CFL Recycling Report

Recommendations for the Collection and Recycling of Spent Residential Compact Fluorescent Bulbs in Nova Scotia

Prepared for: Nova Scotia Resource Recovery Fund Board

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LIST OF ACRONYMS			
CFL	Compact Fluorescent Lamp	MEPS	Minimum Energy Performance Standards
CMA	Central Metropolitan Area	NEMA	National Electrical Manufacturers Association
CNS	Central Nervous System	NGO	Non-Government Organization
EPA	Environmental Protection Agency	NRCAN	Natural Resources Canada
EPR	Extended Producer Responsibility	NSE	Nova Scotia Environment
FL	Fluorescent Lamp	OEE	Office Of Energy Efficiency
HHW	Household Hazardous Waste	OHS	Occupational Health And Safety
HID	High Intensity Discharge	PCA	Product Care Association
LED	Light Emitting Diode	PPH	Pollution Prevention Hierarchy
MDEP	Maine Department Of Environmental Protection	RRFB	Resource Recovery Fund Board

EXECUTIVE SUMMARY

With the federal ban on the sale of incandescent bulbs, use of compact fluorescent light (CFL) bulbs in Nova Scotia and the rest of Canada has been increasing. Because each bulb contains a small amount of mercury, an element harmful to humans and the environment, there are a number of concerns surrounding their disposal in landfills. Currently there is no recycling option for the end of life management of mercury-containing bulbs such as CFLs in Nova Scotia; the majority end up in landfills. Through a collaboration between the RRFB and Clean Foundation, this study was undertaken to determine the need for, feasibility, and potential structure of a province-wide CFL recycling program.

It is well understood that mercury, in its many forms, both elemental and compound, is harmful to the environment. Plants and animals experience severe negative effects when exposed to mercury from anthropogenic sources. In humans mercury can have a range of effects, including damage to the central nervous system. The average Canadian CFL contains 3.7 milligrams (mg) of mercury, which is released when the bulb breaks. If CFL bulbs are not recycled they will break either on the way to the landfill or in the landfill. Not only does this pose human and environmental risks, but the benefit of fewer mercury emissions from power generation is negated by the mercury that seeps out of the bulb during and after disposal. A lack of recycling options means that landfills are a significant source of mercury emissions from CFL bulbs, primarily in vapour form.

Up until 2013 incandescent bulbs remained the bulb of choice for residential consumers in Nova Scotia, making up 77% of bulbs sold that year. Despite this, industry data indicates that over 2 million CFL bulbs are currently in use in Nova Scotia. CFL sales throughout the province have been steadily increasing over the past decade, with a spike in 2007 potentially due to an outcropping of energy efficiency programs. Based on the current lifespan of CFLs, over 352,000 bulbs will become available for collection throughout 2014, increasing to 354,000 CFLs available in 2015. Although CFL sales are predicted to plateau due to improvements to LEDs, the number of bulbs available to collect in the coming decade will remain high. While LED sales are increasing exponentially, total sales for 2013 still remained well below those of CFLs. With the federal ban on incandescent bulbs to come into full force at the end 2014 both LEDs and CFLs will fill the void left by incandescent bulbs.

While the capacity to recycle all CFL bulbs used within the province currently exists (through independent recycler Dan-X Recycling Ltd.), it is not mandatory that CFL bulbs be recycled in Nova Scotia. Unless regulations are in place to make CFL

recycling mandatory, there is little incentive for the public to divert the bulbs from their household waste. However, a number of other provinces have initiated their own recycling programs, including British Columbia, Manitoba and Quebec. The Product Care Association (PCA) is the chosen agency by all provinces operating province-wide CFL recycling to carry out the recycling program. British Columbia is particular has implemented a largely successful program, achieving a bulb capture rate of 74% in 2013.

Should Nova Scotia decide to implement Extended Producer Responsibility (EPR) for CFL recycling, the Nova Scotia *Environment Act* is the piece of legislation under which it would be enacted, as part of the Solid Waste-Resource Management Regulations. The regulations currently include a section on industry stewardship, which includes products such as tires, paint, and bottles. This section on EPR would be expanded to include CFLs. Producers of CFLs sold in Nova Scotia would then be required to develop a plan to recycle used CFLs in the province. The plan would have to be approved by Nova Scotia Environment, the department with authority according to the regulation. The EPR legislation in Nova Scotia would also be paired with a ban on CFLs in the landfill. EPR legislation is necessary when banning products from landfills, so as to provide an alternative to landfill disposal. Conversely, implementing a landfill ban on CFLs helps to increase the success of EPR programs. These changes are already being considered by the province.

This report concludes with a comprehensive list of recommendations for an efficient and cost-effective CFL bulb recycling program. Here are the most pressing recommendations.

- Within such a program responsibility should lie entirely with the producers of the products, though the government body in authority should provide producers with clear directives on how to meet regulatory requirements.
- Enforcement will play a large role in program success, and should be rigorously carried out at both the generator and the receiver stage, until enforcement at the generator stage is considered effective.
- Producers should also be responsible for 100% of the program cost, and no additional cost should be incurred by municipalities.
- With respect to education and program outreach, information should be highly accessible and uniform and should strive to educate consumers on proper disposal practices.
- Collection of the bulbs should strive to eliminate all real and perceived inconveniences to the consumer. Producers should also use the services of the most local recycler.
- Producers should be required to implement a pollution prevention hierarchy, and the province should consider bulb collection measures in the interim period until regulations have been implemented

1 INTRODUCTION

For waste educators in Nova Scotia, forefront among the list of issues raised by residents is that of CFL bulb disposal. The media has highlighted this issue of late, displaying the discontent among residents that CFLs are difficult to dispose of safely. Elsewhere in Canada residents have access to CFL recycling programs, yet Nova Scotia lags behind provinces such as Quebec and British Columbia, with the vast majority of CFLs used in the province ending up in the landfill. Purportedly a leader in waste management, Nova Scotia has been slow to tackle CFLs, and the result is thousands of milligrams of mercury entering its landfills each year. This report assesses the need for and feasibility of a residential CFL recycling program in Nova Scotia, and provides recommendations for such a program.

1.1 REGULATORY BASIS FOR INCANDESCENT PHASE-OUT

In 2007 the federal government of Canada made the decision to phase-out incandescent light bulbs. The phase-out allows for all bulbs that were made before a certain date, or which remain as stock with retailers, to be sold, after which point incandescent light bulbs will no longer be available to the public. The phase-out is based on a set of energy efficiency standards that require light bulbs to consume at least 28% less energy than incandescent light bulbs (Dewis, 2014).

Section 20 of Canada's *Energy Efficiency Act* gives the Governor in Council the ability to make regulations prescribing energy efficiency standards for energy using products or for classes of energy using products (*Energy Efficiency Act* S.C. 1992, c. 36, s. 20). Canada's Energy Efficiency Regulations are therefore enacted under this statute. A phase-out of incandescent light bulbs was announced on April 24, 2007 by the Minister of Natural Resources; The Office of Energy Efficiency (OEE) initiated the regulatory process, and Natural Resources Canada (NRCan) engaged stakeholders to develop a proposal for the regulations. Since 2008 there have been three amendments to the Energy Efficiency Regulations, pertaining to the intended phase-out of general service incandescent lamps (incandescent light bulbs). Amendment 10 was made in December of 2008, and was intended to introduce minimum energy performance standards (MEPS) for general service lamps (light bulbs) beginning in 2012. This means that a phase-out of incandescent light bulbs was intended in Canada to begin in 2012. However, amendment 12, which delayed the application of the MEPS (ie. the phase-out) for incandescent light bulbs by two years, was made in November of 2011. The phase-out for 100- and 75-watt bulbs therefore occurred on January 1, 2014, and the phase-out for 60- and 40-watt bulbs will take place December 31, 2014.

In Nova Scotia there is no existing provincial standard which effectively limits the use of general service incandescent light bulbs. However, the federal phase-out applies to all of Nova Scotia. Currently, there is neither federal nor provincial regulations for recycling CFL light bulbs, though the federal government has indicated that regulations may be in place someday regarding end-of-life management for CFLs. Other provinces, such as British Columbia, Manitoba, and Quebec, have implemented their own recycling regulations for CFLs.

1.2 CONCERNS ABOUT CFLS AND THE ENVIRONMENT

Compact fluorescent lights, along with halogen lights and light-emitting diode (LED) lights, are a form of energy-efficient light which uses less electricity to produce the same amount of light as conventional incandescent bulbs. Incandescent bulbs convert just a fraction of the electricity they use to light, usually less than 5%, and the rest is emitted as heat. CFLs use about 75% less electricity and also last ten times longer than incandescent bulbs - on average five to six years (Li, 2011).

Incandescent light bulbs are composed mainly of glass and trace amounts of metals, such as tungsten, which do not pose environmental risk when disposed of into the regular waste stream (Dewis, 2014). However, CFL bulbs contain a small amount of mercury, an element which is toxic to humans. A household CFL bulb may contain anywhere from 0.1 to 5.0 mg of mercury, with best practice CFLs generally containing lest than 3mg (Salthammer, 2011; Li, 2011).

Mercury is a substance that has historically played a significant role in generating electricity, as a by-product of coal-fired generation. As a comparison, a power plant that emits 10mg of mercury to produce the electricity to run an incandescent bulb, will only emit 2.4mg to run a CFL bulb for the same time (70-80% less) (Arendt, 2011; Taghipour, 2014). For this reason CFLs remain the preferred bulb type, even though they still contain a small amount of mercury, which poses an environmental risk if not disposed of safely. A suitable replacement for mercury in CFLs has not yet been found.

1.3 WHY RECYCLE

Hargreen (2004) found that fluorescent lights are the most significant product source of mercury to the atmosphere in Canada, and the second most significant product source of mercury on land, after industrial switches and relays. This is likely still true in 2014 as CFL bulb use has increased. Municipal waste and hazardous waste landfills are the primary repository for products that contain mercury in Canada, such

as CFL bulbs, and are therefore the largest reservoirs of mercury on land (Hargreen, 2004).

A report released by Statistics Canada in March of 2014 expressed data from the Households and Environment Survey conducted in 2011. The report disclosed information regarding the consumer uptake of CFL bulbs and the disposal of the bulbs in Canadian census metropolitan areas (CMAs). In Nova Scotia, Halifax was surveyed, and demonstrated poor results for both uptake and disposal. In 2011, 74% of households in Halifax had at least one CFL light bulb, slightly below the national average of 76%. However, this represents a decrease in the rate of CFL uptake by Halifax households, down from 84% in 2009. In terms of disposal, households in Halifax were the most likely to have disposed of their dead or unwanted CFLs in the garbage. No other CMA in Canada had a higher rate of CFL disposal in the garbage than Halifax, where 84% of all households surveyed disposed of CFLs in this way. This was well above the national average of 50% of household CFL disposal in the garbage. When combining the figures for both uptake and disposal, it is evident that between 2009 and 2011, Haligonians both decreased their uptake of CFL bulbs, and increased their disposal of CFLs in the garbage from 61% to 84% of households (Dewis, 2014). While the findings from the report do not represent household trends outside of CMAs, the data pertaining to Halifax may provide a picture of uptake and disposal throughout Nova Scotia. In Cape Breton in particular, neither recycling nor hazardous waste disposal are available to residents, leaving no other option than disposing of the bulbs into the waste.

The benefits of recycling CFL bulbs are numerous, and not solely environmental. Nova Scotia has set a waste diversion target which would limit each Nova Scotian to 300kg of waste per year. Diverting CFLs would contribute to the achievement of this goal. Furthermore, CFLs disposed of in household waste can pose a risk to residents as well as waste collectors, if bulbs are broken within the waste. Recycling the bulbs serves to reduce the risk of breakage and exposure to harmful mercury gas. CFL recycling also contributes useful materials to Nova Scotia industries, including raw glass and metal, which are recycled and reused by various businesses. In addition, Nova Scotia is seen as a leader in waste diversion, yet the province lags behind other provinces with respect to CFL recycling. This must be remedied for Nova Scotia to remain such a leader.

1.4 REPORT STRUCTURE

This report begins with an investigation into how mercury behaves in a landfill and how landfills in Nova Scotia currently manage mercury. This section discusses the potential environmental effects that CFLs can have in a landfill. The following section provides an estimation as to the number of CFLs currently in use in Nova Scotia, as

well as projections for future use of both CFLs and LEDs. Next, a summary of best management practices for CFL recycling programs in other jurisdictions is provided, with a focus on those which have proven most successful. Successful programs are then further discussed in terms of their regulatory framework, to inform a potential regulatory framework for Nova Scotia. The final section of the report compiles recommendations for each element of a CFL recycling program in Nova Scotia.

2 MERCURY

There is a small amount of mercury in each CFL light bulb, about as much as would fit on the tip of a pen. As long as the bulb remains intact the mercury does not leave the bulb. However, if not properly recycled it is extremely unlikely that a CFL bulb will remain intact. Therefore, the bulbs pose a risk to human and environmental health due to the potential for their mercury to be released during disposal.

2.1 HOW CFLS WORK

A CFL bulb comprises a glass tube, an electronic ballast, a metal end, mercury vapor, inert gases, and a phosphor coating on the inside of the tube. Table 1 lists the components of a CFL light bulb. The bulbs function by passing an electric current from the ballast through the tube, exciting the mercury vapor and generating radiant energy. The energy is in the ultraviolet range; however, it causes the phosphor coating on the inside of the glass tube to fluoresce, converting the UV light to visible light (Li, 2011). As of yet, there is no way to make a CFL bulb without the use of mercury. As mentioned, the mercury in the bulb is in vapour form, and the bulb begins with pure elemental mercury. Over the course of the bulb's life, the pure mercury is "consumed" and binds to the glass tube and the phosphor coating. Some mercury also becomes mercuric oxide, a toxic powdered mercury compound, which is released if the bulb is broken (Li, 2011; Sylvania, 2006).

When a CFL bulb becomes waste, the mercury remains in the bulb in a divalent state (meaning it is capable of forming compounds, which can be harmful), but mercury also contaminates the phosphor powder within the bulb (Rey-Raap, 2013). When the bulb breaks mercury in a number of forms can be released. First, elemental mercury vapour is released, which enters the air. Second, mercury is incorporated into the phosphor coating on the tube, and which can enter the environment over time if not recycled. Finally, mercuric oxide, a toxic powder, can be present in the tube.

Table 1. Composition of CFL bulbs

Material	Composition
Glass	75-90%
Mercury	<0.015%
Lead Oxide	0.2-2%
Aluminum Oxide	0-2%
Phosphor Powder	0.5-3%
Miscellaneous Compounds (fluoride, manganese dust, tin dust etc.)	0-0.1%

(Product Care, 2011)

2.1.1 How much mercury is in a CFL bulb?

The amount of mercury in a CFL bulb, measured in milligrams, varies greatly depending on bulb wattage, bulb type, date of manufacture, and brand (Hilkene, 2005). As a general rule, bulbs with higher wattage contain more mercury (Li, 2011). Brands such as Philips, Sylvania, and General Electric, among others, have made efforts to reduce the amount of mercury in the bulbs they sell. Currently, newly manufactured CFL bulbs rarely contain more than 5mg of mercury, and never less than 0.1mg. Depending on brand, the range of mercury in a typical 13 watt (60 watt incandescent equivalent) bulb is generally between 0.17 and 3.6mg (Li, 2011; Wagner, 2011; Sylvania, 2014). To contextualize, the current human health maximum exposure limit is 0.025mg of elemental mercury per cubic meter of air, and 0.001mg per litre of water according to Health Canada guidelines (Health Canada, 2004). Though the amount of mercury in each bulb is small, the market for CFLs is large, which means that the bulbs represent a significant category of mercury-containing wastes (Eckleman, 2008).

2.2 TOXICITY OF MERCURY

The history of mercury use and subsequent environmental and human health impacts is long and grim, spanning back to ages when mercury was believed to provide eternal life. It is now understood that mercury is an extremely toxic substance. Depending on the form that the mercury takes, the degree of toxicity and the toxic effects will vary. Elemental mercury is usually most dangerous as a vapour, since orally ingested or percutaneously absorbed elemental mercury rarely causes acute toxic effects (Langford, 1999). If small amounts of mercury repeatedly

enter the environment, bioaccumulation and chronic exposure are significant issues.

A number of major physical and chemical forms of mercury are present in the environment and which can result from releasing the mercury in CFL bulbs. Elemental mercury, or metallic mercury, refers to mercury in either its liquid or gaseous state. Liquid mercury is most familiar, and is silver in colour. Mercury also exists in two ionized states. Of the two, mercury exists most commonly in a divalent state, where the element has lost two electrons and can form both organic and inorganic compounds. Divalent mercury is also known as mercuric mercury (monovalent mercury is known as mercurous mercury). Inorganic mercury is a compound containing mercuric mercury, and it is corrosive and extremely toxic; organic mercury is a compound of a mercury atom bonded to at least one carbon atom. Organic mercury, especially methyl-mercury, has different toxic properties than the other forms, and causes irreversible damage to the central nervous system (CNS). This form of mercury is responsible for several mass health and environmental disasters, namely the case of Minamata in Japan, where methyl-mercury contained in the effluent from a chemical factory contaminated local fish stocks, poisoning and killing thousands of victims (Clarkson, 1997).

2.2.1 Mercury and Fauna

Discoveries in the mid 1900's led to the understanding that mercury, especially methyl-mercury, is an ecological poison. Organic mercury has particularly devastating effects on animal species, targeting the brain with sometimes irreversible effects. Mercury accumulates in the tissues of organisms, with the largest and longest-lived organisms exhibiting the highest concentrations of mercury. In particular, fish readily accumulate mercury, especially where acidification has occurred. In the case of Minamata, the accumulation of mercury in fish tissues reached levels lethal to humans. Depending on the level of exposure, mercury has a severe effect on humans, ranging from loss of sight and hearing, Parkinson's disease, cerebral palsy, developmental delays, skin damage, kidney damage, lung damage, damage to the CNS, and death (Clarkson, 1992; Clarkson, 1997; Langford, 1999).

2.2.2 Mercury and Flora

The effects of mercury on plants are not as severe as those on animals. Many plant species have the ability to block the intake of mercury. For this reason, the absorption of mercury from the soil is low, especially as there is a physiological barrier to mercury moving from plant roots to tops. However, there are a myriad of negative effects that mercury can have on plants, including reduced seed viability, and reduced stem, root, and leaf size. Mercury concentrations in the aboveground parts of the plant are largely from foliar uptake of mercury in its vapour form.

Mercury in the soil is volatilized to become vapour. Airborne mercury is therefore a significant contributor to the mercury content of crops and the intake by humans as food. In addition to intake of mercury via air and soil, aquatic plants have shown bioaccumulation of mercury. Organic mercury exposure results in the greatest concentration of mercury in plants (Patra, 2000).

2.3 DISPOSING OF CFL BULBS

2.3.1 Mercury released during disposal

The Environmental Protection Agency estimates that 100% of CFLs that enter household waste streams break during bulb disposal (Arendt, 2013). The possibility of breakage persists from the initial entry into the household trash receptacle inside or outside the residence, until the bulb reaches the landfill. CFL bulbs that arrive intact at a landfill will ultimately break during dumping, spreading, compacting, or burial (Arendt, 2013). When studying the release of mercury from waste transportation to landfill, Southworth (2005) found that mercury emissions that occur before reaching the landfill constitute a significant amount of the total emissions during the disposal cycle.

When CFL bulbs break gaseous mercury and mercuric oxide can be released. When broken in an indoor environment, air concentrations of mercury are high, but adverse health effects can be avoided if immediate measures are taken. Salthammer (2011) identifies that adverse health effects are conceivable in cases where individuals are unaware that CFLs contain mercury, or when the CFL breaks without anyone noticing. The risk of this may increase when there is no safe disposal available for CFLs. For example, without recycling options CFLs may be at greater risk of breaking in the household waste. Furthermore, as large quantities of CFLs are stored by households for later recycling there may be greater risk of accidental breakage.

2.3.1.1 CFL Life Cycle

Tests done By Li (2011) found that broken CFL bulbs generally emit less than 0.2mg of mercury when broken, indicating that they are non-hazardous. However, CFLs continually release mercury vapor once broken, lasting weeks or months. The total amount released can exceed 1.0mg. In fact, disposing of CFL bulbs in landfills, rather than safely recycling them, increases their total atmospheric emissions by half (50%). For example, on average a CFL bulb accounts for 1.2mg of mercury emissions from coal combustion, and disposing of it in a landfill will increase the emissions to 1.8mg. Not only does their atmospheric emission increase, but disposing of CFLs in landfills brings their total mercury-generated-as-waste level up

to 5.7mg, as the mercury contained in the phosphor powder and the mercuric oxide totals 3.9mg. Perhaps surprisingly, the total mercury generated as waste from incandescent bulbs is just 5.8mg (completely as atmospheric emissions from coal combustion) (Arendt, 2013). Therefore, by not recycling CFLs, any mercury emissions offset by using CFLs instead of incandescent bulbs are to some degree negated as the mercury contained within the bulb enters the landfill (Eckleman, 2008; Wagner, 2011). Figure 1 depicts this phenomenon.

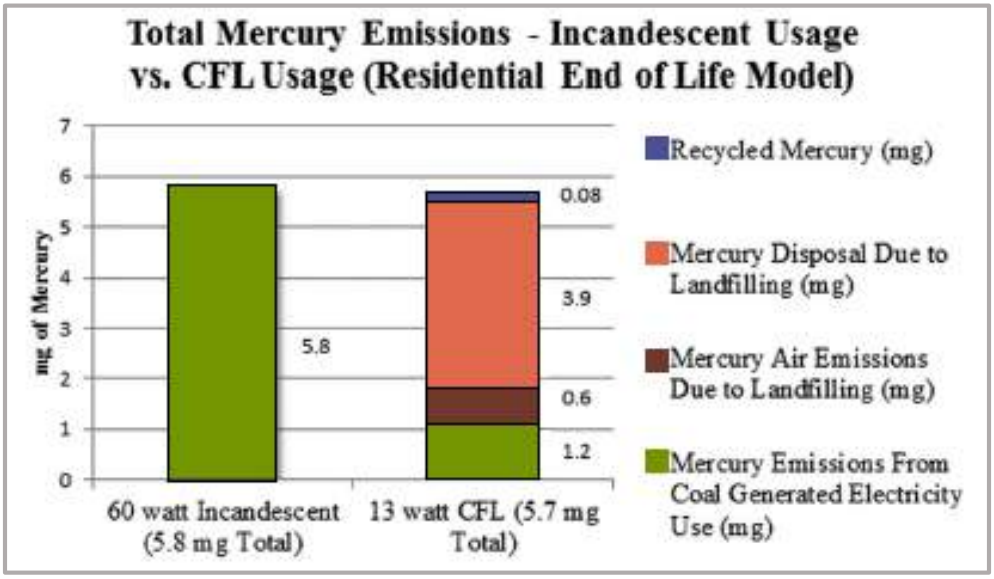


Figure 1. Mercury emissions end of life model (Arendt, 2013)

2.3.2 Mercury in a landfill

Historically, it was thought that mercury sent to landfills was sequestered and not made bioavailable. However, the current understanding is that mercury reservoirs in landfills are significant sources of mercury to the environment, including methyl-mercury, the most toxic form of the substance (Hargreen, 2004). When deposited in soil, mercury can be transformed by soil bacteria into methyl-mercury and other compounds, that have a myriad of effects on flora and fauna depending on composition (Wang, 2012). Furthermore, mercury is an element that is known to persist, bioaccumulate, and biomagnify (increase in concentration further up the food chain) in the environment (Eckleman, 2008).

Modern landfills make considerable efforts to prevent leaching or emission of harmful substances into the environment, though they are unable to completely prevent contamination. Landfills in Nova Scotia adhere to guidelines that dictate the operation of the landfill, including requiring such features as a liner system, a final cover system, leachate management, and gas management systems. Gas

management systems are not meant to prevent the release of emissions; instead they are meant to allow gases to escape from the covered landfill, so as not to build up pressure under the landfill cap. With respect to leachate management, leachate is collected to prevent its escape into groundwater.

When municipal waste arrives at the landfill the bags are either opened and sorted to ensure that no banned waste enters the landfill, or are deposited directly into the landfill. The latter is a common practice in Nova Scotia. If the waste is first inspected it is then dried or placed directly into the landfill cell in operation. Waste in the cell is regularly compacted and covered at the end of each day. The purpose of the cover is in part to control the amount of water infiltration into the waste and to control the release of gas. The cells are lined with many layers to prevent the escape of leachate, including a leachate collection layer.

2.3.2.1 Groundwater

Landfills that are lined and use leachate collection systems, including all landfills in Nova Scotia, are less likely to leach mercury into the groundwater than unlined landfills. However, depending on how the leachate is treated, the mercury may reenter the environment. In Nova Scotia, the leachate is treated in municipal waste water treatment facilities, to eliminate particulate matter. If mercury is bound to the particulate matter or nutrients, such as phosphorus, it will be removed, but the treatment is not specifically designed to remove mercury (Blouin, 2014). Due to the complexities of understanding in what form the mercury is once it reaches the treatment facility, it is currently impossible to know whether mercury will be removed by the process. Thorough analysis of Nova Scotia leachate would be needed for better understanding. Furthermore, in the past, liners of landfills have been known to eventually leak. A recent report by Stantec was unable to confirm whether liquid collected in the Otter Lake leak detection system was leachate or another water source, though it appeared unlikely to be leachate (Stantec, 2013). It is not likely, therefore, that significant amounts of mercury enter into the groundwater from landfills in Nova Scotia, though mercury may enter the environment with treated leachate.

To expand upon this point, the chemical and biological processes that might occur in a landfill are highly complex and depend on a myriad of factors. Mercury is relatively inert, but biochemical and microbial processes serve to oxidize or reduce the mercury to another form, especially in the lower parts of a landfill, where temperatures can be quite elevated due to biological processes. In this part of the landfill elemental mercury will be vaporized, at which point it can be metabolized by microorganisms to produce oxidized mercury species. These can be water soluble, which allows them to be collected in the leachate. While processes such as this

are known to occur in landfills, the degree to which they cause harm to humans and the environment depend on the number of CFLs deposited in the landfill per day and the speed at which their mercury descends to the lower portion of the landfill (Grossert, 2014).

While these rates are unknown, it is possible to create estimates as to the number of bulbs which would produce harmful levels of mercury in leachate. Levels of mercury in leachate are most effectively measured on a daily basis, so as not to overstate the amount of mercury that could accumulate. As will be discussed, about 350,000 bulbs will expire in Nova Scotia in 2014. While some may be treated as hazardous waste, the majority are deposited in a landfill. Allowing for about 15% of bulbs to be diverted as hazardous waste, 822 bulbs will end up in landfill on average each day. Assuming that each bulb contains 3.5mg of mercury on average, this many CFLs would produce 2.8 g of mercury. Assuming a 50% conversion of this by microorganisms (which allows for the fact that not all mercury will be available or converted by the microorganisms), there would be 1.4 g of mercury in soluble salts for instant release. If this quantity was diluted by 120 000 liters (the volume of a typical rail tank car), the concentration would be 0.0119 mg/L. This represents a "best case scenario", as actual levels would likely be higher. As stated previously, the current maximum level of mercury concentration in water according to the Canada health standard is 0.001mg/L, meaning that the best case scenario is almost 20 times in excess of healthy levels.

2.3.2.2 Air Emissions

Landfills present a greater risk in terms of release of mercury to the air. Mercury emissions from a landfill occur from the working face of the landfill, as well as from gas vents. Delivery of the bulbs and subsequent crushing allows for the escape of mercury into the air, as does the release of gases through vents at the surface of the landfill. The vents are intended to prevent the buildup of methane within the cell. Mercury released to the air can be either inorganic (such as the mercury vapour that is released directly from a broken CFL bulb), or organic (if the mercury is converted by bacteria within the landfill). Inorganic mercury can be retained in the atmosphere for up to two years and can be transported by air currents around the globe. Organic mercury presents a more local risk, as it is usually deposited within rain quickly after being emitted, and it is more toxic than inorganic mercury (NEWMOA, 2009).

2.4 SUMMARY

This section has touched on various issues surrounding the mercury content of CFL bulbs. It is well understood that mercury, in its many forms, both elemental and

compound, is harmful to the environment. Plants and animals experience severe negative effects when exposed to mercury from anthropogenic sources. In humans mercury can have a range of effects, including damage to the CNS. The average Canadian CFL contains 3.7mg of mercury, which is released when the bulb breaks. If CFL bulbs are not recycled they break either on the way to the landfill or in the landfill. Not only does this pose human and environmental risk, but the benefit of fewer mercury emissions from power generation is negated by the mercury that seeps out of the bulb during and after disposal. A lack of recycling options means that landfills are a significant source of mercury emissions from CFL bulbs, primarily in vapour form.

3 CFLS IN NOVA SCOTIA AND FUTURE PROJECTIONS

Over 2 million residential CFL bulbs are currently in use in Nova Scotia. This number is based on sales data of CFL bulbs in Atlantic Canada that have been extrapolated based on 2011 population census data, as well as bulb lifespan data. To be more specific, between 2,179,972 and 2,843,730 bulbs are currently in use. The first number represents the total of all CFL bulbs sold in Nova Scotia since 2006, while the second number represents the total of all CFL bulbs sold in Nova Scotia since 2003. This is based on the lifespan range of CFLs currently, which is between seven and ten years. These bulbs represent an increasing reservoir of CFLs in Nova Scotia, a certain number of which expire and end up in a landfill each year. As seen in Figure 2, CFLs make up a significant portion of bulb sales in Nova Scotia, though incandescent bulbs continued to be the bulb of choice through 2013.

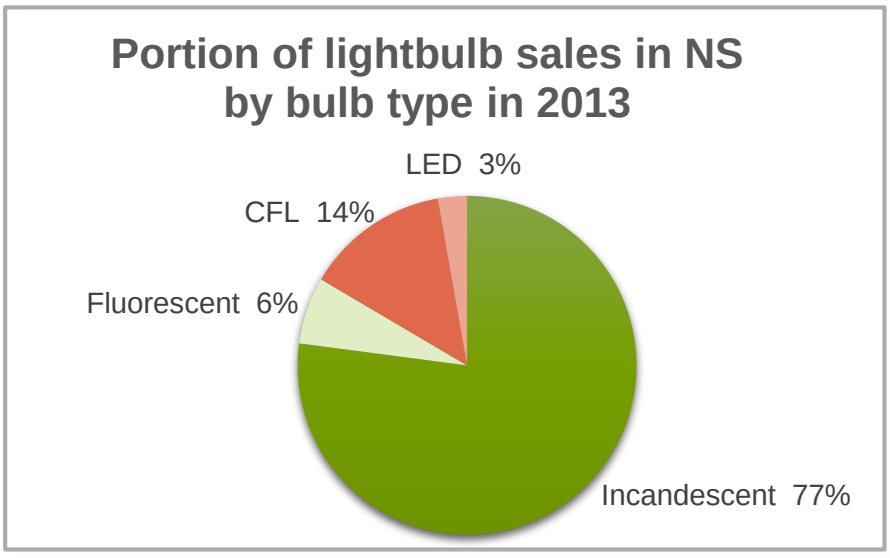


Figure 2. Light bulb sales by bulb type in 2013

The information used in this section is based upon industry sales data sourced from Electro-Federation Canada. The data has been divided by the percent of the population of Atlantic Canada which Nova Scotia comprised in 2011. In this way, all data in this report are considered estimates, as other factors may influence CFL uptake in Nova Scotia. For example, Efficiency Nova Scotia runs a program called "Instant Savings", which has been in operation since the spring of 2011. The program runs three to four months each year in the spring and fall, and encourages home-owners to use CFLs instead of incandescent bulbs. Since 2011 the program has sold 586,427 CFL bulbs. These bulbs constitute a portion of the bulbs represented in industry data, but it is not possible to separate the two for the purpose of this study.

To calculate the amount of bulbs which expire, or become available for collection, in a given year, CFL lifespans are applied to historical sales. Atlantic Canada and Nova Scotia have witnessed an increase in CFL sales over the past 10 years, with peak sales for the period occurring in 2007, as seen in Figure 3. CFLs are exhibiting both increasing sales and increasing lifespans, though sales are predicted to eventually plateau as LED technology advances and becomes cost-competitive. Despite a potential plateau, the number of CFLs available to collect will continue to increase likely for at least seven years due to increasing lifespans and historical sales. The lifespan of a CFL bulb generally ranges from 6,000 to 10,000 hours, though some bulbs have reached up to 15,000 hours. When calculating the lifespan in years, producers assume an average daily bulb usage of three hours; a 6,000 hour bulb would therefore last approximately 5.5 years, while a 10,000 hour bulb would last approximately 9 years. Based on these lifespans and historical sales data, over 354,000 CFLs would be available to collect in 2015. Figure 4 depicts a projected upward trend in the number of CFLs available to collect, based solely on historical sales data. Applying bulb lifespan data would likely increase the number of bulbs available.

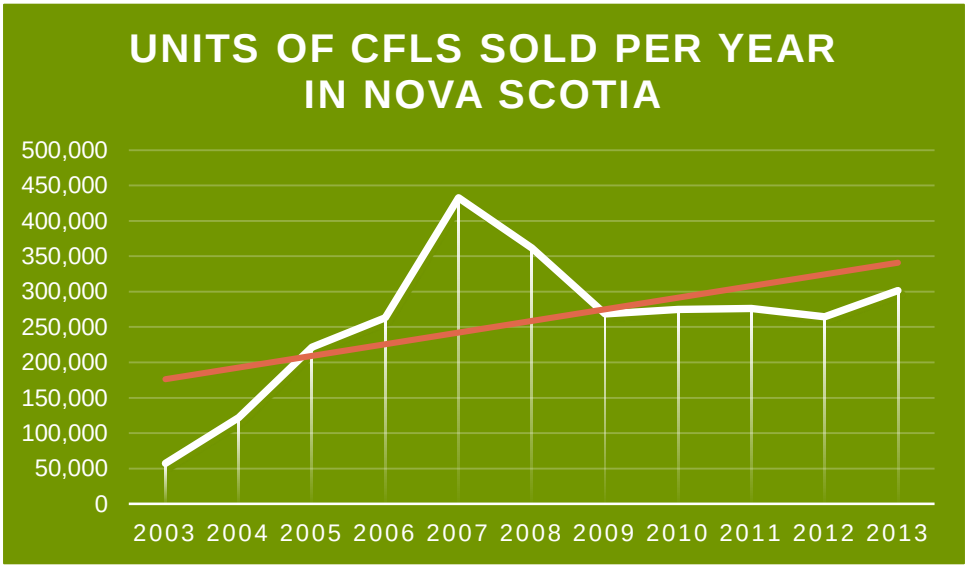


Figure 3. Residential units of CFLs sold each year in Nova Scotia

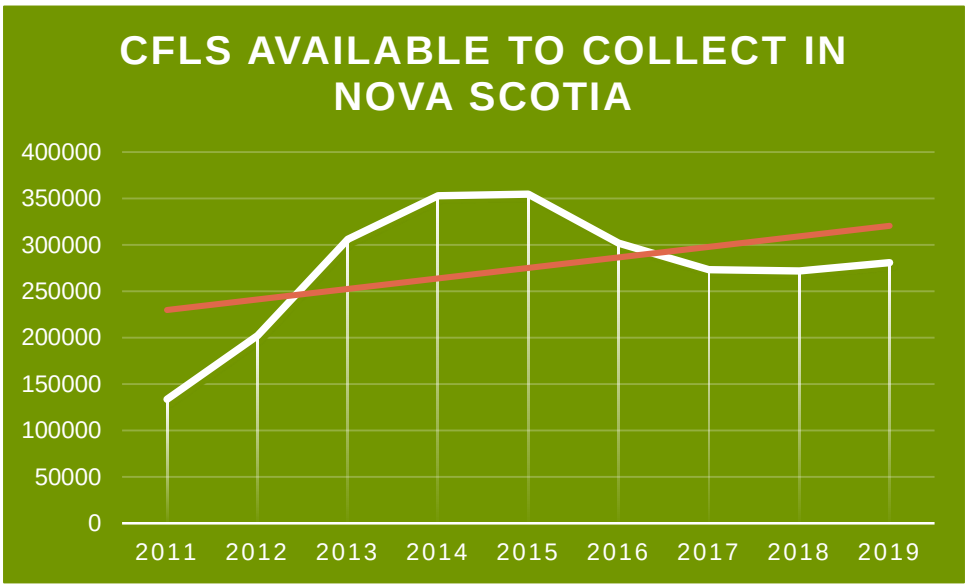


Figure 4. Projection of residential units of CFLs available to collect in Nova Scotia

The 2007 spike in CFL sales in Atlantic Canada may be attributed to the proliferation of provincial efficiency programs. In May, 2007 Conserve Nova Scotia (now Efficiency Nova Scotia) ran a program called “It Starts With Me”, during which Nova Scotians could visit any Home Depot in the province to receive two free 15-watt CFLs. Also, community groups, landlords, municipalities, utilities, and businesses could receive a $1 subsidy per bulb from the province for the purchase of 100 CFLs or more. At the same time PEI launched a program through “Green

Light PEI" aimed at installing CFLs in single-family dwellings in PEI. Following this, in September 2007, the province of Newfoundland and Labrador began its SAVE Energy Events, which saw over 20,000 CFLs distributed to residential energy users. During this time all three of these provinces, as well as New Brunswick, were involved in Shared Atlantic Vision for Energy Efficiency, a campaign aimed at helping Atlantic Canadians cut energy consumption. Since 2007, CFL sales have not reached this level; however, excluding the brief spike in CFL sales, the trend continues upward toward a potential plateau. Based on lifespan estimates from Product Care Association, CFLs sold in 2007 began to expire as of 2013, and will continue to become available for collection in large quantities until 2019.

3.1 LEDS

Central to the CFL discussion are LEDs. Sales data indicate that LED uptake is increasing at a much faster pace than that of CFLs, as seen in Figure 5 (data are not available for the period before 2010). Industry estimates hold that LEDs will be cost-competitive with CFLs within the next five years, suggesting that CFLs will have been a "transition" bulb, serving as a suitable option following the phase-out of incandescent bulbs. LED bulbs last generally five times longer than CFLs, require less electricity to produce the same amount of light, and do not contain mercury. Considering the extended lifespan of LEDs, and the potential for the uptake of these types of bulbs to exceed that of CFLs, the number of bulbs available for collection would eventually decrease.

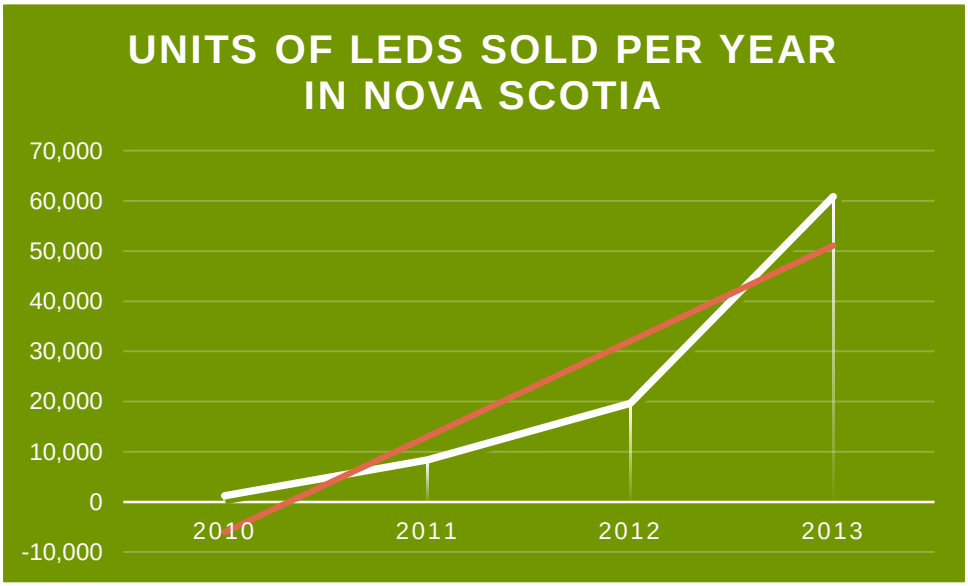


Figure 5. Residential units of LEDs sold each year in Nova Scotia

As CFL and LED uptake increase, overall bulb sales decrease as residents need to replace bulbs much less frequently. The ban on incandescent bulbs will effectively ensure that the transition away from incandescents is finalized by the end of 2014, at which point sales of residential incandescent bulbs will be close to zero, as retailers sell the last of their stock. Incandescent bulbs currently dominate bulb sales, as seen in Figures 2 and 6, but will be replaced by either CFLs or LEDs in 2014 and subsequent years. Figure 6 demonstrates the decrease in bulb sales in Nova Scotia between 2011 and 2012. In this time period sales of incandescent bulbs decreased by 31%, while CFLs decreased by 4%. Conversely, LED sales increased by 135%. Figure 6 shows the quantity of the total bulb sale decrease from 2011 to 2012. Despite the slight decrease in CFL sales between these years, 2013 saw an increase in CFL sales of 14%.

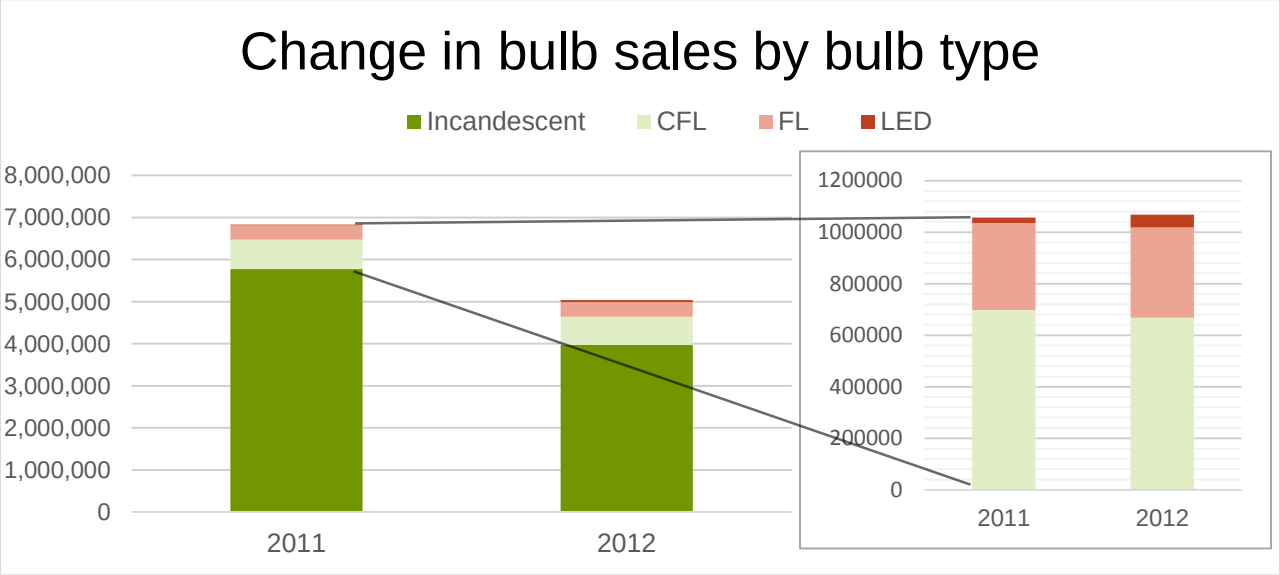


Figure 6. Change in bulbs sales between 2011 and 2012 in Nova Scotia

3.2 SUMMARY

Up until 2013 incandescent bulbs remained the bulb of choice for residential consumers in Nova Scotia, making up 77% of bulbs sold that year. Despite this, industry data indicates that over 2 million CFL bulbs are currently in use in Nova Scotia. CFL sales throughout the province have been steadily increasing over the past decade, with a spike in 2007 potentially due to an outcropping of energy efficiency programs. Based on the current lifespan of CFLs, over 352,000 bulbs will

become available for collection throughout 2014, increasing to 354,000 CFLs available in 2015. Although CFL sales are predicted to plateau, due to improvements to LEDs, the number of bulbs available to collect in the coming decade will remain high. While LED sales are increasing exponentially, total sales for 2013 still remained well below those of CFLs. With the federal ban on incandescent bulbs to come into full force at the end 2014 both LEDs and CFLs will fill the void left by incandescent bulbs.

4 CFL RECYCLING PROGRAMS

4.1 CURRENT RECYCLING OPTIONS FOR NOVA SCOTIANS

While the capacity to recycle all CFL bulbs used within the province currently exists (through independent recycler Dan-X Recycling Ltd.), it is not mandatory that CFL bulbs be recycled in Nova Scotia. Unless regulations are in place to make CFL recycling mandatory, there is little incentive for the public to divert the bulbs from their household waste. Nova Scotia residents are able to drop off CFL bulbs to local household hazardous waste (HHW) locations, however there is no system in place to collect the bulbs and deliver them to a recycling facility; instead bulbs are crushed, the gases and chemical particles are trapped and disposed of as hazardous waste, and the rest of the bulb is sent to the landfill. Some Nova Scotians, therefore, retain their used CFL bulbs in their home until a recycling option is available. The rest of Nova Scotians (84% of Haligonians in 2011) dispose of their bulbs in the municipal solid waste stream. The provincial government instructs residents to place used CFL bulbs in a sealed plastic bag and dispose of them in their household waste. Should residents wish to recycle the bulbs, they are able to take them directly to the recycler for a small fee, but this option is not feasible for most Nova Scotians, and is not promoted by the government.

4.2 CFL RECYCLING IN OTHER JURISDICTIONS

While there is no federal requirement to recycle CFL bulbs, a number of provinces have initiated their own recycling programs. Countries including the UK, Austria, Taiwan, Germany, Japan, and parts of the US have also structured CFL recycling regulations and programs. This section assesses the recycling programs in a number of jurisdictions to inform Nova Scotia's potential program, touching on the regulatory bases for the programs, the funding of the programs, and the logistics regarding collection and recycling. The jurisdictions assessed were chosen based on their similarity to Nova Scotia in terms of regulatory structure, population size and

distribution, and social and economic atmosphere.

The Product Care Association operates recycling programs in all Canadian provinces except Alberta and the Territories. Currently, the association is the chosen agency by all provinces operating province-wide CFL recycling to carry-out the recycling program. These provinces are British Columbia, Manitoba and Quebec. In Nova Scotia, PCA manages paint recycling only. PCA was formed by manufacturers, distributers and retailers (i.e. producers) of products which are subject to product stewardship regulations in Canada. Such regulations require that the producers find a way for consumers to dispose of their products in an environmentally responsible manner. PCA has 500 such producer members, for which it devises, implements and runs waste diversion programs. For example, in British Columbia as of March 20, 2014 PCA's LightRecycle program has 376 member organizations, which include organizations that either make, distribute, or sell CFLs. All program information is sourced from PCA annual reports and personal communication.

4.2.1 British Columbia

4.2.1.1 Regulation

British Columbia's Recycling Regulation, under the *Environmental Management Act*, requires that producers of all "electronic or electrical lighting equipment, parts and bulbs" have a product stewardship plan or meet product stewardship requirements (Recycling Regulation BC Reg 449/2004). These regulations are based on the Extended Producer Responsibility principle. This strategy shifts the financial and administrative responsibility for recycling CFLs from the general taxpayer to the producers or consumers of the bulbs. Producers of CFLs can engage a third party agency to carry out the recycling duties. In British Columbia PCA manages the LightRecycle program. The program was created in 2010 in response to the British Columbia Recycling Regulations requiring recycling for residential CFLs, and extended to meet the new regulations for commercial-use fluorescent lights in 2012.

4.2.1.2 Fees

The LightRecycle program is funded solely by fees applied to the sale of lighting products in British Columbia. The fees are used only to run the program, and are not a tax. The fee applied to CFL bulbs is $0.15 per bulb, and is either included in the price of the bulb or displayed as a separate charge, and is subject to sales tax. For the first year of the program the fee per bulb was $0.25. The regulations require that the producers assume the cost of collection and recycling, but producers can choose to apply such a fee to their products so that consumers

assume the cost instead. The fee must be identified separately on the consumer receipt of sale but can otherwise be included in the product price. The fees are the

sole source of revenues, and are used to fund program expenses including depot supplies, collection, transportation, processing, program expansion, and administrative expenses. The fees are paid to the stewardship agency by the producer, as collected from the consumer.

4.2.1.3 Collection and Recycling

PCA has established over 200 collection sites in the province. These are permanent, year-round, sites which are not owned or operated by PCA. Sites include primarily return-to-retail locations (collection of bulbs at the bulb retailer), private depots, or municipal facilities. Consumers are able to drop-off their bulbs free-of-charge, and the bulbs are then collected and transported to a central recycling facility. The collection sites are equipped with collection boxes, supplies, and point-of-sale materials. Once the depot has a full load they notify PCA who sets up transport from the depot to the processor. The components of the bulbs are recycled and reused. The program does not own the sites, but rather contracts with the site owners. Collection facilities already in place to collect other products, such as bottles and electronics, were approached to expand their collection to include CFL bulbs. The collection system has a number of different channels, including collection for up to 16 bulbs, up to one pallet (1,200 CFLs), and pick-up for more than one pallet. PCA has also found one-time collection events to be successful, primarily in areas where no collection depot is available. A map of British Columbia collection sites can be found in Appendix A.

In addition to recycling used CFLs, producers must adhere to the pollution prevention hierarchy. The hierarchy requires that all feasible opportunities for pollution prevention at the highest level be taken before undertaking pollution prevention at a lower level. For example, producers must work to reduce or eliminate the use of toxic components in their products if possible before working to improve the reusability and recyclability of their products. Producers must report on these efforts to the provincial government, including targets and what they have achieved each year.

4.2.1.4 Program Success

In 2013 roughly 845,681 CFL bulbs were available for collection in British Columbia. Of those bulbs, 625,788 were diverted from landfill through the LightRecycle program. This equates to a capture rate of 74%. When measuring program success, capture rates are calculated by dividing the quantity of products collected in a year by the quantity of products believed to be “available for collection” in that

year. The products available for collection are totaled by looking at how many products are sold each year and how soon they will be disposed of. Capture rates

are a more accurate tool to measure program success than are recovery rates, which divide the units collected by the units sold in that year. The 2013 capture rate target for British Columbia was 28-38%, and it was exceeded by twice that rate. When comparing British Columbia to other provinces it is important to note that the capture rate from the first year of program operation was 10.3%, followed by 31.8% in 2011.

As for program costs, $2,577,322 was generated in revenues from eco-fees applied to products (all bulbs and light fixtures, not just CFLs). These revenues were used to fund program expenses of $1,294,794. Based on sales data for 2012, CFL bulbs contributed to about one fifth of all revenues, the other revenues coming from other types of bulbs and light fixtures. It is unsure what portion of program expenses are attributed solely to CFL recycling; however, the program saw overall excess revenues of $1,282,528. Further explanation for excess revenues can be found in section 4.2.3.4.

4.2.2 Manitoba

4.2.2.1 Regulation

Manitoba includes the recycling of CFLs in its Household Hazardous Material and Prescribed Material Stewardship Regulation, under the *Waste Reduction and Prevention Act*. The regulation identifies that any person who supplies (sells, exchanges, barters) "fluorescent lighting tubes and compact fluorescent lights" must operate or subscribe to a household hazardous material or material stewardship program, or must designate a stewardship agency (in this case, PCA) to operate or subscribe to such a program (Household Hazardous Material and Prescribed Material Stewardship Regulation). In essence this structure is the same as that of B.C. except that it is less robust and encompasses fewer bulb and lighting fixture types.

4.2.2.2 Fees

Funding for the program in Manitoba is the same as that for British Columbia. Environmental handling fees (EHFs) are paid to PCA by producers of CFLs which are generated from the fee being applied to CFL bulbs. Producers may display the fee or include it in the price of the bulb. CFLs are subject to a fee of $0.15, which is subject to sales tax. The fees are the sole source of revue for the program, and as with British Columbia they are used to fund such expenses as collection, transportation, and processing.

4.2.2.3 Collection and Recycling

As of 2012 PCA operated 59 permanent, year-round collection sites for CFLs in

Manitoba, almost entirely comprising return-to-retail sites. PCA also contracted for the operation of multiple one-day collection events (23 in 2012). The CFLs are collected from individual sites and shipped to a processor for recycling. All materials are recycled for reuse except for the phosphor powder which is sent to landfill. Collection sites do not allow more than 16 bulbs to be dropped off at any one time, to prevent the drop-off of commercial material. Some sites collect CFLs as well as paint and household hazardous waste, while others collect only CFLs. Manitoba also requires that producers adhere to the pollution prevention hierarchy, which encompasses such goals as reduce, redesign, reuse, and recycle.

4.2.2.4 Program Success

In 2012, the first year of program operation, the Manitoba CFL recycling program saw a capture rate of 6.6%. At this point the program had only been in operation for a partial year, but the 6.6% actual capture rate is below the 10% target rate. About 55,200 CFL bulbs were available for collection, while 3,619 bulbs were actually collected.

Financial information solely for CFL recycling is unavailable; however, information is available for the hazardous waste program as a whole. Revenues totaled $887,427 for all program products, $124,828 of which was from the sale of light bulbs. Based on CFL sales, about $78,953 of those revenues were from the sale of CFLs in the province. Of the total revenues, $397,327 was incurred in expenses, leaving $490,100 in excess revenues.

4.2.3 Quebec

4.2.3.1 Regulations

Under the *Environment Quality Act* the government of Quebec implemented EPR regulations for called the Regulation Respecting the Recovery and Reclamation of Products by Enterprises. Section 35(2) states that CFLs are included in the list of products for which producers must have a recovery and reclamation program. The program must have an agreement with RECYC-QUEBEC, the agency responsible for Quebec's product stewardship programs. The regulations go so far as to mandate that a minimum of 40% of CFLs must be recovered by 2015, with yearly increases thereafter.

4.2.3.2 Fees

Funding for the program in Quebec is also garnered from recycling fees paid to the program by producers, generated from the sale of CFLs. Divergent from British Columbia and Manitoba, Quebec producers charge $0.20 for each bulb, though the regulations allow for up to $0.30 to be charged per bulb. The fees collected from the sale of bulbs include retail, industrial, commercial, and institutional sales. The fees cover all program costs, including collection, transportation, recycling, public education, and program advertising. As in the case of British Columbia and Manitoba the fee is subject to sales taxes.

4.2.3.3 Collection and Recycling

As of August 2013 the RecycFluo program operated over 700 sites throughout Quebec, each of which accepts up to 16 CFL bulbs at a time. For large volumes of bulbs the program offers an on-site pick up service. Retailers can act as collection sites, and many do, but it is not mandatory. PCA contracts with service providers to collect and transport the CFLs. One recycler, Aevitas, is responsible for recycling all CFLs collected through the program.

4.2.3.4 Program Success

Because the Quebec program is still in its development stage, data for program capture rates are not publicly available. However, the program director estimates that for the 2013 program year the recovery rate will be 5%. No data is available for a capture rate.

The RecycFluo program began partway through 2012. Revenues from the period of July to December totaled $1,073,683 from the eco-fees applied to all lighting products. After $661,152 in expenses, the program ended the year with $412,531 in excess revenues. The excess revenues from each program in Canada remain within the programs as a reserve fund. In the case of CFL bulbs, sales, and consequently program revenue, are expected to decrease as consumers transition to LEDs due to technology improvements. At the same time, expenses are expected to increase as collection increases, in which case the reserve fund would be consumed by the program. PCA states that if this trend does not occur, the fees would be reduced.

4.2.4 Maine

4.2.4.1 Regulations

As of 2007, the state of Maine employs a ban on the disposal of CFLs, a CFL

recycling program and an education campaign. A state-wide CFL recycling program was in place in Maine before regulations (Legislative Directive 973) were enacted in 2011 which required manufacturers of CFLs to implement a recycling program.

4.2.4.2 Fees

Originally, Efficiency Maine, the organization responsible for the recycling program, paid for the cost of shipping and recycling; however, the new regulations have shifted the financial burden from taxpayers and ratepayers to the producers of CFLs, who are now responsible for recycling related costs. The new legislation allowed producers to change the program structure, or to simply fund existing collection infrastructure. Under the new legislation the cost of CFL recycling is funded by the increased price of CFL bulbs, shifting the cost of recycling from the end of the bulb life to the beginning. Unlike Canadian programs there is no fixed fee; instead, producers set fees per bulb separate from other producers, based on their cost of operating the program.

4.2.4.3 Collection and Recycling

Over 200 return-to-retail sites exist in the state for household CFL drop-off, as well as approximately 164 municipal collection depots. Bulbs are collected at the retail location, and are shipped by the retailer for recycling; the program makes use of a recycling contractor. The program does not accept broken CFLs. Bulbs are placed in receptacles and shipped to the recycler, Veolia Environmental Services.

4.2.4.4 Program Success

The CFL recycling program in Maine was the first state-wide program of this kind in the United States. The program began in 2007, and experienced low capture rates for the first few years of operation. In 2012 the PCA estimated that 708, 889 CFL bulbs were available for collection, and that 50, 492 of those bulbs were captured through the program. This equates to a capture rate of 7.1%, which is still below the capture rate of British Columbia in the same year. Financial information for the program is not fully available. Table 5 summarizes the success of each program discussed in this section.

Table 2. Summary table of recycling program structure by jurisdiction

Jurisdiction (Program Name)	Regulation	Funding	Collection	Strategy
Nova Scotia	No provincial regulation for recycling CFLs	NA	NA	NA
British Columbia (Light Recycle)	"Producers" must operate or be a member of an approved post-consumer collection and recycling program	Producers must fund collection and recycling but can offload cost to consumers	Many drop-off sites; collection and transportation to central recycling facility	Extended Producer Responsibility
Manitoba (Light Recycling Program)	"Stewards of designated material" must operate or be a member of an approved post-consumer collection and recycling program	Producers must fund collection and recycling but can offload cost to consumers	Many drop-off sites; collection and transportation to central recycling facility	Extended Producer Responsibility
Quebec (RecycFluo)	"Brand owner or first supplier" must operate or be a member of an approved post-consumer collection and recycling program	Producers must fund collection and recycling but can offload cost to consumers	Many drop-off sites; collection and transportation to central recycling facility	Extended Producer Responsibility
Maine	Ban on CFLs in landfills, and "manufacturers" must implement an approved post-consumer collection and recycling program	Producers must fund collection and recycling but can offload cost to consumers	Many drop-off site, primarily with retailers; bulbs are shipped to a contracted recycler	EPR, Education and outreach, disposal bans

Table 3. Indicators of Success for CFL Recycling Programs in First Year of Program.

Jurisdiction	Capture Rate (%)	Excess Revenues (% of total revenues)	Fee per bulb ($)
British Columbia	10	17.4	0.25
Manitoba	6.6	55.2	0.15
Quebec	5*	38.4	0.20
Maine	7.1	NA	Varies by producer

*recovery rate (%) (project is in development stage, capture rate data is unknown)

5 REGULATORY FRAMEWORK

Regulatory frameworks can consist of different components depending on the legal system within which they function, but they are generally considered a set of rules which are created by governments to implement policy decisions. They are often used to regulate specific activities, such as the disposing of CFL bulbs. To regulate such an activity legislation must first be in place, under which regulations can be made. The legislation is the foundation for the regulations, which are the legal basis for enforcement of the policy decisions. They designate which parties hold authority and what conditions must be met to be in compliance. After regulations are in place, documents which support the regulations are released, to aid and guide parties which must comply with the regulations. These are often in the form of directives, which explain the legal requirements detailed in the regulations. Figure 7 displays this structure. This section delves into the regulatory framework of the British Columbia CFL recycling regulations, as well as the regulations in Maine, and potential regulations in Nova Scotia.

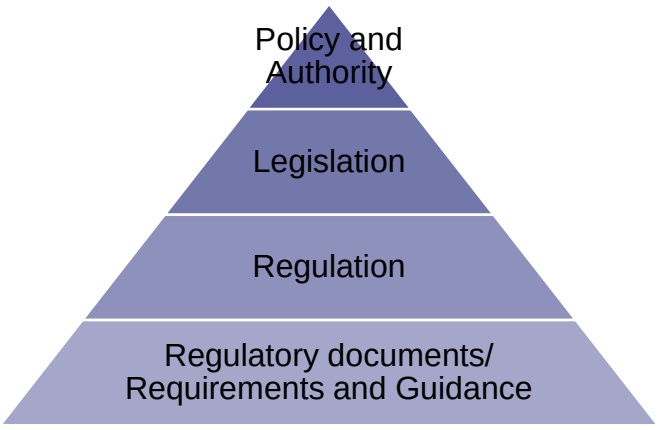


Figure 7. Basic regulatory framework structure

5.1 BRITISH COLUMBIA FRAMEWORK

The British Columbia Recycling Regulation is considered both non-prescriptive as well as results based. The Recycling Regulation was enacted in 2004, to replace regulations enacted in 1971 under the *Environmental Management Act*. The newer regulations allow producers to determine the design of stewardship programs for regulated products, while also including core requirements. The Ministry of the Environment ensures that environmental outcomes and requirements are met by reviewing and approving stewardship plans and annual reports. The Ministry makes sure that producers understand the requirements of the regulations, particularly with documents such as the Recycling Regulation Guide and the Industry Product Stewardship Compliance Strategy. Of the three provinces with provincial regulations for CFL recycling, the British Columbia model is the most preferred model by the third party stewardship agency, PCA. Figure 8 reflects the regulatory framework specific to British Columbia.

Figure 8. British Columbia regulatory framework

The British Columbia framework is characterized by a number of principles; they are producer and user responsibility, level playing field, results-based program, and producer transparency and accountability. Producer and user responsibility refers to the central theme of EPR, that the responsibility for managing products is shifted from general taxpayers to producers and users. The principle of a level playing field means that all producers of a certain product are subject to the same stewardship responsibilities, and that all consumers have access to collection facilities. With respect to being results-based, the framework is structured so that producers have the flexibility to create programs that are cost-effective, and are focused on achieving results without excessive government involvement. Lastly, industry must be transparent and accountable to stakeholders, government and consumers.

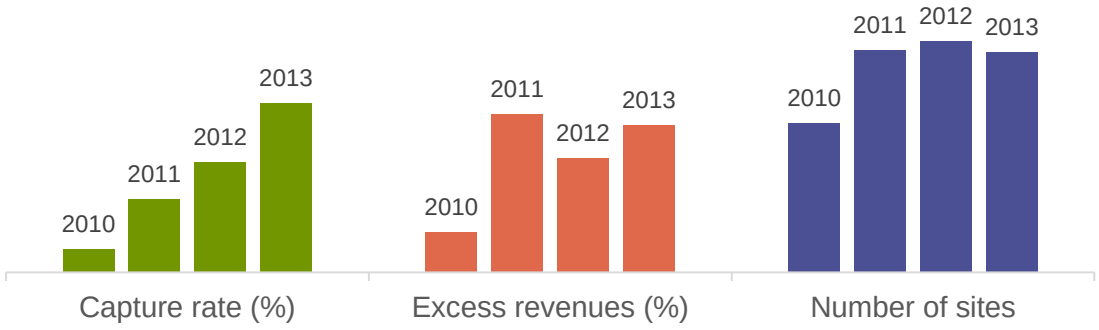
Stewardship plans are approved based on a range of requirements; plans must be able to achieve a high rate of recovery, engage stakeholders, provide reasonable, free consumer access to facilities, and provide consumer awareness of the plan,

collection facilities, and product safety. A yearly report is required and a program review must be completed every 5 years. If producers do not have a plan, they must comply with the requirements laid out in the regulations. Other requirements in the regulations include:

- Consumer information must be provided by the producer and disseminated by the retailer.
- The producer must operate collection facilities.
- If the facilities are not return-to-retail then they must be located within a certain distance from the retailer.
- Facilities must collect unlimited numbers of bulbs and be open 5 days per week including Saturday.
- Producers must follow a pollution prevention hierarchy.
- Producers must pay a fine of $200,000 if they do not comply.

The British Columbia model has been successful based on a number of criteria, and has seen improvements each year since its beginning. Table 4 shows this improvement.

Table 4. Performance of B.C. CFL recycling program from 2010 to 2013



Evaluation Criteria	2010	2011	2012	2013
Capture rate (%)	10	31	48	74
Excess revenues (%)*	17.4	68.9	49.7	64.2
Number of residential sites	165	197	201†	196‡
Fee per bulb	$0.25	$0.15	$0.15	$0.15

*% of total revenues.

†does not account for the 248 additional commercial collection sites added in 2012.

‡does not account for the 95 additional commercial collection sites added in 2013.

5.2 MAINE FRAMEWORK

In 2002 Maine enacted a disposal ban on mercury-added products. In 2007 the Maine Public Utilities Commission (MPUC) and the Maine Department of Environmental Protection (MDEP) announced that Efficiency Maine was implementing a CFL recycling program. The program served to promote and ensure proper CFL recycling in conjunction with the disposal ban. In 2009 EPR regulations came into place and the CFL recycling program was phased out at the end of 2010. The EPR regulations, made under *An Act to Provide for the Safe Collection and Recycling of Mercury-containing Lighting* (38 M.R.S. 1672.4), require producers to individually or collectively implement a department-approved program to recycle CFLs from households. Figure 9 shows this regulatory framework. The program must be approved by the MDEP, and must include the following:

- Convenient collection sites throughout the state, free of cost.
- Recycling in compliance with universal waste rules.
- Effective education and outreach.
- An annual report submitted to the department.
- A sales ban on products of non-participating manufacturers.

Figure 9. Maine regulatory framework

Producers were required to submit plans to MDEP at the beginning of 2010, with implementation taking place at the beginning of 2011. To implement the program the National Electrical Manufacturers Association (NEMA) (the producers) and MDEP worked together to recruit voluntary retail and municipal collection sites, to which they provided free containers, shipping and recycling. The collection sites used the services of FedEx to transport the bulbs. Annual reports were due in 2012, and

annual collection site visits were conducted by both MDEP and NEMA beginning the same year. Few guiding documents are available to direct producers, but the legislation is clear with respect to the requirements to producers.

5.3 NOVA SCOTIA FRAMEWORK

Should Nova Scotia decided to implement EPR for CFL recycling, the Nova Scotia *Environment Act* is the piece of legislation under which it would presumably be enacted, as part of the Solid Waste-Resource Management Regulations. The regulations currently include a section on industry stewardship, which includes products such as tires, paint, and bottles. This section on EPR would be expanded to include CFLs. Producers of CFLs sold in Nova Scotia would then be required to develop a plan to recycle used CFLs in the province. The plan would have to be approved by Nova Scotia Environment, the department with authority according to the regulation. The regulations would ideally stipulate requirements for the following areas:

- location, abundance, hours of operation, and collection limits of CFL bulb collection sites
- selection of recycler(s)
- adherence to a pollution prevention hierarchy
- submission of annual reports and periodic program reviews
- dissemination of consumer information and program outreach
- efficiency and success of program, based on capture rates
- penalties for non-compliance

The EPR legislation in Nova Scotia would be paired with a ban on CFLs in the landfill. Currently a host of products are prohibited from entering landfills in Nova Scotia, with a proposal to add more products to the list. EPR legislation is necessary when banning products from landfills, so as to provide an alternative to landfill disposal. Conversely, implementing a landfill ban on CFLs helps to increase the success of EPR programs. Figure 10 shows the potential regulatory framework for Nova Scotia.

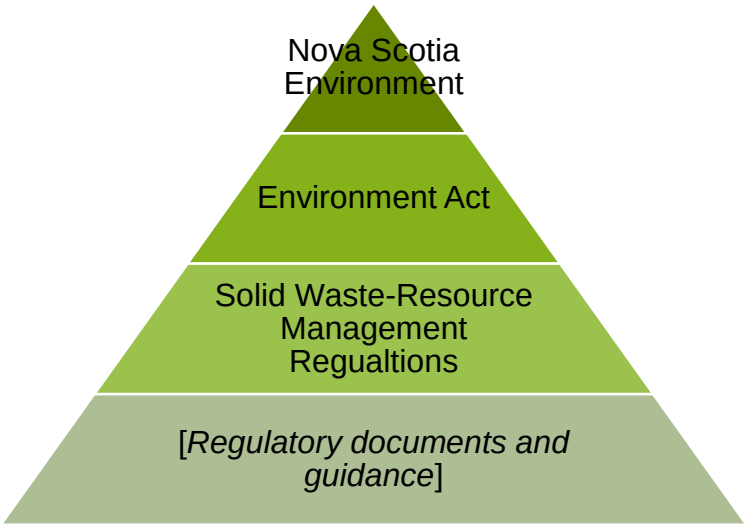


Figure 10. Potential Nova Scotia regulatory framework.

It should be noted that the federal government is currently considering legislation involving the disposal of CFL bulbs. Legislative changes which would regulate CFL recycling would have bearing on Nova Scotia if the province did not already have its own CFL legislation in place.

6 PROGRAM STRUCTURE AND RECOMMENDATIONS

Among Nova Scotia municipal representatives, there is a disconnect between the concepts of 'recycling' and 'safe disposal'. Often, the option of disposing of CFLs as hazardous waste is communicated as recycling. When asked about the recycling options for household CFL light bulbs, many municipalities indicated that the bulbs could be "recycled" by bringing them to local Household Hazardous Waste (HHW) facility. The HHW facilities in Nova Scotia put the bulbs into a "bulb eater", which removes the harmful gases and particles, but the bulb components are then sent to the landfill and the filtered matter is disposed as hazardous waste. As such, no recycling actually takes place. Furthermore, while bringing the bulbs to a HHW facility is an option for residents, many municipalities instruct residents to put the bulbs in their household waste. Even in municipalities where HHW facilities are promoted and available, most residents continue to dispose of bulbs in the waste. This indicates that simply having safe disposal options available does not mean that they will be used, and that there is a need for uniformity throughout the province.

Based on examples like this, as well as stakeholder consultation and the experiences in other jurisdictions discussed previously, this section will discuss the need for regulation, convenience, and education, among other elements, in a CFL recycling

program. Also, based on this program framework, this section makes some recommendations for the implementation of a CFL recycling program in Nova Scotia.

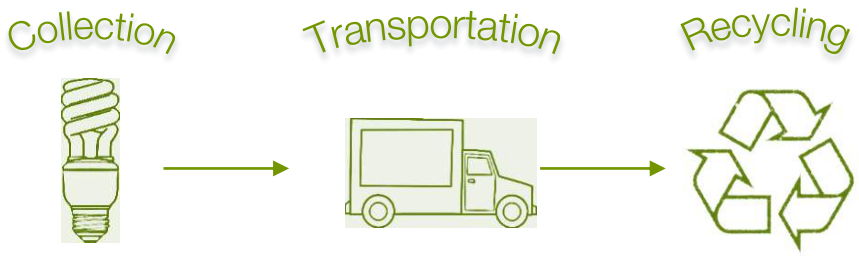


Figure 11. Basic CFL recycling program structure

6.1 RESPONSIBILITY AND AUTHORITY

EPR legislation places the responsibility to recycle CFL bulbs on the producers. Producers generally include manufacturers, distributors, and retailers, and are sometimes referred to as brand-owners. EPR legislation should – and most often does – allow producers to partner with a third-party stewardship agency to operate the recycling program. The stewardship agency typically handles all aspects of meeting regulatory requirements, though responsibility remains with the producers to ensure that the requirements are being met. Third-party stewardship agencies make compliance by producers extremely easy; some such agencies will even explain to producers their responsibilities under the regulations. Consumers of CFL bulbs are responsible for disposing of their bulbs properly, and should be held accountable when improperly placed in household waste.

For an EPR-based CFL recycling program in Nova Scotia, authority will lie with Nova Scotia Environment (NSE), the government branch which currently holds authority over EPR legislation for other products. Stewardship plans submitted by producers will have to be approved by the government before a recycling program can begin. Producers should then have to submit annual reports and periodical program reviews, which the government will review. NSE would also be responsible for implementing the regulations and ensuring that producers are aware of their responsibilities. Municipalities will be responsible for enforcing landfill bans, as discussed in the following section. Municipalities should also play a role in facilitating collection and education for EPR programs, when possible.

RECOMMENDATIONS

- Producers (or brand owners) should be responsible for meeting regulatory requirements, though stewardship agencies may aid them.

- NSE should provide clear directives to producers concerning their regulatory requirements.

6.2 ENFORCEMENT

The issue of enforcement for both EPR and disposal ban legislation is highly contentious in Nova Scotia. The primary goal of both pieces of legislation is to prevent CFLs from entering the landfill and to ensure that they are recycled properly. For this to be a reality the regulations must be enforced and producers and consumers must be in compliance. The atmosphere in Nova Scotia around waste enforcement is fairly polarized; government officials and waste practitioners tout enforcement methods and protocols as being effective, while other stakeholders contend that such methods and protocols are infrequently carried out, resulting in banned materials entering the landfill. It is difficult to determine how rigorous enforcement has been to date in Nova Scotia on waste diversion; however, there are clear areas that must be addressed should new EPR and landfill ban legislation come into place. Further details on these areas can be found in section 6.11.1.

Without delving into landfill ban enforcement at this time, it is important to note that EPR legislation can be enforced by requiring producers to meet certain targets. EPR legislation for CFLs in Nova Scotia should include minimum diversion targets for producers. For example, regulations should require that recycling programs implemented by producers meet certain capture rate targets (e.g. 10% in the first year, 20% in the second year, etc.). Having this requirement would push producers to take an active role in ensuring that bulbs are diverted properly. Programs in other jurisdictions have relied primarily on voluntary drop-off of bulbs, and while this method is largely successful, it does not capture all bulbs. In an effort to alleviate the demands on municipalities to enforce landfill bans, producers of CFLs should be required under regulation to play a role in enforcement at the receiver end.

RECOMMENDATIONS

- Require a minimum diversion achievement by producers under EPR legislation, with yearly incremental increases.

6.3 COST AND FUNDING

Under EPR legislation producers would be responsible for covering all costs associated with a CFL recycling program. EPR legislation gives producers the option to assume the cost themselves, but producers most often pass the cost on to consumers by applying a small fee to each CFL bulb. The fee is generally negligible

and provides ample funding for CFL recycling. A minimum fee of $0.15 has been applied with success in other jurisdictions in Canada. Such a fee covers all program expenses, including collection, transportation, and recycling, as well as administrative costs and costs associated with education, outreach, and program development and expansion. Producers should be responsible for providing annual financial reports which detail the use of the fees. The fee can be displayed as part of the price of the bulb, or as an additional charge, but must be visible on the customer receipt. These options are depicted in Appendix B.

Despite all enforcement and efforts to inform consumers on proper disposal, some materials under EPR inevitably end up in the regular waste stream. Costs associated with disposal of this material are left to the municipality, and producers are considered "off the hook" for these improperly disposed materials. EPR regulations should require producers to not only pay for the cost of recycling CFLs that are captured, but to also contribute funding to municipal costs associated with end of life management of CFLs that are not captured under voluntary drop-off.

RECOMMENDATIONS

- Producers should be responsible for 100% of the funding for recycling programs.
- EPR legislation should require producers to contribute to the cost currently faced by municipalities for end of life management of CFLs not captured through voluntary drop-off.

6.4 EDUCATION

Consumer awareness and education has been identified by jurisdictions with CFL recycling programs as the most important tool in promoting proper disposal. Studies from Maine suggest that education and consumer awareness has the most significant impact on capture rates. Canadian studies on CFL recycling, such as those performed by Summerhill Impact and Pollution Probe, indicate that education and outreach are essential to CFL recycling programs (Summerhill, 2012 ; Hilkene, 2005). As well, awareness is essential for disposal bans to be followed. Education for EPR programs will be the responsibility of the producers, but integration of the message into various communication channels is necessary to reach the greatest number of consumers.

Research by Summerhill in 2012 determined that the most appropriate message for EPR programs to promote is not that of the negative risks of CFLs, but rather of the appropriate disposal methods. This shifts the focus from a "fear of mercury" to

"positive sustainability", which is beneficial because the aim of CFL recycling education is not to discourage consumers from using the bulbs, but rather to encourage them to dispose of them properly. The report also determined other key components of CFL education, including providing a tool for Nova Scotians to find collection sites, and educating consumers on CFL application by addressing concerns around colour, longevity, and heat (Summerhill, 2012).

Currently, waste educators in the province find that integration of the message into many channels of communication is essential for effective waste education. Having as many educational tools as possible allows for the greatest audience. Tools such as hotlines, calendars, websites, news stories, and advertising all work together to ensure that the message is ubiquitous. Producers of CFLs should work with municipalities and non-profit environmental organizations to access all possible communication channels, and to ensure that there is consistency when disseminating information. Currently a discrepancy exists in Nova Scotia with waste education between various communication channels (e.g., Municipalities and waste educators providing contradicting information to residents). One method of averting this is to create a website which caters specifically to CFL recycling, such as the website operated by PCA in British Columbia (www.lightrecycle.ca).

RECOMMENDATIONS

- Consumer education should focus on appropriate disposal practices rather than the negative risks of CFLs.
- Education should make use of a range of methods and communication channels, but messages should be kept consistent between them.

6.5 COLLECTION

Establishing a collection network for CFL bulbs is highly dependent on the province it is being designed for. The creation of a network will depend on the network already in place for other products, the willingness of site owners to participate, the population distribution throughout the province, and the role that the recycler is able to play in transportation. A range of options exist for collecting residential CFL bulbs; current programs in Canada primarily use return-to-retail, pre-existing collection depots, municipal collection sites, and one-time collection events. These are discussed in more detail in the following section.

Census data from 2011 show that the population density in Nova Scotia is 17.4 persons per square kilometer, with 65.1% of the population living in census metropolitan areas or census agglomerations (urban areas), and 34.9% living outside

these areas (rural areas). Figure 12 shows the population of Nova Scotia by county, as well as the location of provincial Enviro-Depots in green. Studies conducted on CFL collection systems and consumer behavior indicate that the single most influential factor affecting voluntary drop-off is convenience (Wagner, 2011). With a large portion of the population of Nova Scotia living in rural areas program designers must keep in mind the necessity for convenience. That is not to say that population density would pose an insurmountable problem; British Columbia runs a highly successful CFL recycling program and has a lower population density than Nova Scotia.

Another concern often voiced is the risk to human safety associated with collecting CFL bulbs, due to their mercury content. Occupational health and safety (OHS) standards have sometimes prevented certain collection sites from accepting CFLs in other jurisdictions. As seen in other jurisdictions, it is possible for collection sites to follow OHS standards, by using appropriate collection receptacles, training staff, and taking other precautionary measures.

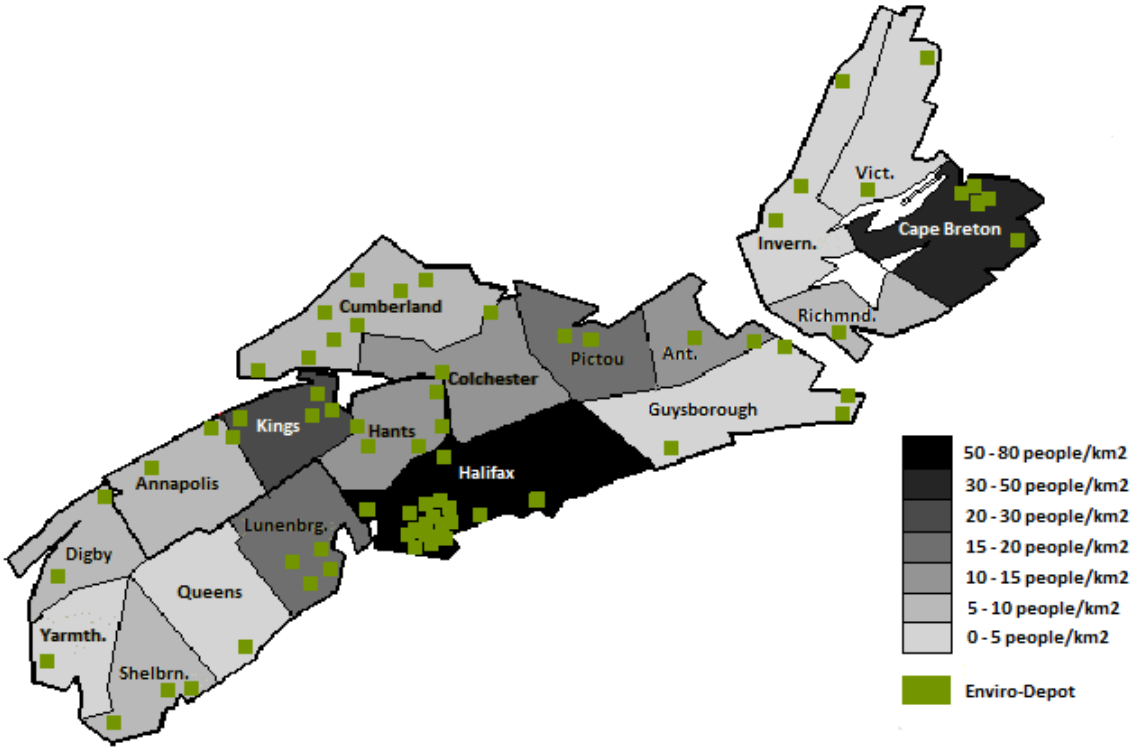


Figure 12. Nova Scotia population density by county and location of Enviro-Depots

Published in 2011, Dr. Travis Wagner conducted a study on what factors influenced recycling rates of CFLs in Maine. Consumer education and recycling convenience were found to be the most significant factors affecting recycling rates. Pertaining to

this section in particular, Wagner found that to increase collection rates, policy makers need to increase the convenience of collection. The inconveniences identified include having to drive to a collection point, long distances to collection sites and lack of collection sites, as well inconveniences at the point of collection. Similarly, the study identified which factors would *prompt* consumers to recycle bulbs. Wagner found that a sense of environmental responsibility was the single largest driver of CFL recycling, followed by economic incentive (free recycling), and convenience. Wagner recommends consideration of curbside collection, as well as a system of free collection sites designed to minimize driving distance. Based on studies done previously, the study asserts that 8km is the maximum distance consumers are willing to drive to recycle, after which distance consumers are not likely to recycle. Co-locating recycling collection sites with frequently visited destinations, such as retail stores, grocery stores, post offices, etc., also helps make recycling more convenient.

A key aspect of convenience is eliminating the need for residents to ask, "What do I take where?". Ideally collection sites would accept all bulb types - not just CFLs - including LEDs, incandescents, high-intensity discharge bulbs (HIDs), fluorescent lights (FLs), etc. Placing a limit on the number of bulbs that can be dropped off at one time helps to eliminate improper drop-off by members of the industrial and commercial sector, but the limit should not be so low as to prevent residents from disposing of all their bulbs. Generally 16 bulbs is considered an appropriate limit. Restrictions should also not be placed on bulbs that have been broken before reaching the collection site.

6.5.1 Existing Depots

Nova Scotia already has an extensive Enviro-Depot system in place throughout the province, as shown in Figure 12. These depots, of which there are approximately 80, are privately-owned and are operated by the Resource Recovery Fund Board (RRFB), serving as collection sites for recyclable products. Operators of a province-wide CFL recycling program would need to contract with Enviro-Depots to ensure that they are willing to accept CFLs. This may include providing the depots with economic incentive and training. All other programs in Canada have used pre-existing depots as part of the collection network. Using Enviro-Depots as collection sites for CFLs means that new infrastructure is not being created to accommodate the bulbs, and that if the CFL recycling program is ever phased out infrastructure will still have a function.

In addition to Enviro-Depots, hazardous waste depots, waste transfer stations, and recycling depots could all serve as CFL collection sites. The number of collection sites is often used as a measure of success for CFL recycling programs; integrating

many collection sites would likely lead to greater capture rates, as it increases the convenience to residents.

6.5.2 Municipal Collection

Many residents turn to their municipality for information on how to recycle CFLs. In fact, studies have shown that consumers rarely consider end of life management for CFLs at the point of purchase, but rather once the bulbs have burnt out. For this reason consumers direct their inquiries towards their municipality rather than the retailer. Having collection sites located at municipal buildings would strengthen the collection network and may allow for municipalities to play an active role in program awareness.

A concern surrounding bulb collection is that voluntary drop-off does not capture all bulbs. Voluntary drop-off tends to neglect residents who have limited access to transportation or who are elderly. To better access these residents it may be beneficial to carry out periodical curbside collection events. Regular curbside collection may cause too much overlap with collection depots and may be unsafe to waste collectors, though periodic collection events would target residents who do not participate in voluntary drop-off.

6.5.3 Return-to-retail

A report completed at the end of 2012 by Summerhill Impact found a range of concerns from retailers with return-to-retail CFL collection. The majority of retailers surveyed indicated that this method was not an ideal collection channel. Operational barriers include health and safety concerns, cost, and location. Retail employees found it difficult to empty and replace collection bins in a timely manner. Health and safety concerns were raised regarding broken CFLs being deposited in the collection bins, as well as the risk of bulbs breaking once collected. With respect to cost, retailers found that CFL collection is not revenue generating, and programs were often cancelled because the costs associated were left to the retailer. Retailers could not justify this cost, as they did not see a correlation between in-store collection and sales of CFL bulbs (Summerhill, 2012). These are concerns that need to be addressed by a potential CFL recycling program in Nova Scotia.

A study conducted two years after the state of Maine implemented a CFL recycling program recommended that CFL collection sites should include return-to-retail locations, to coincide with primary CFL purchase locations (Wagner, 2009). The barriers mentioned above can be addressed in a Nova Scotia CFL recycling program as follows: Under EPR legislation retailers alone should not be responsible

for transportation of the bulbs to the recycler, and therefore a program would ensure that the bulbs are collected from the retailer in a timely manner, to avoid build-up of bulbs and difficulties associated with emptying the collection containers. The issue of cost is non-existent under EPR legislation, and OHS concerns can be addressed with proper training, and safe collection receptacles; because the bulbs are sold from the retailer with no OHS concerns, it follows that there would be a method to safely return them to the retailer.

RECOMMENDATIONS

- Have as few barriers as possible for collection (e.g. allow for collection of both whole and broken bulbs).
- Encompass collection of all bulb types.
- Design of the collection network should focus on integration, rather than patchwork collection sites, and should strive to include as many collection sites as possible.
- Eliminate both real and perceived inconveniences to residents as much as possible.
- Collection and drop-off must be free of charge.

6.6 TRANSPORTATION

After the bulbs are collected they must all be transported to the recycler. Other EPR programs in Nova Scotia, namely for paint, contract with haulers to routinely collect the products and deliver them to the recycler. Under EPR legislation this process will be arranged by the producer, who may select the hauler. There are few potential barriers to bulb collection, but producers may have difficulties with OHS standards for haulers. If this is the case, recyclers often provide hauling services, which lack these OHS concerns. In Nova Scotia, Dan-X Recycling Ltd. – which is also currently the only local recycler – offers bulb collection for a fee throughout Atlantic Canada. The company charges $35 for a collection of up to 40,000 CFL bulbs.

RECOMMENDATIONS

- Consider using existing a local recycler's hauling services for bulb transportation.

6.7 RECYCLING

Ultimately, the destination for household CFLs is the recycler. Atlantic Canada is fortunate to have a recycling facility capable of recycling mercury-containing

products, located in Dartmouth, Nova Scotia. Dan-X Recycling Ltd., a privately owned recycling facility, currently accepts all bulb types and sizes, as well as batteries and thermostats, for a fee. The plant has immense capacity, and currently operates at just 7% of that capacity. CEO Dave Hall asserts that the facility has the capacity to recycle all bulbs, both residential and commercial and industrial, in Atlantic Canada. Before the establishment of the recycling plant in 2009, bulbs from Atlantic Canada were shipped to recycling company Aevitas, in Ontario (pers. comm.).

The recycling plant, a Balcan Hazardous Lamp Recycler, separates the phosphorous, the glass, and the metal and plastic end caps using negative pressure and a crushing process. The crushed and polished glass is sold by the barrel at $5/ton (about $5 for two barrels) to a company in New Glasgow, Nova Scotia for use in drainage and septic systems. The metal caps are sold to Dartmouth Metals to be melted and reused as a raw material. The phosphorous is shipped to Bethlehem Apparatus Co. Inc. in Pennsylvania to remove the mercury from the phosphorous powder. Using a mercury distiller, the company recycles the phosphorous to produce mercury and 'rare earth minerals'. The mercury is sold for use in gold mining and the 'rare earth minerals' are sold for use in new bulbs. Dan-X considers themselves a 'true recycler' as no part of the bulbs is disposed of; all parts are reused.

Figure 13 displays the recycling process for light bulbs at the Dan-X facility.

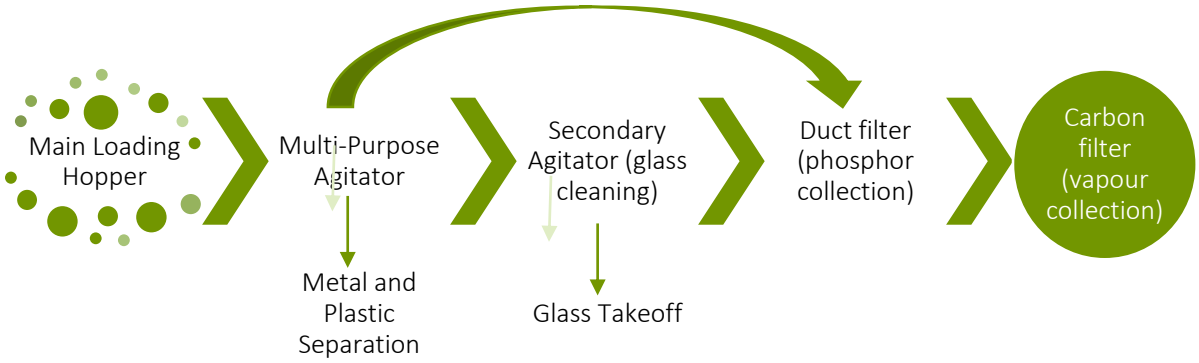


Figure 13. Balcan light bulb recycling process.

Currently Dan-X recycles bulbs primarily on an industrial basis. CFLs comprise about 10% of the bulbs recycled, the majority being two-, four-, and eight-foot FLs. Organizations such as the Clean Foundation, Efficiency NS, the New Brunswick government, Nova Scotia Power Inc., and individual companies such as SNC Lavalin, all use Dan-X's services. Bulbs can also be dropped-off at the depot on a bulb-by-bulb basis. Dan-X currently operates its take-back system by offering a

bulb receptacle on premise, where bulbs can be deposited for a fee of $0.50 per CFL bulb.

With respect to the capacity of the recycling plant, the front loading section can hold about 1,000 CFL bulbs at one time. These bulbs can then be fully processed and sorted in three minutes. The facility currently operates at 7% capacity and expects to be operating at 80% should the regulations come into place banning CFL bulbs from landfills. The plant can recycle any bulb, including CFLs, LEDs, street lights, HIDs, and any product which contains mercury, including batteries and thermostats. Dan-X also accepts whole or broken bulbs, as well as taped bulbs. The facility can accommodate storage of between one and two million bulbs on site, as well as the recycled material for shipment.

Dan-X is currently waiting for EPR legislation in Nova Scotia, as the company would like to be at least 80% operational within the next year. If EPR legislation is not enacted soon, the company may have to sell their recycling plant due to a lack of bulbs available for recycling. Without a local recycler producers would face costs of $25,000 per truck load to ship the bulbs to a recycler in Ontario or Quebec. This would likely increase the cost to consumers in terms of the fee per bulb.

RECOMMENDATIONS

- Producers should contract with a recycler local to Nova Scotia to recycle CFL bulbs. Currently the only such recycler is Dan-X Recycling Ltd.

6.8 DESIGN FOR THE ENVIRONMENT

Key to some EPR programs in other jurisdictions are requirements for producers to employ “design for the environment” principles to their products. In British Columbia this concept is included in the EPR regulations as “pollution prevention hierarchy” (PPH). A study commissioned by Environment Canada about ten years ago found little connection between EPR legislation and voluntary design for the environment. However, by regulating that producers must follow a PPH, design for the environment can be achieved with greater success. Figure 14 demonstrates a generic PPH, which requires that producers first work to eliminate the use of certain components in their products, such as chemicals or unnecessary materials. Only after having achieved this can producers work to reduce the amount of waste that is created from their product, and so on. By regulating that producers adhere to such a hierarchy EPR legislation ensures that measures are taken to design products to be environmentally sustainable, rather than simply requiring producers to recycle products.

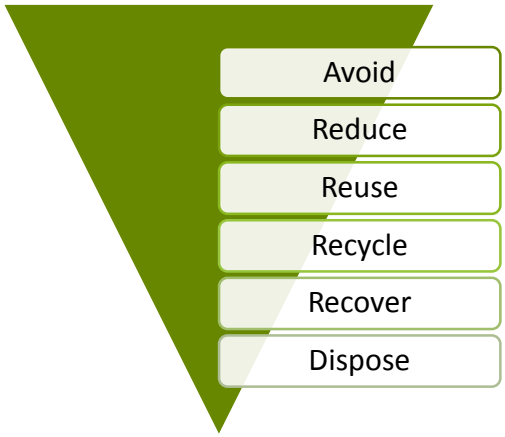


Figure 14. Example pollution prevention hierarchy

RECOMMENDATIONS

- Include in EPR regulations the requirement that producers adhere to a pollution prevention hierarchy.

6.9 MEASURING SUCCESS

Measuring the performance of a CFL recycling program is important to determine if the program is successfully capturing the bulbs. Producers will be responsible for reporting on the efficiency of the program, in particular the capture rate for each year. The capture rate, number of collection sites, consistency with PPH, and program costs are all indicators of program performance that should be included in annual reports by the producers. Measuring capture rates is the most accurate way to establish how effective the program is at collecting bulbs; the capture rate is a measurement of the number of bulbs captured compared to the number of bulbs available to collect. Measuring the number of collection sites helps to identify if the program has been successful in partnering with site owners or in creating new collection sites. As well, reporting on the costs of the program provides in indication of how efficient the program is at using eco-fee revenues to collect bulbs.

RECOMMENDATIONS

- Require producers to use a range of indicators when reporting on program performance, including capture rates, number of collection sites, consistency with PPH, and program costs.

6.10 INTERIM

While CFL regulations should be passed as soon as possible, full implementation of a CFL program may take a considerable amount of time. CFLs must be managed until there is a formal program in place to collect and recycle them; if not, upwards of half a million CFLs could end up in landfills throughout Nova Scotia in the interim. A number of options exist for such measures, yet the safest place for CFLs to be stored is at the recycling facility, which is able to store over 1.7 million bulbs on site. NSE may consider working with the RRFB and Dan-X Recycling to divert bulbs on a voluntary basis until regulations mandate such diversion. Furthermore, HHW facilities throughout the province present a location which could store bulbs until regulations are in place. This would allow for a supply of bulbs to be available to the recycler at the onset of EPR legislation.

RECOMMENDATIONS

- Until a CFL recycling program is operational municipalities, NGO's, and other organizations that have the capacity to safely store mercury-containing products should consider collecting CFLs for later recycling.

6.11 PROGRAM OUTLOOK

Like programs in other jurisdictions, a CFL recycling program in Nova Scotia would likely begin with modest results. As seen with the successful British Colombia program, capture rates may begin as low as 10% in the first year. This is generally due to the time required to educate consumers, as well as to troubleshoot problems that arise with program implementation. Program success is therefore best measured over time, as capture rates generally increase from the first year to the next.

CFL recycling alone will not address the issue of mercury contamination and waste generation. Nova Scotia should consider encompassing all mercury containing bulbs and products under EPR legislation. Further, the program could consider encompassing all bulb types, including LED and HID bulbs. This would make program education more uniform and allow consumers to dispose of all their bulbs uniformly and safely. This would also provide recyclers with greater economic stability.

6.11.1 Ban Enforcement

Receiver Enforcement

Currently the task of ban enforcement, along with its associated costs, lies with

municipalities. Enforcement is carried out on a receiver basis, meaning that while waste separation is largely the task of generators (residents), enforcement at the generation end is minimal, and is instead carried out at the receiving end. Enforcement at the generator stage includes curbside inspection and subsequent rejection of waste at the curb if not in compliance. If residents dispose of banned materials in their household waste collectors can reject the waste. However, the extent to which this form of enforcement prevents banned materials from entering the landfill is unknown. Instead, municipalities invest resources into monitoring the waste as it arrives at the landfill. For example, the Otter Lake waste facility opens and inspects waste from residential bags before it is deposited in the landfill. This process is costly to municipalities but is an effective way of preventing banned material in residential waste from entering the landfill. Few landfills in Nova Scotia currently sort the waste entering the landfill. This process should be in effect if CFL bulbs are to be banned from Nova Scotia landfills, until generator enforcement is considered an effective replacement, as will be discussed subsequently.

Generator Enforcement

At the generator stage, clear garbage bags help to identify households which have disposed of CFLs improperly. These have been used in some municipalities in Nova Scotia and are considered to be a successful way of ensuring that household waste does not contain banned material. Municipalities such as HRM are even now considering a shift to clear bags in an effort to mitigate improper disposal. Without clear garbage bags waste collectors cannot know whether banned material is being disposed of in household waste. Clear bags enable collectors to reject household waste at the curb if it is not in compliance with ban regulations. Bags should be rejected and labeled so the resident is aware of how their waste is not in compliance. This is an effective enforcement tool which can be incorporated into existing procedures, as bags are already checked for material such as paint cans, and does not required additional personnel or funding. By using this method, some of the burden of compliance shifts from landfill operators to waste generators. Residents are generally averse to having their garbage left at the curb and so will strive to avoid incurring the associated stigma by modifying their disposal habits.

A major concern surrounding lack of enforcement is the dearth of recyclable material available to private recyclers if CFLs are not being diverted from the landfill. If landfill bans are not properly enforced, and if not enough CFLs are being collected and brought to the recycler, then the operational sustainability of the recycling plant is at risk – i.e., it is simply not economical for the plant to operate. A recycling facility has the ability to process huge quantities of bulbs, but if Nova Scotia regulations do not engender strict enforcement, there is a risk that the province might cease to be a viable operating environment for the recycler. Without a local recycler, program

costs would be greatly increased, with bulbs having to be shipped out of the province for recycling.

RECOMMENDATIONS

- Waste should be sorted at the landfill (before actually entering the landfill) to prevent CFLs from accidentally entering, until generator enforcement is considered an effective replacement.
- Clear garbage bags are a necessity for enforcement and should become a province-wide requirement.
- With the use of clear garbage bags, rejection of residential bags should occur if bags are not in compliance, with information regarding why the waste was rejected.
- Municipalities should utilize all available tools to aid in enforcement, beyond increasing education and outreach.

APPENDICES

6.12 APPENDIX A

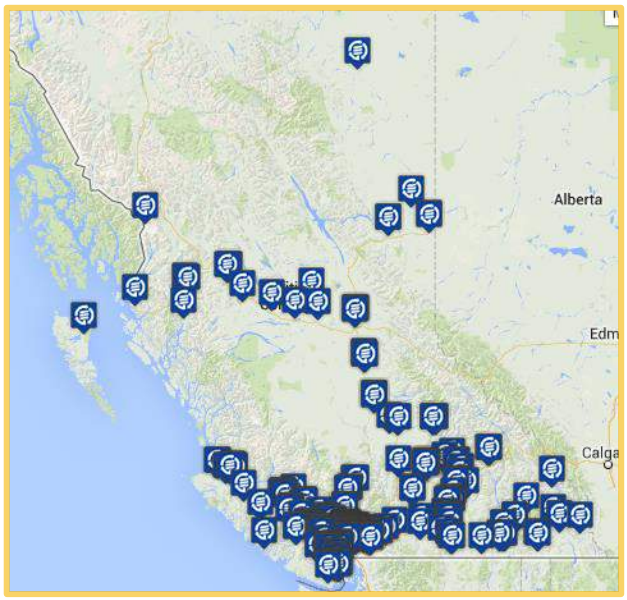


Figure A.1. Distribution of British Columbia bulb drop-off locations

6.13 APPENDIX B

Figure B.1. Example eco-fee display

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