Environment and Climate Change Canada
Environnement et Changement climatique Canada

Development of a National Strategy for Safe and Environmentally Sound Disposal of Lamps Containing Mercury: Discussion Paper

Canada

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Introduction

The National Strategy for Safe and Environmentally Sound Disposal of Lamps Containing Mercury Act (the Act) was enacted in June 2017. The Act requires the Minister of Environment and Climate Change to develop a National Strategy by June 2019, in cooperation with the provinces, territories and other interested governments in Canada responsible for the environment, and in consultation with other interested persons or organizations deemed appropriate by the Minister.[1] The Minister must also report on implementation of the National Strategy every five years thereafter.

The Act suggests three elements for inclusion in the National Strategy:

- Identification of best practices for safe and environmentally sound disposal;
- Establishment of guidelines for facilities involved in end of life management; and,
- Development of a plan to promote public awareness of the importance of safe and environmentally sound disposal.

While considering the above recommendations, there are also a number of key elements found in successful strategies which may be considered in the development of a National Strategy including: a shared vision of the future; common strategy goals and actions to be taken to achieve these goals; endorsement of strategy elements by relevant parties; clear timelines for implementation; and, measurement and evaluation of results achieved.

There are a variety of end-of-life management programs in place in Canada for lamps containing mercury that are administered by provincial, territorial, and municipal governments as well as the private sector. While there are no known technical barriers to the environmentally sound disposal of all lamps containing mercury in Canada, many of these lamps are still being improperly disposed, leading to releases of mercury into the environment.

Development of a National Strategy offers an opportunity to bring together all of the relevant information and compare elements of the various programs so that governments, the private sector, civil society and the public may identify and replicate best practices across the country. It provides an opportunity to better understand whether there are gaps in existing best practices, guidelines, and programs for end-of-life management. It also provides an opportunity to consider specific programs or approaches targeted to northern, remote, and small communities.

This discussion paper is designed to support collaboration and consultation for the development of a National Strategy for Safe and Environmentally Sound Disposal of Lamps Containing Mercury. The document provides an overview of the current use and end-of-life management of lamps containing mercury in Canada, identifies potential broad goals for consideration in development of a National Strategy, and is intended to form the basis of a discussion between governments and stakeholders on how to define and achieve the goals of a National Strategy.

Background

Environmental Releases from Lamps Containing Mercury

Mercury and its compounds are listed on Schedule 1 of the Canadian Environmental Protection Act, 1999 (CEPA) and are toxic to both human health and the environment.[2] In the environment, mercury can cycle between air, water, land, and living things, and can be transported over long distances in the atmosphere. In 2015, Canada emitted approximately 4.4 tonnes of mercury to air[3] and 121 kilograms to water,[4] while an estimated 115 tonnes of mercury are deposited in Canada every year from sources around the world.[5]

Emissions from products containing mercury account for approximately 5% of total global anthropogenic releases.[6] Emissions of mercury from lamps occur at end-of-life if lamps are improperly disposed or recycled (i.e. landfilled or incinerated). In 2001, the Canadian Council of Ministers of the Environment (CCME) estimated that 1150 kg of mercury from lamps was disposed in Canadian landfills each year.[7] Due to significant reductions in the mercury content of lamps and the implementation of recycling programs since 2001 (see "Overview of Current End-of-Life Management for Lamps Containing Mercury in Canada" below), this has been reduced to between 250 to 400 kg, based on currently available sales and end-of-life collection data. The range of this estimate is broad due to a lack of currently available information on end-of-life management.

Once these lamps are landfilled, mercury can enter the environment as vapour and in leachate, where small amounts can cause adverse effects. The Canadian water quality guideline for the protection of aquatic life for mercury in freshwater is 26 nanograms/litre.[8] To put this in perspective, an Olympic size swimming pool, consisting of 2.5 million litres, would exceed this guideline if 65 mg of mercury were dissolved in it, an amount that can often be found in a single Canadian household.

Improper disposal of lamps containing mercury represents a potential source of human exposure to mercury, which can cause adverse health effects at very low levels.[9] Consumers and workers involved in end-of-life management may not be aware of the presence of mercury in these lamps, routes of potential exposure (primarily inhalation), or the best practices for handling and cleaning up broken lamps.

Categories and Uses of Lamps Containing Mercury in Canada

A number of lamp categories contain mercury as part of their essential function. The most common types are linear fluorescent lamps (LFLs; also known as straight fluorescent lamps) and compact fluorescent lamps (CFLs) (Figure 1). LFLs are typically used in institutional and commercial buildings, while CFLs are more commonly used for residential lighting. Other mercury-containing lamp types include high intensity discharge (HID) lamps for street and stadium lighting, neon lamps for signs, cold-cathode fluorescent lamps for backlighting in electronics, and a few other specialty lamps. During the operational lifetime of a fluorescent lamp, the elemental (liquid) mercury within the lamp gradually becomes converted to solid compounds (mainly mercuric oxide) and concentrates in the phosphor powder that coats the glass.[10] Not all lamps containing mercury contain a phosphor coating (e.g. HID lamps, UV lights for tanning beds) and therefore these lamps may be more likely to contain elemental mercury at end-of-life.[11]

Figure 1: Common types of lamps containing mercury

Compact fluorescent lamps

High intensity discharge lamp

Linear fluorescent lamps

Cold cathode tubing for signage or cove lighting

In 2001, the CCME published the Canada-wide Standard for Mercury-containing Lamps, which called for an 80% reduction in the average content of mercury in all mercury-containing lamps sold in Canada by 2010, from a 1990 baseline (43 mg).[12] By 2006, this target was achieved with an 81.6% reduction in mercury content for an average of 7.9 mg per lamp.[13] In 2016, the average mercury content in imported and manufactured lamps for general lighting purposes was 5.7 mg per lamp based on data collected under the Products Containing Mercury Regulations' first reporting period (current as of September 13, 2017). The averages were calculated using data for CFLs, LFLs, and HID lamps for general lighting purposes.

The Products Containing Mercury Regulations under CEPA, in force since 2015, prohibit the import and manufacture of products containing mercury or any of its compounds, with some exemptions for essential products which have no technically or economically viable alternatives. In the case of lamps, rather than introducing a prohibition, the Regulations limit the amount of mercury contained in fluorescent and other types of lamps (Figure 1). The Regulations also require reporting on import and manufacturing of mercury-containing products every three years in order to monitor the trend in reduction of mercury in products in Canada, and that these products be labelled to inform consumers about the presence of mercury, safe handling procedures, and options for end-of-life management.[14]

According to data received as part of the Products Containing Mercury Regulations' first reporting period in 2016, the average mercury content in lamps for general lighting purposes imported or manufactured in Canada was around: 2 to 3 mg/lamp for CFLs; 2.5 to 4 mg/lamp for smaller-diameter T5 and T8 4-foot LFLs (the number after T indicates the diameter of the lamp in eighths of an inch); and 6 to 8.5 mg/lamp for larger-diameter T12 LFLs. For HID and specialty lamps, the mercury content varies widely based on design and wattage.

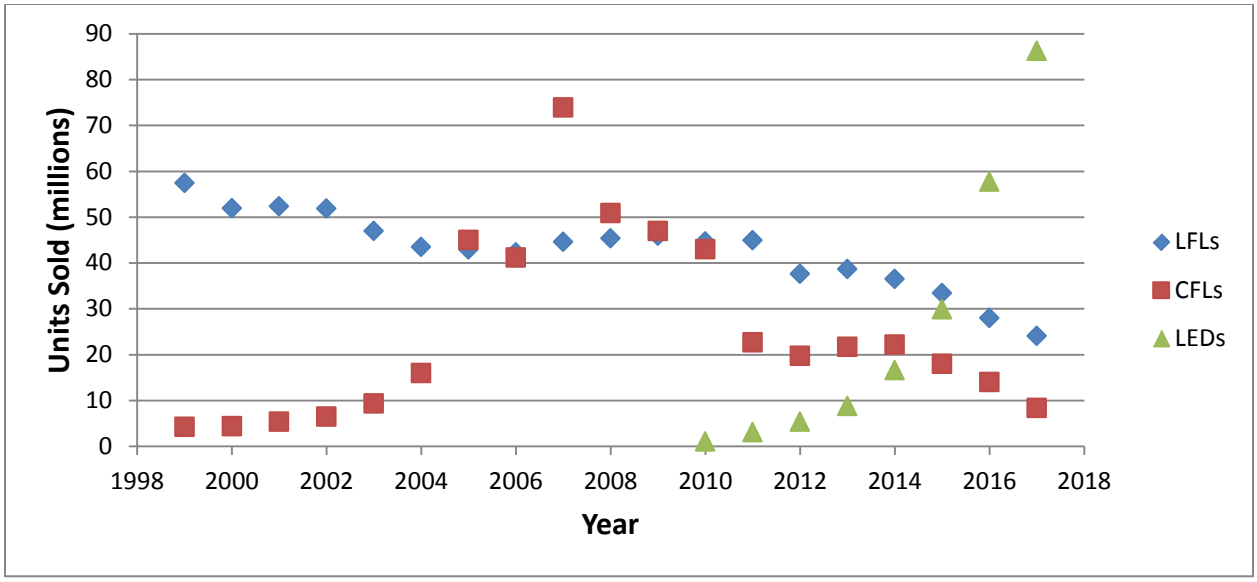
The Energy Efficiency Regulations, 2016 (under the Energy Efficiency Act) establish energy efficiency standards for a wide range of energy-using products, with the objective of eliminating the least energy-efficient products from the Canadian market.[15] For the last decade, the replacement of incandescent lightbulbs with CFLs has been promoted as requirements under these Regulations have become increasingly stringent. Given the past trends in lighting efficiency improvements, in the next ten years these regulations may lead to phase-outs of sales of many lamps containing mercury in favour of alternatives (e.g. light-emitting diodes (LED)). However, given their long lifetimes, existing stocks, and the unquantified amount of replacement lamps already purchased, it may be decades before some lamps containing mercury reach end-of-life. In addition, some specialty lamps currently have no mercury-free alternative and will remain in use for the foreseeable future.

Sales of Mercury Containing Lamps and Replacement Options

CFL sales peaked in Canada in 2007 at approximately 70 million and have since declined significantly as LEDs have become more common for A-type (lightbulb-type) lighting (Figure 2).[16] [17] LEDs are now cost-competitive with CFLs, as A-line LED prices have declined by an average of approximately 30% per year from 2012-2016, and they offer a longer useful life.[18] Due to this trend, at least one major lamp manufacturer has discontinued production of CFLs.[19] On February 1st, 2018, ECCC released a consultation document and is beginning consultations on proposed amendments to the Products Containing Mercury Regulations, which include a proposed ban on the manufacture or import into Canada of CFLs for general lighting purposes starting in 2023.[20]

LFLs, on the other hand, have until recently lacked a viable mercury-free replacement (e.g. linear LEDs or other LED fixtures), and replacing these lamps with LEDs is more complex and costly than replacing CFLs. Therefore, sales of LFLs have only started declining in recent years. Sales of LFLs in Canada declined an average of 8.7% per year from 2012 to 2016, and one major manufacturer has reported sales are currently declining by 15-20% per year directly in favour of LEDs. Sales of linear LEDs have only been tracked by the lamp industry association Electro-Federation Canada since 2016, when roughly 8 million were sold, compared to 26 million LFLs.[21] In the U.S., linear LEDs accounted for 21.7% of sales in the period from April to June 2017.[22]

Figure 2: Sales of compact fluorescent lamps (CFL), linear fluorescent lamps (LFL), and light-emitting diode (LED) lamps in Canada, 1999 to 2017



Source: Electro-Federation Canada

In 2016, estimated LED sales in Canada outpaced all other lamp types for the first time (Figure 2). The United States (U.S.) Department of Energy estimated in 2016 that the market penetration of LEDs in the U.S. lighting market will increase from 6% in 2015, to 30% by 2020, 59% by 2025, and 78% by 2030.[23] Given recent trends, the Canadian market is expected to move in a parallel course, however, recent evidence suggests the speed of this market transition was underestimated. Outdoor lighting is amongst the fastest transitioning sectors as approximately 30% of the 2.7 million streetlights in Canada have been or are committed to being replaced by LEDs.[24]

Organic light emitting diodes (OLED) are a more recent technology in the lighting market. They are currently less efficient, significantly more expensive, and are mainly limited to flat-screen devices, though some lamps are currently sold in Canada.

Overview of Current End-of-Life Management for Lamps Containing Mercury in Canada

Provincial, territorial, federal and municipal governments have taken a number of actions in recent years to address the end-of-life management of lamps containing mercury, and some private sector companies collect these lamps.

- International
  - Basel convention on Hazardous Waste
  - Minamata Convention on Mercury
- Federal
  - Canadian Environmental Protection Act, 1999
  - Products Containing Mercury Regulations

    - Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations
    - Code of practice for the environmentally sound management of end-of-life lamps containing mercury
    - Energy Efficiency Regulations
- Provincial
    - Extended producer responsibility (BC, MB, QC, and PE)
    - Industry-led vonluntary stewardship program (NS)
    - Voluntary stewardship program for large volume generators (ON)
- Municipal
    - Administration of household hazardous waste management programs
    - Landfill disposal bans
    - Household hazardous waste events
- Private sector
    - Voluntary return-to-return programs
    - Lamp processor pick-up and courier services
    - Recycling company services

In 2009, the CCME targeted lamps containing mercury in the Canada-wide Action Plan for Extended Producer Responsibility (CAP-EPR).[25] Extended producer responsibility (EPR) shifts the cost of end-of-life management for selected products from municipalities to producers, who pass the cost to consumers. Jurisdictions committed to work towards the development of EPR framework legislation and/or regulations and to promote a harmonized approach across Canada. Since the adoption of CAP-EPR, there has been a significant increase in the number of product categories covered by legislated EPR programs across jurisdictions, such as electronics and electrical equipment. These programs require the producers, or the stewardship organization running the program on their behalf, to service all areas of the province, thus providing important household hazardous waste services to remote areas where options were previously limited.

Additionally, the territories have made important strides towards exploring opportunities for EPR and product stewardship in Canada's North, and some partnerships have developed between territories and nearby provinces for targeted products.

Prince Edward Island, Quebec, Manitoba and British Columbia have legislated mandatory EPR programs for lamps containing mercury. Product Care Association manages these EPR programs under the brands LightRecycle (in PE, MB, and BC) and RecycFluo (in Quebec). Provincial rates of diversion (the capture rate) and the types of lamps covered by legislation vary (Table 1).[26] [27] The BC LightRecycle program is the most comprehensive in that it accepts all lamp types as well as fixtures and ballasts.

Ontario has announced it is planning to introduce EPR regulations for lamps containing mercury within the next few years,[28] and Saskatchewan is currently consulting on the development of household hazardous waste (including lamps containing mercury) product stewardship and recycling regulations.[29]

A stewardship program has been implemented in Nova Scotia (Table 1). Nova Scotia's mercury collection program is funded through electricity utility Nova Scotia Power, administered by the province's energy efficiency utility EfficiencyOne, and delivered in partnership with Scout Environmental. The program offers free pick-ups and drop-offs of CFLs, LFLs, HID lamps, and other products containing mercury for residents and businesses.[30] The province provided an incentive to support the program's development through its Air Quality Regulations, which allow a generator of mercury emissions to earn emissions

credits through diversion of products containing mercury from landfill.[31] The regulations allow the program to exist until the end of 2024. It is the only known program in Canada that takes back any product containing mercury and even elemental mercury.

"Take Back the Light" is a national voluntary program established by the Recycling Council of Ontario for matching up non-residential lamp purchasers with sellers who will collect the lamps at end-of-life (Table 1). Users of the service register free of charge while lamp distributors are charged a fee based on gross sales. The program has collected over 26 million lamps since its launch in 2008.[32] The program has stringent requirements for processors, such as the stipulation that all mercury be recovered from the lamp components and no mercury should be sent to landfill.

Table 1: Stewardship programs for lamps containing mercury in Canada

Province	Initiative	Types of lamps	Capture rate target (2016)	Capture rate (2016)	Sectors
British Columbia	Legislated EPR	All lamps fixtures, and ballasts	LFL: 34-62% CFL: 36-62%	LFL: 42% CFL: 51%	All sectors
Manitoba	Legislated EPR	LFL and CFL	40% of all lamps	LFL: 150%* CFL: 35%	Residential only
Ontario	Voluntary stewardship Legislated EPR planned	CFL, LFL, HID	N/A	Unknown	Non-residential only
Quebec	Legislated EPR	All lamps containing mercury	LFL: 40% CFL: 30% HID: 40%	LFL: 40%, CFL: 8% HID: 32%	All sectors
Nova Scotia	Stewardship (industry-led)	CFL, LFL, HID	Unknown / No target	Unknown	All sectors
Prince Edward Island	Legislated EPR	LFL, CFL, HID, LED	Unknown / No target yet	13% of total lamps	All sectors

* Note: capture rates exceeding 100% indicate greater than expected returns and/or non-residential users taking advantage of the residential program

Many municipalities offer annual or more frequent household hazardous waste collection days. These programs can be particularly effective for communities where residents do not have easy access to collection sites. Some municipalities may collect bulbs year-round (e.g. at community centres) and may have contracts in place to consolidate and send for processing. Municipalities may also play a role in promoting lamp recycling programs or providing information on collection sites for lamps on municipal web sites. Some municipal and private landfills will refuse large volumes of lamps whether or not a municipal ban is in place, which necessitates industry finding environmentally sound solutions.

Some retail stores that sell lamps voluntarily take back certain residential lamps free of charge in provinces without mandatory EPR programs as part of corporate product stewardship policy. According to company websites, RONA stores generally accept all types of lamps containing mercury, IKEA and

Lowe's accept CFLs only, and London Drugs takes back any product they sell, including any lamps and their packaging. Smaller retailers may also participate in recycling programs.

Other private sector companies offer end-of-life lamp collection services. These include lamp processors and companies that offer waste management solutions (e.g. containers and pickup service) to the industrial, commercial and institutional (ICI) sectors. Some lamp processors offer a courier service, where sturdy boxes are sent out to be filled with appropriately-sized lamps, with pre-paid shipping back to the processor included in the price of the box. Some lamp processors also attend household hazardous waste collection events.

In February 2017, ECCC published the Code of Practice for the Environmentally Sound Management of End-of-Life Lamps Containing Mercury (the Code of Practice) to complement provincial, territorial and other initiatives.[33] This voluntary instrument includes best practices for collection, storage, transport, processing, and disposal of lamps containing mercury at end-of-life, as well as guidance specific to northern and remote areas, where access to recycling and disposal facilities is limited, and additional information such as guidance for safely cleaning up broken lamps. A National Strategy may seek to follow-up on this publication by measuring awareness and implementation of the Code of Practice by targeted governments and stakeholders.

In addition, with ratification of the Minamata Convention in April 2017, Canada has obligations and reporting requirements through the entire life-cycle of mercury, including waste. Development of a National Strategy for lamps containing mercury and reporting on implementation every 5 years will contribute to Canada's on-going commitment to the Convention, including on managing mercury waste in an environmentally sound manner, and on providing information for Canada's national report. Canada is also Party to the Basel Convention, which sets requirements for the transboundary movement of hazardous wastes and hazardous recyclable materials including lamps containing mercury. Canada complies with the Convention through the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations.[34]

Key Challenges for End-of-Life Management

There is currently no economic incentive for the environmentally sound end-of-life management of lamps containing mercury. These lamps are inconvenient to store and transport as they are fragile, hazardous if broken, and highly distributed across the country. From a recycling perspective, they are high cost relative to the value of their recovered (recycled) components and they contain hazardous material which requires special equipment and expertise to manage.

A key challenge is the need to increase diversion from the residential sector, which is the primary user of CFLs. According to the U.S. Department of Energy, in 2014 CFLs were the most-used lamp type in the residential sector, representing about half of all A-type lamps.[35] In 2009, 56% of Canadians reported disposing CFLs with their regular waste;[36] capture rates have since improved in some jurisdictions due to the provincial, municipal and other programs that are now in place. However, in 2015, 44% of Canadians still reported disposing CFLs with their regular waste, and some provincial disposal rates have remained static.[37] A survey of households in Maine identified two main factors to increase diversion of CFLs:

- increasing easy access to and comprehensiveness of recycling information, and

- increasing the convenience of collection.[38]

Increasing diversion from the ICI sector and the construction, renovation, and demolition (CRD) sectors is a different challenge as these users generate larger volumes of lamps. It may be more difficult for these sectors to dispose of large volumes at landfill, but if they do so their impact is proportionally much larger compared to the residential sector. The BC and PE EPR programs offer free collection for these sectors and in other provinces these sectors can contract a waste management company to pick up spent lamps, however environmentally sound disposal then depends on the latter company's practices. Additional information is needed to better assess the capture rates from the ICI and CRD sectors.

Under EPR programs, producers are responsible for physical, financial, and informative aspects of end-of-life management. Producer Responsibility Organizations track and report on the amount of lamps collected and their disposal. EPR and voluntary programs have shown variable rates of success by province and by lamp type, with some achieving greater than 100% capture rates (more lamps collected than were expected to have reached end-of-life) and others capturing less than 15% of available lamps. In the absence of EPR, jurisdictions do not have practical access to this information, so the capture rates of lamps containing mercury are not known for most jurisdictions or, as a result, for Canada as a whole. However, estimates could be made based on the number of lamps received and processed by lamp processors.

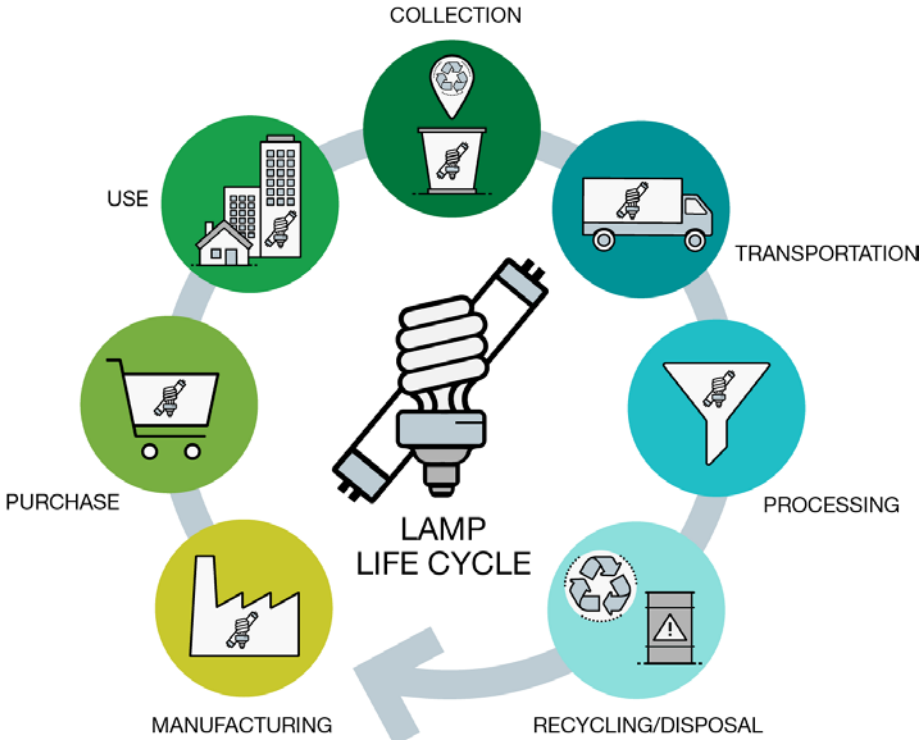
In provinces with EPR for lamps containing mercury, Producer Responsibility Organizations will soon or are already facing a decline in sales of lamps containing mercury, which reduces the funds available for operating the EPR program (generated at point-of-sale).[39] This problem may be mitigated by including LEDs in the EPR program, as British Columbia and Prince Edward Island do, but it is unknown if funds will remain sufficient to maintain capture rates, let alone increase them.

Northern, remote and Indigenous communities face unique challenges in end-of-life management of lamps containing mercury. These challenges can include, but are not limited to: limited access to supplies and training for safe end-of-life management, limited or inadequate storage facilities, high cost to transport to processing facilities (particularly when the community has no road access), and a lack of incentives for private industry to develop recycling infrastructure.

Discussion Issues: Potential Elements of a National Strategy

To ensure that lamps containing mercury throughout Canada are disposed in a safe and environmentally sound manner, proper management at each step of end-of-life management is required, as well as communication up and down the management chain. The key steps are collection, transport, storage, processing, treatment, and final disposal or recycling (Figure 4). This section provides an overview of the current status of these actions in Canada and potential goals for a National Strategy. Information included in this section helps inform practices for safe and environmentally sound disposal and guidelines for facilities where these activities are carried out, as suggested in the Act.

Figure 3: Life cycle of a lamp containing



Collection and Short-Term Storage

A number of actions have been taken in Canadian jurisdictions to establish easily-accessible collection networks for the residential and industrial, commercial, and institutional (ICI) sectors. Information about collection sites (location, types of lamps collected, and sectors they accept lamps from) is available online through the Product Care website for the provinces it operates in (British Columbia, Manitoba, Quebec, Prince Edward Island), while in Nova Scotia this information is found on the Efficiency Nova Scotia website.[40] [41]

In other provinces and the territories, this information may be available online (e.g. on recycling council websites), but collection sites tend to be fewer in number and sometime less accessible to the public, particularly for residents of rural, northern, remote, and Indigenous communities. In these jurisdictions, some municipalities may operate collection programs for lamps and some retailers may offer voluntary take-back programs, primarily for the residential sector. In addition, in some jurisdictions, collection sites may charge for drop-off of lamps, further reducing incentives to return spent lamps.[42]

Collection and storage of lamps in northern, remote and Indigenous communities is often a challenge due to a lack of collection programs and designated facilities for storage. By implementing best practices, lamps can be safely received and temporarily stored at a convenient drop-off point, such as a retail store or community centre. A National Strategy could seek to identify practical options for

collection and storage of end-of-life lamps in these communities, potentially by linking with existing household hazardous waste programs. A National Strategy could also consider training needs for individuals responsible for collection and storage of these lamps.

Another option for northern and remote communities that may be preferred is to accelerate the transition to more energy efficient LED lighting and simultaneously seek to collect all lamps containing mercury. A so-called LED swap out initiative may be more feasible in communities that currently have the resources to segregate and store spent lamps.

Potential Goal for a National Strategy:

All people living in Canada have easy access to programs, services or events that collect and store lamps temporarily

Transportation

Provinces and territories generally follow the federal Transportation of Dangerous Goods Regulations to classify spent, broken, or crushed lamps and mercury-rich phosphor for transport, however some provincial and territorial regulations specify how to classify lamps in these different forms.

In Ontario, a special exemption exists for "common mercury waste", which includes intact or damaged lamps among other items.[43] A transporter of common mercury waste does not need to be registered for carrying hazardous waste as long as the lamps are being transported to a "common mercury recovery facility". This exemption works to facilitate programs such as "Take Back the Light". A similar designation exists in the U.S. under the Universal Waste Rule for lamps that would otherwise be classified as hazardous waste.[44]

The transportation of hazardous waste out of northern, remote and Indigenous communities should be considered a high priority as these communities often do not have access to proper storage or processing facilities. A National Strategy could seek to identify practical solutions for transporting lamps containing mercury out of these communities. Such initiatives could draw from examples of successful past actions by the public or private sector, or could be tied into related existing or planned initiatives for the shipment out of other hazardous wastes or materials. Some lamp processors directly pick up lamps from remote communities and some offer a courier service whereby a pre-paid shipping container, generally a sturdy cardboard box containing a thick plastic liner, is sent to a community along with instructions on how to seal the liner and box to safely prepare it for shipping.

To facilitate storage and transport, some communities and organizations make use of drum-top lamp crushing devices to significantly reduce the volume of spent lamps. Though they are useful for this purpose, these devices require careful use, maintenance, and training for operators to ensure they are not exposed to mercury. In addition, crushed lamps may be classified as hazardous waste in some jurisdictions, which increases the cost of transportation. The Code of Practice provides best practices for their use; however, when possible lamps should be stored and transported intact to processing facilities in order to minimize the potential for mercury exposure to workers during shipping, transportation, and receiving. Another consideration for these devices is that they may not function optimally at the low

temperatures they are often exposed to, particularly in Northern communities where a heated storage area is unavailable.

Potential Goal for a National Strategy:

Consider mechanisms to facilitate transportation of lamps between collection and processing facilities

Processing

Processes for crushing the lamps, separating the component parts (glass, metal, plastic, mercury-rich phosphor powder), and disposing or recycling each component are well-established in Canada. The Code of Practice is a source for guidance specific to the separation and fate of mercury, while acceptable and unacceptable practices for disposal or recycling of each component of lamps are listed in requirements for lamp processors in Ontario.[45] Existing processing technologies are able to recover close to 100% of the material weight. In Ontario, processors must demonstrate an annual diversion rate of greater than 90% (by weight) of lamps and lamp packaging material.

A "common mercury waste recovery facility" in Ontario can process lamps without the need to register as a hazardous waste generator, but cannot dispose of them.[46] These exemptions exist to increase the number of facilities handling certain common hazardous wastes while reducing regulatory burden.

There are a number of facilities in Canada that separate mercury-rich phosphor powder from other components of the lamps using vacuum-sealed systems that capture any airborne mercury. There is at least one facility each in six provinces, all of which are located close to or within major metropolitan areas. Processing of lamps that are not coated with phosphor (e.g. some UV lamps) can only be done at some of these facilities due to the higher elemental mercury content in these lamps. Separation of the phosphor from the glass is done by mechanical agitation and filtration or through solvent extraction.

In general, processing facilities do not treat the lamp components (e.g. glass) to remove any potential remaining mercury contamination after separating the phosphor powder. This contamination may be minor but not insignificant for human or environmental exposure depending on how these components are later processed or used.

Treatment of the phosphor powder to remove and capture the mercury from lamps is generally done through thermal treatment (retort; other methods such as solvent extraction have been reported). This method is not known to occur in Canada for lamps, though one facility is known to retort other mercury waste. In addition, there are currently no facilities in Canada that purify mercury waste (through multiple distillations) to a commercial grade so that it can be reused in new lamps or other products. Instead, a significant amount of mercury waste, including phosphor powder from lamps, is sent to the U.S. for this purpose.

Potential Goal for a National Strategy:

All mercury from lamps is recovered during processing for reuse or environmentally sound disposal to prevent releases of mercury to the environment and minimize risks to human health.

Recycling or Long-Term Storage/Disposal of Mercury Wastes

In Canada, some mercury waste, such as contaminated soil or fly ash, is processed into a solid material using a stabilization/solidification (S/S) process prior to final disposal in a hazardous waste landfill. This process produces a stable, water-insoluble material that meets provincial leachate requirements for disposal in these engineered landfills (see below). S/S processes are known to be carried out at two facilities in Canada, while another facility uses a chemical process to stabilize mercury wastes prior to shipment to the U.S. for further treatment.

Only a few provinces have regulations specifically addressing spent lamp disposal, and those that do have variable requirements. Wastes containing mercury are generally classified using the US EPA's Toxicity Characteristic Leaching Procedure.[47] Most provinces have set a limit of 0.1 mg/l for leachate from mercury waste that would be considered hazardous, and some provinces have higher leachate limits for disposal in hazardous waste facilities. Some, mostly older, lamps produce a leachate in excess of 0.2 mg/l, while newer lamps generally produce a leachate below 0.1 mg/l.[48] Some U.S. states have implemented disposal bans (i.e. non-hazardous waste landfills) on all lamps containing mercury.[49] Some Canadian municipalities have also implemented disposal bans.[50] The quantity of mercury entering landfills due to lamps has been reduced from the 1150 kg estimated in 2001 to an estimated 200-400 kg, however information on end-of-life management is incomplete. A National Strategy could seek to update this information and report on progress.

In 2015, 55 tonnes of mercury and its compounds were disposed on-site at facilities in Canada (mostly at two hazardous waste landfills), 50 tonnes were disposed off-site or treated prior to off-site disposal, and 24 tonnes were sent for off-site recycling (primarily metal recovery, in the U.S.).[51] Tracking how the mercury recovered from lamp waste is ultimately disposed or re-used is challenging due to its consolidation with other types of mercury waste and cross-border shipments (Canada also receives mercury waste from the U.S. for disposal). The re-use of mercury recovered from waste for new lamps and other products could be considered as part of closing the loop on this toxic material. As Canada does not have facilities to purify mercury to commercial grade or to store elemental mercury, development of such a facility could also be considered.

Potential elements of a National Strategy:

Information is updated and made available on the quantity of mercury entering non-hazardous waste landfills from lamps

Disposal of lamps containing mercury in non-hazardous waste landfills and all incinerators is prevented

Public Awareness, Education and Participation

A key element of a National Strategy could be efforts to increase participation in end-of-life lamp programs from all sectors by increasing awareness and education of the hazards associated with lamps containing mercury, the importance of end-of-life management, and the programs, services, sites, and events available to return spent lamps.

Even when returning lamps is free, some users may choose not to because they may be unaware of the presence or hazards of mercury. In 2015 only 43% of Canadian households reported returning their spent lamps (LFLs and CFLs) to a depot or retailer, while 41% put them in the garbage and 18% still had them.[52] Comparable information for the ICI and CRD sectors is not available.

In provinces with extended producer responsibility (EPR) for lamps, Producer Responsibility Organizations are responsible for informing users of the hazards associated with lamps containing mercury as well as the availability of programs for the collection of lamps at end-of-life. In some provinces, public awareness campaigns have been comprehensive in using products such as advertising on TV and in public spaces such as transit, community events, displays at point of sale and point of return, hotlines, and informational webpages. Several provinces also set targets for and measure consumer awareness.

Provinces and territories without EPR for lamps, as well as many municipalities, may conduct public awareness programs for lamp recycling. Additional information on the scope and costs of these programs, as well as their impact on capture and diversion rates, would help inform development of a National Strategy. A National Strategy could use successful programs as a guide to designing a potential broad public awareness campaign.

Potential element of a National Strategy:

All Canadians are aware of the hazards associated with lamps and other products containing mercury, the importance of recycling them, and the programs, services, sites and events available to return spent lamps.

Measurement and Reporting

In provinces with legislated EPR for lamps, the capture rate is defined as the amount of lamps collected, divided by a baseline that is calculated slightly differently by each of the provinces.[53] In BC and Manitoba, the baseline is the amount collected as a percentage of the quantity of lamps available to collect in the same year based on prior sales and expected lamp lifespan. In Quebec, the quantity collected is compared to sales in a reference year (e.g. 2014 sales for the 2016 capture rate), and in PEI the comparison is to sales in the same year as collection. In the European Union, this metric is called the collection rate and the reference is the average volume put on the market over the last 3 years. The targets set for lamp capture rates vary between the provinces with EPR.

However it is measured, the rapid transition to LEDs has resulted in uncertainty in setting a capture rate, with many users bringing back lamps before end-of-life, resulting in capture rates sometimes exceeding

100% for some categories in some years in BC and Manitoba. For this reason, Product Care Association is moving away from capture rate targets as they renew their stewardship plans with provinces. They are instead intending to measure absolute collection by regional district, and to measure program success with targets for other metrics such as accessibility (see below) and awareness.[54]

Another key metric to measuring end-of-life management is the diversion rate, also known as the recycling rate or the recovery rate. It is the measurement of the amount (by weight) of material received by a processor that is ultimately diverted from landfill. In Ontario, lamp processors must demonstrate an annual diversion rate of 90% of lamps and lamp packaging. The EU has an 80% lamp diversion rate target and a requirement to recover 100% of the mercury from those lamps.[55]

Capture rates tend to correlate with accessibility of lamp users to collection sites or pick-up services. BC's stewardship organizations measure and set targets for accessibility for residents to collection points for materials subject to EPR legislation. The accessibility standard applies to communities of more than 4000 people, and is met when a collection site lies within a 30 or 45 minute drive from a household, depending on whether the resident lives in an urban or rural area, respectively. The accessibility targets are set at 95% for both commercial and residential sources, and as of 2016 the targets were exceeded.[56] In Quebec, accessibility to collection site is prescribed in legislation and is based on the size of a community. For example, at least one seasonal collection site (open at least one day per season) is required for a community with less than 15,000 inhabitants, while 3 full-time collection site, plus an additional collection site for each 50,000 inhabitants, is required for a community with more than 100,000 residents.[57]

Stewardship organizations for other products subject to provincial EPR regulations report using additional or different metrics. Electronic waste is a more complex sector than lamps in that the products have variable lifetimes, weight, and a vast repair and reuse market. Therefore, stewardship for this waste stream is focused on improving accessibility to and awareness of the program. Some EPR programs focus on increasing the number of product categories consumers can return. Tire stewardship programs in some provinces track the type of processing used after being returned, with targets for increasing the use of the most environmentally-sound processes. Other measurements and targets for EPR products include the cost per capita to recycle a product, the weight of a product collected per capita, the number of collection events, and the number of participating stewards, among others.

Northern, Remote, and Indigenous Communities

It is challenging to precisely estimate the number of lamps containing mercury currently in use in Northern, remote, and Indigenous communities throughout Canada. In the territories, for example, based on per capita U.S. data,[58] the current estimated use of CFLs and LFLs is each around 800,000 to 900,000, and between 10,000 and 100,000 HID and specialty lamps are expected to be in use, which collectively contain around 10 to 15 kg of mercury.

Northern, remote, and Indigenous communities have a range of access (or no access) to collection and storage options for spent lamps, depending on the community. Collection and storage is often a challenge due to a lack of resources, facilities for storage, waste management workers, and collection programs. Where hazardous waste segregation and storage facilities do not exist, lamps are very likely to be disposed in the community landfill.

The transportation of hazardous waste out of northern, remote, and Indigenous communities is a necessity for environmentally sound disposal as all lamp processing facilities in Canada are located in southern Canada. In provinces with EPR, stewardship organizations running programs for various materials (e.g. electronic waste) often pool together resources to conduct collection events of multiple materials from these communities. Producer Responsibility Organizations in Alberta and BC have been known to work with waste management or stewardship organizations in Northwest Territories and Yukon to bring materials to processing facilities. However, there is currently a lack of information on the frequency and effectiveness of these collection programs.

To facilitate storage and transport, some communities make use of drum-top lamp crushing devices to significantly reduce the volume of LFLs and with some drum-top crusher models other lamps are also crushed. A typical device can store over 1000 lamps in a single drum and are useful for facilitating transport. These devices require careful use, maintenance, and training for operators to ensure they are not exposed to mercury. Northern, remote, and Indigenous communities may face a lack of access to replacement parts and trained operators, which increases the risk of mercury exposure to workers and the environment. In addition, these devices may not function optimally at low temperatures. This is problematic, particularly in Northern communities, where a heated storage area is often unavailable, and the extreme range of temperatures may increase wear and tear of these devices.

A National Strategy could seek to identify practical options for collection and storage of end-of-life lamps in these communities, potentially by linking with existing household hazardous waste programs, and by considering training needs for individuals responsible for collection and storage of these lamps. By implementing best practices, lamps can be safely received and temporarily stored at a convenient drop-off point, such as a retail store or community centre. Transportation out will depend on the community but could include working with Producer Responsibility Organizations to facilitate collection of lamps and other materials (even if lamps are not covered by EPR legislation in that jurisdiction). Other options include courier services and an LED swap out initiative.

Path Forward to Develop a National Strategy

Environment and Climate Change Canada (ECCC) has developed this discussion paper to provide an overview of the current state of end-of-life management of lamps containing mercury in Canada, to identify potential broad strategy goals, and to facilitate consultations with governments and stakeholders. The discussion paper was provided to stakeholders in advance of a national forum for the development of a National Strategy, held in Ottawa on February 27 and 28, 2018. ECCC will continue to work with governments and key stakeholders on the development of a National Strategy through the summer of 2018.

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