) lists additional lamp recyclers on its LampRecycle.org website, but upon review, the ALMR membership list appears to be the most useful starting point for expansion of the survey recipients.[44]

Tracking of "box" programs, in which participants send their spent lamps to recyclers in prepaid mailing packages, can be problematic. Some of the companies listed above offer box programs, which should be included in their totals. Mail-back boxes are also provided through other waste companies and through industrial supply companies like Grainger; these supply companies in turn typically partner with one of the major national recyclers, such as Veolia or EPSI, to provide the recycling service. If reporting companies cannot track the *returned* boxes and lamps received by state of origin, they may be able to provide data on box *sales* instead. Due to their relatively high per-lamp costs, box programs are generally most viable for smaller generators of lamps, particularly those in remote locations. Although tracking of lamp recycling through box programs may remain incomplete by necessity, we expect that this lamp recycling stream will remain a relatively small contribution to Washington's total lamp recycling.

[43] Association of Lighting and Mercury Recyclers (ALMR), Membership Roster, www.almr.org/Membership_Roster.pdf.

[44] LampRecycle.org, National Electrical Manufacturers Association, Lamp Section, "List of Companies Claiming to Recycle or Handle Spent Mercury Containing Lamps (last update May 2006)," www.nema.org/lamprecycle/recyclers.html#Other.

2. **Create survey instrument.** We recommend asking recyclers to report the number of lamps recycled from Washington sources in each given year under several categories. Recommended categories include those in the following list but could be revised based on feedback from recyclers. Most recyclers do not currently track tubes by diameter (e.g., T12, T8, T5), though such identification of such types would be useful to obtain, as it correlates with mercury quantity and energy efficiency, if recyclers can provide more detailed tracking in the future.

Table 3. Sample Categories for Collecting Lamp Recycling Data

Linear Fluorescent Tubes	Other Lamp Types
▪ Less than 4 feet	▪ U-shaped
▪ 4 feet	▪ Circular
▪ 5-7 feet	▪ Compact fluorescent (CFL)
▪ 8 feet	▪ High intensity discharge (HID)
▪ Other linear tubes	▪ Other mercury-added lamps

Acquiring data in these categories can help track changes in the lamp marketplace over time, improve estimates of mercury reduction (since the mercury content of different lamps varies with shape and sizes), and possibly allow for calculation of recycling rates in each of these lamp categories. In addition, experience in King County indicates that asking recyclers to report in individual categories encourages accurate record-keeping and reporting by the recyclers. Some recyclers may have difficulty identifying the state of origin (e.g., Washington) of their incoming lamps. In these cases, the survey will need to incorporate their best estimates of market share, but government analysts can work with recyclers to encourage them and offer incentives to improve their tracking systems in the future.

In addition to the counts of lamps recycled, the survey also provides an opportunity to gather qualitative information about lamp use patterns. We recommend that the survey ask recyclers to estimate the percent of lamps they recycle that are generated by households, state government and institutions, K-12 schools, office buildings, retail stores, and industry, with the total adding to 100 percent. Although most recyclers will not know detailed information about relative generation from these categories, ballpark estimates can help confirm or refute findings from other sources.

3. **Conduct survey.** Both Ecology and King County have extensive survey experience. Sending the survey form (either in paper or electronic form) and then following up with phone calls generally garners the highest level of response and accuracy. In addition, incentives can help increase participation. For example, King County has required survey participation in order for the firm to be listed as a recommended recycler on the County website. Ecology and King County should jointly develop the survey to ensure that it meets their respective data needs and establish a single point of contact with recycling companies for ongoing data collection. In previous years, King County has required companies to provide their recycling data in order to be listed in the county's "Yellow Book" Waste Directory; providing a similar incentive in the future may help facilitate obtaining survey responses from lamp recyclers.

4. **Tabulate and assess results.** One of the great challenges in surveying recyclers – particularly when only a small number of players control a large percentage of the marketplace – is how to handle non-reporting or other significant variation from year to year. The Department of Ecology has recently experimented with "smoothing" approaches for its annual survey on recyclable materials; such approaches could also be used here. In addition, if one company does not report in one year, we recommend using its figure from the previous year as a proxy unless there is reason to believe that its operations have changed significantly.

The above process will produce an estimate of the number of fluorescent lamps recycled from Washington sources in each year. The method is not without limitations, however. One potentially significant hurdle is acquiring data in comparable units (i.e., number of lamps in each of several categories). Some companies track lamps by raw numbers and type (as desired), whereas others may track by linear feet. Follow-up interviews with each survey respondent will be needed to help estimate each firm's total in the consistent units of number of lamps.

3.3 Estimating End-of-life Lamps Generated from Sales Data

While deriving an estimate of the number of lamps recycled involves collecting actual data from a limited number of lamp recyclers, estimates of lamp *generation* require a more creative approach. Since millions of individual entities (including businesses, institutions, residences, and even public transit vehicles) contain fluorescent tubes, targeted surveys and interviews are not appropriate. Although a statistically valid survey or sampling protocol could, in theory, be designed, the expected cost (tens of thousands of dollars) does not likely support such an approach.

Alternately, some previous calculations in Washington have been conducted using estimates of the quantity of lamps disposed in the waste stream as estimated by waste composition studies. However, the high level of uncertainties in quantity estimates in waste composition studies – especially for products that represent such small proportions of the overall waste stream – suggest that this approach is too speculative to serve as the central method. It could, however, serve as a reasonable check on estimates calculated using another method, such as the approach presented below.

As an alternative way to estimate lamp generation, many researchers (including other state programs) have taken the reasonable approach of using sales data and lifespan metrics to estimate annual lamp generation. The advantage of this approach is that it is relatively inexpensive, can be based on actual data from other studies applied to the local situation, and can be based on reasonable assumptions that could be individually evaluated if additional funds were available.

In short, the recommended method to determine approximate lamp generation is to estimate annual sales of each lamp type and use lifespan metrics to estimate how many lamps will be generated in each year. Because state-specific sales and lifespan metrics are not available, we recommend using national data applied to Washington on a per-unit basis.

More specifically, we recommend the following steps to estimate the number of lamps generated in Washington each year.

1. **Gather data on annual national sales of lamps.** The U.S. Census Bureau discontinued its detailed tracking of lamp sales more than a decade ago, and currently the National Electrical Manufacturers Association (NEMA) is the most widely cited source on national lamp sales data. NEMA has provided support to other organizations in the past, including King County, and has reported annual U.S. sales of fluorescent lamps in the range of 670-680 million units in recent years. NEMA could likely provide updated estimates, perhaps including figures for CFLs and also for net import of lamps to the United States. In addition, the Association of Lighting and Mercury Recyclers (ALMR) has issued a report that estimated lamp generation and recycling rates based on NEMA sales data as well as an assessment of U.S. Census import data. ALMR published national lamp recycling data for 2003 and may begin annual updates as soon as this year, though such a report was not yet available at the time of the publication. Sales estimates should be tabulated for at least 10 years prior to the date of the first recycling rate calculation, but in each subsequent year only the newest year of data need be gathered, since previous years' data will have already been collected.

2. **Scale national sales to Washington.** The vast majority of fluorescent tubes sold each year are sold into business and industry. Therefore, a readily available measure of business activity such as employment is likely to correlate better with lamp sales than would number of residents. Accordingly, we recommend using Washington State and national employment data from the U.S. Economic Census to scale national fluorescent tube sales to Washington. If national sales data on compact fluorescents are available, we recommend scaling those totals based on number of households from the U.S. Census, since compact fluorescents are more prevalent in households than in business and industry. As noted in the following section on validating assumptions, if Washington State is found to differ from national averages in terms of market penetration of energy-efficient fluorescent lighting, a multiplication factor could be applied to the national data. If regional figures become available, such as from the Northwest Energy Efficiency Alliance, these could be used in place of or to supplement the national data.

3. **Estimate lifespan metrics.** Lifespan metrics can be used to estimate when each year's lamp purchases will be generated as waste. The simplest methodology is to use a single, estimated lifespan. For example, the ALMR uses an estimated lifespan of 5 years, while the U.S. Environmental Protection Agency and other sources use 4 years as a standard estimated lifespan, which is intended to account for breakage and other early failure associated with real-world lamp use.[45] Therefore, if 100 million tubes are sold in the year 2005, then in the year 2010, 100 million tubes will be generated as waste.

   This basic method ignores the fact that the lifespan is an average, however, and that many lamps will be replaced earlier and many lamps will be replaced later. A common definition of lifespan is the age at which 50% of the lamps will have expired. Accordingly, some researchers use a probability density function, or "bell curve," to estimate how many lamps expire in each year. For example, if 5% of lamps expire the first year, 10% the second year, 15% the third year, and 20% the fourth year, then the lamps would have an estimated 4-year lifespan, the point at which half of the lamps would have reached their end of life (5% + 10% + 15% + 20% = 50%). Such a method was used by the Zero Waste Alliance in its work on CFLs.

[45] Association of Lighting and Mercury Recyclers, *National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.*, Calistoga, Calif., November 2004, www.almr.org; U.S. EPA Office of Solid Waste, *Modification of the Hazardous Waste Program: Hazardous Waste Lamps - Final Economic Assessment*, March 1999.

For simplicity, however, and for comparability with other national data sources (except for ALMR), we recommend using a single 4-year lifespan. Since the single-year growth in sales data has not changed drastically, the choice of lifespan assumption should not have a major impact on the results. (CFL sales have been rising faster, so the choice of assumption makes a greater difference for that category.) The bell curve method could also be explored further, particularly if the annual sales data show more volatility.

4. **Calculate annual generation.** To estimate annual generation of fluorescent lamps, one need only offset the sales data by the lifespan metric used. For example, in the table below, the 10 million lamps sold in 2000 are estimated to be generated 5 years later in 2005.

Table 4. Sample Sales Data and Generation Estimates
(in hypothetical millions)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sales	10	11	12	13	14	15	16	17	18	19
Generation	*from 1995*	*from 1996*	*from 1997*	*from 1998*	*from 1999*	10	11	12	13	15

The method used above is a reasonable means of estimating annual fluorescent lamp generation that has been used by several other organizations, including the Association of Lighting and Mercury Recyclers (ALMR). In fact, if ALMR continues to publish regularly its own estimates of national lamp generation, the above process could be simplified by starting with ALMR's national generation estimates rather than sales data. The national generation estimates could then be scaled to Washington using the same method described in step 2, above. The benefits of using ALMR's existing estimates are that the method of calculating generation would be identical and data collection (including working with NEMA) would be simplified.[46] The drawback, however, is that Ecology would lose the flexibility of adjusting the lifespan metric or other assumptions used – all assumptions that could benefit from targeted assessment, as discussed in the following section.

3.3.1 Validating Assumptions and Improving the Estimates

The three most significant assumptions used in the method proposed above for estimating fluorescent tube generation are: (1) that national sales or generation data from NEMA or ALMR are accurate; (2) that Washington sales are proportionally similar to national sales; and (3) that bulb failure patterns can be reasonably modeled using a single lifespan metric.

Assumption 1, regarding the validity of NEMA sales data, is probably the strongest assumption. This is fortunate, because there is little alternative other than to do a comprehensive and detailed survey and sampling study of Washington business and industry. Such a study has been carried out at the national level, in the U.S. Department of Energy's *Lighting Market Characterization* study, but replicating this study for Washington would likely be prohibitively expensive.

[46] Given these benefits, and the clear limitations of the other source data (e.g., lamp quantities recycled), we scaled the ALMR's estimate to Washington instead of starting with national sales data when we estimated the current recycling rate in Chapter 2. In the future, however, we recommend starting with national sales data if those data are available from NEMA.

Accounting for lamp imports and exports would improve the sales figures, as NEMA data from U.S. manufacturers may not reflect the rise in imports.

Assumption 2, regarding Washington sales being similar to national sales, is reasonable but has some known, if relatively minor, flaws. For example, the U.S. Energy Information Administration's *2003 Commercial Buildings Energy Consumption Survey* found regional differences in fluorescent bulb use, with the Pacific Coast having the highest fraction of buildings using fluorescent lamps (90%) of all U.S. regions, about 6% greater than the national average (85%). For example, elevated environmental concern in Washington's major population centers may contribute to above-average adoption of energy-efficient lighting such as T5 tubes, T8s, and CFLs. If further research supports such a conclusion, an expansion factor could be developed and applied to the national lamp sales data to compile better estimates for fluorescent lamp sales in Washington State. The Northwest Energy Efficiency Alliance or other Pacific Northwest information sources may be able to help refine lamp sales and generation figures for Washington State.

Similarly, the U.S. Department of Energy's *Lighting Market Characterization* study found differences in fluorescent lamp use in different types of business and industry sectors. For example, on a per-square-foot basis, the printing and publishing industry used fluorescent lamps for approximately 10 times as many hours as did the chemical industry. If Washington's commercial and industrial marketplace was significantly different than the nation's, application of national figures to Washington based only on a per-employee basis could lead to distortions. An alternate approach could be to develop an equation for lamp sales based on the relative employment in a variety of industry groups and apply that equation to Washington's business and industry composition.

Assumption 3, however, regarding lamp lifespan, is likely the weakest and is subject to several possible inaccuracies. For instance, the estimate of a 5-year lifespan used by ALMR is generally rationalized by assuming that lamps with 20,000-hour rated life are used for 250 days per year, 16 hours per day. However, this method not only ignores that all bulbs do not burn out at exactly 5 years, it also does not account for accidental breakage or intentional replacement on a shorter timeline; accordingly, the U.S. Environmental Protection Agency and others use an assumed lifespan of 4 years. Additionally, some retail stores and manufacturing facilities, for example, are known to replace all of their lamps on a regular schedule much shorter than this timeline rather than incur the extra labor cost of individually replacing bulbs as they dim or expire. Group relamping is often conducted every two to three years, though some 24-hour burn facilities, where the lights are always on, may use an even shorter cycle.

To increase the reliability and confidence in *Assumption 3*, we recommend that Ecology, as funds are available, conduct a survey of lighting contractors and large lamp generators to estimate actual replacement schedules more accurately. At a minimum, such a survey could help Ecology refine the single lifespan metric of 4 years which is currently recommended. Based on the stakeholder interviews and surveys conducted as part of this study, only a small fraction of organizations currently practice group relamping on a regular schedule, though the trend is likely to increase as labor costs rise faster than lamp costs. Those facilities that do follow regular schedules for replacement of both spent and still functioning lamps are typically among the largest generators of end-of-life lamps. Future research could address the question of typical lifespans of lamps for those who conduct as-needed relamping.

Even better, however, would be to develop a "bell curve"-type approach, where the fraction of lamps generated in each year is individually estimated. Such a study would necessarily involve direct, on-site observation of lamps in use in a variety of settings in Washington business and industry (and households, particularly for CFLs, as applicable). The desired output data for this preferred approach would resemble the sample data shown in Table 5.

Table 5. Sample Data on Potential Life Expectancy and Generation Rate of Fluorescent Lamps

Years from Installation	Fraction of Bulbs Generated
1	5%
2	10%
3	15%
4	20%
5	20%
6	15%
7	10%
8	5%

While such studies could evaluate the lifespan assumptions and improve the accuracy of estimates, they should not be viewed as necessary for moving forward with estimating lamp recycling rates in Washington. The method recommended above is solidly based in methodologies used by existing stakeholders and can serve as a strong starting point almost immediately.

3.4 Tracking the Recycling Rate in Washington

Estimating the fluorescent lamp recycling rate in each year involves simply dividing the estimated number of lamps recycled by the estimated number of lamps generated. A basic spreadsheet can be constructed with the number recycled, number generated, and percentage recycled for each year.

Note that for this approach to work, however, attention must be paid to how the various inputs and assumptions are calculated over time. In particular, estimates of recycling, sales, and lifespan must be conducted using identical methods in each year. If Ecology chooses to make improvements to the methodology or data quality (some suggestions for which are included above), that methodological change must be applied to each year's calculations, including those in the past, for year-to-year comparisons to be valid. Note especially that if using a single lifespan metric (e.g., 4 years), that metric must be used for each year's quantity estimate of lamps. If in one year the lifespan was switched to 5 years, there would be a single year in the future (the year four years from when the switch was made) where zero lamps would be projected to be generated. This limitation is much less of an issue for the suggested "bell curve" improvement, in which small changes in the yearly lifespan metrics could be tracked and altered without adversely affecting the results. Moreover, monitoring how lamp performance and replacement changes over time in such a detailed manner would only improve generation and recycling rate estimates.

A common problem in tracking recycling rates is determining whether an observed change (e.g., from 18% in one year to 20% in the next) is a meaningful difference or is instead the result of natural variation in the data. This uncertainty is likely to be particularly acute for estimates of the fluorescent lamp recycling rate, given the multiple assumptions involved. Several mathematical and statistical techniques are available for estimating uncertainty and comparing results, and more information could be provided on such techniques as desired. As with other recycling rate data, fluorescent lamp recycling rates are usually more informative to consider and better reflective of overall changes across a multi-year period (e.g., general trends over a five-year period), rather than as a point comparison from a single year to the next.

Finally, note that the method above is based on data across all industry groups. If Ecology needs to compile estimates of lamp generation and recycling for specific industry groups in the state, additional approaches could be developed. Since replicating this methodology for each individual industry group would be resource-intensive, an alternate approach could draw on existing industry usage data from the U.S. Department of Energy's *Lighting Market Characterization* study, other sources, and data gathered during the recycler surveys to allocate the aggregated total into estimates for each industry group.

Based on our analysis of data sources and potential methods, we recommend that Ecology take the following steps to improve the coverage and year-to-year comparability of its lamp recycling data:

- **Expand the lamp recyclers' survey** to include additional out-of-state and national companies.
- **Coordinate with King County** to design and administer a single, unified data collection survey for lamp recycling companies within and outside of Washington State.
- **Track lamp data based on number of lamps**, rather than by weight of lamps.
- **Scale national data to Washington** to estimate annual quantities generated for end-of-life lamps.
- **Conduct further investigation of major assumptions** supporting the proposed methodology for estimating fluorescent tube generation.
- **Consider requiring the tracking and reporting** of lamp quantities from recyclers and sales figures from manufacturers to the Department of Ecology.
- **Apply identical methods to calculate recycling, sales, lifespan, and generation data** from year to year, in order to ensure that comparisons over time remain valid.

4 Stakeholder Practices, Barriers, and Opportunities

This chapter summarizes input obtained from businesses and other stakeholders in Washington regarding their use of fluorescent lamps, management practices, and barriers to and opportunities for lamp recycling. The primary goal of gathering stakeholder input was to obtain information regarding current practices and attitudes with respect to fluorescent lamp usage and recycling and to help inform potential policy options. In addition, contacting stakeholders in key informant interviews and surveys initiated communication, identified potential participants for involvement in future stakeholder dialogues, and provided an opportunity to address the topic of lamp recycling.

This chapter begins with *Key Findings* (section 4.1) and then describes the *Approach and Methods* (4.2) for the stakeholder contact process. Following the methodology is a more detailed discussion of the complete *Interview and Survey Results* (4.3). The chapter concludes with a brief section on *Stakeholder Engagement and Next Steps* (4.4), after which Chapter 5 discusses programs elsewhere and policy options.

4.1 Key Findings from Stakeholder Interviews and Surveys

Cascadia's key informant interviews and surveys with manufacturing and construction companies, government and military institutions, hospitals, hotels and restaurants, retailers and grocery stores, schools, warehouses, property managers, and lamp industry members produced the following results:

- **Most fluorescent lamp users reported that they generated fewer than 400 lamps yearly**, while a handful of large users (not including relampers) that replaced more than 4,000 lamps produced the majority of spent lamps generated.

- **Roughly two-thirds of lamp users and all of the relampers contacted reported recycling at least some of their lamps.** Among companies that recycled, most reported recycling all or nearly all of their lamps.

- **More than a third of non-recycling companies said they needed more information**, the most common reason given for not recycling. Respondents also reported that they did not recycle because it was inconvenient or because they used low-mercury lamps.

- **Nearly three-quarters of lamp users reported that they have encountered no problems with recycling.** Among those who reported problems, the most common concerns were that storage was dangerous or inconvenient, recycling was expensive, and coordinating recycling and pick-ups was difficult.

- **The vast majority of respondents reported they were familiar with the health and environmental concerns** associated with mercury in fluorescent lamps.

- **A majority of respondents said that government should encourage lamp recycling by making it more convenient and less expensive and by providing information.** Support was lowest for disposal bans or mandatory recycling laws. When asked about the impact of mandatory recycling, however, many reported that such a rule would level the playing field for companies that already recycled and improve access to recycling. Only a few reported that it would significantly increase their costs.

- **Stakeholders demonstrated a strong willingness to participate in follow-up talks**, with more than a third registering interest in taking part in future lamp recycling dialogues.

4.2 Approach and Methods

Cascadia gathered stakeholder input through a mix of key informant interviews and targeted online surveys. Confidential input was gathered from distributors, manufacturers, and relamping companies through telephone interviews. Lamp users were contacted primarily through industry associations or Ecology's Pollution Prevention (P2) program using confidential online surveys. Businesses that generate more than 2,640 pounds of hazardous waste per year, or that report under the federal Emergency Planning and Community Right-to-Know Act (EPCRA), are required to prepare Pollution Prevention plans. These companies are also referred to as Pollution Prevention planners, and they formed a core group of survey respondents regarding lamp recycling.[47] This method enabled us to obtain input from a much larger audience of stakeholders than the approximately 20 interviews originally envisioned. Several industry associations sent invitations by electronic mail or included articles in their newsletters encouraging their members to participate in the research.

Stakeholders were asked to provide information in several areas:

- Current fluorescent lighting usage;
- Current lamp recycling;
- Perceived barriers to recycling;
- Attitudes toward potential government interventions; and
- Information sources.

The surveys contained a mix of multiple-choice questions designed to facilitate survey responses as well as options for providing open-ended responses. Note that because respondents were allowed to skip questions, percentages cited refer to the number of respondents who answered the question being discussed, not the total number of respondents to the survey, except where specified. In addition, respondents were allowed to provide multiple responses for some questions, so percentages may sum to more than 100 percent.

4.2.1 Targeted Stakeholders

Cascadia used telephone interviews and online surveys to gather input from stakeholders, including companies in the following target groups:

- Ecology's Pollution Prevention (P2) program, including manufacturing and construction companies, government and military institutions, hospitals, hotels and restaurants, retailers and grocery stores, schools, and warehouses;
- Washington State Hospital Association (WSHA);

[47] *Washington Administrative Code*, Ch. 173-307, apps.leg.wa.gov/WAC/default.aspx?cite=173-307&full=true; Washington State Department of Ecology, "Who Is Required to Submit a Pollution Prevention Plan?" http://www.ecy.wa.gov/programs/hwtr/p2/who.html.

- Building Owners and Managers Association (BOMA), which has four chapters in Washington, and selected members of Building Service Contractors Association International (BSCAI);

- Washington Retail Association (WRA);

- Association of Washington Businesses; and

- Lamp and lighting industry, including distributors, manufacturers, and relampers, including members of the interNational Association of Lighting Management Companies (NALMCO). Electric utility contacts also aided in identifying additional lighting-related companies to interview.

In keeping with an agreement between the Department of Ecology and King County regarding data collection methods, Cascadia did not interview lamp recyclers for this project (with the exception of one local company). Since both Ecology and King County obtained data from lamp recyclers in the previous year, the goal was to use existing information and avoid imposing an undue burden on the industry.

4.2.2 Interview and Survey Respondents

Cascadia obtained a total of 297 unique survey responses from lamp users. In the figures and discussion below, *n* denotes the sample size, or number of respondents to the survey or to a particular question. Of the 297 completed surveys, most responses (71%) were from P2 participants, and the remainder included members of BOMA, WSHA, WRA, and AWB.

Responding lamp users represented a number of business types. Hospitals and property managers were surveyed separately.[48] P2 respondents reported working for a variety of business types, primarily manufacturing/industry, but also government/military, construction, schools, hospitals, warehouses, offices, retail/grocery, research laboratories, and utilities. Companies with multiple locations were asked to provide answers covering all of their facilities in Washington, though not all of the respondents were able to do so.

Cascadia also conducted telephone interviews with members of the lamp industry, including relampers, distributors, and manufacturers. Cascadia contacted more than 20 businesses that provide relamping services, including lighting maintenance or lamp retrofits, of which 16 agreed to participate in interviews. Cascadia interviewed five lamp distributors and two lamp manufacturers, though additional companies were contacted. (Additional interviews and communications with government, industry, and other authorities informed various parts of our analysis, such as the quantity data in Chapter 2 and the policy options in Chapter 5.)

This chapter focuses primarily on presenting findings from lamp users, including manufacturing companies, property managers, and institutions. Comparisons among subsets of stakeholder respondents are presented as appropriate.

[48] In developing the interview guide and survey, we reviewed NEWMOA's previous work on commercial sector recycling, including Aceti Associates, *Management Company Interviews: Promoting Fluorescent Lamp Recycling in the Commercial Sector*, January 31, 2005; Aceti Associates, *Program Survey: Promoting Fluorescent Lamp Recycling in the Commercial Sector*, December 15, 2004.

4.3 Interview and Survey Results

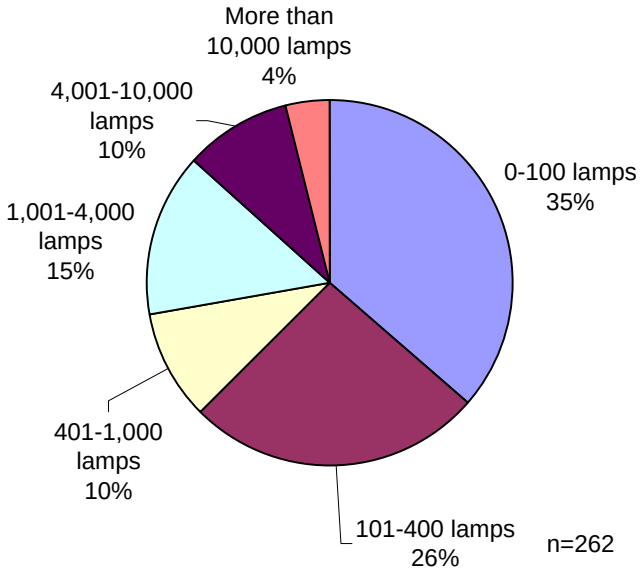
4.3.1 Lighting Usage and Practices

Lamp users were asked about the number of lamps they generate annually, the size and lighting patterns of their indoor facilities, responsibility for lighting decisions, and lamp replacement practices. The majority of survey respondents reported that they generated fewer than 400 fluorescent lamps each year. Despite the relatively small number of companies in this category, the large users who replaced more than 4,000 lamps each year accounted for the majority of spent lamps generated among the respondents.

Lamp Generation

The majority of respondents reported that they replaced 400 or fewer lamps annually, as shown in Figure 4. Nonetheless, more than 60% of the spent lamps reported were generated by large users who replaced over 4,000 lamps annually. The number of fluorescent lamps reported replaced each year ranged from 0 up to 50,000 lamps.

Figure 4. About how many fluorescent lamps (light bulbs) does your company need to replace in a typical year?

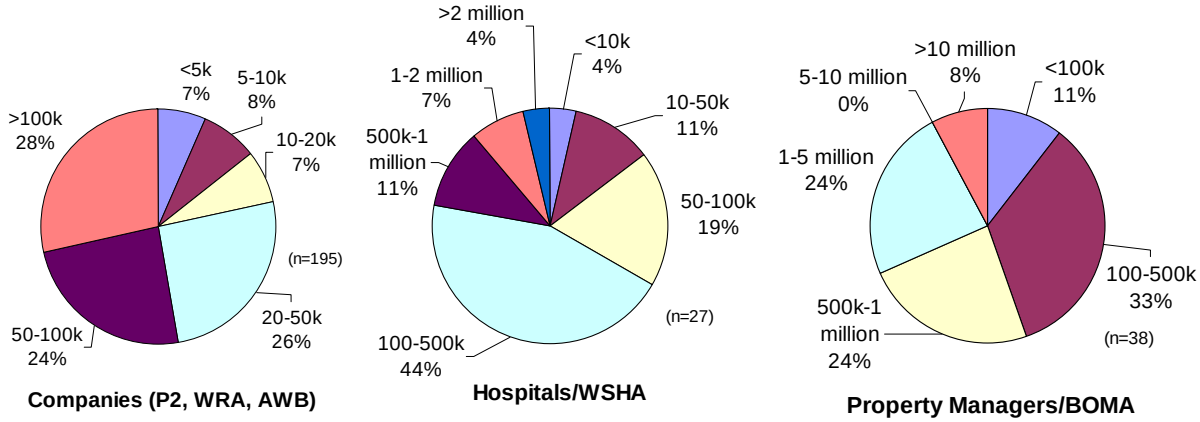


Facility Size

Lamp users were asked to estimate the indoor square footage of their facilities. Facility size responses were divided into three categories because different user groups were offered different size ranges to account for the fact that hospitals and property management firms were expected to have larger facility areas than many other businesses. Note that where users provided an open-ended size estimate (e.g., "more than one million"), the number mentioned was used. Thus, the square footage estimates may underestimate the total square footage. We requested that survey responses cover multiple locations, where feasible; however, some respondents with multiple facilities in Washington noted that they were unable to do so.

As shown in Figure 5, the P2, WRA, and AWB respondents (n=195) were divided fairly evenly between facilities larger and smaller than 50,000 square feet. For hospitals (WSHA respondents), 100,000 to 500,000 square feet was the most common response. For BOMA, just over half of respondents reported that their company managed more than 500,000 square feet of indoor facility space.

Figure 5. What is the approximate indoor square footage of your facilities (or property you manage) in Washington State?



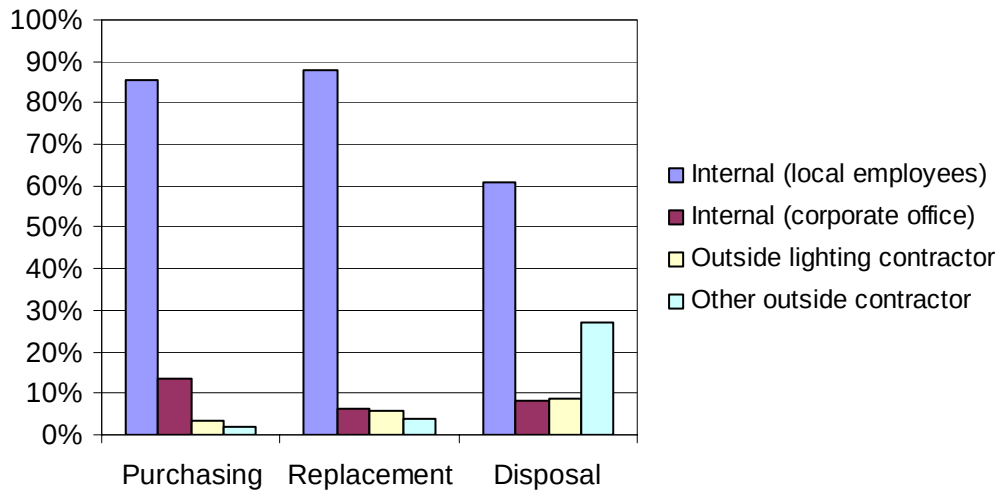
Duration of Lighting Use

Lamp users were asked about the number of hours per day and days per week their lights were typically in use. Except for property managers, the companies responding were evenly divided among the three categories of hours of lighting use per day: 8 to 12 hours, 13 to 20 hours, and "more than 20 hours or always on." More than two-thirds of BOMA members reported that the lights at the properties they manage were on during standard Monday-through-Friday office hours. For number of days of the week of lighting use, 7 days a week was the most common response (except for BOMA), followed by 5 days a week. About a third of respondents were characterized as "24-hour burn" facilities where the lights were nearly always on.

Responsibility for Lamp Decisions

The majority of lamp users reported that lamp purchasing, replacement, and disposal or recycling were handled by in-house staff of the local facility – that is, not by a corporate office or outside contractor. Purchasing was the activity most likely to be handled by a corporate office, while disposal was the activity most likely to be contracted out. Lamp disposal or recycling (n=247) was handled internally by local employees at more than two-thirds of responding businesses and by an outside (non-lighting) contractor at less than a third of businesses, as shown in Figure 6.

Figure 6. Who currently handles your lamp purchases, replacement, and recycling/disposal?

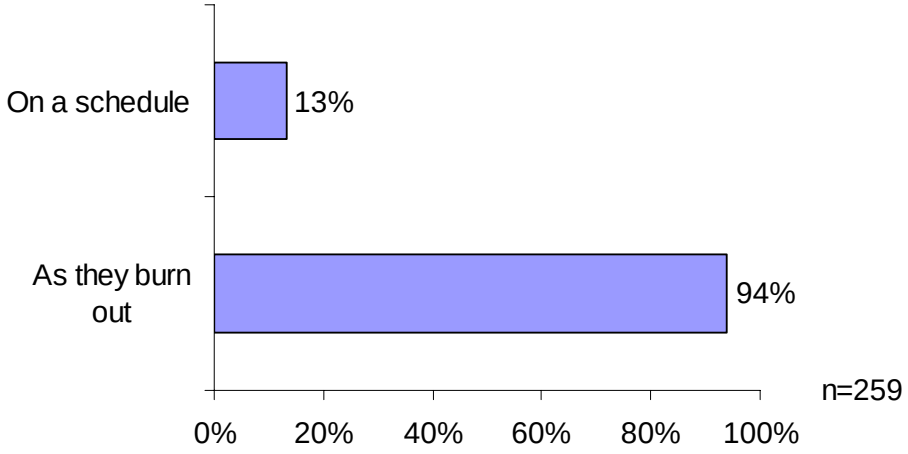


Note: Multiple responses were allowed.

Lamp Replacement Methods

Whether companies replace their spent lamps one at a time or replace them all at once prior to their burnout has a significant impact on the timing of waste lamp generation and resulting management practices. Only 13% of respondents reported the practice of replacing their fluorescent lighting on a regular schedule, also known as group relamping. As shown in Figure 7, the large majority of respondents (94%) replaced their lamps as they burned out, known as spot relamping.

Figure 7. When are your fluorescent lamps replaced?



Note that spot relamping may also be performed as a supplement to group relamping. That is, a facility will replace all of its lamps on a schedule, often timed at 60% to 75% of the rated life of its lamps (e.g., 75% of the rated life of a 20,000-hour lamp is 15,000 hours of use; this schedule would be less than 2 years in a 24-hour burn facility, or about 4 years if the lights are on 10 hours a day). Group relamping prior to the lamp's rated lifespan is designed to address the majority of lamp burnouts, but individual early burnouts can still be handled as needed through spot relamping. Under such a system, the amount of spot relamping needed should be minimal, compared to replacing all of the lamps individually as they burn out.

Group relamping replaces lamps that are still working and thus contributes to earlier generation of lamp waste, but the savings on labor costs can be dramatic. Such savings could be used to help pay for proper lamp recycling. Generating many lamps at once can also facilitate recycling, rather than having to store them onsite until a sufficient volume is collected for recycling or proper disposal. Producing large quantities of waste lamps at one time, however, may cause a business to be moved into a different legal category as a regulated generator of dangerous waste.[49]

[49] According to Ecology, about 400 four-foot fluorescent tubes will equal the 220-pound threshold for being a regulated generator. Washington State Department of Ecology, *Focus: Universal Waste Rule for Dangerous Waste Lamps (WAC 173-303-573)*, Publication # 00-04-020, June 2000. (Using the common conversion factor of 0.15 lbs/ft or 0.6 lbs per 4-ft tube yields the somewhat lower figure of about 365 four-foot fluorescent tube equivalents.) National Lighting Bureau, *The NLB Guide to Energy-Efficient Lighting Systems*, undated, http://www.nlb.org/pubs/pdf/NLBGuidetoEnergyEffLtg.pdf.

4.3.2 Lamp Recycling Practices

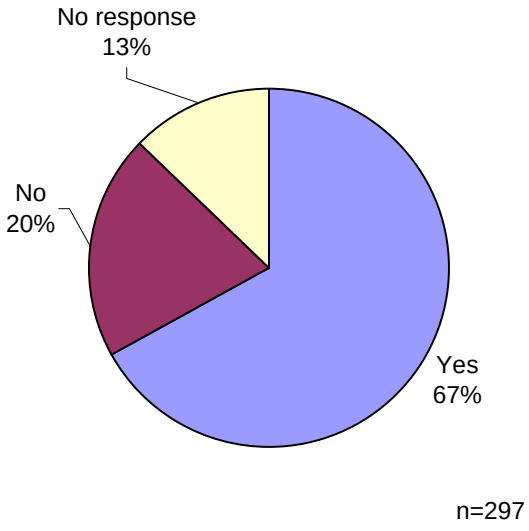
Lamp users and relampers were asked about their current lamp recycling behaviors and experiences with lamp recycling. Roughly two-thirds of lamp user respondents and all of the relampers interviewed reported recycling at least some of their lamps. Among companies that recycled, most recycled all or nearly all of their lamps. The most common reason given for not recycling was that the companies needed more information. They also reported that they did not recycle because it was inconvenient or because they used low-mercury lamps. Nearly three-quarters of lamp users reported that they have encountered no problems with recycling. Among those who reported problems, the most common were that storage is inconvenient or dangerous, recycling is expensive, and coordinating recycling and pick-ups is difficult.

Participation

Over three-quarters (77%) of lamp users who responded to the question about recycling (n=259) reported that they currently recycled at least some of their fluorescent lamps; however, 13% of users skipped this question, and it is reasonable to assume that participants who did not respond to the question did not recycle their lamps. Therefore, of all lamp users, about two-thirds reported that they currently recycled their lamps; the other third reported that they did not recycle or did not respond to the question, as shown in Figure 8.

In light of their existing regulatory status (aside from lamp generation) and participation in pollution prevention efforts, P2 respondents may be more likely to recycle their lamps than other companies. When the P2 respondents were examined separately, they appeared slightly more likely to report lamp recycling than other users (70% for P2 vs. 60% for other respondents). The perception that lamp recycling is required was commonly held among respondents and interviewees.

Figure 8. Do you currently recycle any of your fluorescent lamps?

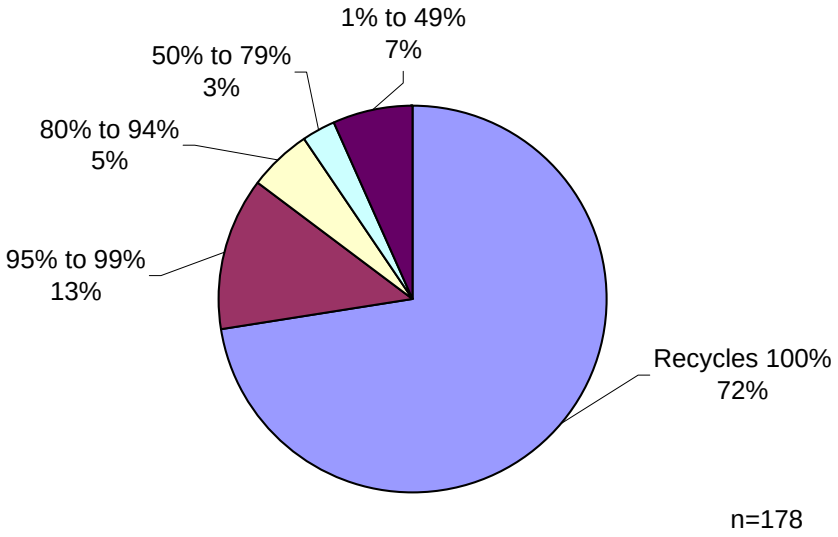


Quantity of Lamps Recycled

Number of lamps. Among lamp users who estimated the number of lamps recycled annually (n=170), the average was about 3,000 lamps (after omitting one outlier that reported recycling "millions" of lamps, which was more than they reported needing to replace each year). The median number of lamps recycled annually was about 100, and half of respondents reported recycling between about 100 and 2,000 lamps annually.

Percentage recycled. Among users who recycled and estimated the percentage of lamps recycled annually (n=178), the average percentage recycled was above 90%, and the most common response was 100%, with nearly three-quarters of those who answered the question reporting they recycled all of their lamps, as shown in Figure 9.

Figure 9. Approximately how many lamps do you recycle each year? *(lamp users)*

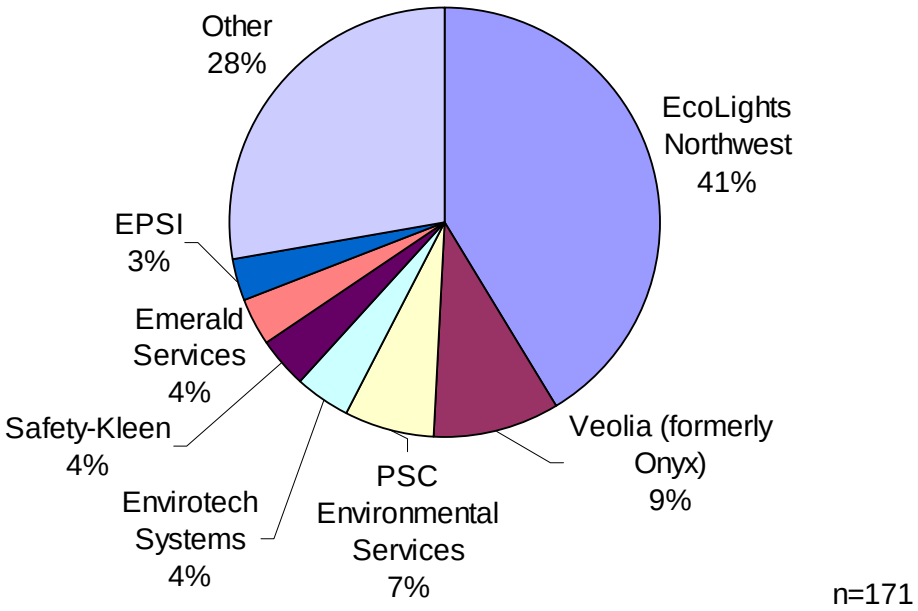


All of the relampers interviewed by Cascadia offered lamp recycling, although a third of them said they also left spent lamps with the customer. Among the nine relampers who estimated the percentage of spent lamps that they recycled, all said that they recycled 80% or more, and more than half reported recycling all of their lamps. In addition, three-quarters of relampers contacted reported that they provided information on recycling or proper disposal to their customers. Half said that they provide information automatically, and two relampers reported that they provided no recycling/disposal information to their customers. One relamper emphatically stated that he educated customers who kept the lamps not to throw them away.

Recycling Companies Used

Lamp users were asked which lamp recycling company they used. The most common company used by far was EcoLights Northwest, which also operates as Total Reclaim. Other commonly used companies included Veolia Environmental Services (formerly known as Onyx until 2006) and PSC Environmental Services, as shown in Figure 10. Roughly 5% of respondents reported that they use a lamp distributor or manufacturer for their lamping. As with the lamp users, most relampers reported using EcoLights Northwest, and several used Earth Protection Services, Inc. (EPSI) or Veolia/Onyx.

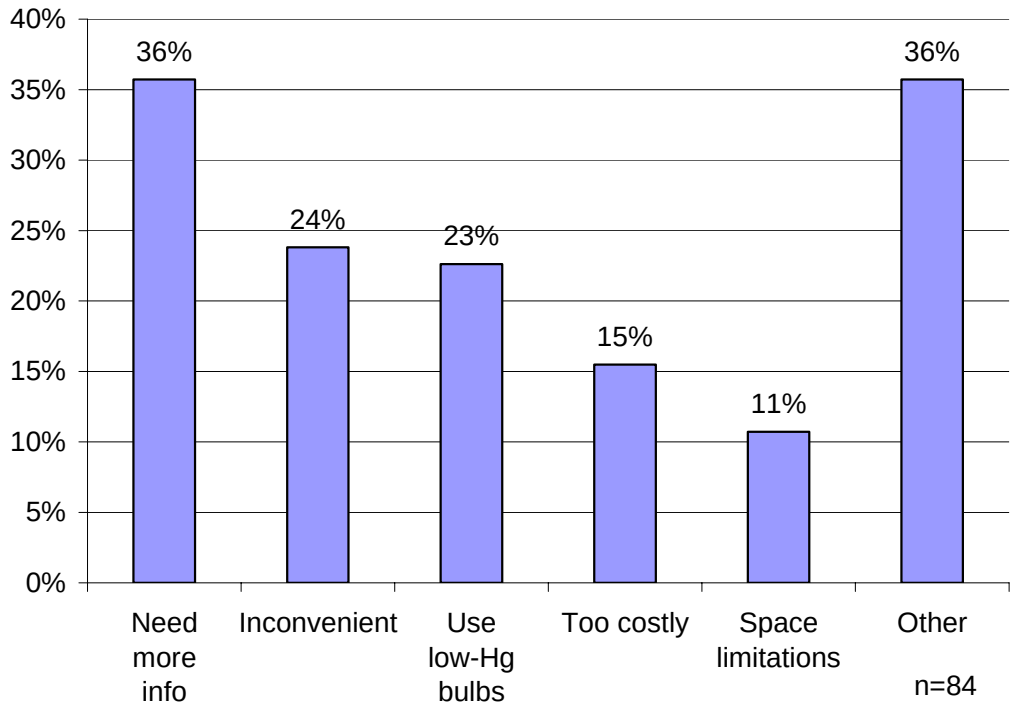
Figure 10. If you use a recycling service, which recycling company do you use?



Reasons for Not Recycling

Companies that did not recycle their fluorescent lamps or recycled less than 100% of lamps offered reasons why their company did not currently recycle all of its spent lamps. The most common answer, from more than a third of respondents, was that they needed more information. As shown in Figure 11, nearly one-quarter of respondents said that recycling was inconvenient, and a similar fraction said that they did not recycle because they used low-mercury lamps ("green-cap" lamps). In addition to the multiple-choice answers, respondents had the opportunity to provide other open-ended responses. Breakage, lack of sufficient volume, or lack of a satisfactory recycler were mentioned as additional reasons. Other answers included that they were planning to recycle in the future, were unaware of recycling, had trouble keeping employees informed, or used an outside contractor that disposed of the lamps.

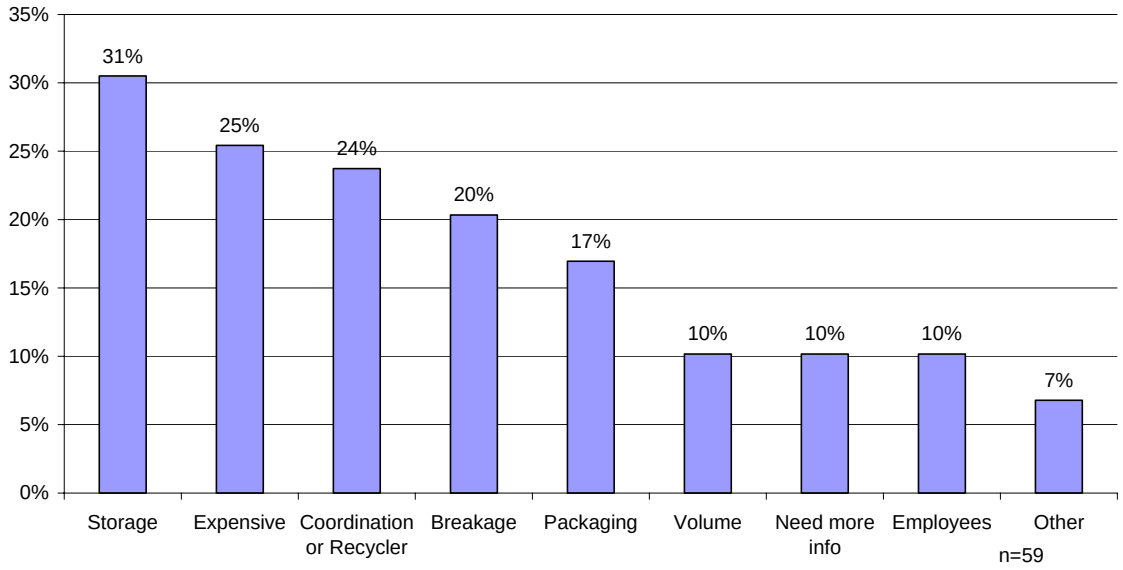
Figure 11. If your company does not currently recycle all of its spent fluorescent lamps, why not?



Recycling Difficulties

About three-quarters of respondents reported that they had encountered no problems with lamp recycling. Of those who did describe problems encountered, the most common issues reported were that lamp storage was dangerous or inconvenient; recycling was expensive; coordination problems or difficulties with recyclers; and lamp breakage, which may relate to storage problems.

Figure 12. If you have encountered with lamp recycling, what problems?



4.3.3 Mercury Awareness

The vast majority of respondents stated they were familiar with the health and environmental concerns associated with mercury in fluorescent lamps. Of the 60 respondents who provided answers regarding what their company did in response, more than half reported that they recycled used lamps. Other responses included that the companies provided training or educational programs for employees; used extra care in handling lamps; and purchased low-mercury lamps.

Figure 13. Are you familiar with the health and environmental concerns associated with mercury in fluorescent lamps?

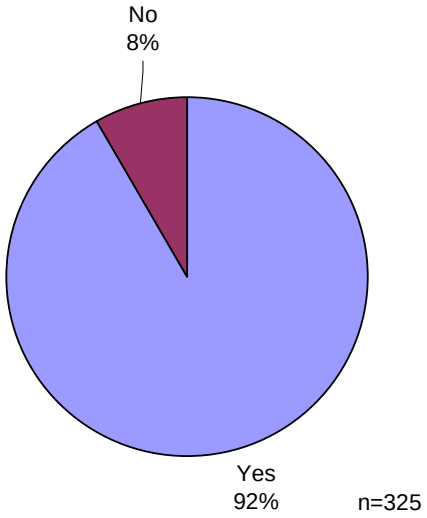
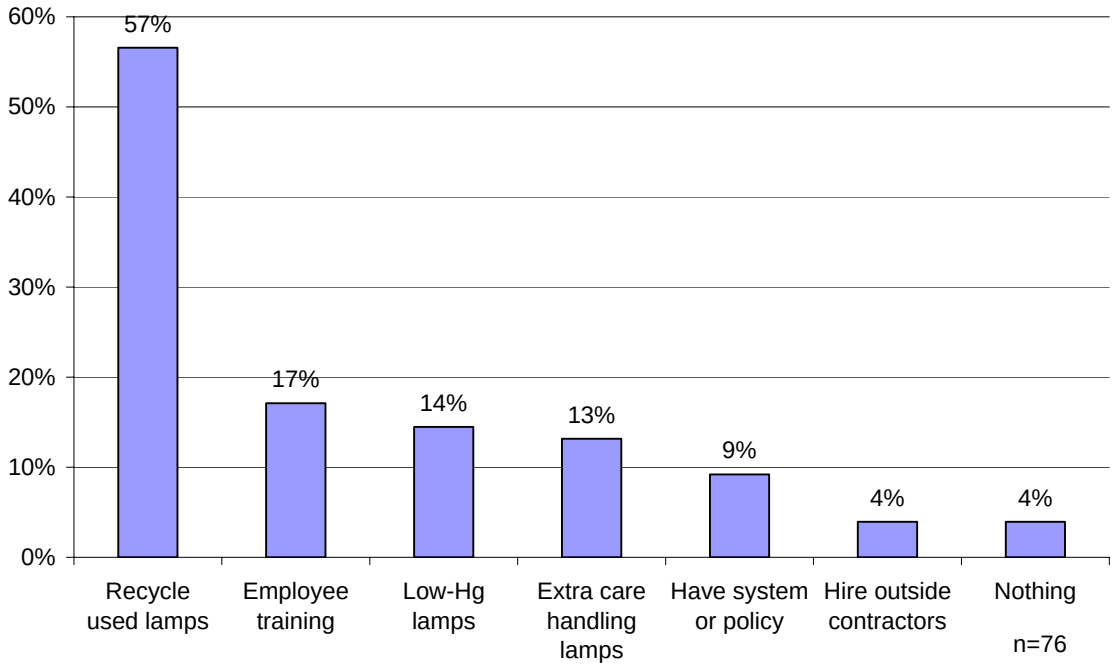


Figure 14. What does your company do in response (to mercury concerns)?



4.3.4 State and Local Government Interventions

Cascadia asked all interviewees and survey respondents how they thought that state and local governments should encourage lamp recycling and what impact they felt mandatory recycling would have on their business.

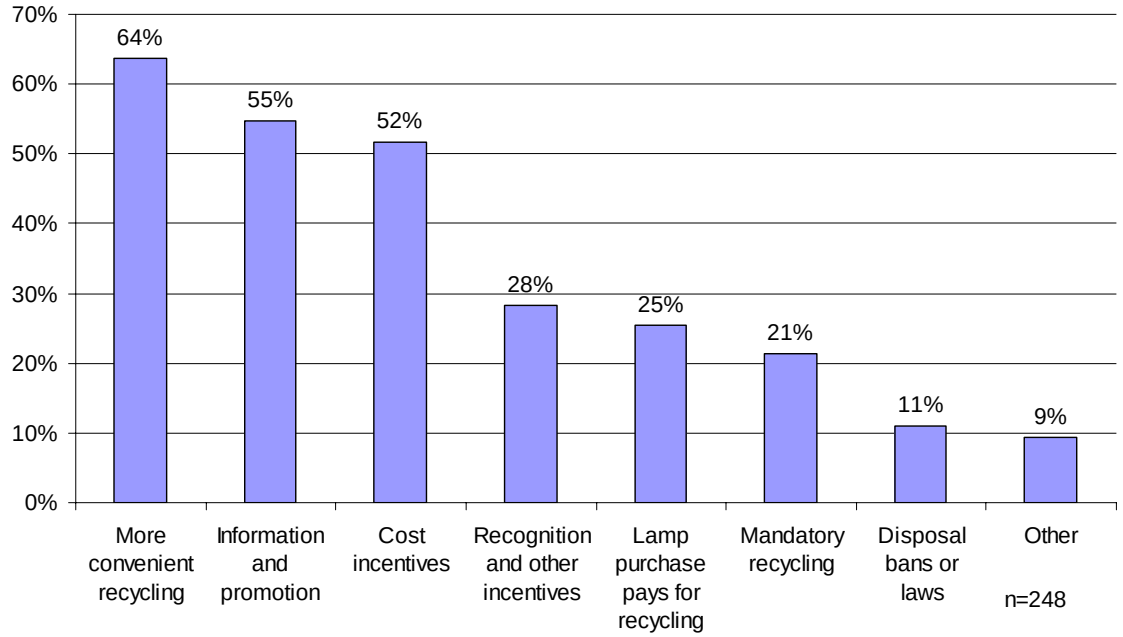
Options for Increasing Recycling

Nearly two-thirds of respondents preferred that government facilitate recycling by supporting more convenient opportunities for recycling. Several open-ended responses called for developing "take-back" programs and convenient drop-off locations. More than half the respondents also mentioned information and promotion campaigns on lamp recycling as well as cost incentives to reduce the cost to companies of lamp recycling. Some open-ended responses recommended increased media coverage and focusing efforts on high-volume lamp users.

Interestingly, one-quarter of respondents supported incorporating the cost of recycling into the purchase price of new lamps; such an advance recycling fee (ARF) could involve an upfront charge on new lamps sold to pay for their eventual recycling. Some of the open-ended responses offered a variation on the ARF theme by recommending a refund when lamps are returned for recycling at their end-of-life. Support for mandatory recycling, disposal bans, or other new laws was lowest. Users also offered other open-ended responses, which included reducing storage and labeling requirements and modifying packaging requirements to support local recycling; as well as promoting research and competition, including support for developing tubes that do not contain toxic constituents.

In addition, some lamp users stated that they thought the government was already doing enough, that they believed recycling was already required, and that mandatory recycling of low-mercury "green lamps" was wasteful of taxpayer dollars.

Figure 15. How do you think state and local governments should encourage more lamp recycling?



Among the lamp users surveyed, hospitals were generally more supportive of recognition efforts and non-cost incentives than other respondents. P2 companies were somewhat less supportive of incorporating recycling costs into lamp purchase prices. Property managers were typically more supportive of requiring mandatory recycling than other respondents.

Relampers. When asked how the government should encourage more fluorescent lamp recycling, nearly half of the relampers mentioned some form of cost incentive. A third of relampers discussed raising awareness or providing more information, and a small number mentioned charging a recycling deposit at the time of purchase. Most relampers said that mandatory recycling either would not affect them or that it would increase their business as they would provide more lamp collection services.

Distributors and manufacturers. As with other groups, distributors reported that cost and convenience are the main barriers to lamp recycling, explaining that it is difficult for businesses to pay the costs of recycling when their competitors do not. Interviewees explained that the recycling infrastructure needs to be improved, particularly for small businesses, households, and areas where recycling centers are not nearby. More convenient recycling points, such as at locations that sell fluorescent lamps, including stores like Wal-Mart, Home Depot, Lowe's, and a take-back program could increase recycling among these users.

One distributor already had a take-back program that it took pride in, despite losing money on it; they were, however, looking for ways to improve the program. Concerns about hazardous waste liability were expressed in the interviews. One distributor reported that they were not interested in participating in a take-back program, mentioning an example of a California company that closed and its employees were held liable. The manufacturer interviewed expressed concerns that a take-back program by manufacturers, rather than distributors or retailers, would increase the price of domestic lamps such that the market would favor lamps from offshore manufacturers or other companies that would avoid the take-back system.

Several distributors supported incorporating the cost of recycling into the purchase price as the best way to pay for recycling because users then would know that they could recycle their lamps for free. However, one distributor suggested that placing a tax on incandescent lamps to pay for fluorescent lamp recycling would be a better way to finance the system than increasing the cost of fluorescents.

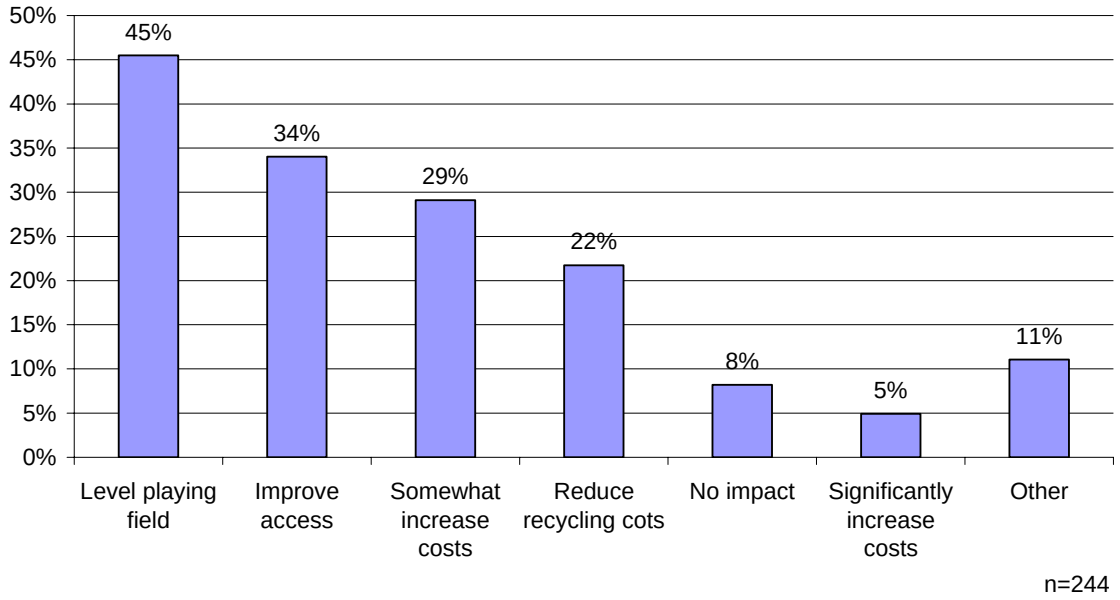
Several distributors also supported mandatory recycling. One reason may be that they have positioned themselves to facilitate recycling by selling mail-in recycling kits or collecting lamps for recycling for a fee. Interviews noted that mandatory recycling dictates who recycles lamps, and making recycling mandatory gives the State more leverage when encouraging recycling. One distributor also suggested banning lamps from landfills.

Finally, interviewees noted that although the commercial market remains much larger than the residential market, CFLs are becoming more popular and should be considered in the system. One distributor reported that homeowners were asking for "Al Gore light bulbs." He reported, however, that homeowners frequently did not understand the mercury content in the lamps, what to do if they broke, how to recycle them, or even that they should be recycled. As multiple distributors mentioned, even for homeowners who understand the risks, the recycling infrastructure is not generally set up for their use.

Potential Impact of Mandatory Recycling

Although only 11% of lamp users supported mandatory recycling as how state and local governments should increase lamp recycling, they did not predict overwhelmingly dire consequences when asked to assess the possible impacts of such a mandatory lamp recycling rule on their companies. As shown in Figure 16, the most common responses (multiple answers allowed) were that mandatory recycling would level the playing field, improve access to recycling facilities, and somewhat increase overall costs to the responding business. Relampers and distributors generally reported that mandatory recycling would either not affect or would improve their business, as many already offer recycling services.

Figure 16. If the law were changed to require all Washington businesses to recycle their lamps, how would this rule affect your company?

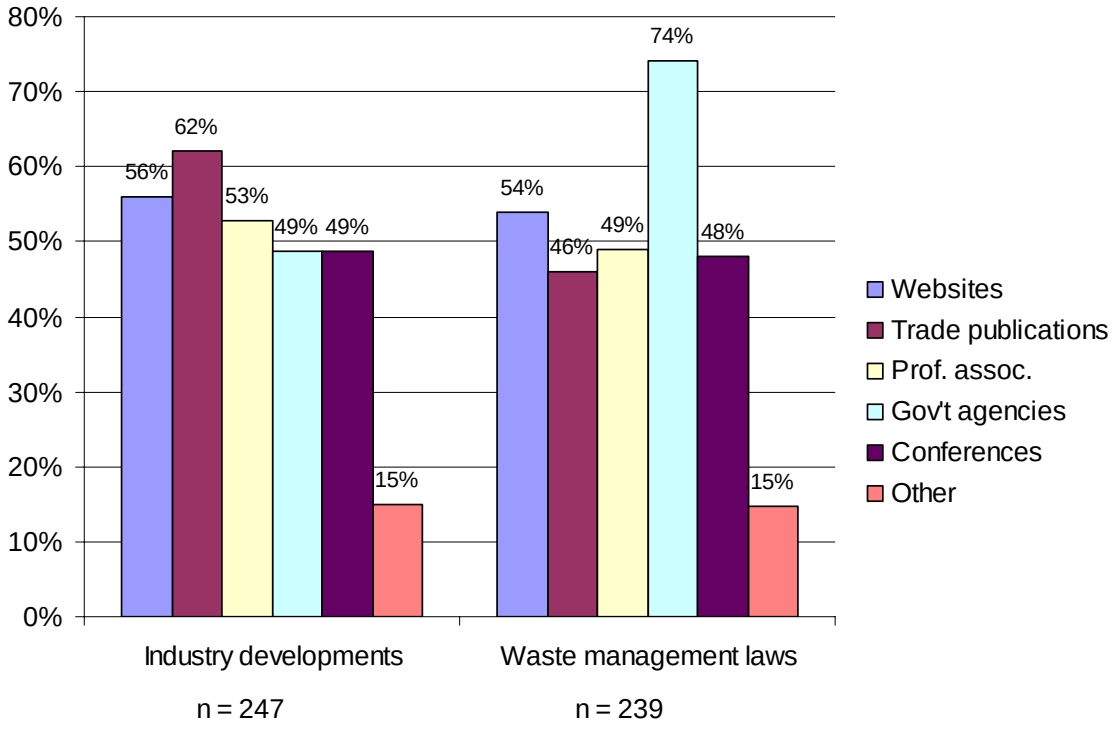


n=244

4.3.5 Information Sources

To help Ecology understand where potential target audiences obtain their information and identify considerations for developing an outreach strategy, Cascadia asked lamp users where they learned about new developments in their industry as well as about laws and regulations on waste management. Government agencies were the top information source on waste management laws and regulations, and trade publications were the most frequent source of information on new industry developments. The remaining data sources were each cited by about half of the respondents. Relampers reported that they obtained their information mainly through government agencies and professional associations, while distributors reported the American Lighting Association, National Association of Electrical Distributors, manufacturers, and utilities as information sources. Accordingly, a multi-pronged approach to disseminating information may be warranted.

Figure 17. Where do you usually learn about (1) new developments in your industry, and (2) laws and regulations on waste management?

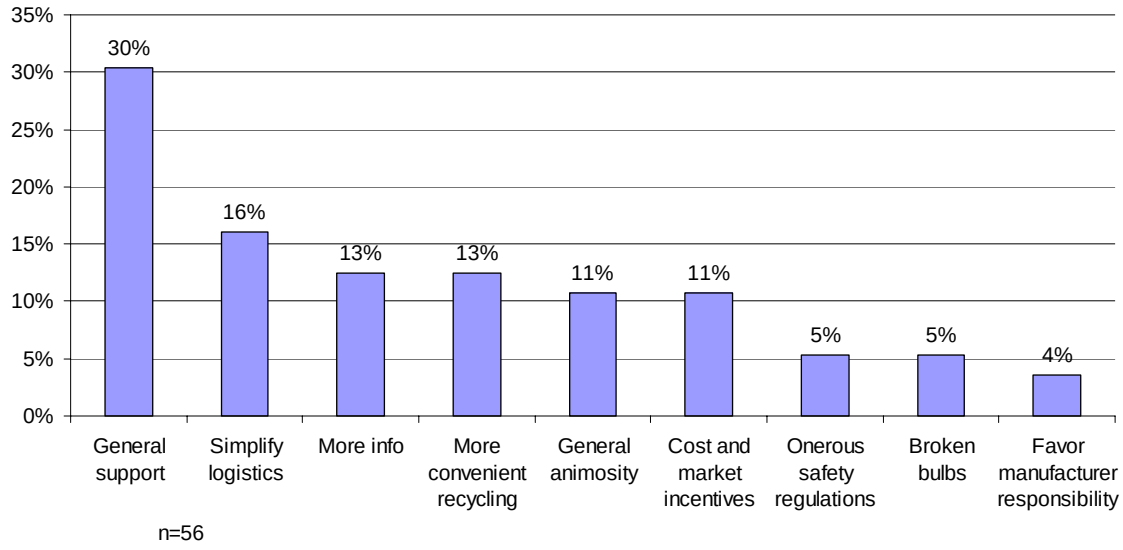


4.3.6 Additional Comments

At the conclusion of the survey and interviews, we also offered participants the opportunity to provide additional open-ended responses regarding fluorescent lamp recycling. Of these, about a third offered general support for fluorescent lamp recycling. The next most common comment was to simplify the recycling process, particularly for small businesses and homeowners. Figure 18 summarizes additional stakeholder comments.

General comments from relampers included that Ecology should focus on incentives rather than punishments, that relampers needed assistance because they have so many lamps to recycle, and that the large businesses already knew to recycle but that small businesses and homeowners needed information and more convenient recycling options.

Figure 18. Do you have any additional comments to share regarding this survey on fluorescent lamp recycling?



4.4 Stakeholder Engagement and Next Steps

As part of the survey and interview effort, we collected the names and contact information for more than 100 stakeholders who expressed interest or willingness to participate in further discussions regarding fluorescent lamp recycling with Ecology and other stakeholders.

Efforts to increase the fluorescent lamp recycling rate to reach the 80% goal should include following up with these and other interested stakeholders, including schools, building maintenance professionals, and recyclers. Such dialogue could occur through focus groups, roundtable discussions, additional interviews, and other methods. Maintaining a continued dialogue with stakeholders could help inform the development of outreach strategies, specific policy options, and other lamp recycling efforts.

Among other agency concerns, relevant topics for discussion may include:

- Cost incentives and financing mechanisms, including advance recycling fees;
- Expanding access to recycling service for small businesses, homeowners, and remote locations;
- Simplifying the recycling process, including storage, packaging, and documentation requirements;
- Reducing regulatory burdens associated with recycling, particularly for broken lamps;
- Regulations such as a disposal ban or mandatory recycling; and
- Improving methods for counting the number of lamps sold, generated, disposed, and recycled in Washington.

5 Policy Options, Other States, and Strategies

As part of its effort to reduce mercury in the environment to safeguard human health and ecosystems, Washington State seeks to increase its recycling rate for mercury-added lamps from its current level around 20 percent up to 80 percent by 2015. Similarly, the U.S. Environmental Protection Agency established a goal to reach 40% lamp recycling by 2005 and 80% by 2009.[50] The European Union also set a goal of 80% recovery of lighting products by 2006.[51] Achieving such a dramatic increase in recycling levels would necessitate significant changes in current behavior of businesses and households as well as public investments in supporting policies, programs, and infrastructure. Tripling the recycling rate for fluorescent lamps in less than a decade is indeed an ambitious goal. The good news for Washington State is that successful, replicable models for such a path to success exist elsewhere, in comparable state policies and programs.

Meeting Washington's lighting needs with less energy can reduce our state's contributions to climate change, and fluorescent lamps represent an important energy-efficient technology. Advocates often point out that, on average over their lifecycle when energy use is considered, fluorescent lamps result in fewer mercury emissions than incandescent lights, which contain no mercury but use more electricity. Electricity generation from fossil fuels is a significant source of mercury emissions to the environment, particularly in other parts of the country where coal is a dominant power source. Since mercury is currently a small but essential component of much energy-efficient lighting, ensuring proper management and recycling will help fluorescent lamps further reduce their environmental impact and maintain or expand their position in the marketplace, particularly for households. Accordingly, addressing the mercury problem will help Washington to keep toxics out of the environment to protect ecosystems and human health, while conserving energy and reducing our carbon footprint. (Some mercury-free alternatives are currently available for sodium lamps, and a mercury-free energy-efficient fluorescent lamp has been demonstrated in Sweden but is not yet available.[52])

The Department of Ecology adopted the Universal Waste rule for lamps in June 2000. The state rule provided that Universal Waste (UW) does not need to be included in waste generation totals for the determination of generator status; UW does not require hazardous waste manifests when sent off-site; and the time and quantity limits on waste accumulation were raised. Because hazardous waste manifests are not required for Universal Waste, most fluorescent lamp wastes are not tracked under the Resource Conservation and Recovery Act (RCRA). Universal wastes are required to go to a permitted treatment, storage, and disposal (TSD) or recycling facility. [53]

In 2003, the Washington State Legislature passed the Mercury Education and Reduction Act (MERA) and adopted a *Chemical Action Plan* for mercury.[54] The law requires the labeling of all mercury-containing lamps manufactured after November 2003, along with their packaging.

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[50] U.S. Environmental Protection Agency, "Development and Implementation of a Mercury Lamp Recycling Outreach Program," *Federal Register*, Volume 68, Number 91 (May 12, 2003), pp. 25368-25371. See also NEMA website, http://www.nema.org/lamprecycle/support_files/messageforall.htm.

[51] Environment Canada and Natural Resources Canada, *Background Study on Increasing Recycling of End-of-life Mercury-containing Lamps from Residential and Commercial Sources in Canada*, October 31, 2005.

[52] INFORM, *Shedding Light on Mercury in Fluorescents: A Workbook for Design Professionals*, New York, 2004, page 4.

[53] Ecology Publication No. 00-04-020, "Universal Waste Rule for Dangerous Waste Lamps," Washington Administrative Code (WAC), 173-303-573.

[54] *Revised Code of Washington* (RCW), Chapter 70.95M, "Mercury."

MERA also requires the state government to purchase mercury-free or reduced-mercury products or, where alternatives are not available, to purchase products containing the least amount of added mercury need for appropriate product performance. Among other provisions, MERA also prohibits the sale of certain mercury-added products, including most novelty items, thermometers, manometers, thermostats, and motor vehicles containing mercury switches. The act calls for an educational plan on proper disposal, but it does not mandate disposal or recycling practices for mercury-added products such as lamps. MERA also authorizes Ecology to participate in a regional or multi-state clearinghouse to aid in implementing the requirements of the law.

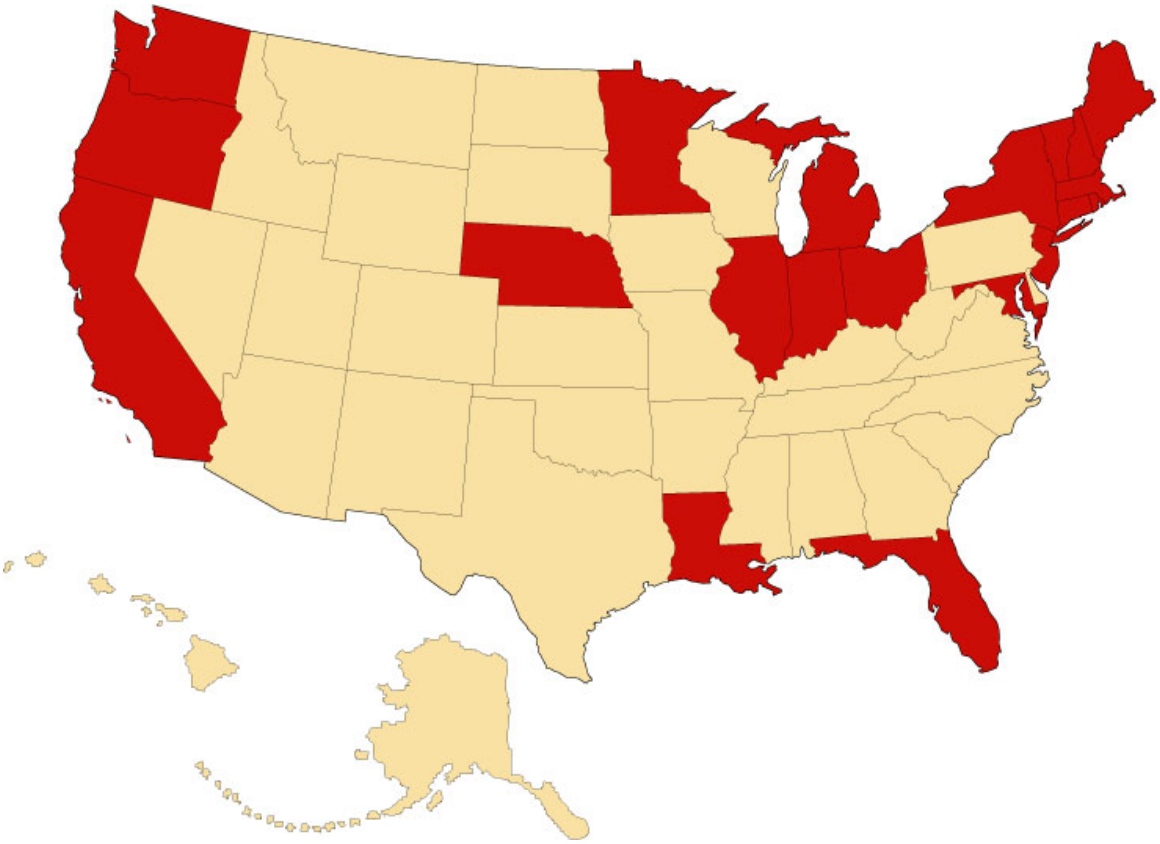
As authorized in MERA, Washington State joined the Interstate Mercury Education and Reduction Clearinghouse (IMERC) in 2003, becoming the first state outside of the northeastern U.S. to enter the coalition. The Clearinghouse is designed to provide assistance to states that have enacted legislation on mercury education and reduction, such as Washington's Mercury Education and Reduction Act of 2003 and similar laws in other states. IMERC's 13 member states are among the nation's leaders on mercury reduction efforts, and the dozen other states offer valuable examples for Washington to consider in its efforts to increase lamp recycling and remove mercury from the environment. (In turn, Washington's example can also provide useful lessons for other mercury and lamp programs, both to IMERC members as well as other states and jurisdictions.)

The Mercury Education and Reduction Act and the *Mercury Chemical Action Plan*, both adopted in 2003, represent important steps toward safeguarding Washington from mercury hazards. Other states that have adopted comprehensive mercury reduction laws, including such measures as disposal bans and mandatory recycling, provide examples of additional steps that Washington could take to meet its mercury reduction and lamp recycling goals.

To help identify and assess lamp recycling and mercury reduction options for Washington State, we researched model programs elsewhere and interviewed a number of program managers. Many of the states we interviewed are members of the Interstate Mercury Education and Reduction Clearinghouse (IMERC), the Northeast Waste Management Officials' Association (NEWMOA), or both. We also contacted several other states with active mercury reduction programs, often including efforts related to fluorescent lamps. Input from the stakeholder research and other contacts in Washington also informed the consideration of options for increasing lamp recycling in the state. In considering strategies for increasing fluorescent lamp recycling in Washington State, we gathered information on mercury-related programs throughout the United States, plus several Canadian and overseas programs. In the U.S., we focused on our efforts on reviewing programs in the following 20 states, including conducting a number of interviews with relevant program managers:

- California
- Connecticut
- Florida
- Illinois
- Indiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Montana
- Nebraska
- New Hampshire
- New Jersey
- New York
- Ohio
- Oregon
- Rhode Island
- Vermont
- Wisconsin

Figure 19. U.S. States with Legislation on Mercury-containing Products[55]
(map credit: NEMA)



This chapter covers a number of options, from voluntary, incentive- and education-based programs; to changes in enforcement; to new policies, such as statewide disposal bans or mandatory recycling. Thorough analysis of alternate strategies involves assessment of their efficacy, cost, enforceability, political feasibility, stakeholder acceptability, technical feasibility, distributional effects, and other evaluative criteria. The primary focus of the current effort was on identifying strategies that could help Washington meet its 80% recycling goal. The fact that most of these policies have been successfully implemented in other states bodes well for their feasibility in Washington, though further examination of costs, feasibility, and other factors may be desired. Although the focus of the current project was on commercial, industrial, and institutional entities, rather than residential lamp users, many of the recommended strategies for increasing commercial lamp recycling levels will also help support residential recycling of fluorescent lamps. In fact, reaching the 80% lamp recycling goal will necessitate the participation of lamp users in all sectors of Washington's economy and population.

[55] National Electrical Manufacturers Association, *State Mercury-containing Product Legislation*, including state requirements on labeling, product phase-out, manufacturer take-back, notification, and disposal bans for mercury-containing products. http://www.nema.org/gov/env_conscious_design/mercury/

In reviewing lamp recycling and mercury reduction programs in other states, we noted that evaluation of program results is often limited. In particular, only a few states conduct regular tracking of recycling rates, including lamp generation data. Minnesota is the only state reported to have reached 80% recycling, though anecdotal reports suggest that several other states are recycling significantly more lamps than the national average. Based on this review, key elements of programs that show recycling success are full disposal bans, coupled with convenient take-back mechanisms for residents, such as collection at most hardware stores.

In identifying potential options for Washington, we researched the efforts that other states have undertaken and obtained additional insights through interviews with program managers and relevant nongovernmental organizations, such as NEWMOA. We supplemented these findings with information from some local government representatives as well as a brief review of programs outside of the United States. From these sources, we identified and reviewed both voluntary and regulatory approaches to increasing lamp recycling in order to present the options outlined in this report.

5.1 Key Findings

Chapter 5 outlines recommended approaches for increasing recycling rates, reducing mercury in the environment, and achieving Ecology's fluorescent lamp goals, based on analysis and input from key contacts in programs elsewhere working to reduce mercury in the environment. Potential options were developed through telephone interviews, in-person meetings, research, and other communications with states, counties, other public agency staff members, and additional contacts.

Reaching an 80% fluorescent lamp recycling rate in the next eight years is an ambitious goal, and meeting the goal will require significant changes from the status quo. Model programs like Minnesota's, which achieved estimated 80% recycling in 2005, demonstrate that such success is possible. The options offered herein are intended to provide a path to 80% lamp recycling in Washington, though it should be recognized that the most effective approaches for dramatically increasing recycling are not likely those that are most easily feasible, convenient, or expedient. Successful implementation of these policies requires significant resource investments, commensurate with the degree of change desired. Though this project was designed to focus on commercial lamp generation, not residential, many of the policies needed to reach 80% recycling also involve approaches to increasing recycling among residents.

- **Achieving 80% lamp recycling likely requires a broad-based disposal ban**, which must be accompanied by convenient recycling options to be effective.

- **Ecology should actively support and participate in a product stewardship initiative** on fluorescent lamps, including reducing mercury content, developing take-back mechanisms, and financing the lamp management system.

- **Washington State government should lead by example**, purchasing low-mercury lamps, integrating recycling with lamp purchases and contracting, and recycling all of its spent lamps. Such efforts should include local governments and schools, and together they can provide an effective model for other lamp users.

- **Conduct inspections and actively enforce existing rules**, including waste management, labeling, and notification laws and regulations; use any fines collected to support progress on lamp recycling. Clearly articulating the need for mercury control beforehand can help make enforcement more palatable. A disposal ban on all mercury-containing lamps would facilitate enforcement. In addition to otherwise regulated generators of dangerous waste, many commercial, office, and retail establishments offer

ripe targets for increase lamp recycling in light of their spent-lamp generation and current recycling rates.

- **Support development of a reverse-distribution system**, particularly one in which costs of recycling are covered at the front end. Such an effort is likely to be costly and difficult, but coupled with a disposal ban, it is the most effective way to increase lamp recycling.

- **Support local government efforts** to expand recycling opportunities, enforce existing waste rules, conduct education and outreach, and "walk the talk" through internal procurement, contracting, and lamp recycling efforts. Such support may include Coordinated Prevention Grants.

- **Consider a legislative mandate on manufacturers to track and meet recycling goals**, or face stiff monetary penalties. Monitor Massachusetts' experience with such efforts to see if they offer an appropriate and effective model for Washington State.

- **Partner with other states to develop effective lamp recycling and mercury reduction policies.** Washington's current involvement in the Interstate Mercury Education and Reduction Clearinghouse is valuable and should be continued.

- **Expand existing education and promotion efforts** to address the number-one reported reason for not recycling lamps: needing more information. Improved labeling of lamps and their packages may also contribute to such efforts.

- **Engage industry stakeholders** in Washington in developing tangible approaches to increasing lamp recycling and forging effective strategies to reach non-recyclers.

- **Consider fees on toxics use and energy-inefficiency to finance lamp recycling**, such as a tax on mercury content or incandescent light bulbs.

5.2 Initial Actions to Increase Lamp Recycling

Initial recommended actions require no significant policy changes, such as new legislation, for implementation. These options are generally not expected to make as sizeable contributions to Washington's lamp recycling as the *New Policies* outlined in the subsequent section. Even taken together, the initial actions likely remain insufficient to help Washington reach its 80% lamp recycling goal, though they do represent important steps in the right direction. These activities are expected to contribute to incremental improvements in the state's recycling rate, though achieving more dramatic increases will likely necessitate at least some of the broader policy changes outlined in the *New Policies* section following these *Initial Actions*. Despite these shortcomings, the *Initial Actions* remain a useful part of Washington's lamp recycling and mercury reduction strategy because they can generally be implemented within existing policy and political frameworks and do not require substantive new legislation in order to take effect. We recommend consideration and adoption of these efforts in the interim period as Washington works toward more ambitious policy changes to enhance fluorescent lamp recycling in the state.

5.2.1 Education and Promotion Campaigns

Education, promotion, and outreach campaigns are a mainstay of mercury reduction and lamp recycling efforts. Such efforts are more effective in combination with other measures, such as a disposal ban, but providing information on the need for lamp recycling and instructions on how to recycle lamps can help address the key awareness gaps identified in the stakeholder surveys and interviews.

Such campaigns could be targeted toward particular user groups identified as having high information needs, high potential for behavior change, or both. Groups such as property managers, grocery stores, lighting contractors, or tanning salons could be the subjects of targeted educational campaigns on why and how to recycle lamps. The Oregon Department of Environmental Quality, for example, has found substantial success in recycling outreach to large contractors, who dispose of entire lighting systems at once. It warns, however, that reaching smaller contractors has been a much less fruitful endeavor. Businesses that are already regulated as dangerous waste generators overall appear more likely than other companies to recycle their fluorescent lamps, though this sector still shows room for improvement. Many commercial, office, and retail establishments offer ripe targets for outreach in light of their sizeable generation of spent lamps and typically lower recycling rates.

One type of targeted outreach campaign could focus on encouraging businesses to develop **lamp management plans**. (Such plans could also be required under state regulations.) California emphasizes to businesses that such plans will help streamline their compliance efforts.

Key educational messages could include the following topics:

- The laws and penalties associated with improper lamp disposal, particularly if new, more stringent policies are adopted;
- The proper procedures and channels for fluorescent lamp recycling;
- The environmental and health impacts of mercury contamination; and
- Proper cleanup procedures in case of accidental lamp breakage and spills.

Mechanisms for educational outreach to businesses and residents may include efforts such as the following:

- Stickers on dumpsters regarding fluorescent lamp recycling and proper disposal (e.g., “Dump No Fluorescent Lamps”);
- Outreach through appropriate industry associations, including newsletters, websites, and other publications;
- Improved labeling on lamps and their packaging could help make warning labels more clear as well as provide more information on how and why users should handle lamps properly.
- Direct mailings;
- Media campaigns, including public-service announcements, television ads, radio spots, and newspaper inserts;
- Billboards and other public advertising;

- Websites;
- Utility bill inserts;[56] and
- Displays in retail stores.

A broad-based education campaign could raise awareness among residents as well as businesses. Ecology's 2002 *Mercury Awareness Study* found that only about a third of respondents knew that fluorescent light bulbs contained mercury, and only a tiny fraction mentioned fluorescents when asked to name items that contain mercury. About 60% of residents reported having fluorescent lamps in their homes, and the large majority of those said they would throw burned-out lights in the trash.[57] It would be helpful to repeat this survey to determine if awareness levels have risen in the last five years.

In Minnesota, the program manager emphasized that keeping businesses and residents informed is central to their lamp recycling success. Such an approach entails ongoing reminders about lamp recycling, rather than simply an initial media blitz when new policies are first implemented.

In the past, several states have successfully procured grants from the U.S. Environmental Protection Agency to implement educational campaigns, including California, New Jersey, and Vermont. Educational efforts alone do not necessarily produce measurable change, however. For example, Maine sent out two direct mailings of about 60,000 pieces each and did not receive a single phone call in return. Coupling education with new policies, such as a disposal ban, can enhance overall effectiveness and boost lamp recycling.

5.2.2 Enhanced Regulatory Enforcement

The existing regulatory framework makes it difficult for Ecology to identify and penalize violators of lamp management rules. Manifesting and annual waste reporting of fluorescent lamps is not required under the Universal Waste rule, so Ecology inspectors cannot easily identify generators of waste lamps. Also, the infrequency with which lamps are replaced in large quantities – typically once every several years – makes it difficult for an inspector to spot illegal lamp disposal. Inspectors essentially have to catch violators in the act of throwing away more than the threshold quantity (220 pounds, which is equal to about 350 to 400 four-foot tubes) of hazardous waste lamps at one time. Currently, Ecology does not conduct dedicated inspections for fluorescent lamps, so a violation of dangerous waste or Universal Waste rules would only be identified in conjunction with an overall hazardous waste inspection. Some increases in regulatory enforcement may be possible under existing rules. Potentially, Ecology could work with local governments and health jurisdictions on enforcement, possibly contracting with them to conduct their own inspection and enforcement activities on lamps. Currently, the main enforcement mechanism that local governments have for their own city and county disposal bans is refusal to accept the waste for disposal, not monetary fines or other penalties. More stringent penalties may be needed, as discussed in the *Disposal Ban* section below.

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[56] Some states have found electric utilities to be a valuable ally in outreach. The Public Utilities Commission (PUC) of Minnesota recognized that improper disposal of mercury containing lamps could threaten the transition to energy-efficient fluorescent lighting from inefficient incandescent bulbs. Accordingly, the PUC included brochures about proper lamp disposal with electricity bills, and the Minnesota Department of Environmental Protection supported bill-stuffing as an effective strategy.

[57] Gilmore Research Group, *Mercury Awareness Study: Survey of Residents, State of Washington*, prepared for Washington State Department of Ecology, 02-03-060, November 2002, pp. 9, 14-15.

The Mercury Education and Reduction Act of 2003 (MERA) requires that new fluorescent lamps be labeled as containing mercury and include information on proper disposal. Compliance has likely increased since Ecology conducted initial spot checks of labeling in 2005, but continued inspections and enforcement may be needed to ensure that manufacturers, distributors, and retailers are complying with MERA's labeling requirements for mercury-added lamps. In response to various state laws, NEMA has since implemented a nationwide labeling program.

Vigorous enforcement activities, particularly against smaller businesses, may not be popular politically and would likely elevate tensions between Ecology and the business community. Education and outreach efforts that raise awareness of the risks of mercury and need for action may help build public support for regulatory action, including strong enforcement.

Without enforcement, mercury laws lack teeth. For example, Minnesota reports that its success would not have been possible without punitive measures. Improper disposal of mercury carries a maximum fine of $700 for individuals and $25,000 for businesses. In Alberta, the maximum fines are $50,000 and $500,000 Canadian, respectively. California subsidizes spot-checking in part with the fines it collects from violations.

Enacting a comprehensive disposal ban, however, would greatly simplify and strengthen enforcement efforts. Under a ban, lamps found in the garbage would be a clear sign of an infraction, as opposed to the onerous task of proving illegal disposal under the current dangerous waste laws. Ecology could also consider ways to make relampers and lighting contractors responsible for the spent lamps that they replace, though many contractors interviewed said that they already embed the cost of lamp recycling in their service fees.

5.2.3 Government Leadership

Given their size, government entities can make a dent in the recycling rate by greatly increasing their own recycling efforts. The State should lead by example, ensuring full implementation of and compliance with the Governor's Executive Orders and related directives on lamp recycling. Staff resources and agency budgets could be directed to achieving 100% lamp recycling and monitoring progress toward that goal.

The State is currently working to incorporate Environmentally Preferable Purchasing goals into its new contracts as they arise for renegotiation. Requiring purchase of the lowest mercury lamps on the market would reduce mercury generation at the source. Contracts can also require lamp recycling and prohibit disposal of lamps. For example, Washington's Department of General Administration contractually requires that contractors performing lighting upgrades must recycle their spent lamps. Combining mandatory lamp recycling with lamp purchases in the contracting and procurement process would also help boost recycling, particularly if it is paid for up-front with the purchase of new lamps. For example, publicly supported energy retrofits should be required to include lamp recycling in the upfront prices when new lamps and fixtures are purchased and installed. Moving toward a "service" approach where the contract covers provision of bundled lighting services, including lamp recycling, instead of simply buying lamps would also foster recycling.

Washington State can also work with its many political subdivisions, including cities, counties, and public educational institutions, to implement similar policies and to strive for total lamp recycling, at least in the public sector. These local governments and institutions have access to the State's contracts for lamp purchasing and recycling, and encouraging their use could increase lamp recycling. State partnerships with local governments as well as with other states, both within and beyond the Pacific Northwest region, can help advance lamp recycling. Finally, as Washington State conducts and models successful lamp recycling within its own state government operations, it can identify strategies and approaches that could also help increase lamp recycling in the private sector.

5.2.4 Expanded Recycling Opportunities

When asked how they thought state and local governments should encourage more lamp recycling, nearly two-thirds of respondents called for more convenient recycling options. Making it as easy to recycle a lamp as it is to buy one would boost recycling and minimize barriers that could impede the transition from incandescent bulbs to energy-efficient fluorescent lamps. Because the market value of recycled lamp components is negligible, however, lamp recycling is unlikely to be self-supporting. Accordingly, a funding source, such as lamp generators, government, or manufacturers, will need to support the cost of lamp recycling.

Under the agreement between the Department of Ecology and King County, we did not interview lamp recyclers, with the exception of one local company. Accordingly, we could not assess their existing capacity and contributions to Washington State's infrastructure for recycling fluorescent lamps. Based on our contacts with lamp users, relamping companies, and other resources, however, we expect that Washington's lamp recycling infrastructure is generally sufficient for handling lamps from significant generators in the state's population centers. Washington State has only one in-state recycler that crushes and processes lamps, EcoLights Northwest. This situation does not appear to create a significant barrier to lamp recycling in the state, however, as multiple companies based elsewhere offer recycling services in Washington. Both local and regional lamp recyclers may have additional capacity to accept and process more fluorescent lamps, and national recycling companies are also available to provide recycling services in the region. In a previous review of the national system for lamp recycling, the Association of Lighting and Mercury Recyclers noted that some recyclers were operating at only one-third of their design and permitted capacity.[58]

The existing infrastructure, however, does not always support cost-effective recycling services for small businesses and households, especially when located in more remote areas. Service from lamp recyclers or haulers may be limited in more rural locations, where pick-up and transportation costs are typically higher. Mail-back box programs are an option available to companies in remote locations, though box mailers are a relatively expensive way to handle fluorescents on a per-lamp basis. Though households were not a focus of the current project, residents may be able to dispose of fluorescent lamps through local government programs for household hazardous waste (HHW) or moderate risk waste (MRW) collection. The Take-It-Back Network of participating retailers also offers lamp recycling for a per-unit fee for residents in King, Pierce, Snohomish, and Yakima counties. Veolia also recently unveiled a prepaid mailer designed for households to use for recycling their compact fluorescent lamps, though at $20 for 12 lamps, its use may not be widespread.[59]

- **Support for existing recycling options.** Though recycling opportunities exist, transportation and costs may prevent lamp generators from using them. Government support through sponsored or subsidized lamp pick-ups in rural areas, cost-incentive vouchers, and other subsidies may help increase lamp recycling, though such efforts are costly and necessitate a funding source. Educational efforts to raise awareness of existing recycling opportunities may also promote the use of these recycling options.

- **Lamp take-back for residents.** Fostering take-back opportunities in the retail, wholesale, and lamp installation channels – or, "reverse-distribution" models – would make recycling more convenient. Such models are most commonly applied to retailers

[58] Association of Lighting and Mercury Recyclers, *National Mercury-Lamp Recycling Rate and Availability of Lamp Recycling Services in the U.S.*, Calistoga, Calif., November 2004, http://www.lamprecycle.org.

[59] Veolia Environmental Services, "Veolia Environmental Services Announces Pre-paid Compact Fluorescent Lamp (CFL) Recycling Program for Households: Consumer CFL Kit Makes Recycling of Compact Fluorescent Lamps Simple and Convenient for Households," Lombard, Illinois, 2007.

for residential lamp users, such as the network of lamp recycling depots at Ace and True Value hardware stores in Minnesota and Vermont. In these programs, these smaller retailers have voluntarily collected used lamps for recycling as a way to provide a valuable service, differentiate themselves from the "big box" chain stores, and draw customers to their stores. California reported, for example, that auto-part stores tend to sell $60 to $80 worth of merchandise every time a consumer returns to dispose of oil; comparable figures are not available for lamp recycling, but retailers may offer programs with similar sales goals in mind. Some stores may charge a nominal fee for recycling, while others provide free recycling with the purchase of new lamps, as is common in Minnesota.

Smaller, independent hardware stores such as Ace and True Value have been cooperative with reverse-distribution product stewardship in other states. The larger hardware chains, like Home Depot and Lowe's, have not been amenable thus far to such approaches for their own stores. In contrast, international retailer IKEA committed to sell only low-mercury lamps and to establish free recycling programs before launching its fluorescent lamp sales campaign. With only 30 stores in the U.S., IKEA does not offer widespread recycling opportunities, though its take-back model may prove useful for other retailers. In comparison, Wal-Mart has not pursued a take-back effort to accompany its pledge to sell 100 million compact fluorescent lamps in 2007, though it has offered several one-day pilot collection events using boxes from Mercury Waste Solutions and Waste Management. (Curbside collection is generally not considered a viable option for residential lamp recycling, primarily due to cost and safety concerns.)

- **Lamp take-back for businesses.** Reverse-distribution models can also be developed to recycle lamps from commercial and institutional generators. For example, lamp distributors can take back the lamps that they sell when they reach the end of their useful life, either through pick-ups or drop-off deliveries. Relamping contractors can include lamp recycling as part of their lamp replacement services. Establishing an extensive statewide network of lamp take-back opportunities may require a legislative mandate, but some companies that sell and install lamps may be willing to undertake such efforts voluntarily, as a way to expand and improve the services they offer to their customers. NEWMOA identified several successful models for wholesaler lamp take-back in Connecticut, Maine, Massachusetts, and Vermont. Take-back programs involved customer drop-offs, wholesaler pick-up from customers, and subcontracting with a recycler that used mail-back boxes. When Maine enacted its disposal ban, one lamp distributor in Bangor recognized a business opportunity and become permitted as a Universal Waste consolidation facility in order to collect its customers' lamps and store them for pick-up from a national lamp recycler.[60]

[60] Northeast Waste Management Officials' Association, *Sample Electrical Wholesaler Lamp Take Back Programs*, June 8, 2005.

- **Public facilities.** Local governments can also provide a channel for recycling lamps through their moderate risk waste (MRW) collection facilities, such as hazsheds at transfer stations, mobile collection services, or other dedicated depots. These facilities collect household hazardous waste (HHW), and some also accept materials from businesses that are conditionally exempt small-quantity generators (CESQGs). Lamp manufacturers have recommended that local governments open all MRW facilities to SQGs, though such a step would increase costs to the public sector. This idea, however, represents a step in the opposite direction from local government goals to engage lamp producers in the responsibility for recycling costs. State support could assist local government programs in increasing lamp recycling, but again funding is needed. States like Minnesota and Maine have made substantial investments in their lamp recycling infrastructure to ensure that convenient lamp recycling opportunities are available throughout the state. Other states without such a recycling infrastructure, such as Oregon, report that comprehensive lamp recycling will not be realistic as long as lamp generators find it inconvenient.

Policy changes, subsidies, or additional government support may be needed to help facilitate and foster lamp recycling for smaller-quantity lamp generators, rural areas, as well as households. Some of the options outlined elsewhere in this chapter could help address these needs, though additional efforts may be necessary, particularly for the residential sector. If Washington State pursues a lamp disposal ban, a brief investigation of recycling capacity, coupled with regular communication with recyclers, should help avoid major disruptions in supply and demand as Washington's lamp recycling levels rise.

5.2.5 Product Stewardship

Product stewardship is a product-oriented approach to waste management that distributes the responsibility of environmental protection across the various parties involved in the product's lifecycle. By involving the appropriate parties, including manufacturers and distributors, regulators can make substantial progress on environmental goals with reduced impacts on stakeholders and governments. Product stewardship efforts for lamps could focus on either the product itself (e.g., reducing mercury content in lamps) or end-of-life product management issues (e.g., lamp recycling through take-back programs).

Product stewardship efforts could include research support for the development of new technologies for lower-mercury or mercury-free lamps, including lighting alternatives such as light-emitting diodes (LEDs). Indeed, keeping mercury out of the environment through prevention or source reduction of mercury content in lighting offers some advantages over trying to capture it through end-of-life product recovery and recycling.

Product stewardship could also involve development of and funding mechanisms to support lamp take-back programs through retailers or manufacturers, though manufacturers and big-box retailers have not expressed interest in such efforts in the past. The Product Stewardship Institute, a national nonprofit organization, has proposed to initiate a stakeholder dialogue on the topic of fluorescent lamp recycling, with the goal of developing a national solution for managing lamps, including a sustainable, non-government funding source. Washington State should join this process as an active participant and potential sponsor.

Product stewardship efforts can be either voluntary, including signing a Memorandum of Understanding with industry groups and other parties, or mandated, such as a take-back program required in legislation. Connecticut offers an example of voluntary product stewardship, in which wholesalers and retailers are encouraged to establish reverse distribution programs to take spent lamps from residents and businesses and return them to a facility for recycling. In contrast, Massachusetts has mandated product stewardship efforts by requiring that lamp manufacturers increase lamp recycling rates in the state or face hefty financial penalties.

5.3 New Policies to Reach 80 Percent Lamp Recycling

Evidence suggests that achieving Washington's 80% lamp recycling goal will take more than voluntary efforts enacted under the existing legislative framework. Dramatic increases in recycling will likely require enacting comprehensive new policies to foster lamp recycling. Adopting a disposal ban is foremost among these options, and additional efforts could include mandatory take-back programs, reporting, or required recycling rates.

5.3.1 Disposal Bans

The states with the strongest lamp recycling programs all have bans on the disposal of mercury-containing lamps. Several Washington counties also have lamp disposal bans in place, though they lack the authority for strong enforcement provisions. Some state bans are farther-reaching than others, with some covering only businesses, non-TCLP-compliant lamps, or incineration, while others extend to all residents and include even "low-mercury" fluorescent lamps.

A broad disposal ban that extends to all fluorescent lamps, regardless of type, generators, or quantity is most effective in supporting recycling. Having improper disposal of mercury-containing lamps be illegal under all circumstances also facilitates enforcement. Enforcement of a disposal ban can include spot-checking dumpsters, landfill inspections, and other activities; some enforcement may occur through local governments. Sufficient funding and legal penalties are key ingredients of successful enforcement and thus implementation of a disposal ban. In Minnesota, the state can levy fines of up to $700 for individuals and $25,000 for businesses, and the law even includes provisions for jail time if infractions persist.

Lamp manufacturers like Philips that have made significant investments in developing low-mercury lamps have argued that these "green-cap" lamps should not be included in disposal bans. Several states have opted to extend their bans to all lamps, however. Maine chose to ban the disposal of fluorescent lamps after its independent testing had difficulty discerning substantial differences in measured mercury content of lamps designated as meeting the testing requirements of the Toxicity Characteristic Leaching Procedure (TCLP) and non-compliant lamps. Exempting some lamps also makes a disposal ban more difficult to enforce.

Washington could consider lowering the mercury threshold for regulation or using a test of total mercury content, such as California's, instead of TCLP levels. Based on our review of program options, however, we believe than a full disposal ban would be more effective.

Though a full disposal ban is more effective for boosting recycling, Washington could consider a phased approach in which the ban covers some or all businesses first and is later extended to include small-quantity generators and households. Such a ban could be enacted as an amendment to the Mercury Education and Reduction Act (MERA) or in a separate bill. Building public awareness of the problem and support for mercury control would assist passage of such a law, and ensuring that adequate recycling options are available will promote the success of any such policy enacted.

To level the playing field among lamps and avoid creating a disincentive for fluorescent use, the idea of covering *all* lamps, including incandescent lamps, in a disposal ban or recycling mandate has recently emerged. Though such a policy could be highly effective, passage would be a steep uphill battle. Accordingly, we recommend focusing efforts on passing a disposal ban on mercury-added lamps.

5.3.2 Recycling Mandates

Coupled with disposal bans, several states have also enacted mandatory recycling policies, sometimes aimed at specific groups. In Minnesota, for example, utilities serving populations greater than 200,000 people must provide lamp collection for both households and small businesses. Other laws require all businesses, residents, or both to recycle their fluorescent lamps; some recycling mandates only apply to businesses of a certain size or that generate a specified number of lamps.

Massachusetts has enacted the most sweeping recycling requirement to date, placing the responsibility on lamp manufacturers to achieve a specified schedule of recycling rate improvements or face financial penalties. Under the law, lamp manufacturers must develop outreach and education programs on lamp disposal. If annual recycling targets are not met (e.g., 30% by 2008, up to 70% by 2011), each manufacturer must pay up to $1 million per year of non-compliance into a fund to support the cost of municipal or regional mercury recycling programs.[61] Massachusetts passed its law in 2006, so implementation has just begun, but Washington should track the state's experience closely. If successful, this ambitious plan could offer a model for other states seeking new ways to achieve lamp recycling success.

In cooperation with other states, such as through the IMERC coalition, Washington may be able to help advocate for a national lamp recycling program. New Hampshire and other eastern states have supported such a strategy, though industry challenges would make passage difficult. ALMR has also advanced recycling legislation at the national level, but manufacturers, represented by NEMA, opposed it, and it did not progress through Congress. Accordingly, we see this option as desirable, but not particularly viable, at the current time.

5.3.3 Lamp Take-back Programs

Some product stewardship efforts, including take-back initiatives, can take place voluntarily, while others may require a legislative push. Mandated take-back programs require purveyors (which could include manufacturers, retailers, wholesalers, installers, and other distributors) of mercury-added products to take back their products for proper management and recycling at end-of-life. In Connecticut, for example, manufacturers of any mercury-added product must establish a collection system plan. Such policies can be targeted to lamp producers (i.e., manufacturers) or other participants in the distribution supply chain. Lamp manufacturers have generally been hesitant about such Extended Producer Responsibility policies, and they advance a number of arguments regarding why manufacturer take-back of lamp would be inefficient and undesirable. Responsibility for take-back can also be placed on the companies in the distribution network, such as retailers and wholesalers.

Having a strong take-back network would bolster lamp recycling. If such a system cannot be developed through voluntary measures, Washington should consider a mandatory take-back program, though such efforts may be costly. Leaving some flexibility to manufacturers and purveyors for how they implement such a requirement may help make the program more palatable to the regulated community and also more effective. Along these lines, policymakers could set broad performance goals and allow businesses room for innovation in how they achieve the desired outcomes, in terms of lamp recycling or mercury reduction, rather than prescribing a specific method.

[61] State of Massachusetts, *An Act Relative to Mercury Management*, Chapter 190 of the Acts of 2006.

5.3.4 Mandated Reporting for Lamp Sales and Recycling

The ability to measure lamp recycling rates accurately is an important element of making progress toward a recycling goal. Washington has a strong starting point on tracking recycling rates, more than most states, though tracking could be improved significantly. Two states have adopted laws that require lamp manufacturers or lamp recyclers to report lamp quantities to the state. Currently, Minnesota is the only state reported to have achieved an 80% lamp recycling rate. To measure its recycling rate, the state requires that all recycling facilities track and report the quantities of lamps that they process.

- **Recycling reports.** Minnesota's early and strong implementation of a mercury-added lamp disposal ban has lead to the development of a strong local lamp recycling industry, which also includes national recycling companies such as Mercury Waste Solutions, Inc. (MWSI) and Mercury Technologies, Inc. Accordingly, much of the state's lamp generation is expected to be recycled within the state, which facilitates tracking. Lamps brought to Minnesota for recycling from out-of-state sources are also accounted for. Like other states, Minnesota uses national data on lamp sales and generation for the denominator in calculating its recycling rate. Mandated reporting could help Ecology obtain better data from recyclers for use in its recycling rate calculations, though voluntary approaches may be sufficient. Washington has only one in-state lamp recycler. One national company has physical locations in the state, but Washington's lamp recycling is otherwise served by out-of-state companies, or waste handlers that send the lamps to another company for processing. Imposing reporting requirements on non-Washington companies may be less than effective without a sufficient incentive to comply or penalty for failure to report.

- **Sales reports.** Mandatory reporting can also apply to the denominator of the recycling rate equation – that is, lamp sales and generation data. In 2006, Massachusetts passed legislation requiring manufacturers to report on the number of lamps sold to retailers, wholesalers, and contractors within the state.[62] This law is designed to enable Massachusetts to obtain a more precise number of lamps within the state, rather than apply estimates based on per-capita lamp consumption extrapolated from national data. If the Massachusetts experience proves successful, Washington may wish to consider similar requirements to obtain state-specific data from lamp manufacturers.

5.3.5 Integrating Recycling into Lamp Prices

Although lamp recycling represents only a small portion of the *lifecycle* cost of the lamp (estimated at 1% to less 5%), when energy costs are factored in, recycling can equate to a more significant portion of the lamp's *purchase* cost (up to a quarter or a third). Such costs, however, represent an unfunded mandate and can pose a barrier to recycling. Indeed, recycling cost was a common concern reported in the stakeholder interviews and surveys. Finding a way to pay for recycling up-front and cover the cost of recycling earlier in the lamp lifecycle could remove a barrier to recycling and boost recovery rates. Washington's electronic waste legislation may offer a potential model for such an approach.

Product stewardship approaches, mandatory or otherwise, have the potential to incorporate recycling costs at the manufacturer level, though lamp makers currently oppose such measures. Alternately, the cost of recycling could be paid at the retail or wholesale level in the form of an

[62] National Electrical Manufacturers Association, *Education Plan for Massachusetts Consumers and Municipalities for the Proper Use and Disposal of Mercury-added Lamps*, provided to Massachusetts Department of Environmental Protection, December 22, 2006.

advance recycling fee (ARF), or front-end fee, which covers the cost of recycling at the time of the lamp purchase. Similar methods are used for other products that pose end-of-life management concerns, such as automobile tires. The downside of such measures is that fluorescents, at least in residential markets, compete with incandescent lamps, which are much cheaper in terms of original purchase price (though they are more expensive when energy costs are accounted for). Manufacturers, retailers, and likely consumers are thus sensitive to any measures that could further increase the price of fluorescent lamps.

Utilities, governments, and others that are promoting the use of energy-efficient fluorescents may be able to help defray these costs, but ultimately the money will have to come from somewhere, whether it is direct payment from buyers or manufacturers or by way of taxes. In planning for the Take-It-Back Network in the central Puget Sound region, local utilities argued against funding the system, saying they already lose money on energy-efficient lamps and cannot afford further payments to support lamp recycling.

In addition to paying for recycling, a front-end fee could also be structured to allow the creation of a "bounty," or deposit payback, for lamps that are returned for recycling. Similar to a bottle bill for container recycling, such an effort would create an additional market-based incentive for lamp recycling. Deposit-refund systems such as these are often considered by economists to be the most economically efficient policy choices to support recycling.

An alternate scheme could place a tax on incandescent lamps to support the recycling of fluorescents, and thus avoid creating a disincentive for fluorescent purchases. In its recent legislative session, Minnesota proposed a 25-cent tax on incandescent bulbs. In related efforts, several U.S. states have proposed phase-outs of incandescent lamps. No incandescent ban is in force yet, but Canada, Australia, South Africa, Cuba, and other nations are currently moving forward with bans or phase-outs on incandescent lamps.[63]

5.3.6 Taxes and Credits

Though it poses political and technical feasibility challenges, a tax on mercury content of products could help foster decreases in mercury content of lamps and other products as well as provide funds to support recycling of lamps and other mercury-added products. The tax could be structured to encourage producers to develop low-mercury lamps by weighting taxation in proportion with a product's mercury content.

According to IMERC's database, for instance, 12% of fluorescent tubes contain less than five milligrams of mercury, while nearly half contain between five and ten milligrams. Taxing the low-mercury lamps at a lower rate than those with higher mercury content would encourage reduced mercury levels as well as help finance recycling programs. The tax could be directed to the manufacturers or the purchasers, though better disclosure of mercury content is needed. (MERA currently requires labeling of mercury-containing lamps, though it does not require reporting of the

[63] Minnesota Senate Bill 1442 (2007); Alaska, residential and office by 2008 (HB 219); California, by 2012 (AB 722); Connecticut (H.B. No. 6550); New York, by 2012) (A 7944 and S 5823); North Carolina, ban by 2016, amended to a study of ban (HB 838); Rhode Island, ban by 2012 (S 0806); South Carolina, ban by 2017 (S 0697); Australian Greenhouse Office, "World First! Australia slashes greenhouse gases from inefficient lighting," press release February 20, 2007 (http://www.environment.gov.au/minister/env/2007/pubs/mr20feb07.pdf); Natural Resources Canada, "Lighting the Way to a Greener Future: Canada's New Government to Ban Inefficient Light Bulbs," press release April 25, 2007 (http://www.nrcan-rncan.gc.ca/media/newsreleases/2007/200735_e.htm); Spongenberg, Helena, "EU Could Ban Incandescent Bulbs," Business Week, June 22, 2007. http://www.businessweek.com/globalbiz/content/jun2007/gb20070622_706666.htm?chan=globalbiz_europe+index+page_top+stories; Ban the Bulb campaign, www.banthebulb.org.

amount of mercury. Some states have notification requirements for manufacturers regarding mercury content; these reports are assembled in the IMERC database of mercury-containing products.)

As climate change concerns become more pressing, Washington or the U.S. may at some point adopt a carbon tax. Depending how it is structured, such a tax may favor the sale of energy-efficient fluorescent lamps and increase the cost of incandescent lights. A portion of these costs could be redirected to support lamp recycling.

In Oregon, the state offers tax credits for fluorescent lamp and ballast recycling, but the impact of this policy is uncertain.

The Minnesota Model, Part I: Achieving 80 Percent Lamp Recycling Statewide

Minnesota has been a pioneer in establishing programs to reduce mercury. The state has developed programs which have been emulated around the country, including the predecessor to the federal Universal Waste rule. The disposal ban and recycling requirement for mercury-containing products spurred local and state governments, manufacturers, waste haulers, and companies to establish programs to handle these products. Recycling facilities were established in the state, and lamp recycling became a viable industry. Minnesota has a state lamp recycling contract and a mercury recycling contract, which also handles lamps. Local hazardous waste facilities cover the entire state, and county HHW facilities can use the state contracts for any materials they collect and obtain the State's volume pricing for hazardous waste management.

In 1993-1994, Minnesota became the first state to ban fluorescent lamp disposal and require all households and businesses to recycle such lamps, including low-mercury models. The Minnesota Pollution Control Agency (MPCA) states that they focus enforcement efforts on lamps. Most violators pay only a small fine or no fine, but the maximums are $700 for individuals and $25,000 for businesses. The law even includes provisions for jail time if an infraction persists. The National Electrical Manufacturers Association fought this state legislation bitterly but lost its battle.

Small-scale lamp recycling is largely conducted through retail stores and county-run hazardous waste collection programs. Providing convenient opportunities to recycle lamps is a key to the program's success. Mercury Technologies, a Minnesota-based lamp recycling company, has partnered with over 200 hardware stores to collect spent lamps from customers. In many cases, small retailers voluntarily collect lamps for recycling and have contracts with recyclers. The big-box stores have generally not embraced lamp recycling efforts, including product stewardship approaches. Hardware stores usually charge a fee for recycling or offer recycling services in exchange for the purchase of a new lamp. At least one utility, Xcel, regularly offers its customers coupons for lamp recycling and reimburses participating hardware stores. County-run voluntary hazardous waste collection programs for households and small businesses have accepted fluorescent lamps since 1993, and utilities serving populations greater than 200,000 are required to provide lamp collection for households and small businesses.

Little information is available on programs targeted to larger businesses. The MPCA has developed outreach programs for key mercury use sectors such as hospitals and schools. Under the Mercury-Free Zone Program, schools which pledge to reduce mercury-containing equipment from science labs and health-care facilities are eligible to receive a visit from the MPCA's mercury-detecting dog. While this program has led to the removal from schools of 1,000 pounds of mercury, it is unclear how much of that amount was in the form of fluorescent lamps.

Unlike in many other states, Minnesota has no lamp labeling requirement; however, lamp wholesalers must provide information on how to manage spent lamps to purchasers. The details of this program are not readily available.

Sources: Minnesota Pollution Control Agency, *2002 Mercury Reduction Progress Report to the Legislature*, Appendix B. http://www.pca.state.mn.us/publications/reports/lrp-mercury05-appa.pdf; National Electrical Manufacturers Association, http://www.nema.org/gov/env_conscious_design/mercury/mn.cfm.

The Minnesota Model, Part II: Actual Mercury Reductions

Between 1990 and 1995, mercury content in Minnesota's municipal solid waste declined from 4 parts per million to 1.5 ppm. The lamp recycling rate increased from 0% in 1990 to 50% in 1995 to 80% in 2005. A breakdown of recycling rates among sectors (e.g., residential, commercial) was not readily available. The increase in lamp recycling from zero in 1990 to 80% in 2005 yielded a corresponding decrease in mercury emissions from fluorescent lamp breakage from 272 pounds to 15 pounds, assuming that 25% of the mercury is volatilized. This is roughly a 94% reduction in mercury from lamps, but it represents only about 1-2% of the state's total mercury emissions. There was a simultaneous reduction in mercury content from about 45 mg of Hg per lamp in 1990 to 10 mg of Hg per lamp in 2005.

Over this same time period, mercury emissions in the state were reduced by 70%, meeting the target set by the 1999 Mercury Reduction Law. Since 1999, however, improved understanding of the amount of mercury volatilized from latex paint led to a revision of the 1990 baseline emissions from 8,540 pounds to 11,272 pounds. Had that revision not been made, the emissions reductions from 1990-2005 would have been closer to 60%. Discontinuation of sales of mercury-containing latex paints and two types of fungicides in the early 1990s caused 38% of the total emissions reductions from 1990 levels.

Minnesota now has a new requirement in place to require reporting of quantity data from lamp recyclers. By March 1 of each year beginning in 2008, lamp recyclers must report to Minnesota on the number and type of lamps received by recycling facilities within the state and number of generators. Currently, they approximate total number of lamps consumed as fraction of national figures based on population, but these new data will increase the accuracy of their recycling rate calculations.

Sources: Minnesota Pollution Control Agency, 2002 Mercury Reduction Progress Report to the Legislature, Appendix B. http://www.pca.state.mn.us/publications/reports/lrp-mercury05-appa.pdf; MPCA, 2005 Mercury Reduction Progress Report to the Legislature. http://www.pca.state.mn.us/publications/reports/lrp-mercury/2005.pdf

Table 6 provides an overview and comparisons with Washington State regarding existing policies and programs for management of mercury-added fluorescent lamps in several U.S. states with leading programs, including California, Maine, Massachusetts, Minnesota, and Vermont.

Table 6. Policies on Mercury-added Lamps in Washington and Selected U.S. States[64]

Selected State Policies on Mercury-added Lamps	CA	ME	MA	MN	VT	WA
Fluorescent lamp disposal ban	x	x	x	x	x	
- Lamp disposal ban includes residents	x	x		x	x	
- Lamp disposal ban includes low-mercury lamps	x	x		x		
Mandatory lamp recycling	x			x		
Lamp take-back (voluntary or mandatory)	x	x		x	x	
Onsite lamp crushing ban	x	x		x	x	
Reporting mandate for lamp recyclers				x		
Reporting mandate for lamp manufacturers			x			
Reported recycling rate greater than 50%				x		
Lamp labeling requirements	x	x	x	x	x	x
Utility-sponsored collection and/or education programs	x	x		x		
Manufacturer responsibility for achieving recycling rate goals			x			

5.4 Other Options

In the course of reviewing policy options that could help Washington State achieve its lamp recycling goal of 80 percent by the year 2015, we also considered several other options that are not recommended for pursuit. These options are discussed briefly below.

5.4.1 Status Quo

Continuing with business as usual is anticipated to have little or no effect on lamp recycling rates in Washington. New efforts are needed to help boost recycling rates and achieve the goal of 80% lamp recycling by 2015.

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[64] California, http://www.ciwmb.ca.gov/WPIE/FluoresLamps;
Maine, http://www.maine.gov/dep/mercury/mercury_in_maine.pdf,
http://www.maine.gov/dep/rwm/mercury/pdf/mpac04report.pdf;
Massachusetts, http://www.mass.gov/dep/recycle/hazardous/fluores.htm,
http://www.mass.gov/dep/toxics/stypes/hgtoc.htm,
http://www.mass.gov/dep/public/publications/1006merc.htm,
http://www.mass.gov/envir/Sustainable/resources/pdf/Resources_Hg_Strategy.pdf;
Minnesota, http://www.pca.state.mn.us/publications/reports/lrp-mercury2005.pdf,
http://www.pca.state.mn.us/publications/w-hw4-62.pdf;
Vermont, http://www.anr.state.vt.us/dec/ead/mercury/merc.htm;
national information, http://www.newmoa.org/prevention/mercury/imerc/legislation-2006.pdf;
http://www.nema.org/gov/env_conscious_design/mercury/ma.cfm.

5.4.2 Lamp Crushing

Manufacturers of lamp-crushing devices assert that their products can help increase lamp recycling, and Ecology sought to determine whether it should revise its Universal Waste rule to allow lamp crushing as a way to support recycling. Though other rationale may favor its adoption, lamp crushing is not recommended *as a strategy to increase lamp recycling*. Based on review of existing studies, we also have reservations about its safe implementation. According to Ecology's survey of agency and community college Sustainability Coordinators, only one respondent, a community college, reported using a drum-top crusher to manage its end-of-life lamps.

Contractors or businesses that generate significant volumes of fluorescent lamps may find that storage and transportation of end-of-life lamps is space-consuming and costly. Use of drum-top crushing (DTC) devices allows several hundred crushed lamps to occupy the space that 40 or 50 whole lamps would occupy, thereby reducing storage requirements. DTC manufacturers promote their devices as a way to lower costs, though recycling costs for crushed lamps often exceed costs for handling intact lamps. Accordingly, drum-top crushing may be a relatively costly option that is best suited for locations with severe space constraints. Concerns have also been raised regarding the release of hazardous mercury vapors, which can put device operators at risk.

Several states have categorically prohibited onsite lamp crushing, such as Maine, New Hampshire, Rhode Island and Vermont.[65] Other states rigidly regulate the procedure by issuing permits under hazardous waste management rules; in California, these permits are so difficult to acquire that none have been granted. At the federal level, Occupational Safety and Health Administration (OSHA) standards set a Permissible Exposure Limit (PEL) of 0.10 milligrams of airborne mercury per cubic meter. In a much-awaited study released in August 2006, the U.S. Environmental Protection Agency found that, when drum-top crushing devices were used properly, three out of four models maintained mercury below the PEL. However, it warned that minor errors in the installation or operation of these devices can greatly impact the level of mercury vapors emitted, and 70% exceed the PEL when drums must be changed.[66]

5.5 Next Steps on Policy Options

Reaching an 80% fluorescent lamp recycling rate in the next eight years is an ambitious goal. Achieving it will not be cheap or easy, but doing so would prevent the release of an estimated 280 pounds of mercury annually to Washington's environment and waste stream in support of Washington's *Chemical Action Plan* for mercury. Meeting an 80% recycling rate will require significant changes from the status quo and may face hurdles in engaging important stakeholders. However, model programs like Minnesota's, which achieved an estimated 80% recycling rate in 2005, demonstrate that such success is possible. The options presented in this report are intended to offer a path to 80% lamp recycling here in Washington State.

Recommended options include those that can be implemented without new legislation, such as education and promotion campaigns, voluntary product stewardship and take-back efforts, and support for expanded recycling options. Together, these options are expected to make incremental improvements to Washington's lamp recycling rate.

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[65] NEWMOA and U.S. Environmental Protection Agency, *Summary of Northeast State's Policies Regarding Use of Drum Top Crushers*. http://www.epa.gov/epaoswer/hazwaste/id/univwast/drumtop/newmoa.pdf

[66] U.S. Environmental Protection Agency, *Mercury Lamp Drum-top Crusher Study*, EPA530-R-06-002, August 24, 2006. http://www.epa.gov/epaoswer/hazwaste/id/univwast/drumtop/drum-top.pdf

To achieve greater gains in lamp recycling requires greater efforts on the part of the State, in the form of new laws and policies. Drawing on the experience of other states, the single most important step Washington can take toward reaching its 80% lamp recycling goal is enacting a broad ban on the disposal of all mercury-containing lamps, regardless of their source. To be effective, such a disposal ban must be coupled with enforcement and numerous opportunities for lamp recycling. Product stewardship and take-back programs, either voluntary or mandatory, may be a part of ensuring the availability and diversity of recycling options. Washington should also consider options for supporting lamp recycling through up-front funding via contracting mechanisms, fees, or taxes.

Ecology managers and policymakers should explore these options further, including obtaining input from stakeholders, communications with other states, and participation in multi-stakeholder efforts such as the Interstate Mercury Education and Reduction Clearinghouse and the Product Stewardship Institute's likely upcoming dialogue on fluorescent lamps. Such efforts will enable the State to develop and enact an effective package of policies to achieve its lamp recycling goals.

6 Next Steps for Lamp Recycling in Washington

During the course of this project, Cascadia Consulting Group conducted research with the goal of determining a strategy leading to a significant increase in lamp recycling. The project was divided into three main phases to accomplish Ecology's objectives:

I. **Lamp Recycling Rate Methodology.** Determine the statewide annual lamp recycling rate, estimate cumulative mercury reduction achieved through lamp recycling, and estimate end-of-life lamp generation. Develop a standard methodology to determine the statewide annual lamp recycling rate.

II. **Lamp Sector Analysis.** Gather stakeholder input to understand current attitudes, behaviors, barriers, and opportunities regarding increased lamp recycling.

III. **Develop Strategies.** Identify options, including through research on programs in other states, and make recommendations for increased fluorescent lamp recycling in Washington.

Ecology now has the opportunity to move forward on implementing strategies to increase lamp recycling significantly and to track changes in lamp recycling over time. Proposed next steps include the following:

- Implement the recommended methodology to improve estimates of the statewide recycling rate.
- Follow up with stakeholders who agreed to participate in a dialogue on lamp recycling.
- Pursue recommended policies, including a disposal ban on mercury lamps, engagement in product stewardship initiatives, and development of a lamp take-back system.

These steps are discussed further in the remainder of this chapter.

Implement the recommended methodology outlined in Chapter 3 to improve the estimation and tracking of the statewide annual lamp recycling rate.

The recommended method to estimate recycling quantities is to administer a single annual survey to lamp recyclers to tabulate the number of lamps recycled from Washington generators each year. The recommendation for determining approximate lamp generation is to scale national sales or generation estimates to Washington. Lamp data should be tracked based on number of lamps rather than by weight of lamps, for ease of data collection and relevance to stakeholders and the public. Mandated tracking and reporting of recycling and sales data would improve the accuracy of recycling rate calculations, though enacting such policies would likely be unpopular with members of the lamp recycling and manufacturing industries.

Follow up with stakeholders who agreed to participate in a dialogue through focus groups, roundtable discussions, or additional interviews regarding policy options.

As part of the survey and interview effort, the consultant collected the names and contact information for more than 100 company representatives who expressed interest in participating in further discussions regarding fluorescent lamp recycling with Ecology.

The next steps in increasing the fluorescent lamp recycling rate will be to follow up with stakeholders who agreed to participate in a dialogue through focus groups, roundtable discussions, or additional interviews regarding development and implementation of particular policy options. In addition, Ecology should work to collect input from additional stakeholder groups, such as schools, smaller businesses, building maintenance professionals, and lamp recyclers. Topics for discussion could include:

- Cost incentives supporting lamp recycling such as advance recycling fees;
- Expanding access to lamp recycling services for small businesses, homeowners, and rural locations;
- Simplifying the lamp recycling process, including storage, packaging, and documentation requirements;
- Reducing regulatory burdens associated with lamp recycling, especially regarding broken lamps;
- Regulations such as a disposal ban or mandatory recycling; and
- Improving methods for tracking the number of lamps sold, generated, recycled, and disposed in Washington.

Pursue recommended policies, including a disposal ban on mercury lamps, engagement in product stewardship initiatives, and development of a lamp take-back system.

Recommended options include those that can be implemented without new legislation, such as education and promotion campaigns, voluntary product stewardship and take-back efforts, and support for expanded recycling options. Together, these options are expected to make incremental improvements to Washington's lamp recycling rate.

To achieve greater gains in lamp recycling requires greater efforts on the part of the State, in the form of new laws and policies. Drawing on the experience of other states, the single most important step Washington can take toward reaching its 80% lamp recycling goal is enacting a broad ban on the disposal of all mercury-containing lamps, regardless of their source. To be effective, such a disposal ban must be coupled with enforcement and numerous opportunities for lamp recycling. Product stewardship and take-back programs, either voluntary or mandatory, may be a part of ensuring the availability and diversity of recycling options. Washington should also consider options for supporting lamp recycling through up-front funding via contracting mechanisms, fees, or taxes.

Ecology managers and policymakers should explore these options further, including obtaining input from stakeholders, communications with other states, and participation in multi-stakeholder efforts such as the Interstate Mercury Education and Reduction Clearinghouse and the Product Stewardship Institute's likely upcoming dialogue on fluorescent lamps. Such efforts will enable Washington State to develop and enact an effective package of policies to achieve its lamp recycling goals.

Appendix A. Data Sources on Lamp Quantities

This appendix describes the original data sources reviewed and used for the calculations and conclusions presented in the main body of this report, particularly in Chapter 2, on lamp recycling, generation and usage, and mercury content. The data are summarized under three headings:

- **Recycling Data**, a section that describes methods used by King County and the Washington State Department of Ecology to estimate statewide lamp recycling;
- **Generation Data**, which describes data sources used to estimate lamp generation, including other estimates of generation as well as data sources such as sales and lifespan that were used to estimate generation; and
- **Mercury Content Data**, which describes different sources of the data concerning the quantity of mercury in fluorescent lamps.

A.1 Recycling Data

Both King County and the Washington State Department of Ecology have estimated statewide lamp recycling in Washington. These two studies are summarized below.

A.1.1 King County Recycling Data

In 2006, King County contacted regional and national lamp recycling companies that serve the Pacific Northwest region, including Washington State, to obtain their statewide lamp recycling data for the 2005 calendar year. From the survey responses, King County calculated that six companies recycled 2.4 to 2.6 million lamps, primarily four-foot tubes, from Washington State in 2005. The seven companies surveyed (one company did not respond in 2005, though a recycling estimate for that company was included in 2004) were listed in the main body of this report.

King County's survey data provided a useful measure of lamp recycling in Washington, but due to several data inconsistencies it could not serve as the only basis for quantifying lamp recycling for this study. In particular, data were reported inconsistently among the recyclers. Recyclers reported quantities of lamps recycled in several different units of measure, such as number (actual count of lamp units), linear feet of tubes, weight, and other measures. The recyclers did not consistently categorize or report the various lamp types collected. Other confounding factors include using different conversion factors (e.g., among units of measure), internal disagreement among separate reports from the same company, and anonymity hindering follow-up queries.

A.1.2 Department of Ecology Recycling Data

The Department of Ecology's data were gathered as part of the Solid Waste Program's annual survey of recycling companies in Washington. The survey is voluntary and includes only companies with a presence in Washington. Only two companies included in Ecology's survey were also included in King County's survey: EcoLights Northwest and Veolia Environmental Services (formerly Onyx). These two companies accounted for more than 80% of the total lamps recycled in Ecology's survey.

Ecology's survey estimates that 877 tons of fluorescents were recycled by Washington recyclers in 2004. Weight (tons), however, is an unusual measure for fluorescent lamps, which makes it difficult to compare to results from the King County survey or other sources. If fluorescent lamps received from out-of-state are subtracted from the survey total of 877 tons, then the reporting companies recycled 748 tons of lamps from in-state sources. This tonnage can be converted to estimate the number of four-foot tube fluorescent lamp equivalents. The Department of Ecology, EcoLights, and other recyclers have estimated that lamps weigh 0.15 pounds per foot; therefore, a 4-ft tube weighs 0.6 pounds and an 8-ft tube weighs 1.2 pounds. Estimates from other sources typically range from one-half (0.5) to three-quarters (0.75) of a pound per 4-ft tube; lamp diameter (e.g., T12 or T8) also affects weight.[67] Using the mid-range and locally accepted conversion factor of 0.15 pounds per foot, the Ecology survey data imply that roughly 2½ million 4-ft tube equivalents were recycled from Washington sources.

In separate, informal phone conversations, the top three recyclers of lamps from Washington (EcoLights, EPSI, and Veolia) reported estimates to Ecology that totaled roughly 3 million lamps recycled from Washington in 2004.

A.2 Generation Data

A common method for estimating the quantity of waste lamps generated is to extrapolate the number of lamps that burn out in a given year based on the number of lamps sold in a prior year and their estimated burnout rate based on rated lifespan and typical usage. This section therefore describes data sources for lamp sales and lifespan, plus some independent, national estimates of lamp generation.

A.2.1 Lamp Sales Data and Estimates

The most reliable source of national lamp sales figures is likely to be from the industry itself, organized as the National Electrical Manufacturers Association (NEMA). NEMA tracks sales, and some limited data have previously reported to Cascadia Consulting Group, King County, and others. For example, NEMA previously stated that annual national sales of lamps average approximately 600 million.[68] However, NEMA has not published regular sales summaries in the past, although they did supply sales data to the Association of Lighting and Mercury Recyclers (ALMR) to support that organization's generation and recycling rate calculations.

In addition, several other studies have included estimates of the national lamp sales, although the methodology and primary data sources for these estimates are unclear. Several older studies that have estimated national sales are summarized in the following table, including Ecos-EPA (2001), Reindl (2000), and Ecos-NRDC (1999).[69]

[67] For example, http://www.mass.gov/dep/recycle/hazardous/lampdrum.htm

[68] Ric Erdheim, NEMA, personal communication to Peter Erickson, Cascadia Consulting, 2003.

[69] Chris Calwell, Chris Granda, Lois Gordon, and My Ton, *Lighting the Way to Energy Savings: How Can We Transform Residential Lighting Markets? Volume 2: Background and Reference,* prepared by Ecos Consulting for Noah Horowitz, NRDC, December 1999, p. 10; Ecos Consulting, prepared for U.S. Environmental Protection Agency, 2001; Reindl, J. *Fluorescent Lamp Glass*, March 2000 (in Sustainable Conservation. *Reducing Mercury Releases from Fluorescent Lamps: Analysis of Voluntary Approaches.* Prepared for the Bay Area Clean Water Agencies (BACWA), September 2000).

Table 7. National Lamp Purchasing Estimates

Lamp Type	Quantity	Source
Tubes	500,000,000	Ecos-EPA (2001)
Tubes	600,000,000	Reindl (2000)
CFL	50,000,000	Reindl (2000)
CFL	85,000,000	Ecos-NRDC (1999)

In the Pacific Northwest, the Oregon Environmental Council and the Mercury Solution Team estimated tube and CFL sales figures for Oregon; however, the data and assumptions supporting their estimates are not clear.[70] Nonetheless, scaling the estimate for Oregon to Washington by employment yields an estimate of 10 million tubes, similar to Washington-specific estimates scaled from the national data in Table 7. See Table 8 for details.

Table 8. Annual Lamp Purchase Estimates, Scaled to Washington[71]

Lamp Type	Quantity	Date	Source
Tubes	13,600,000	1999*	Reindl, J. (2000)
Tubes	11,400,000	1997*	Ecos-NRDC (1999)
Tubes	10,000,000	2001	OEC (2001)
CFL	1,000,000	1999*	Reindl, J. (2000)
CFL	1,900,000	1997*	Ecos-NRDC (1999)
CFL	4,400,000	2001**	NEEA

* Exact year of sale unknown

** Includes coupon sales for discounted bulbs

[70] Laura Weiss, MPH and Sandy Wright, *Mercury – On the Road to Zero: Recommended Strategies to Eliminate Mercury Releases from Human Activities in Oregon by 2020*, Oregon Environmental Council and the Mercury Solutions Team, December 2001.

[71] Laura Weiss, MPH, and Sandy Wright, *Mercury – On the Road to Zero: Recommended Strategies to Eliminate Mercury Releases from Human Activities in Oregon by 2020*. Oregon Environmental Council and the Mercury Solutions Team. December 2001; Chris Calwell, Chris Granda, Lois Gordon, and My Ton, *Lighting the Way to Energy Savings: How Can We Transform Residential Lighting Markets? Volume 2: Background and Reference*, prepared by Ecos Consulting for Noah Horowitz, NRDC, December 1999, p. 10; Reindl, John, *Fluorescent Lamp Glass*, March 2000 (in Sustainable Conservation, *Reducing Mercury Releases From Fluorescent Lamps: Analysis of Voluntary Approaches*, prepared for the Bay Area Clean Water Agencies (BACWA), September 2000.); Zero Waste Alliance. *Northwest Compact Fluorescent Lamp Recycling Project - Phase 1 Report*. http://www.zerowaste.org; Northwest Energy Efficiency Alliance data, via Elizabeth Klumpp, Washington State Department of Community, Trade, and Economic Development, and Robert Rieck, Washington State Department of Ecology, 2006-2007.

A.2.2 Lamp Lifespan

Most information on lamp lifespan is listed in terms of rated life, not actual life. Rated life is generally defined as the number of hours at which half of the lamps will have expired, or the median lifespan. Manufacturers report rated life of their bulbs, and two sources were identified that summarize the typical manufacturer-rated lifespans. Data from these two sources, the U*.S. Lighting Market Characterization Study* (2002) and the *U.S. Lighting Market Sourcebook* (1993), are summarized in the table below.

Table 9. Rated Lamp Lifespans in Hours

Lamp Type	Lighting Market Characterization Study	Lighting Market Sourcebook
T5	6,000-7,500	
T8 – less than 4'	15,000-20,000	
T8 – 4'	15,000-20,000	20,000
T8 – More than 4'	7,500-20,000	
T8 – U-bent	20,000	
T12 – less than 4'	7,500-18,000	
T12 – 4'	20,000	20,000
T12 – More than 4'	9,000-20,000	
T12 – U-bent	10,000-20,000	
Compact – Pin-base	10,000-20,000	10,000
Compact – Screw-in	10,000	10,000

Rated life can be converted to a theoretical actual life based on usage characteristics such as length of use per day. NEMA, for example, has used this logic in explaining its long-held assumption of an actual life of 5 years: 16 hours per day, 250 days per year for a 20,000-hour lamp life would equal 5 years.

However, actual life is frequently shorter than rated life for a number of reasons. For example, bulbs lose some of their brightness before rated life or may burn out prematurely, causing many commercial or industrial facilities to replace them earlier, often in "group relamping" practices that replace an entire suite of bulbs rather than just those that have expired.

For reasons such as these, the EPA (1997) has used an average lifespan estimate of 4 years.[72] However, even this estimate is a coarse average and would not be accurate for some uses, such as in 24-hour-burn facilities, which would be expected to have shorter typical lamp lifespans. The estimate may also be problematic in households, where typical daily usage may be much lower than in the commercial or industrial sectors, but where the dominant burn-out mechanism is more likely related to on-off cycles than to factors more closely tied to rated life (such as life of the phosphor or ballast electronics).

[72] U.S. Environmental Protection Agency, *Mercury Emission from the Disposal of Fluorescent Lamps: Final* Report, June 30, 1997.

A.2.3 Lamp Generation

The most recent and reliable estimates of national fluorescent lamp generation are conducted by the Association of Lighting and Mercury Recyclers (ALMR), which estimates lamp generation by applying the industry's standard 5-year lifespan estimate to NEMA sales data. These, combined with a previous estimate by NEMA, likely using a nearly identical methodology, are presented in the table below.

Table 10. National Lamp Generation Estimates

Lamp Type	Quantity	Year	Source
Total lamps	680,000,000	2004	NEMA (2000)
Total lamps	675,000,000	2006	ALMR (2006, via King County)
- Commercial lamps	529,000,000	2006	ALMR (2006)
- Residential lamps	146,000,000	2006	ALMR (2006)

Note, however, that even these estimates are likely somewhat skewed the by use of a single, 5-year lifespan estimate across all bulb types, sectors, and uses. On balance, however, these remain the best available estimates for use and application to Washington. Although few such estimates are available, existing local estimates of lamp generation are still usually based on these national data. However, in 2003, the Zero Waste Alliance used local CFL sales data and projections to estimate that 2.4 million CFLs would reach end-of-life in Washington, Oregon, and Idaho in 2006. ZWA projects that Washington's share is about 1.4 million CFLs.

A.3 Mercury Content

The primary data used to estimate mercury content in the main body of this report were compiled by the Northeast Waste Management Officials' Association (NEWMOA) from the Interstate Mercury Education and Reduction Clearinghouse (IMERC) database of mercury-containing products. NEWMOA reports for 2004 that 12% of fluorescent lamps, which is understood to mean tubes and to reflect the mix of lamps sold in the market, contain less than 5 mg of mercury. An addition 48% contain between 5 and 10 mg, and 27% contain between 10 and 50 mg.

Other estimates have been conducted for specific types of tubes, primarily T8s and T12s, and often four-foot tubes. The estimates for T8 tubes have a very large range. The Maine study found that TCLP-compliant T8s contained an average of 1.8 mg per lamp (with a range of 1.4 to 4.5 mg), while non-compliant lamps contained an average of 4.8 mg (range 3.0-7.5 mg). However, other estimates from other sources are much higher: 10 mg (New Jersey) and 14 mg (Bay Area).[73] Table 1 summarizes all the estimates compiled and assessed for this study.)[74] Differences in measurements (TCLP vs. total mercury) and sources (actual measurements or manufacturer reports) may help account for some of these differences in mercury quantities.

[73] Sustainable Conservation. *Reducing Mercury Releases From Fluorescent Lamps: Analysis of Voluntary Approaches*, Prepared for the Bay Area Clean Water Agencies (BACWA), September 2000; New Jersey Mercury Task Force, *Volume III: Specific Source Descriptions* (2002).

[74] Christopher Hilkene and Krista Friesen, *Background Study on Increasing Recycling of End-of-life Mercury-containing Lamps from Residential and Commercial Sources in Canada*, prepared for Pollution Probe and Environment Canada, 2005.

Table 11. Mercury Content Estimates, in Milligrams per Lamp

Lamp Type	Low	Avg.	High	Year of Lamp or Study	Source
"Fluorescent"		11.6		1999	NEMA (2001)
"Fluorescent"		22.8		1994	NEMA (2001)
"Fluorescent"		41.6		1990	NEMA (2001)
"Fluorescent"		48.2		1985	NEMA (2001)
Tube (mercury reduced)	*3*		*12*	*2005*	*Canada (2005)*
Tube (not mercury reduced)	*10*		*50*	*2005*	*Canada (2005)*
Tube (General "fluorescent")	0	8.9	100	2004	*NEWMOA (2004)*
Tube		*8*		*2004*	*Lane Co. (2004)*
Tube	*10*	*22.8*	*40*	*2002*	*King Co. (2002)*
Tube	2.5	13.3	70	2001	*NEWMOA (2004)*
Tube (4 ft. TCLP passing)	1.4	5.3	20	2001	*NEWMOA (2004)*
Tube (4 ft.)	4	11.6		2001	New Jersey (2002)
Tube		20		1996	New Jersey (2002)
Tube		30		1996	Bay Area (2000)
Tube		40		early 1990s	Bay Area (2000)
Tube (4 ft.)		50		1986	New Jersey (2002)
T12		22		2001	New Jersey (2002)
T12 (not labeled TCLP compliant)	0.02	3.43	11	2001	Maine (2001)
T12 (TCLP compliant)	0.47	3.18	6.2	2001	Maine (2001)
T12		21		2000	Bay Area (2000)
T12 (manufacturer estimate)		21		1996-2007	EPA (1997)
T12		30		1992-1996	EPA (1997)
T12		41		pre-1992	EPA (1997)
T8		14		2001	New Jersey (2002)
T8 (not labeled TCLP compliant)	0.74	4.77	9.4	2001	Maine (2001)
T8 (TCLP compliant)	0.34	2.75	0	2001	Maine (2001)
T8		10		2000	Bay Area (2000)
T8 (manufacturer estimate from 1997)			10	1996-2007	EPA (1997)
T8		15		1992-1996	EPA (1997)
T8		30		pre-1992	EPA (1997)
CFL	*1*		*25*	*2005*	*Canada (2005)*
CFL		*5*		*2004*	*Lane Co. (2004)*
CFL	*0*	*5.1*	*50*	*2004*	*NEWMOA (2004)*
CFL	*2*	*4.55*	*10*	*unknown*	*NEMA studies*
CFL	*5*		*10*	*2002*	*King Co. (2002)*
Circular		*15*		*2004*	*Lane Co. (2004)*
U-tube	*3*		*12*	*2005*	*Canada (2005)*
U-tube		*4.4*		*2004*	*Lane Co. (2004)*
U-tube		*4.4*		*2004*	*Lane Co. (2004)*
Mercury Vapor Lamps: 75-watt		*25*		*2005*	*Canada (2005)*
Mercury Vapor Lamps: 1500-watt		*225*		*2005*	*Canada (2005)*
Metal Halide Lamps: 75-watt		*25*		*2005*	*Canada (2005)*
Metal Halide Lamps: 1500-watt		*225*		*2005*	*Canada (2005)*
Sodium Vapor Lamps: 35-watt		*20*		*2005*	*Canada (2005)*
Sodium Vapor Lamps: 1000-watt		*145*		*2005*	*Canada (2005)*
Ceramic Metal Halide	*0*		*50*	*2004*	*NEWMOA (2004*
High Pressure Sodium	*10*		*50*	*2004*	*NEWMOA (2004)*
Mercury Vapor	*10*		*1000*	*2004*	*NEWMOA (2004)*
Mercury Short Arc	*100*		*1000*	*2004*	*NEWMOA (2004)*
Mercury Capillary	*100*		*1000*	*2004*	*NEWMOA (2004)*

Appendix B. Overview of Selected State Programs[75]

As part of this study of fluorescent lamp recycling, Cascadia conducted interviews with a number of mercury program managers in other states. This appendix presents a brief overview of several leading programs in selected states.

California

Mercury-added lamps are subject to the universal waste rule in California, and the state has a disposal ban on certain mercury-containing products. All lamps have been included in the disposal ban since 2006, when households became subject to the rule. California enforces proper mercury disposal with spot-checking programs, which it finances partly with fines for violations. On-site lamp crushing is prohibited in California.

The "California Take-it-Back Partnership" is a product stewardship collaboration between government, retailers, and utilities. Utilities assist with lamp collection to help support the use of energy-efficient lighting, and retailers offer drop-off locations in their establishments to attract customers. With the aid of a grant from the U.S. Environmental Protection Agency, California financed several informational programs on the hazards of mercury and options for proper end-of-life management of fluorescent lamps. These programs included online training courses for businesses, a training module for violators, and direct mailings to households and contractors. California also recommends that business develop lamp management plans to support compliance with local, state or federal hazardous waste regulations.

Some challenges have hindered California's progress. Local governments required four to five years to implement lamp recycling infrastructure. Phillips Lighting objected to the blanket disposal ban, since its green-tip lamps have lower mercury content. California estimates that one in five spent lamps in the state is currently recycled.

Maine

In 2002, Maine enacted a disposal ban and recycling requirement on all mercury-added lamps except those generated by households. This regulation was extended to households in 2005, at which time all towns were required to provide for mercury-product collection. The state has worked with municipalities to develop lamp collection and recycling programs, including grants to support storage and collection efforts as well as training and education for municipalities and the public. The state conducted several informational programs on the hazards of mercury and proper disposal options for fluorescent lamps. These programs included formal workshops for

[75] Sources include interviews with state program managers, published reports, and websites, including the following: California, http://www.ciwmb.ca.gov/WPIE/FluoresLamps;
Maine, http://www.maine.gov/dep/mercury/mercury_in_maine.pdf,
http://www.maine.gov/dep/rwm/mercury/pdf/mpac04report.pdf;
Massachusetts, http://www.mass.gov/dep/recycle/hazardous/fluores.htm,
http://www.mass.gov/dep/toxics/stypes/hgtoc.htm,
http://www.mass.gov/dep/public/publications/1006merc.htm,
http://www.mass.gov/envir/Sustainable/resources/pdf/Resources_Hg_Strategy.pdf;
Minnesota, http://www.pca.state.mn.us/publications/reports/lrp-mercury2005.pdf,
http://www.pca.state.mn.us/publications/w-hw4-62.pdf;
Vermont, http://www.anr.state.vt.us/dec/ead/mercury/merc.htm;
national information, http://www.newmoa.org/prevention/mercury/imerc/legislation-2006.pdf;
http://www.nema.org/gov/env_conscious_design/mercury/ma.cfm.

businesses on proper waste disposal, training solid waste transfer station operators, and direct mailing of two brochures and one handbook. Utility bill inserts are also used to promote recycling of mercury-added products, including lamps.

The state has a goal to reach a 70% lamp recycling rate. In 2004, Maine reported an increase in lamp recycling from 15% in 2002 to 23% in 2003, but more recent figures were not available. Maine has pioneered some innovative strategies to regulate mercury-added products, although these policies do not apply to lamps. Such efforts include payment of bounties on returned mercury and conditions for selling mercury-containing products within Maine.

Massachusetts

In Massachusetts, all mercury-added products must be either disposed of as toxic waste or recycled. By May 1, 2008, all such products must carry labels denoting the presence of mercury and describing appropriate disposal. Under the state's recent Mercury Management Act, passed in 2006, manufacturers of many mercury-added products are required to support the costs of collecting and recycling mercury-added products. Lamp manufacturers are treated somewhat differently under the new policies. Either individually or as a group, lamp manufacturers must develop outreach and education programs regarding health issues and proper management of spent lamps.

The state established target lamp recycling rates, increasing from 30% in 2008 to 70% by 2011, and plans to measure the effectiveness of the education programs as the difference between target and actual capture rates. Failure to meet these targets would result in each manufacturer paying a portion, determined based on share of lamp sales, of up to $1,000,000 per year of non-compliance into a fund to pay for municipal or regional mercury recycling programs. In December 2006, NEMA presented a proposed education program to the state covering nine lamp manufacturers; other manufacturers may join this program in the future. These mandates on manufacturers represent a significant departure from many other states' approaches to lamp recycling, and their implementation and results are expected to offer many useful lessons for other management efforts for mercury-added lamps.

Minnesota

In 1993, Minnesota became the first state to ban fluorescent lamp disposal and require all households and businesses to recycle such lamps. Local and state governments, manufacturers, waste haulers, and other companies established handling programs for mercury-added products, and lamp recycling became a viable and competitive industry. A critical factor in Minnesota's success has been availability of recycling facilities. Hazardous waste facilities cover the entire state, and nearly all collect fluorescent lamps. County-run hazardous waste collection programs accept mercury containing items from households and small businesses, and utilities serving populations greater than 200,000 must provide lamp collection for households and small businesses. Smaller retailers including hardware stores voluntarily collect lamps to attract customers to their establishments; however, larger chain stores have not participated in lamp take-back.

Minnesota tracks its success rate with requirements for lamp recyclers to report the number and type of lamps received. The lamp management guidelines allow lamps generated within the state to be managed and tracked in one manner, while products arriving from out of state can be tracked differently. Between 1990 and 1995, mercury in municipal solid waste declined from 4 parts per million to 1.5 ppm. The state estimates that between 1990 and 2005, mercury emissions resulting from fluorescent lamp breakage decreased from about 270 pounds to 15 pounds. Maximum fines for violation of mercury disposal regulations are $700 for individuals and $25,000 for businesses. On-site lamp crushing is prohibited in Minnesota. Minnesota estimates

that 70% of lamps in the state are recycled, assuming the state uses and generates lamps at the national average rate. (The text boxes in Chapter 5 provide additional information on Minnesota's fluorescent lamp management efforts.)

Vermont

Mercury-added products are subject to the universal waste rule and a disposal ban in Vermont. The state works with some electrical wholesalers to establish programs in their storage facilities to manage universal waste. Vermont procured a grant from the U.S. Environmental Protection Agency to design a newspaper insert, of which 145,000 copies were published. The state also sent two direct mailings to the state's 20,000 businesses and another 3,000 directed at contractors. Additionally, it posted informational stickers on dumpsters and posters in lamp retail establishments. Vermont was sued unsuccessfully by lamp makers in 1999 who claimed that its labeling restrictions violated interstate commerce law. Vermont's landmark labeling requirements for mercury-added lamps have been adopted by many other states, and now NEMA has developed a voluntary national standard that manufacturers can use to comply with state labeling requirements.

Appendix C. Lamp Recycling Survey Instruments

This appendix includes a survey instrument used for gathering data on current fluorescent lighting usage, current lamp recycling, perceived barriers to recycling, attitudes toward potential government interventions, and information sources. Variations of this survey were tailored for members of multiple groups, including Pollution Prevention (P2) planners at companies in Washington (according to a list that the Washington State Department of Ecology maintains), Washington State Hospital Association (WSHA), Building Owners and Managers Association (BOMA), Washington Retail Association (WRA), and Association of Washington Businesses (AWB). These surveys followed the same general format and included similar content. Changes were primarily made to language (e.g., *hospitals* or *stores*) and to numerical categories (e.g., facility square footage options up to millions of square feet for BOMA members).

The last page of the appendix shows the survey instrument used to gather the names and contact information from stakeholders. On this form, respondents could express willingness to consider participating in future follow-up discussions with other industry stakeholders and with Ecology personnel regarding fluorescent lamp recycling.

To supplement these online surveys, additional interviews were conducted, primarily by telephone, with other industry representations and stakeholders, including relamping contractors and lamp distributors. Many of these interviews covered similar topics to those included on the electronic survey instrument.

http://www.surveymonkey.com - Confidential Survey on Fluorescent Lighting in Washington - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Confidential Survey on Fluorescent Lighting in Washington

Welcome and thank you for responding! Washington State is considering changes affecting how fluorescent light bulbs are handled and is seeking input from key companies. In this survey, *fluorescent lamps* include linear tubes, circular or U-shaped bulbs, compact fluorescents, and other mercury-containing lamps such as neon or HID lamps (e.g., mercury vapor, metal halide, and high-pressure sodium).

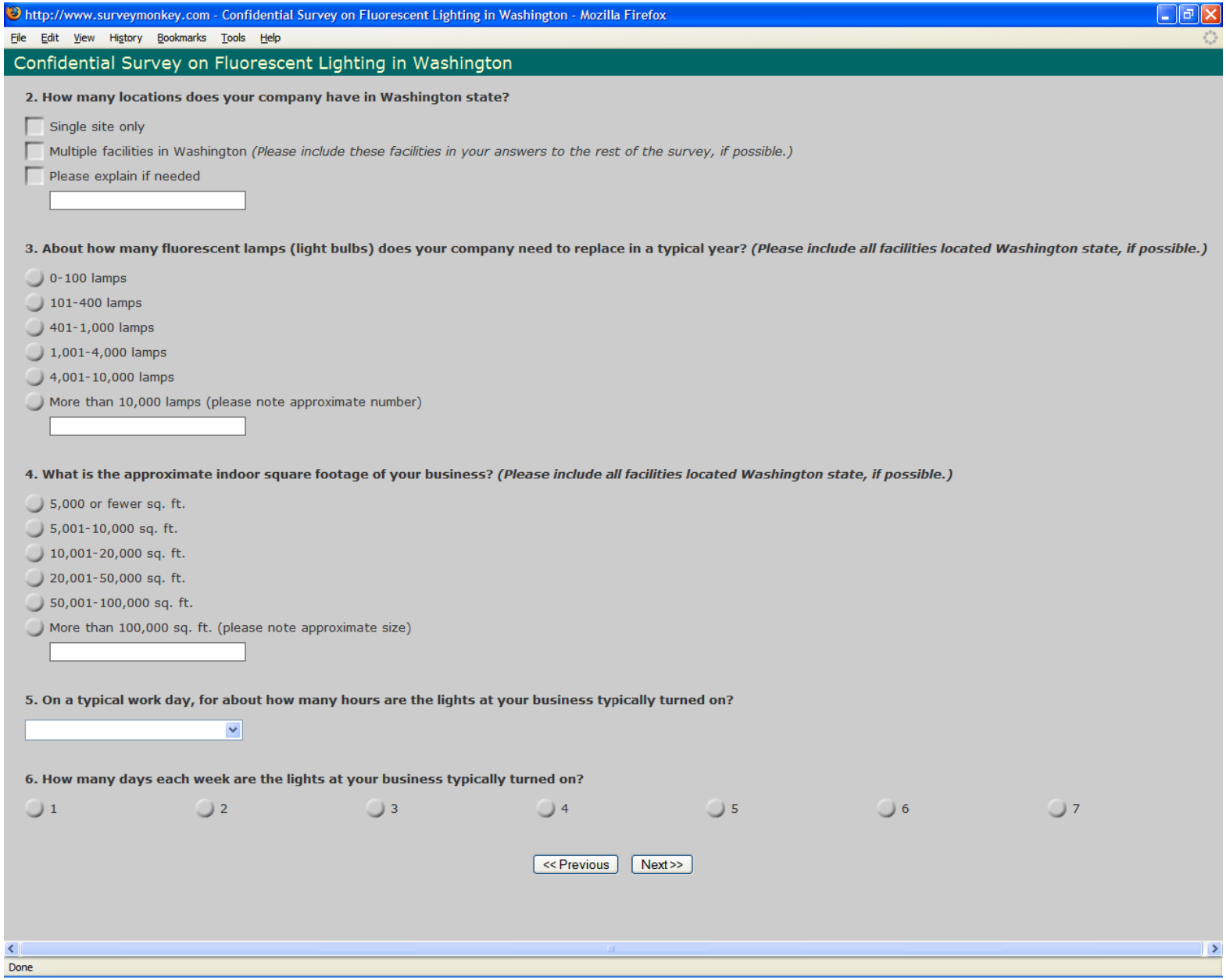
This survey should take about 5-10 minutes to complete. Please note that **there are no right or wrong answers**, and the **survey is confidential**. This survey is being conducted by Cascadia Consulting Group on behalf of the Department of Ecology. *Compiled results only – not identified with any specific company* – will be used to help the State better understand any issues or problems that you face related to fluorescent lights.

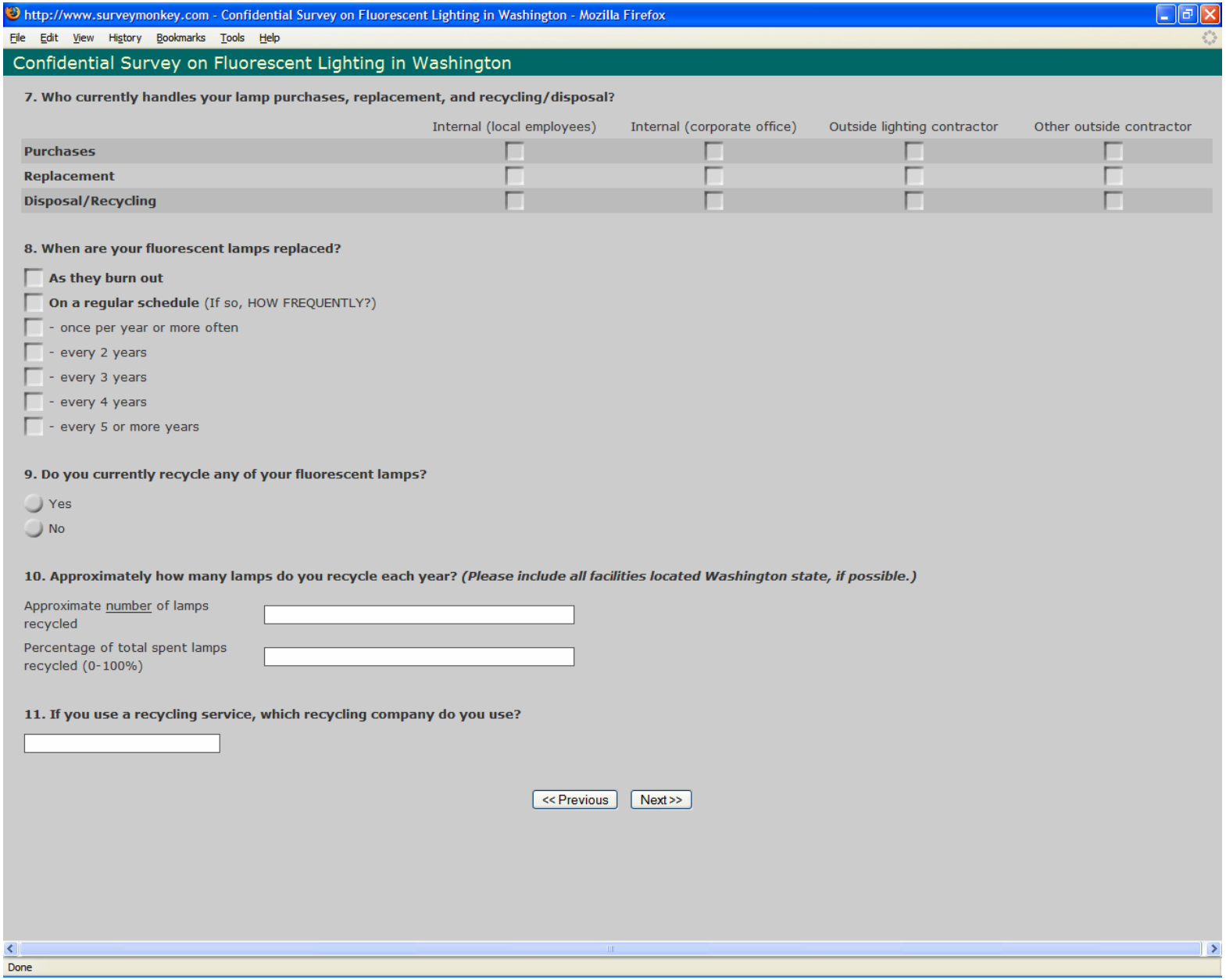
1. Before you begin the survey, please select your type of company or organization:

- [ ] Construction
- [ ] Government/Military
- [ ] Hospital
- [ ] Hotel/Restaurant
- [ ] Manufacturing
- [ ] Office
- [ ] Retail/Grocery
- [ ] School
- [ ] Warehouse
- [ ] Other (please specify)

Next >>

Done


http://www.surveymonkey.com - Confidential Survey on Fluorescent Lighting in Washington - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Confidential Survey on Fluorescent Lighting in Washington
2. How many locations does your company have in Washington state?
Single site only
Multiple facilities in Washington (Please include these facilities in your answers to the rest of the survey, if possible.)
Please explain if needed
3. About how many fluorescent lamps (light bulbs) does your company need to replace in a typical year? (Please include all facilities located Washington state, if possible.)
0-100 lamps
101-400 lamps
401-1,000 lamps
1,001-4,000 lamps
4,001-10,000 lamps
More than 10,000 lamps (please note approximate number)
4. What is the approximate indoor square footage of your business? (Please include all facilities located Washington state, if possible.)
5,000 or fewer sq. ft.
5,001-10,000 sq. ft.
10,001-20,000 sq. ft.
20,001-50,000 sq. ft.
50,001-100,000 sq. ft.
More than 100,000 sq. ft. (please note approximate size)
5. On a typical work day, for about how many hours are the lights at your business typically turned on?
6. How many days each week are the lights at your business typically turned on?
1 2 3 4 5 6 7
<< Previous
Next >>
Done


http://www.surveymonkey.com - Confidential Survey on Fluorescent Lighting in Washington - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Confidential Survey on Fluorescent Lighting in Washington
7. Who currently handles your lamp purchases, replacement, and recycling/disposal?
Internal (local employees)
Internal (corporate office)
Outside lighting contractor
Other outside contractor
Purchases
Replacement
Disposal/Recycling
8. When are your fluorescent lamps replaced?
As they burn out
On a regular schedule (If so, HOW FREQUENTLY?)
- once per year or more often
- every 2 years
- every 3 years
- every 4 years
- every 5 or more years
9. Do you currently recycle any of your fluorescent lamps?
Yes
No
10. Approximately how many lamps do you recycle each year? (Please include all facilities located Washington state, if possible.)
Approximate number of lamps recycled
Percentage of total spent lamps recycled (0-100%)
11. If you use a recycling service, which recycling company do you use?
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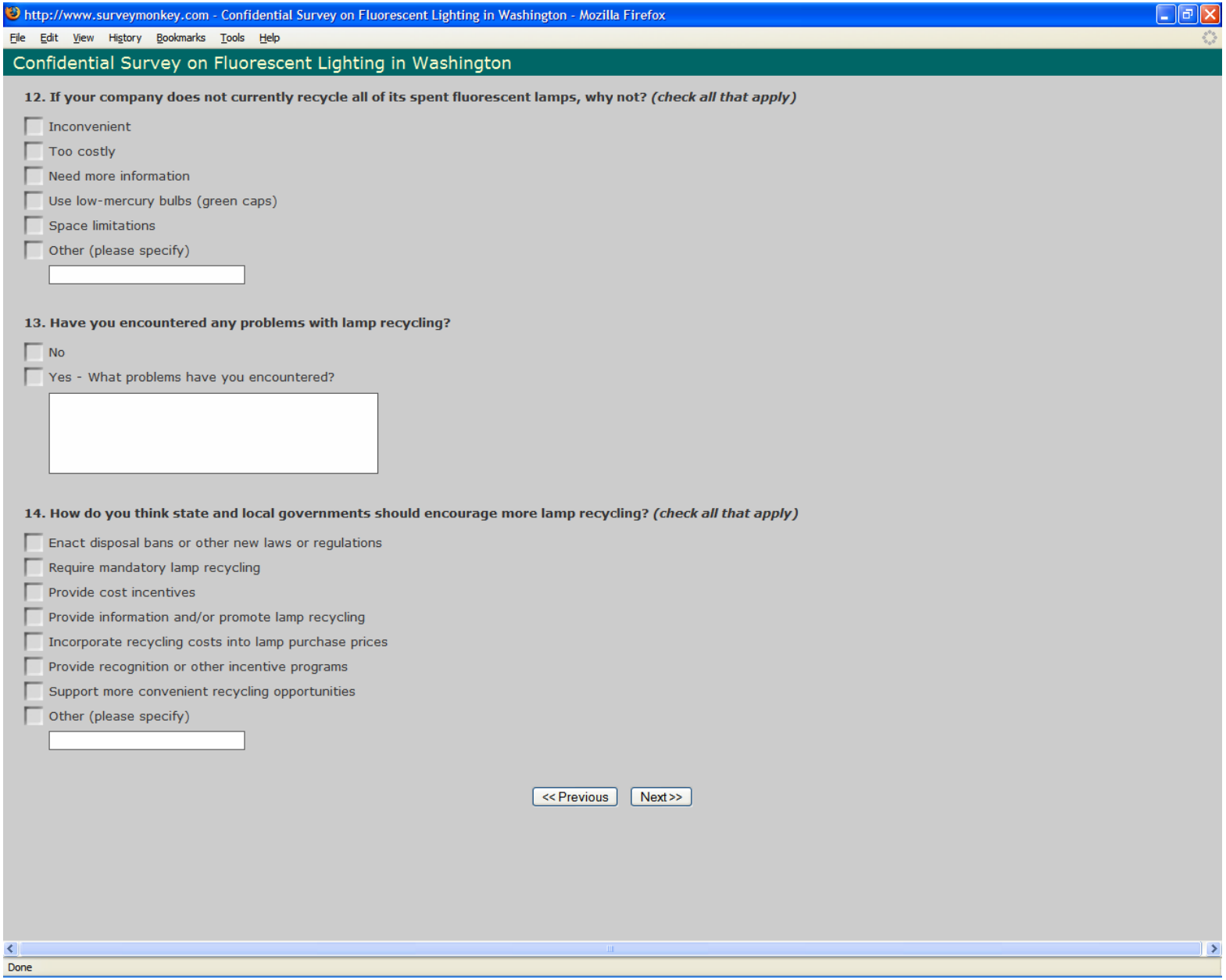
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12. If your company does not currently recycle all of its spent fluorescent lamps, why not? (check all that apply)
Inconvenient
Too costly
Need more information
Use low-mercury bulbs (green caps)
Space limitations
Other (please specify)
13. Have you encountered any problems with lamp recycling?
No
Yes - What problems have you encountered?
14. How do you think state and local governments should encourage more lamp recycling? (check all that apply)
Enact disposal bans or other new laws or regulations
Require mandatory lamp recycling
Provide cost incentives
Provide information and/or promote lamp recycling
Incorporate recycling costs into lamp purchase prices
Provide recognition or other incentive programs
Support more convenient recycling opportunities
Other (please specify)
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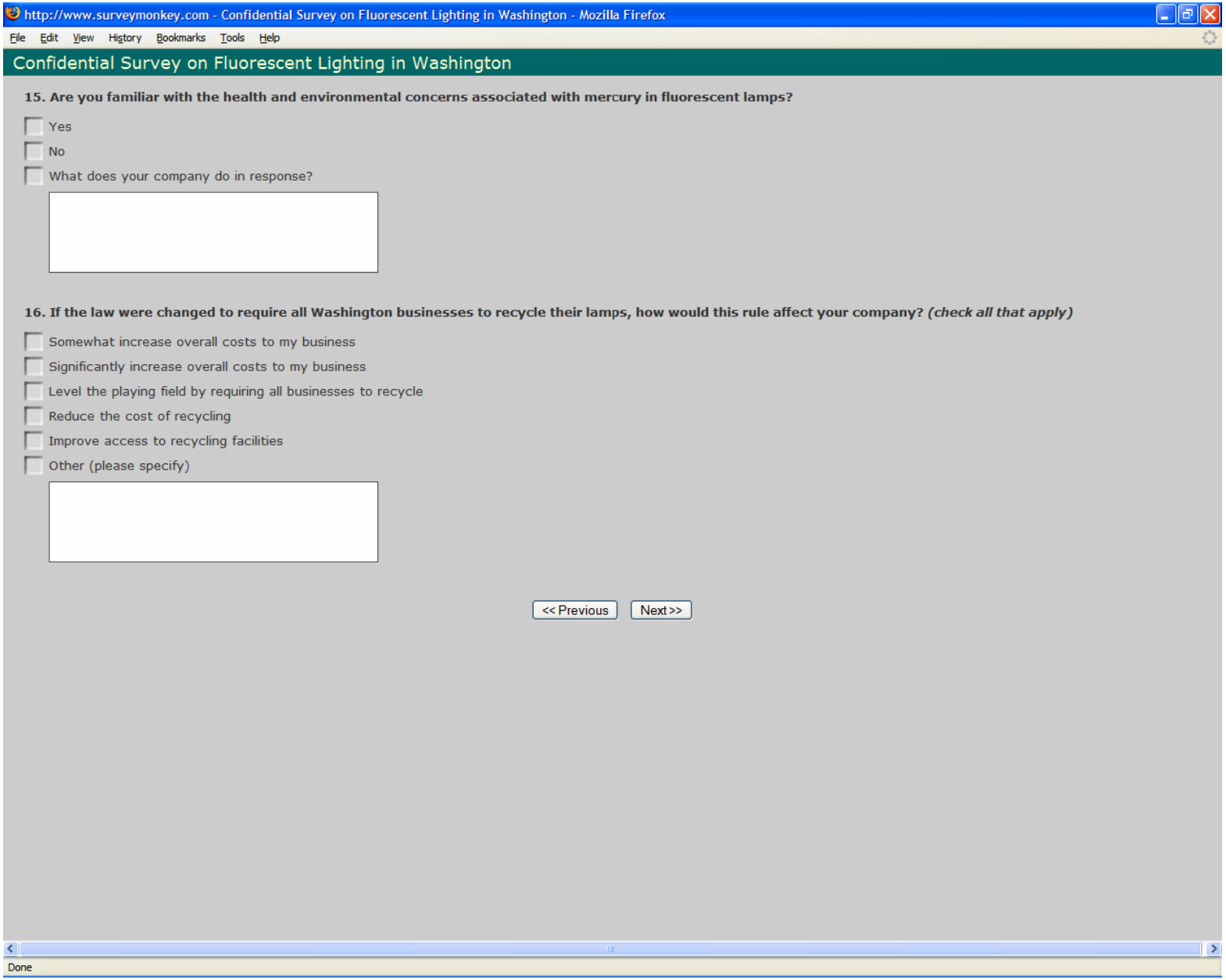
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15. Are you familiar with the health and environmental concerns associated with mercury in fluorescent lamps?
Yes
No
What does your company do in response?
16. If the law were changed to require all Washington businesses to recycle their lamps, how would this rule affect your company? (check all that apply)
Somewhat increase overall costs to my business
Significantly increase overall costs to my business
Level the playing field by requiring all businesses to recycle
Reduce the cost of recycling
Improve access to recycling facilities
Other (please specify)
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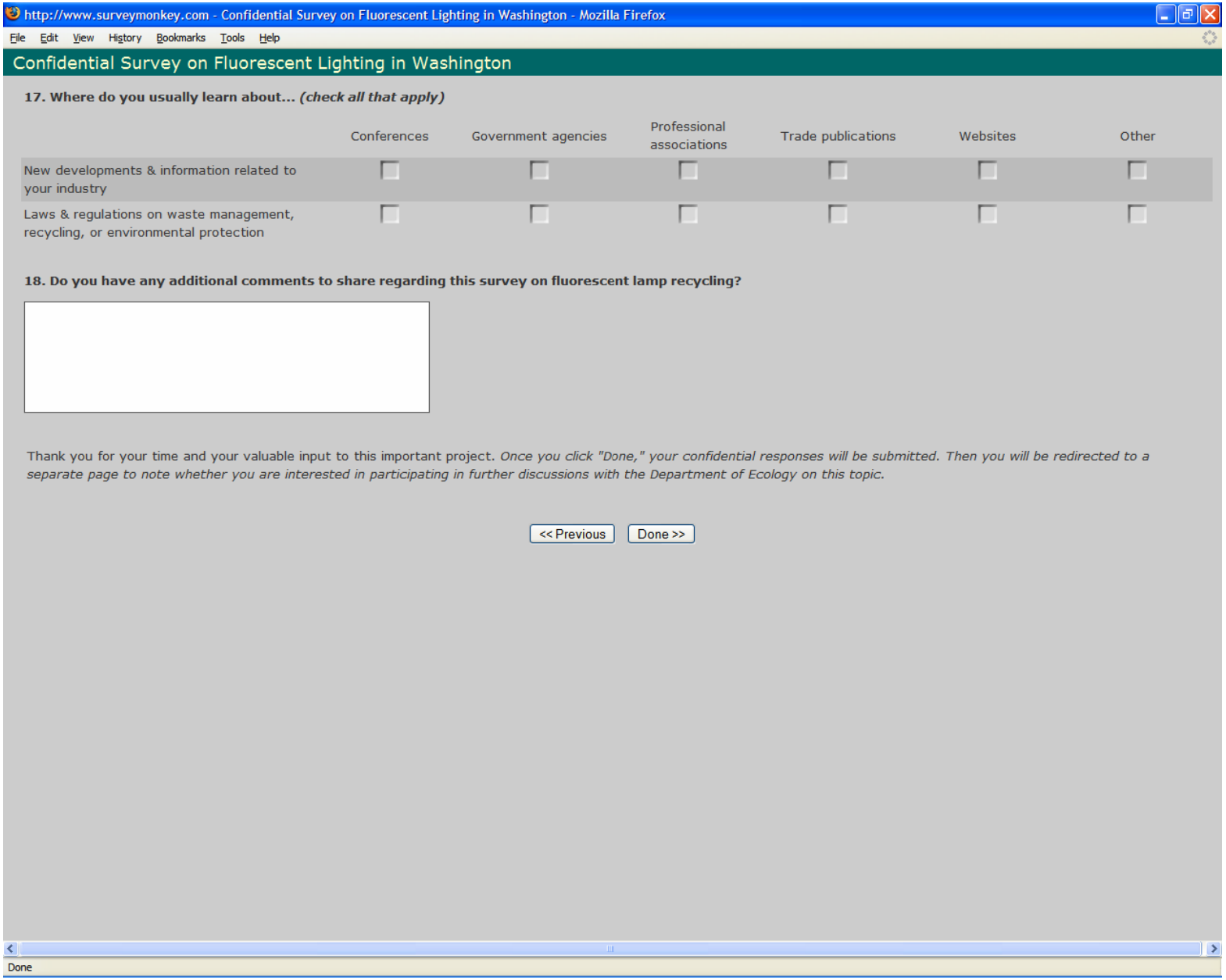
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17. Where do you usually learn about... (check all that apply)
Conferences
Government agencies
Professional associations
Trade publications
Websites
Other
New developments & information related to your industry
Laws & regulations on waste management, recycling, or environmental protection
18. Do you have any additional comments to share regarding this survey on fluorescent lamp recycling?
Thank you for your time and your valuable input to this important project. Once you click "Done," your confidential responses will be submitted. Then you will be redirected to a separate page to note whether you are interested in participating in further discussions with the Department of Ecology on this topic.
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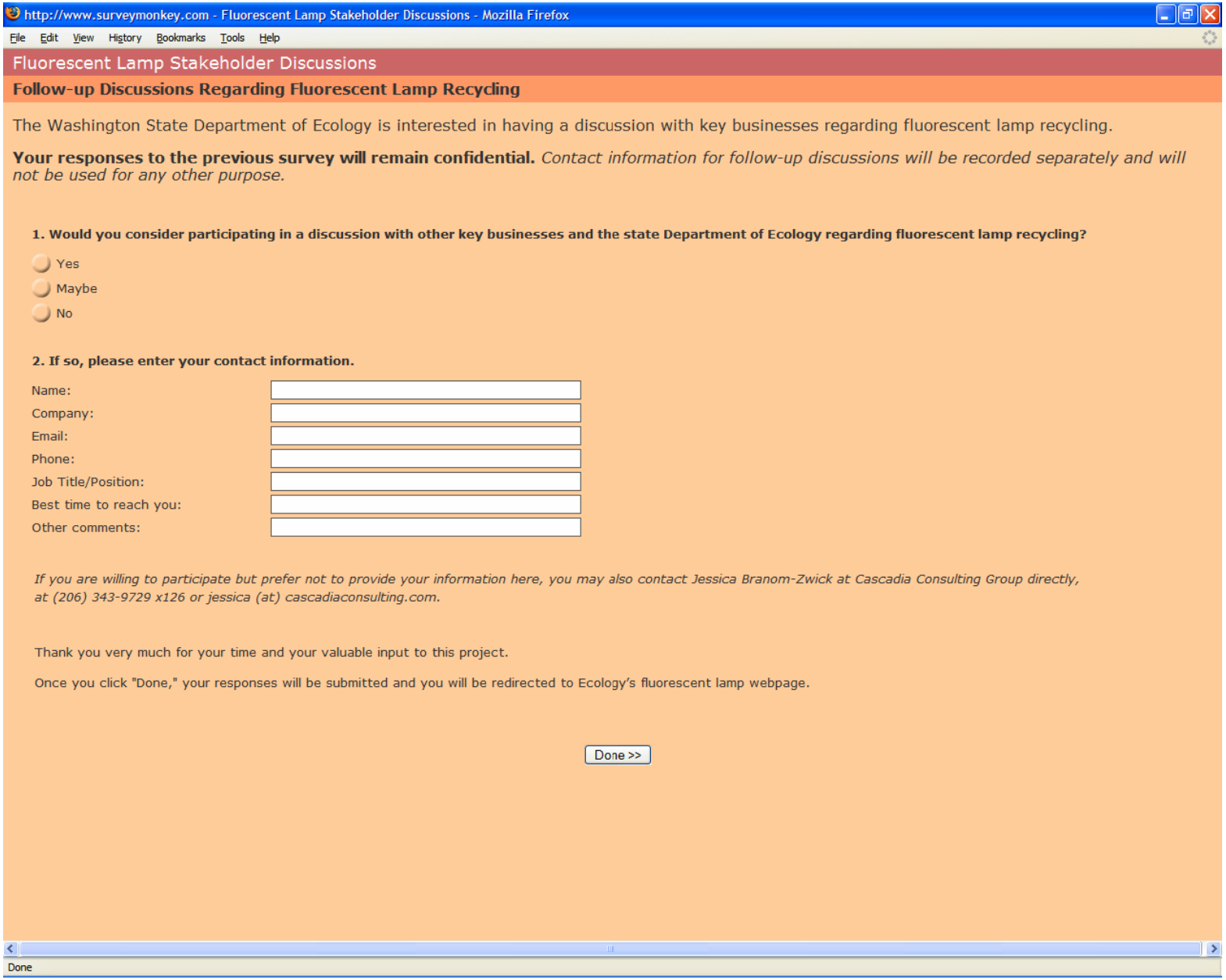
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Fluorescent Lamp Stakeholder Discussions
Follow-up Discussions Regarding Fluorescent Lamp Recycling
The Washington State Department of Ecology is interested in having a discussion with key businesses regarding fluorescent lamp recycling.
Your responses to the previous survey will remain confidential. Contact information for follow-up discussions will be recorded separately and will not be used for any other purpose.
1. Would you consider participating in a discussion with other key businesses and the state Department of Ecology regarding fluorescent lamp recycling?
Yes
Maybe
No
2. If so, please enter your contact information.
Name:
Company:
Email:
Phone:
Job Title/Position:
Best time to reach you:
Other comments:
If you are willing to participate but prefer not to provide your information here, you may also contact Jessica Branom-Zwick at Cascadia Consulting Group directly, at (206) 343-9729 x126 or jessica (at) cascadiaconsulting.com.
Thank you very much for your time and your valuable input to this project.
Once you click "Done," your responses will be submitted and you will be redirected to Ecology's fluorescent lamp webpage.
Done >>
Done