

Independent Third-Party Audit of the Manufacturers' Program for Collection and Disposal of Mercury- Containing Lamps

Submitted by:



Prepared for:

Vermont Agency of Natural Resources

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1. Introduction

Extended producer responsibility (EPR) policy and regulations transfer financial and/or operational responsibility for end-of-life management of discarded products, in whole or in part, away from local governments (typically) to manufacturers of those products.

[Vermont Statutes Title 10, Chapter 164A](#), Collection and Disposal Of Mercury-containing Lamps – is such a regulation. The program began July 1, 2012, and its objective is to divert mercury-containing lamps, commonly called light bulbs, for recycling and reduce the disposal of these products that can lead to emissions of mercury to the environment. The program in Vermont was developed and is operated by the National Electrical Manufacturers Association (NEMA) on behalf of its industry members who are the manufacturers of lamps. Mercury-containing lamps targeted in the program include compact fluorescent lamps (CFLs), fluorescent tubes and high-intensity discharge lamps.

§ 7153 of this law requires that once every five years the manufacturers' mercury-containing lamp collection program (Program):

...shall hire an independent third party to audit the plan and plan operation. The auditor shall examine the effectiveness of the program in collecting and disposing of mercury-containing lamps. The auditor shall evaluate the cost-effectiveness of the program and compare it to that of collection programs for mercury-containing lamps in other jurisdictions. The auditor shall make recommendations to the Secretary on ways to increase program efficacy and cost-effectiveness.

NEMA selected Circular Matters (CM) as the independent third-party auditor to conduct this statutorily required audit. CM's audit focused specifically on assessing Program performance with respect to the criteria identified in the statute – efficacy and cost-effectiveness. Findings and recommendations are provided at the end of this report.

For this evaluation CM relied on program cost data and program recycling records of collection quantities provided by NEMA for the programs they operate in Vermont and Maine, and program operational results and financial data reported publicly by other producer responsibility organizations for similar EPR lamp programs in other jurisdictions.

The statute does not require, nor did CM conduct, a financial audit of the Vermont Program or comparison programs used in this evaluation. Our opinions, conclusions, and recommendations found in this report are based on the information that was provided to us, along with site visits CM made to 10 lamp collection locations in Vermont, where we interviewed collection location staff whose responsibility includes receiving lamps for recycling from generators.

2. Comparison Jurisdictions

In addition to Vermont, there are three additional U.S. states (Washington, Maine, Massachusetts) and four Canadian provinces (British Columbia, Manitoba, Quebec, and Prince Edward Island) known to have EPR laws in place for mercury-containing lamps in North America. In addition, some states restrict the selling of mercury-containing lamps to only those that are labeled that they contain mercury (e.g., Rhode Island, Minnesota, Connecticut).

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Massachusetts' [Mercury Management Act](#) was passed in 2006, implemented in 2008, and amended in 2014. It only requires manufacturers of mercury-containing lamps to remit an annual registration fee, not to exceed \$10,000 per manufacturer per year, into an expendable trust that is used by the state and municipal governments to provide for administration, access, communication, enforcement and education costs for proper mercury-added lamp recycling or disposal. Data on lamp recycling for Massachusetts are not available. Residents and small businesses can deliver mercury-containing lamps to various sites for recycling, including transfer stations and retail collection sites.

With respect to Canadian provinces, British Columbia, Manitoba, Quebec, and Prince Edward Island (PEI) all have EPR programs for mercury-containing lamps. Manitoba's lamp recycling program is the only Canadian EPR lamp recycling program that limits allowable lamps to those containing mercury, however in Manitoba Product Care Association provides a more comprehensive household hazardous waste (HHW) collection and management program. Product Care Association provides collection services for many of the covered materials, such as paint, HHW/pesticides as well as mercury-containing lamps, jointly. Cost data is not separated reported for lamps only, making cost comparison with Vermont's program impossible.

This leaves only lamp recycling programs in Maine and Washington that can be considered for meaningful comparisons with Vermont's program. It should be noted that some large retailers such as Home Depot and Lowe's accept and recycle mercury-containing lamps from the public. They operate their programs separately from EPR programs in Maine, Vermont, and Washington and the quantities of lamps that they collect and recycle is believed to be large but is not known or reported through the industry-sponsored EPR programs. Therefore, recovery estimates understate total portion of lamps being recycled in Vermont and comparison states.

Table 1 below summarizes program details of potential comparison jurisdictions in the U.S. and Canada.

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Table 1: Summary of Mercury-Containing Lamp Recycling Programs

	Vermont	Maine	Washington	Massachusetts	British Columbia	Manitoba	Quebec	PEI
Population¹	645,570	1,372,247	7,738,692	6,984,723	5,214,805	1,383,765	8,604,500	614,318
Program Effective Date	7/1/2012	1/1/2011	1/1/2015	Unknown	7/1/2010	5/1/2012	10/1/2012	4/1/2015
Generators Served/Limits	Any "person," including business - any number of CFLs, 10 or fewer non-CFL mercury containing lamps	Any "person," including business - any number of CFLs, 10 or fewer non-CFL mercury containing lamps	Households and businesses - up to 10 lamps/day "sold at retail"	Program is open to households and small businesses	All households and businesses – all lamp types including incandescent, halogen, and LED lamps as well as some ballasts and fixtures	All households and businesses. ³ Includes tube fluorescents and CFLs only	All households and businesses. Includes tube fluorescents, CFLs and other mercury-containing lamps only	All households and businesses. Includes all lamp types including incandescent, halogen, and LED lamps
Producer Responsibility Organization	NEMA	NEMA	Product Care Association (LightRecycle Washington)	N/A Producers pay an annual fee to MA DEP, who manages the program	Product Care Association (Light Recycling BC)	Product Care Association (Light Recycling Manitoba)	Product Care Association (RecycFluo)	Product Care Association (Light Recycling PEI)
Annual Report	Yes	Yes	Yes	No. Recycling facilities must report annually to DEP. DEP does not report consolidated program data.	Yes	Yes	Yes	Yes
Disposal Ban: Business/Households	Yes/Yes	Yes/Yes	Yes/No	Yes/Yes	Some municipalities	Some municipalities	Not Known	Not Known

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	Vermont	Maine	Washington	Massachusetts	British Columbia	Manitoba	Quebec	PEI
Sales Bans	Ban on high-CRI linear fluorescents, as of July 1, 2020;² CFLs banned as of Feb. 17, 2023; 4-foot linear banned as of Jan. 1, 2024.	Certain CFL lamps (and others) will be banned as of January 1, 2023.	High-CRI linear fluorescent lamps in 2023.	High-CRI linear fluorescent lamps beginning in 2023.	National strategy to ban the sale of screw-based CFLs by 2023 and pin-based compact fluorescent lamps as soon as feasible and no later than 2028, and linear fluorescent lamps by 2028.			

Table Notes:

1. All populations are as of July 1, 2021.
2. High color rendering index (CRI) linear fluorescent lamps have a CRI of 87 or greater.
2. Manitoba's program expanded to include commercial entities as of January 1, 2021.

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As a review of the table shows, except for Maine, there are substantial differences in who is served by the programs that will impact the efficacy and cost-effectiveness of programs for comparison to Vermont. All of the Canadian programs include lamps generated by businesses in their programs. In addition, the programs in British Columbia and PEI include incandescent, halogen, and LED lamps that are not allowable in Vermont's program, further making comparisons of most metrics meaningless.

The U.S. programs are intended to be for households, although Vermont's program accepts CFLs and limited quantities of fluorescent tubes from businesses as well (i.e., intended to serve small businesses). NEMA believes that the vast majority of CFLs are purchased and used by households; however, estimates from British Columbia credit non-residential generators with approximately 25 percent of CFL lamp use, and 75 percent of tube fluorescent lamp use. Including non-residential lamps in collection programs, particularly if unlimited quantities are accepted (i.e., from large businesses), can significantly increase quantities of lamps collected through EPR programs, especially for tube fluorescent lamps, making program data for EPR programs serving all businesses large and small non-comparable to that of Vermont.

Known information pertaining to disposal bans for mercury-containing lamps is included in the table above because it is a government policy that can support manufacturer recycling efforts by raising awareness of and prompting recycling of mercury-containing lamps by generators at no cost to manufacturer-operated programs.

Of the programs in Table 1, the Maine, Massachusetts, and Washington State programs are most comparable to Vermont. However, Massachusetts does not have quantity, cost, or comprehensive collection site information. Producers satisfy their requirements by paying the Massachusetts Department of Environmental Protection (MA DEP) to manage the recycling of mercury-containing lamps, including sharing funding with local governments, but MA DEP does not collect comprehensive cost or recycling data in the state.

3. Program Metrics

Table 2 summarizes an analysis of program metrics for the U.S. and Canadian programs discussed above. As is described above, Maine and Washington are most comparable to Vermont's program, therefore data for those states is presented in bold font, along with Vermont's. No data are available for Massachusetts, so it is not included in the table. Data pertaining to the Canadian provinces are provided for informational purposes, but those programs differ as described above, and as noted in the table below.

**Table 2: Comparison of Mercury-Containing Lamp Recycling Programs Effectiveness and Cost
(2021 Calendar Year Data)**

	Vermont	Maine	Washington	British Columbia	Manitoba	Quebec	PEI
Population¹	645,570	1,372,247	7,738,692	5,214,805	1,383,765	8,604,500	614,318
Collection Sites	156	228 ²	279 ³	454	111 ⁴	896	7
Convenience (People/Site)	4,138	6,019	27,737	11,486	12,446	9,603	11,486
Effectiveness – Total lamps and CFL percent	<ul style="list-style-type: none"> • 159,750 total lamps • 45,458 CFLs (28% of total lamps collected) 	<ul style="list-style-type: none"> • 230,769 total lamps • 37,668 CFLs est. (16% of total lamps collected) 	<ul style="list-style-type: none"> • 1,140,770 total lamps • 268,559 CFLs (24% of total lamps collected) 	<ul style="list-style-type: none"> • 3,728,157 total mercury-containing lamps • 1,075,514 CFLs (29% of total mercury-containing lamps collected) 	<ul style="list-style-type: none"> • 308,201 total lamps • 40,396 CFLs (13% of total lamps collected) 	<ul style="list-style-type: none"> • 3,840,611 total lamps • 449,757 CFLs (12% of total lamps collected) 	<ul style="list-style-type: none"> • 90,255 total mercury-containing lamps • 22,239 CFLs (25% of total mercury-containing lamps collected)
Effectiveness – Per Capita	<ul style="list-style-type: none"> • 0.25 lamps • 0.07 CFLs 	<ul style="list-style-type: none"> • 0.17 lamps • 0.03 CFLs 	<ul style="list-style-type: none"> • 0.15 lamps • 0.03 CFLs 	<ul style="list-style-type: none"> • 0.71 lamps • 0.21 CFLs 	<ul style="list-style-type: none"> • 0.22 lamps • 0.03 CFLs 	<ul style="list-style-type: none"> • 0.45 lamps • 0.05 CFLs 	<ul style="list-style-type: none"> • 0.15 lamps • 0.04 CFLs
Effectiveness – Reported Collection Rate	<ul style="list-style-type: none"> • 24% of retail - sold mercury lamps available • Based on historic sales data and avg. lifespan of tubes (15 years) and CFLs (9 years). 	<ul style="list-style-type: none"> • 16% of estimated lamps available • Same life and sales basis as Vermont. 	N/A	N/A	N/A	N/A	N/A
Cost and Cost-Effectiveness (U.S. Dollars)⁵	<ul style="list-style-type: none"> • \$194,807 • \$1.22/ lamp collected 	<ul style="list-style-type: none"> • \$199,595 • \$0.86/ lamp collected 	<ul style="list-style-type: none"> • \$879,561 • \$0.77/ lamp collected 	<ul style="list-style-type: none"> • \$3,945,424 • \$1.06/ lamp collected 	<ul style="list-style-type: none"> • N/A – program costs reflect entire HHW program 	<ul style="list-style-type: none"> • \$3,062,518 • \$0.80/ lamp collected 	<ul style="list-style-type: none"> • \$58,751 • \$0.65/ lamp collected
Cost Per Capita	• \$0.30	• \$0.15	• \$0.11	• \$0.76	• N/A (entire HHW program is \$1.14)	• \$0.36	• \$0.10

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Table Notes:

1. All populations are as of July 1, 2021.
2. Maine's site number reflects total number of sites on record, though the annual report indicates that only 161 sites were active in 2020/2021. A GIS analysis revealed that 97.83% of Maine residents reside within 15 miles of the 161 collection locations that recycled lamps in either 2020 or 2021.
3. Washington's site count includes all registered sites. At the end of 2021, LRW had a total of 279 registered collection sites, including 185 sites that accept all program products; 66 sites that accept CFLs only; and 28 additional sites that are unadvertised, that accept all program products. According to the law, however, only collection sites that are advertised and accept all program products meet the collection site requirements.
4. Manitoba's site count includes only those that accept mercury-containing lamps.
5. Conversion rate based on U.S. /Canada conversion rate on July 26, 2022 (\$1 U.S. = \$1.29 CA)

4. Results of Analysis

Convenience

Based on analysis of the comparable data, it appears that Vermont has the most sites per capita of all U.S. and Canadian programs, with 4,138 people per collection site. This is an indication of the level of convenience for generators of mercury-containing lamps.

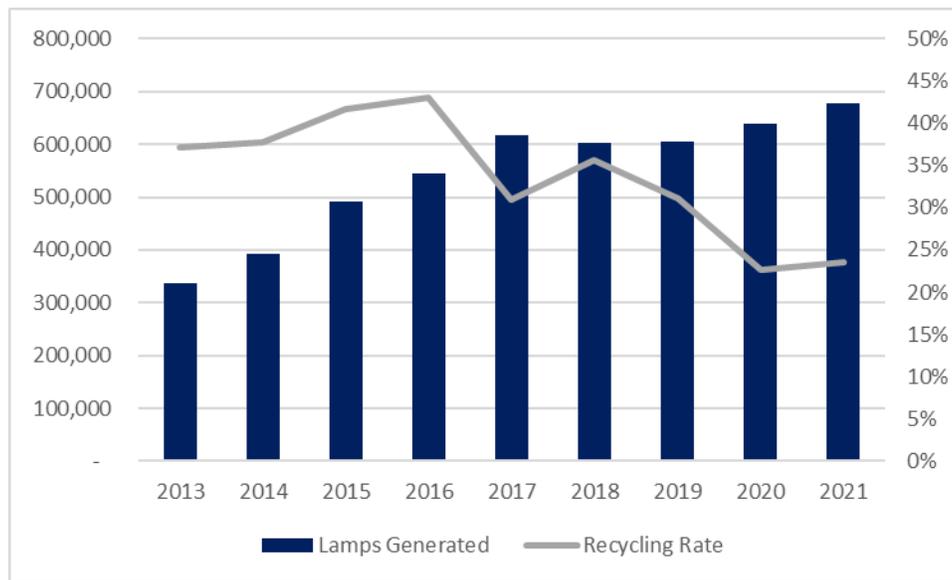
Effectiveness

In terms of number of lamps returned per capita, Vermont's program resulted in a higher per-capita return rate than Maine and Washington (with a per-capita return rate of 0.25 lamps, compared to 0.17 in Maine and 0.15 in Washington). This even exceeds the per-capita return rates for Manitoba, which accepts lamps from businesses, and PEI, which also accepts lamps from businesses, and also accepts more types of lamps than those accepted in Vermont. Per-capita return rates for CFLs are also higher in Vermont than in Maine and Washington (with a per-capita return rate of 0.07 CFLs compared to 0.03 in Maine and Washington). Vermont's CFL per-capita return rate is also higher than that for Manitoba (0.03), Quebec (0.05), and PEI (0.04) where non-residential lamps are included in collection programs.

In terms of recycling rate for lamps estimated to be available for collection, only Vermont and Maine have comparable data, as NEMA estimates the number of lamps available for collection in the states based on national sales data allocated on a per-capita sales data, and considering average lifespans of lamps (e.g., 15 years for tubes, and 9 years for CFLs). Product Care Association (PCA) does not develop an estimate of the number of lamps available for collection in Washington or the Canadian provinces. They do, however, provide data on the quantity of each type of lamp sold in the state or province during the report year, as this is how producers fund the system, paying an environmental handling charge (EHC) on a per-lamp basis in the year the lamps are sold. In Vermont, it is estimated that 24 percent of the lamps available for recycling were returned through NEMA's program. In Maine, it was estimated that 16 percent of the mercury-containing lamps available for recycling were returned through NEMA's program.

The recycling rate of mercury-containing lamps in Vermont appears to have declined over time, as Figure 1 shows. It is important to note that the apparent recycling rate does not include lamps recycled through private programs, such as Home Depot and Lowe's Home Improvement, and certain lamps collected by Vermont Solid Waste Management Districts that use their own contractor to recycle them rather than NEMA's contractor (NEMA reimburses the Districts for the share of cost for lamps that are covered in its program). Furthermore, the estimate of lamps available for recycling is based on national sales data apportioned to Vermont on the basis of population and estimates of lamp life. These factors may not accurately estimate lamps available for recycling, especially since Efficiency Vermont promoted the use of LEDs over CFLs in past years by offering rebates on LED lamps purchased in Vermont, meaning fewer mercury-containing lamps may be generated in Vermont than in other states. Based on the fact that all but one retail location visited had ceased selling CFLs during the site visits conducted, this is likely.

Figure 1: Vermont Mercury-Containing Lamp Generation and Recycling Trends



Cost Effectiveness

Cost effectiveness was examined on a per-lamp basis, with Vermont's program costing \$1.22 per lamp collected. This is higher than Maine's and Washington's programs, where the cost per lamp collected was \$0.86 and \$0.77 respectively. Vermont's program has somewhat high administrative costs spread across a lower population (and thus lower quantity of bulbs) than that of the other comparison states. If only direct program operational costs are considered, NEMA's Vermont program has approximately the same cost per lamp collected as Maine.

Per-Capita Costs

Per-capita program costs can be helpful to industry and consumers in evaluating the cost of the program. However, per-capita costs increase the more lamps are recovered, as there is a cost to recycle each lamp. Vermont's costs are higher when compared to Maine's on a per-capita basis, at \$0.30 vs. \$0.15 for 2021. Washington's program was also less costly than Vermont's at \$0.11 per capita. Vermont's higher per-capita cost is to be expected as Vermont's collection rates are higher than those of the other U.S. programs and Vermont's population is relatively low. Therefore, certain overhead costs, such as advertising, are spread among fewer residents.

Relative to the Canadian provinces, Vermont's program is less costly on a per-capita basis than Quebec's program (\$0.36 per capita) and British Columbia's (\$0.76 per capita). This is not surprising given that both of these programs serve businesses as well as residents, and British Columbia's program also collects additional lamps that do not contain mercury. PEI's program is only \$0.10 per capita, which is relatively inexpensive, even considering the number of lamps collected per capita.

5. Site Visits

As part of this audit, Circular Matters visited 10 Vermont collection sites, which included:

- One Solid Waste Management District site;
- Two local government collection sites;
- Three chain retail sites; and
- Four independent retail sites.

Each individual site visited was randomly selected from NEMA's master list of collection points, after sorting the list into the above four categories. The purpose of the visits was to observe collection and storage practices, visibility of the collection program (e.g., signage), and interview service personnel responsible for receiving lamps from the public for recycling.

Site visit observations and interviews with collection site staff revealed:

- In many cases, municipal and retail collection sites will allow small commercial generators to recycle more than 10 tube fluorescent lamps through the NEMA program. Staff at most of these sites seemed unaware that there was a limit.
- No sites except the Solid Waste District site visited retained records for people recycling more than the allowable quantity of lamps.
- Many site staff indicated that the number of CFLs being returned are declining, which they attributed to residents and businesses having already replaced CFLs with LEDs.
- Most collection site staff believed that most Vermonters were aware of recycling opportunities for lamps in Vermont and that many participate in the NEMA collection program. However, only a couple of sites (the Solid Waste District site and one municipal site) had signage to remind households of the state's disposal ban on fluorescent lamps. None of the retail collection sites visited had visible signage to promote the collection program. Staff indicated that they often would inform customers verbally of the program when helping them find replacement lamps.
- Of the seven retail sites visited in July 2022, only one was still selling CFLs.¹

6. Conclusions and Recommendations

- Vermont's program is more effective than comparable programs in terms of per-capita collection rates.
- Vermont's program is less cost effective than comparable programs, due to a somewhat high level of administrative and education/outreach cost allocated to Vermont's program, which serves a relatively low population state.
- Vermont's apparent lamp recycling rate has trended downward since its peak in 2016, which is a concern as many mercury-containing lamps have yet to reach the end of their life. However, the apparent lamp recycling rate may be understated, as it is likely that the quantity of mercury-containing bulbs is lower in Vermont due to efforts to transition to LEDs, largely led by Efficiency Vermont.

¹ The sale of CFLs was being phased out in Vermont at the time of this report. Stores were allowed to sell their remaining stock, but as of February 17, 2023 CFLs will no longer be allowed to be sold in Vermont.

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- The existence of other private collection programs, and some Solid Waste Management Districts with other contractors, whose lamp collection numbers were not included in NEMA's collection figures also means the estimated lamp recycling rate for Vermont is understated.
- The pending sales bans of CFLs in 2023 and of four-foot fluorescent lamps in 2024 will result in an inability of NEMA to accurately estimate the number of lamps available for collection based on national sales data in the future.
- In terms of providing a service to Vermonters, the average cost per resident is \$0.30 annually. Of course, per-capita costs increase as more lamps are recycled; alternatively, cost per lamp recycled tends to decrease the more lamps are recycled.
- Differences among U.S. state and Canadian province EPR programs for mercury-containing lamps means U.S. program data cannot be compared to Canadian program data. Canadian programs include commercial lamps in program data, and some provinces include non-mercury containing lamps in their programs as well.
- Circular Matters found errors in NEMA's annual reports submitted to the Vermont Agency of Natural Resources from 2017 to 2021. The errors are in NEMA's estimates of the annual quantity of lamps generated/available for collection. It appears that the percent of national retail sales of lamps attributed to Vermont was 0.41 percent of the national population (Maine's population is 0.41 percent of the U.S. total) – according to the 2020 Census, Vermont residents make up 0.19 percent of the U.S. population. Therefore, the quantity available for recycling was overstated for those years. NEMA also reported approximately \$45,000 less program cost for Vermont in its 2021 annual report than actually spent on the program.
- The LampRecycle.org consumer-facing website for Vermont should be updated:
 - The retail participation agreement link is broken;
 - The [Residential Lighting State Regulations page](#) for Vermont has two links to the same Vermont Department of Environmental Conservation fact sheet;
 - The link to the Universal Waste Rule is broken; and
 - The list of participating sites needs to be updated, as two (one retail and one municipal site) were identified that no longer accept lamps. The updated information should be shared with Earth911, as Earth911 is referenced as a source for identifying lamp recycling locations on LampRecycle.org's website.
- Circular Matters recommends that NEMA provide additional education and outreach material to retailers, as they often provide point-of-sale information about EnergyStar lighting products, but similar awareness-building materials for mercury-containing lamp recycling opportunities was not observed during CM's site visits. Signage could include window clings, posters, and shelf tags. It is acknowledged that retailers may be reluctant to add additional messaging to consumers in their stores.
- Circular Matters recommends that the Vermont Agency of Natural Resources, local governments, and solid waste haulers remind Vermonters of the state's disposal ban on mercury-containing lamps. A higher level of awareness could lead to higher collection rates of mercury-containing lamps through the Lamp Recycle program.

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