MASTER OF PUBLIC POLICY
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Electronic Waste Management in Canada

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Abstract

Worldwide, human life and society have been positively impacted by globalization and ongoing technological advancements. Technology and consumer electronics have changed daily life, leading to a more interconnected society where knowledge and information are readily and easily accessible. However, society must also bear in mind the consequences associated with our increasing dependence on consumer electronic products and technology. Apparent are the environmental, ethical and economic impacts through the entire chain from extraction of raw materials, to production as well as consumption and final disposal. This paper will address some of these externalities and attempt to identify working solutions for the Canadian waste management and recycling system.

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Executive Summary

Waste management is becoming a major global policy issue for several reasons including pollution control, the increasing demand for the extraction of rare and finite natural resources required for consumer and industrial product and the diminishing availability of landfill sites for disposal. Improper waste management and landfill use have implications for policy development regarding environmental degradation and human health issues. Of particular note is the increasing production and consumption of consumer electronic products, such as laptops, televisions and mobile phones, which are composed of rare and precious metals, other metals, plastics, minerals and chemicals. Many of these substances are toxic when inadequately disposed of or dismantled and they pose significant risks to human health and well-being as well as environmental damage through contamination of air, soil and groundwater sources. In addition, the improper disposal of end-of-life electronics and their components represents a significant resource loss. Improperly managing electronic waste is a global as well as a Canadian issue.

A worldwide phenomenon of exporting electronic waste (e-waste) from the developed to developing world, often illegally and without adequate regulation, has been recognized over the past couple decades. The international community has stepped in to alleviate this ethical problem by prohibiting the export of hazardous waste from OECD to non-OECD countries. However, this international action has done little to encourage effective domestic waste management in Canada. Instead, provinces have taken initiatives at different levels, leading to misaligned policies at the national level. This purpose in this paper is to investigate Canada's initiatives in terms of e-waste management and whether a more domestically focused strategy would be more effective in improving Canada's landfill use, general waste management and environmental performance, as well as further deterring the illegal export of e-waste..

The complexities and expenses associated with properly recycling and managing e-waste in comparison to other types of waste provides adequate reason for a coherent federal strategy to address the issue. Different capabilities across provinces and

jurisdictions in terms of available infrastructure, financing and expertise justifies federal action to help provide a more effective and efficient solution to e-waste management. Producers and industry are significant stakeholders in e-waste management. Not only would a standardized national policy on e-waste management enable them to operate more easily and effectively in Canada, it also has the potential to develop economies of scale in e-waste recycling. The EU has recognized the necessity of a unified approach to ensure that all jurisdictions have the capacity to manage e-waste successfully. A two-tier strategy that focuses on the market, encouraging producer stewardship and responsibility throughout the product lifecycle, as well regulates through standards of recycling and disposal would be the most effective approach.

Introduction

The worldwide increased production and consumption of consumer electronics over the last several decades has impacted society in a variety of ways. The rapid turnover of consumer electronics and the rate at which they penetrating the market has led to new policy issues related to managing the enormous amount of waste associated with end-of-life electronics. Electronic waste, or "e-waste," is defined as "all waste that comes from or is caused by electronics. It contains materials such as lead, mercury, arsenic and chromium – all known or suspected agents of harm to wildlife and human health."[1] The Environmental Protection Agency has recognized the global proliferation of e-waste and has concluded that the continually growing stream of waste is a result of "rapid sales growth and change in the [consumer electronics] sector." [2]

A largely unrecognized, yet significant downstream issue associated with the growing demand for and consumption of consumer electronics is the growing inequity that has resulted between the developed and developing world in relation to toxic pollution from e-waste. The economically valuable, precious metals that are key components in the production and manufacture of electronic products are the key incentive for a harmful trade relationship that has developed between low-income nations and the first world. Developed nations have responded to a demand by the developing world to supply end-of-life electronics, however this has essentially resulted in a harmful and illegal trade of hazardous waste. Furthermore, although electronics are dismantled in the developing world, the process is crude and therefore metals and recoverable materials present in electronic goods are not reaching their full potential lifecycle as they are not re-used in an effective manner. Components of electronics, specifically metals, have the capacity to be recovered and re-used many times, thus minimizing the environmental impact of extracting and mining for raw materials. A lack of incentive for consumers to properly recycle these products has led to stockpiling toxic

[1] Statistics Canada. "Goodbye e-waste". *Government of Canada* (2006). http://www41.statcan.gc.ca/2006/1762/ceb1762_003-eng.htm (accessed 20/08 2013).

[2] US Environmental Protection Agency. "Electronics Waste Management in the United States through 2009" Washington, D.C.: *US Environmental Protection Agency* (2011).

pollution and wasteful disposal in landfills. Demand from the developing world for the components of end-of-life electronics as well as the lack of infrastructure or economic incentive in the developed world to properly recycle electronics domestically has further facilitated this harmful trade. The policy implications for the ineffective management of end-of-life electronics relate not only to the toxic environmental pollution, which differentially affects the developing world, but also are influenced by the inherent economic loss in not recycling certain metals or components, which in many instances are relatively rare.

Ineffective waste management, minimal requirements for producer responsibility, as well as a lack of streamlined national e-waste management policies, are core reasons for Canada's contribution to this widespread and growing problem. Canada has made an international effort to combat the illegal trade of e-waste, through signing an international treaty on prohibiting the export of hazardous wastes to developing countries (the Basel Convention) and through implementing a federal law against the export of hazardous wastes. However, it lacks a national, unified strategy to address the issue of effective e-waste management at the domestic level.

Background/Literature Review

The waste produced by end-of-life electronics is staggering. Worldwide, "humans generate an estimated 20 to 50 million tonnes of e-waste each year, an amount that is expected to grow to 40 to 70 million tonnes by 2015."[3] In Canada, an estimated 140,000 tonnes of e-waste ends up in landfills each year. This figure continues to increase.[4] The United Nations Environment

"Electronic waste is the fastest-growing portion of the municipal waste stream. While other types of municipal waste are decreasing, e-waste is growing by close to 5% annually." (WellHome Energy Audits, 2011)

[3] T. Whitehouse, "E-Waste Exports: Why the National Strategy for Electronics Stewardship Does Not Go Far Enough," *Journal of Energy and Environmental Law* 3 (2012), 110.
[4] Statistics Canada, 2006.

Programme (UNEP) has concluded that the fastest growing waste stream in the industrialized world is in fact, end-of-life electronics.[5] In the United States, e-waste deposited in landfills is three times higher than other municipal solid waste.[6] A compounding factor for Canada is that landfill space is diminishing, while solid waste is on the rise.[7] This has the potential to create serious policy implications for Canada in terms of land use, costs associated with waste disposal and environmental pollution. Furthermore, the export and market penetration of both used and end-of-life electronics to the developing world, has resulted in a widespread waste management problem as well, the magnitude of which is growing.

> "By 2020, e-waste from old computers will have increased by 200% to 400% from 2007 levels in South Africa and China and by 500% in India. By 2020, e-waste from discarded mobile phones will be approximately 2 and 18 times higher than 2007 levels in China and India, respectively."[8]

Although Canada will not experience as significant an impact from e-waste as countries like China and India, Canadian producers, consumers and policy makers need to be aware of the severity of the issue as it is rapidly becoming a global environmental and policy issue. In the literature reviewed, the main underlying issue associated with e-waste pollution is the increasing consumption and inherent obsolescence of consumer electronic equipment due to the continuous improvement of electronics and evolving technologies. The generation and consumption of consumer electronics has been phenomenal over the past several decades and worldwide the growth is on an exponential trajectory. The proliferation of tablets and smart phones has been a major

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[5] M. H. Wong et al."Export of Toxic Chemicals E A Review of the Case of Uncontrolled Electronic-Waste Recycling," *Environmental Pollution* 149 (2007), 131-140.

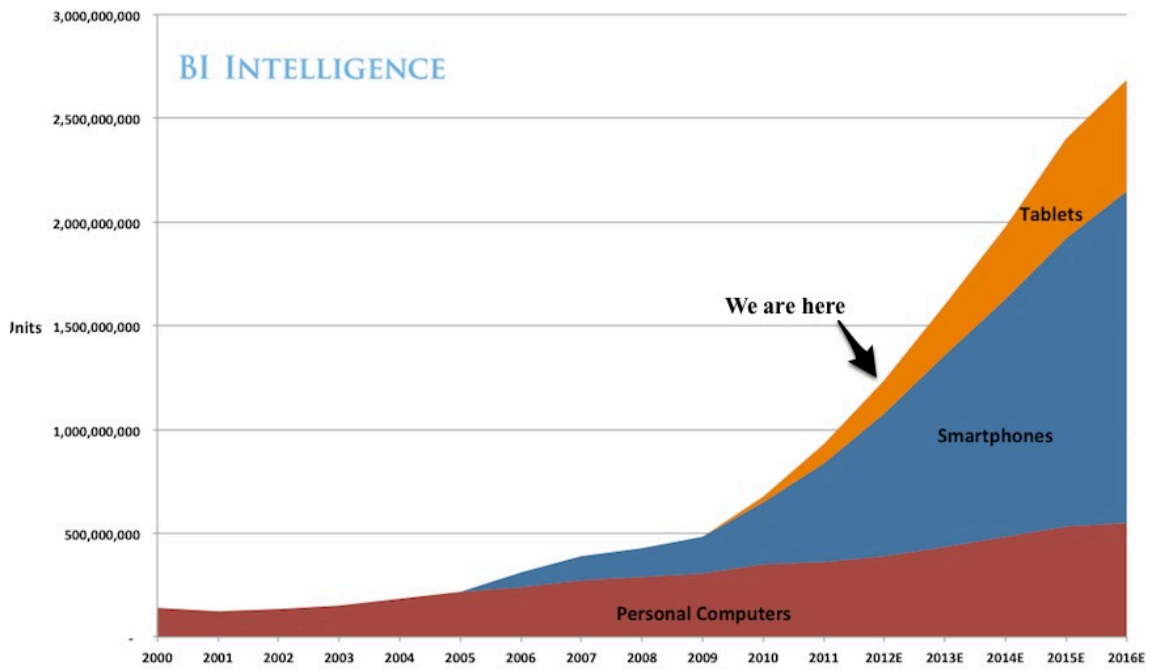
[6] J. Boon, "Stemming the Tide of Patchwork Policies: The Case of E-Waste," *Transnational Law and Contemporary Problems* 15 (2005), 731.

[7] K. McKerlie, N. Knight and B. Thorpe, "Advancing Extended Producer Responsibility in Canada," *Journal of Cleaner Production* 14 (2006), 616.

[8] Q. Liu et al., "Environmental and Health Challenges of the Global Growth of Electronic Waste," *Environ Sci Pollut Res* 19 (2012), 2460.

contributor to the growing demand and sales of consumer electronics. As indicated in Figure 1, these sales are projected to continue well into the future.[9]

Figure 1: Global Internet Device Sales



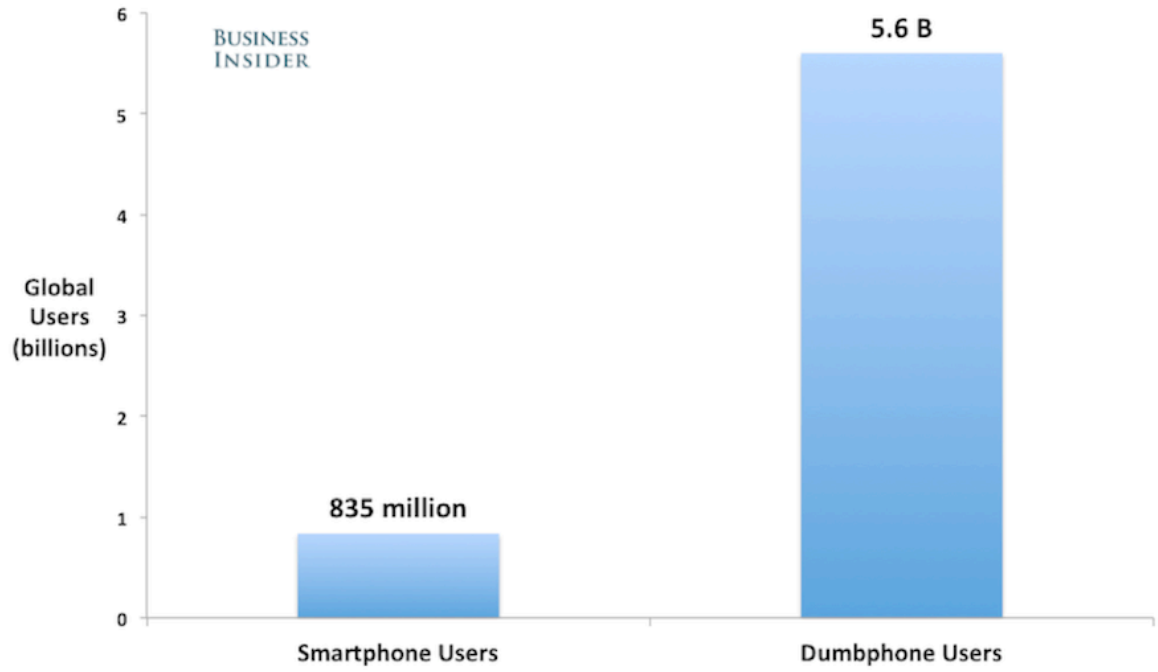
Source: Platt et al.[10]

The replacement of old cellular devices, or "dumb phones," with smart phones will also have implications for the amount of old electronics entering the global e-waste stream. As outlined in Figure 2, in 2011 there were 835 million smart phone users and 5.6 billion dumb phone users. According to a study done by the Business Insider, the "dumbphone conversion cycle" (converting old cellular devices into smartphones) is about one fifth of the way complete, meaning in the coming years, many consumers will

[9] Platt, E.; Boesler, M.; Nisen, M. "The Global 20: The Big Trends that are Changing the World." Business Insider (2012), 1. http://www.businessinsider.com/the-global-20-2012-5?op=1 (accessed 02/09 2013).
[10] Ibid.

make the switch to smart phones.[11] The result of this mass conversion will be a large amount of old mobile devices being discarded or stockpiled by consumers.

Figure 2: Global Smartphone vs. Dumbphone Subscribers, 2011 E



Source: Platt et al.[12]

As with the rest of the world, Canada has experienced growth in the units of consumer electronics sold. Forecasts also show an increase in sales in the coming years. Figure 3 outlines growth in Canada's consumer electronics sales throughout the past half-decade.

[11] Ibid.
[12] Ibid.

Figure 3: Sales of Consumer Electronics by Category: Volume, 2006-2011

(in thousands of units)

	2006	2007	2008	2009	2010	2011
Computers and Peripherals	7,912.0	8,528.1	8,718.3	8,699.5	8,893.7	9,590.1
In-Car Entertainment	1,556.2	1,750.2	1,961.3	2,003.9	2,106.4	2,135.5
In-Home Consumer Electronics	8,908.4	8,505.7	8,592.9	8,123.1	8,651.2	9,104.0
Portable Consumer Electronics	17,056.3	18,450.7	18,846.3	18,946.3	21,056.4	22,728.9
Consumer Electronics	35,432.9	37,234.6	38,118.8	37,772.8	40,707.7	43,558.5

Source: Table Taken from, Euromonitor International. "Consumer Electronics in Canada, Industry Overview" Passport (2012). Data accessed 02/09 2013.

As figure 4 indicates, global sales in consumer electronics have also witnessed growth in the past couple years and are projected to increase. [13]

Figure 4: Sales in Electronics – How Much Electronics Are We Buying?

	What we bought in 2010	What we bought in 2011	What we will buy in 2012	Future Year Projections
Computers				
Desktop, laptop, but not tablet	350.9 million	352.8 million	404 million	
Tablets (incl. e-readers)	19.5 million	72.7 million	103.4 million	183.2 million by 2017
Televisions				
All Televisions	247 million	248 million	254 million	
LCD TVs	195 million	206 million		
Cell Phones				
Smart Phones	304.7 million	491.4 million		Over one billion by 2015

Source: Table taken from "Facts and Figures on E-waste and Recycling." *Electronics Take Back Coalition* (2013), 4.

[13]Electronics Take Back Coalition. "Facts and Figures on E-waste and Recycling." (2013) http://www.electronicstakeback.com/wp-content/uploads/Facts_and_Figures_on_EWaste_and_Recycling.pdf (accessed 21/05 2013).

Although most growth has been witnessed in North America and Europe, Asia is quickly catching up. In a 2010 study on the global management of e-waste, Ongondo et al studied various regions around the world including Europe, North America, Australia, Asia and Africa and concluded that there is a worldwide contribution to resource depletion due to the production and consumption of electronic equipment. The authors state, "for all countries reviewed, evidence suggests that quantities of [e-waste] generated are high and/or on the increase."[14] They further argue that primary resources are being unnecessarily wasted due to the rate they are consumed at.

> "The rate at which electronic devices are discarded is a key contributor to resource depletion since the manufacture of new products to replace 'perceived' obsolete ones necessitates mining of raw materials."[15]

It is estimated that technology and cheap electronics will penetrate the market quickly, especially in developing countries, thus considerably increasing the potential e-waste generated.

Consumer electronics are made up of an assortment of metals, all of which must be extracted through mining operations worldwide. The increased development of and subsequent demand for these electronics has amplified pressure on firms and industry to extract these metals that make up electronics. The metals can be divided into three different groups based on their characteristics. The first is the rare earths, which are essential components in many consumer electronics, such as smart phones, televisions, computers and hybrid vehicles. Even in industrial use they are widespread (e.g., they are a major component in wind turbines). There are 17 rare earth elements located under the earth's crust. Although these metals are not 'rare' in the sense that they are noticeably disappearing, they are considered rare because they are not often found in their pure form. Mining rare earth metals is often environmentally harmful and destructive. As with many mining operations, the extraction of rare earth metals

[14] F. Ongondo, I. Williams and T. Cherrett, "How are WEEE Doing? A Global Review of the Management of Electrical and Electronic Wastes," *Waste Management* 31 (2011), 725.
[15] Ibid, 726.

changes land-use patterns, degrades ecosystems, has implications for ground water sources and uses heavy, carbon emitting machinery. Furthermore, the tailings ponds that hold the toxic by-products of rare earth mining operations are often radioactive due to contamination from uranium and thorium.[16] Precious and ordinary metals make up the next group of metals present in electronics. Precious metals include gold, silver, platinum and palladium. Ordinary metals include copper, zinc, aluminium and nickel. These metals are economically very valuable and are important components in electronics because of their various characteristics, especially their ability to conduct electricity. The third group, heavy metals, are also considered 'toxic metals'. These metals include lead, mercury, cadmium and beryllium. Heavy metals are essential components in many electronics. However, they are also very toxic to humans and should be kept out of the environment so that both humans and other organisms are not exposed to excessive levels of them.[17] As with most chemicals in consumer products, the full extent of the interaction of these heavy metals with the environment and organisms is unknown. Nevertheless, there is recognized evidence that some of these metals are known carcinogens, endocrine disruptors and linked to various skin diseases and developmental problems.[18] The physical and chemical characteristics of these heavy metals and the 'persistent organic pollutants' from e-waste plastics cause them to dissipate in the environment and bio-accumulate in organisms, thus affecting the entire food chain and life cycle.

Like most resources that make up anthropogenic development, these metals, namely special metals (gold, silver, platinum etc.) and ordinary/base metals (copper, aluminium, nickel, tin etc.) are finite and extraction is producing declining yields. Recycling these metals is a recurring theme among suggestions from scientists exploring

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[16] Russell McLendon, "What are Rare Earth Metals?" *Mother Nature Network* (2011). http://www.mnn.com/earth-matters/translating-uncle-sam/stories/what-are-rare-earth-metals#environmental (accessed 12/08, 2012).

[17] C. Hagelüken. "Improving Metal Returns and Eco-Efficiency in Electronics Recycling" San Francisco: *IEEE International Symposium on Electronics & the Environment*. (2006), 218-223.

[18] J. Puckett et al. "Exporting Harm the High-Tech Trashing of Asia". *The Basel Action Network; Silicon Valley Toxics Coalition* (2002).

this issue. In an article on metal stocks and sustainability, geologists at Yale University stressed two points:

> 1) "Providing today's developed-country level of services for copper worldwide (as well as for zinc and perhaps platinum) would appear to require the conversion of essentially all of the ore in the lithosphere to stock-in-use plus near-complete recycling from that point forward."[19]
>
> 2)"The fraction of the stock of recoverable resources in the lithosphere already placed in use or in wastes from which it will probably never be recovered is approximately 26% for copper and 19% for zinc…Similar proportions probably apply for other industrially important, geochemically scarce metals." [20]

This ineffective recycling process has obvious environmental consequences as well as political implications. Mining operations for these metals are environmentally invasive as well as expensive and the geopolitics surrounding international metal and mineral trade can become complicated and explosive politically. Recycling electronics has definite advantages over mining raw materials in terms of cost savings and accessibility.

> "One metric tonne of circuit boards can contain up to 40 to 800 times the amount of gold and 30 to 40 times the amount of copper mined from one metric tonne of ore in the US."[21]

Precious metals are now extracted worldwide, and the extraction of these metals is being paid for in increased environmental destruction and rising prices.[22] Studies have shown that hundreds of millions of dollars are lost in obsolete electronics equipment (e.g. cell phones) due to the metals not being recovered and re-used.[23]

The increasingly shrinking lifespan of electronics has a major impact on proper waste disposal strategies. The Office of Consumer Affairs at Industry Canada has also

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[19] R. Gordon, M. Bertram and T. E. Graedel, "Metal Stocks and Sustainability," *PNAS* 103, no. 5 (2006), 1213.
[20] Ibid,1210.
[21] US Environmental Protection Agency. "Frequent Questions." *EPA*, 2012. http://www.epa.gov/osw/conserve/materials/ecycling/faq.htm (accessed 25/08, 2013).
[22] McLendon, 2011.
[23] D. Sullivan. "Recycled Cell Phones—A Treasure Trove of Valuable Metals." *U.S. Department of the Interior; U.S. Geological Survey* (2006) 1-4.

recognized this significant issue. Studies have found that the average lifespan of a cell phone in Canada is about 18 months.[24]

Figure 5: Replacement Rate of Consumer Electronics

Consumer Electronic Category	Replacement Rate
Cellphones	18-22 months
Desktop Computers	2 years
Television	10+ years
DVD Player	4-5 years
Printer	5+ years

Source: Wellhome Energy Audits, 2011.[25]

Although cell phones and similar consumer electronics realize high turnovers, "the cellular phone's potential for sustainable disposal is significant, as approximately 96% of its weight is recyclable."[26] Once a consumer is finished with their electronic products, there are three possible places for e-waste to end up: (1) storage, (2) direct disposal to landfills, and (3) recycling. A lack of consumer knowledge and a lack of adequate disposal facilities results in large amounts of e-waste being disposed of into regular waste facilities, such as landfills, which are not equipped to handle the hazardous components of electronics. Unfortunately, only a small share of total e-waste is actually recycled.[27] Storage and disposal of end-of-life electronics is driven by the rapid market penetration and subsequent sales of new electronics.[28] Over the past decade, it has been discovered that a significant amount of end-of-life electronics collected in the developed world actually end up being exported to developing countries

[24] Office of Consumer Affairs. "Consumer Trends." *Industry Canada*, 2012. http://www.ic.gc.ca/eic/site/oca-bc.nsf/eng/ca02267.html (accessed 25/08, 2013).
[25] Wellhome Energy Audits. "Electronic Waste, where does it all end up?" *Treehugger Infographic* (2011). Web. http://www.treehugger.com/clean-technology/crazy-e-waste-statistics- explored-in-infographic.html (accessed 02/09 2013)
[26] Office of Consumer Affairs, 2012.
[27] R. Widmer et al., "Global Perspectives on E-Waste," *Environmental Impact Assessment Review* 25 (2005), 436–458.
[28] US Environmental Protection Agency, 2011.

(China, India, Pakistan, Africa), where a market has developed to crudely recycle these materials for the most valuable components in them. This exchange often comes at a huge environmental and human cost, especially in the developing world.[29] Although international law has made this practice is illegal, it is still widespread. This pervasive practice is the result of a lack of a market and subsequent economic incentives in industrialized society to recycle e-waste and bring precious and rare metals back into re-use and circulation. Producers also lack incentive to re-design their products with fewer hazardous substances.

Waste electronics are dangerous once they enter a landfill because of the heavy metals and other toxic chemicals. There are thousands of different materials present in consumer electronic products; many of them are toxic to humans and the surrounding environment and many are known carcinogens and endocrine disruptors that accumulate in human blood and tissue. If not properly dismantled, end-of-life electronics can release toxic substances that disperse and accumulate in soil, water and air and therefore have a significant impact on our health and the well-being of the environment.[30] When e-waste is disposed of improperly in municipal landfills that are designed only to handle household waste, problems of leaching and degrading of the toxic components in these electronics become dangerous. For example, one intensive study found that about 70% of the heavy metal present in US landfills was due to e-waste.[31]

The presence of valuable materials in old electronics has made them attractive for unofficial recycling activity in countries like China, India, Africa and Pakistan.[32] Scavengers in developing countries dismantle electronics in hopes of recovering valuable materials that can be re-sold for a small profit. Evidence suggests that most electronics disposed of or 'recycled', in North America and Europe especially, end up in

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[29] A. Sepúlveda et al., "A Review of the Environmental Fate and Effects of Hazardous Substances Released from Electrical and Electronic Equipments during Recycling: Examples from China and India." *Environmental Impact Assessment Review* 30 (2010), 28-41.
[30] Ibid.
[31] Widmer et al., 2005.
[32] Puckett et al., 2002.

Asia or Africa. A large amount of electronics, including mobile phones, televisions, computers and printers are manually broken down in informal recycling plants where human safety and environmental pollution are not considered. The incentive in developing countries for most of this rudimentary recycling is to gather small amounts of gold, palladium, platinum, silver and copper, which are components found in most electronics. However, the presence of hazardous chemicals and metals present enormous risks for the health of the workers and scavengers (many of whom are children) as well as for the surrounding environment.[33]

There are three stages in the electronic recycling process. The first is the manual disassembly of various components, second is upgrading in which mechanical processes are used to further separate components and the third is refining in which metals are melted or dissolved in acid baths, known as metallurgical processing.[34] If done properly, recycling can be quite safe and productive because it allows metals to become regenerated and reintroduced into the materials cycle. In actuality, the conditions in some developing countries where most of this recycling takes place lack imposed regulatory standards or adherence to environmental stewardship measures. In these countries, open flames are often used to incinerate electronics that create numerous toxic fumes and produce dioxins in particular.[35] Studies have found a causal relationship between emission levels from informal e-waste recycling and the subsequent pollution.[36] The substances in these emissions have a pervasive and lasting effect on entire surrounding ecosystems, including drinking water, air and soil quality. The reason for this is that noxious chemicals and materials inevitably leach into soil and groundwater sources; as well there is harmful particulate matter build up in the air and in wastewater disposal. When electronics are not dismantled with proper care, dust particles and other toxic materials are released into the surrounding environment.

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[33] Ibid.
[34] O. Tsydenova and M. Bengtsson, "Chemical Hazards Associated with Treatment of Waste Electrical and Electronic Equipment," *Waste Management* 31 (2010), 45-58.
[35] Puckett et al., 2002.
[36] Sepúlveda et al., 2010.

The city of Guiyu, China is often used as an example of the severity of the implications of informal e-waste recycling. China has banned the import of electronic waste and is also party to the Basel convention, but the problem is still pervasive and deleterious environmental and health issues have resulted from decades of toxic waste build-up. Watchdog agencies have mapped waste from the developed world to Guiyu, and have concluded that Canadian e-waste has also been exported to this e-waste hub.[37] Guiyu has been informally processing e-waste for decades and the result has been devastating, particularly on their potable water source which has been destroyed due to the toxins.[38] Although the connection to Canada is indirect, the severity of the problem in Guiyu is a result of a continuously expanding waste market, which has emerged between developed and developing countries. Canadian legislation should therefore be effective in controlling the safe production, distribution and end-of-life disposal or recycling of electronics.

Market forces and consumer ignorance, as well as lack of policies, have significant implications in Canada and abroad. These implications re-enforce the case for stronger, more streamlined domestic policies and regulation regarding the safe control and management of end-of-life electronics. Recognizing that there is an exponential increase in the rate of electronics being consumed and disposed of in both the developed and developing world, it will be increasingly important to implement comprehensive solutions. Investment by producers and strategic initiatives by local governments will need to focus on educating consumers, training skilled workers and providing facilities to properly handle these harmful, yet valuable, wastes.

"Every year, the world tosses 20 to 50 million metric tons of electronics, recycling only 10% to 18%.

That's like throwing away 45,500 to 125,000 fully loaded 747s annually"

(WellHome Energy Audits, 2011)

[37] Puckett et al., 2002.

[38] I. Nnoron and O. Osibanjo, "Overview of Electronic Waste (E-Waste) Management Practices and Legislations and their Poor Applications in the Developing Countries," *Resources, Conservation and Recycling* 52 (2008), 843-858.

Governments in both the developed and developing world should recognize the importance of the geopolitics surrounding mining rights (mineral and metal) and the positive impact that recovering and re-using these metals could have on the environment and the economy.

The appropriate and rational management of e-waste is a pressing challenge facing global policy makers today and it represents a major environmental and economic problem requiring an immediate solution. Clearly, our future is enmeshed with technology and electronics and policy needs to be implemented to reflect this reality and its effective management. Both international and national coordination and action are needed. Producers, regulatory agencies and government need to collaborate and enact positive policy changes throughout the entire life cycle of electronic development, use, re-use and disposal.

International Initiatives

The international community has come together in an attempt to mitigate damaging export and trade of end-of-life electronics and e-waste from developed to developing countries through the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal. The Basel Convention was established in 1989 in order to harmonize the goal of signatory nations to end the harmful and unethical export of electronic waste from developed to developing countries. To date, 180 parties have signed and ratified the convention, with the exception of the US, which has not ratified.[39] The treaty is legally binding only to countries that have adopted it. Canada signed and ratified the treaty in 1992 and therefore has an international, legal obligation to manage its trans-boundary export of hazardous waste. A significant amendment, "to prohibit immediately all trans-boundary movements of hazardous wastes which are destined for the final disposal from OECD to

[39] Basel Action Network. "About the Basel Ban". *BAN* (2011) http://ban.org/about_basel_ban/copsII_12.html (accessed 03/08, 2013).

non-OECD States," was passed in 1994.[40] This amendment was proposed and accepted in an attempt to rectify a recognized situation; namely, that developing countries were not demonstrating the legal capacity to deter e-waste imports. While Canada did not support this amendment, it was nevertheless outvoted and remains legally required to abide by the amendment.[41] Developed countries have access to the expertise and funds to take on a leadership role in terms of developing strategies to mitigate the damage associated with the improper disposal of electronics. Although the international community has taken action, Canada must also take unilateral action at the domestic level regarding how waste is managed.

Applicable Law in Canada

The existence of the Basel Convention should give Canada ample incentive to manage its hazardous waste domestically so as not to defy the Basel Convention and face the possibility of trade sanctions and a negative image in the international community. However, there is currently no binding applicable federal law, policy or framework in Canada that deals directly with e-waste recycling. The only federal law governing Canada in relation to e-waste is under the Canadian Environmental Protection Act (CEPA). Division 8, Part 7 of the Act outlines the 'Control of Movement of Hazardous Recyclable Material and of Prescribed Non-Hazardous Waste for Final Disposal.' This legislation has been effective in diminishing the illegal export of hazardous materials, such as end-of-life electronics, however standardized legislation and policies are lacking in the area of proper waste management. Although there has been a concerted effort through legislation to stop the export of hazardous waste, there hasn't been a unified and binding strategy across all provinces and territories to deal with the waste domestically. The Canadian constitution regulates the alignment of responsibility over waste management between the federal government and the provinces. Whereas the federal government has jurisdiction over controlling the illegal export of waste, the

[40] Ibid.
[41] Basel Action Network. "What is the Basel Ban? " BAN (2011). http://ban.org/about_basel_ban/what_is_basel_ban.html (accessed 03/08, 2013).

responsibility for managing landfill use and facilitating recycling lies with the provinces. As each province and jurisdiction differs in its capability to facilitate adequate disposal of wastes, different strategies and policies have emerged across Canada. This results in a gap between legislation and policy in Canada regarding e-waste management. The Canadian constitution allows federal action to be taken in the realm of waste management, especially e-waste management, due to the ease by which materials are transported over provincial borders. The environmental impacts of e-waste cannot be contained within one province and therefore it should not be the sole responsibility of the province to effectively manage the waste. Federal intervention is needed to ensure that all provinces are adequately equipped to deal with the waste.

Currently, there are two major initiatives in Canada to target domestic e-waste management, the Canadian Council for Ministers of the Environment (CCME) and Electronics Product Stewardship Canada (EPSC). The CCME seeks to develop nation-wide strategies, which are easily followed by provincial ministries of environment. The fact that the federal and provincial governments share jurisdiction over the environment provides sufficient grounds for the CCME to work towards a common national goal of environmental sustainability. In terms of e-waste management, the CCME has implemented a strategy, "Canada Wide Principles for Electronic Product Stewardship." These twelve principles encourage producer responsibility in managing end of life electronics as well as consistency in policies and regulations throughout the provinces and industries (Appendix 1).

Electronics Product Stewardship Canada (EPSC) is a non-profit, industry led organization, "created to design, promote and implement sustainable solutions for recycling of end-of-life electronics."[42] It has established and provides oversight to product stewardship programs in British Columbia, Nova Scotia, Prince Edward Island, Ontario, Saskatchewan, Manitoba and Quebec. The EPSC seeks to provide a, "flexible, effective and efficient Canadian solution," to e-waste management by working closely

[42] Electronics Product Stewardship Canada. *EPSC* (2013). http://www.epsc.ca/ (accessed (03/10 2013).

with industry and government through providing guidelines and audits.[43] Although there is no legislation that empowers EPSC to impose sanctions and create rules, the organization has established guiding principles that it uses to focus its initiatives. These principles include: establishing a level playing field across the nation; harmonizing with other electronic stewardship programs to establish economies of scale as well as operational efficiencies through focusing on specialization; developing appropriate standards applicable to all recyclers, monitored through audits; and a common goal of environmental improvement.[44] EPSC has also established four conditions for succeeding in national electronic product stewardship. These conditions include: 1) non-prescriptive regulation to allow for greater flexibility in interpreting and enacting provincial strategies; 2) industry led and phased approach, in terms of which electronics are accepted; 3) leveraging existing infrastructure to save costs on development and construction; and 4) funding flexibility, where industry is able to determine funding for various products.[45] EPSC is affiliated with the Electronic Products Recycling Association (EPRA) in Canada, a "national non-profit entity entrusted with improving the efficiency and effectiveness of Canada's industry-led and regulated electronics stewardship programs."[46]

Operating under the EPRA is the Recycler Qualification Office (RQO), which designates and certifies recycling facilities across Canada.

> "The RQO was established by the industry-led end-of-life electronics stewardship programs to ensure that environmentally sound electronics reuse and recycling standards are established, met, maintained and continually improved on."[47]

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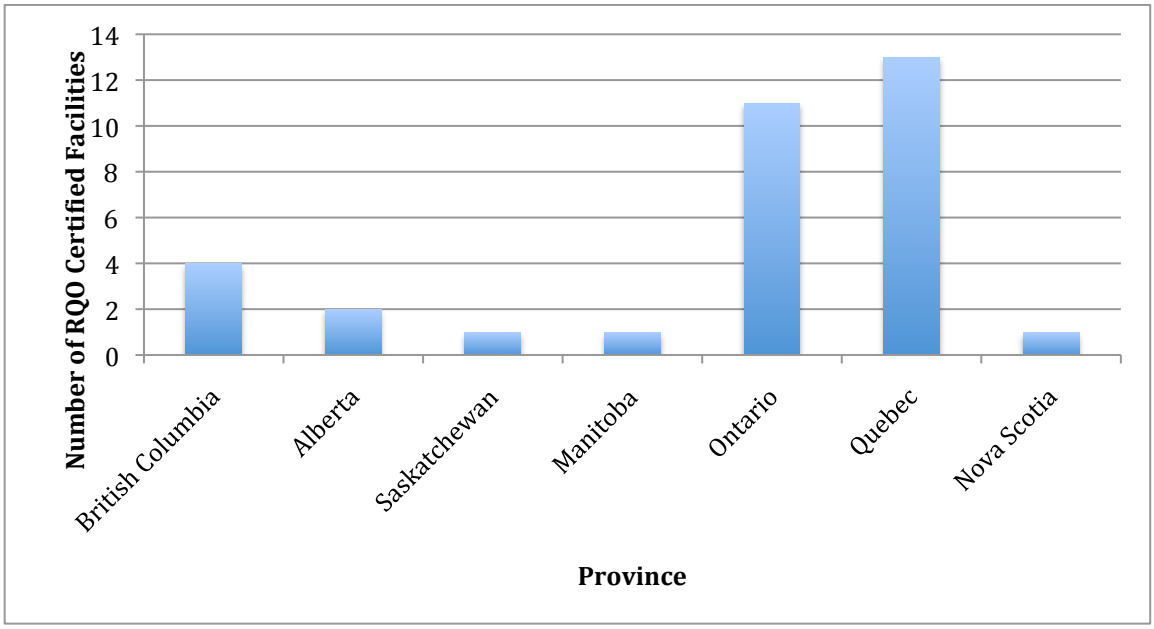
[43] Ibid
[44] Ibid.
[45] Ibid.
[46] Electronic Products Recycling Association. *EPRA* (2013). http://www.recyclemyelectronics.ca/ (accessed 25/08 2013).
[47] Recycler Qualification Office. *EPRA* (2013). http://www.recyclemyelectronics.ca/ (accessed 25/08 2013)

The RQO assesses recyclers and collection sites and has verified recyclers across Canada. It should be noted that some provinces, namely Ontario and Quebec, are very heavily equipped with certified recyclers and facilities while others do not have any. Figure 6 outlines the RQO verified recyclers in Canada.

Figure 6: Distribution of Certified Electronic Recyclers in Canada



Source: Data from EPRA, 2013.[48]

Appendix 2 summarizes the most current information in provincial e-waste initiatives across Canada. Canada's e-waste management policies are currently primarily devised and initiated by industry and NGO partnerships. However, in an effort to minimize the environmental impact of the waste produced by end-of-life electronics, some provinces have enacted legislation and strategies to manage the problem. Of note is that these policies are not uniform across Canada, with some provinces doing more than others and some doing nothing at all. This could be attributed to differences in priorities across provinces, as well as different capabilities, infrastructure and financing available in different provinces. As emphasized above, provinces vary in their access to

[48] Electronic Products Recycling Association. *EPRA* (2013). http://www.recyclemyelectronics.ca/ (accessed 25/08 2013).

qualified recyclers and facilities. Significantly, none of the territories or smaller provinces have e-waste recycling infrastructure set up and have little or no regulations. For all provinces that have an e-waste initiative, as well as some that don't, EPSC provides a general framework as well as oversees and controls the auditing system, thereby attempting to unify the provincial strategies. Although the EPSC can influence recycling through the RQO's power to certify recyclers, the EPSC cannot force provinces with no strategy or legislation to enact one. As will be discussed in the next section, a stronger federal backing of EPSC's initiatives would help provide provinces and producers with a more solidified and streamlined framework to abide by and to contribute to more effective e-waste management policies.

Best Practices: What can Canada Learn?

Europe has emerged as a worldwide leader in waste management, which has become increasingly necessary due to declining availability of landfill space. The European Union has been has been particularly successful in its management strategies for end-of-life electronics. All countries in the EU are party to the Basel Convention. By abiding to the Basel Convention as well as encouraging extended producer responsibility and cleaner product design, EU member states have been able to target the problem from the top-down through managing waste produced and monitoring the illegal export of hazardous wastes. Following the European example would be beneficial for Canada because of the influence that European standards have over producers worldwide.[49] The European Parliament has identified why a more streamlined, national approach to e-waste regulation is more effective than multi-jurisdictional action. Studies conducted on EU policies have identified a main concern with a non-unified approach being the potential negative influences non-standardization could have on the Internal Market. Three Internal Market concerns identified by the European Parliament and the European Council include:

[49] Boon, 2005.

1) "Different national applications of the principle of producer responsibility might lead to substantial disparities of financial burden for the economic operators.
2) Different national policies on the management of end-of-life electrical and electronic equipment could hamper the effectiveness of national recycling policies, as trans-boundary movement of WEEE to cheaper waste management systems could occur.
3) Diverging requirements on the phasing-out of specific substances could have implications on trade in electrical and electronic equipment."[50]

The EU is similar to Canada in that it resembles a federalist system, where the division of power for certain issues is somewhat unclear, especially in terms of environmental issues that are often not confined to a single jurisdiction. However, to date Canada has not taken action on e-waste management quite as effectively as has Europe. The initiatives outlined below demonstrate Europe's leadership and innovation in effectively handling the e-waste problem.

"Though discrepancies will inevitably persist, the WEEE and RoHS Directives are bringing Member States closer to being on the same page." (Boon 2005, 26)

Two initiatives have been established within the European Union in an effort to manage e-waste. The Waste Electronic and Electrical Equipment Directive (WEEE) and the Restrictions of Hazardous Substances in Electrical and Electronic Equipment Directive (RoHS). While both the WEEE Directive and the RoHS directive aim to reduce the impact of electronic waste on the environment through unified involvement across the European Union, they each take a different avenue of action. The WEEE Directive has been primarily identified to be about 'waste management' for environmental protection and deals with downstream impacts of e-waste, such as encouraging re-use and recycling, whereas the RoHS directive is based more on trade and the internal market for electronics. It deals with the upstream market, dictating to producers which components and chemicals they are able to use in electronics.[51]

[50] Ibid, 8.
[51] Ongondo et al., *2011*.

The EU established the WEEE directive in 2003 to mandate manufacturers and electronic importers to establish "take back regimes" for their products. EU Member states have subsequently been required to apply the directive to their own legislations. The responsibility mainly falls to producers, manufacturers and importers who are required to ensure that their electronics have been adequately labelled with a WEEE label. This label is the mechanism by which consumers and recyclers are able to recognize those materials that should and should not be disposed of in regular landfills. In addition, the WEEE directive stipulates that consumers must be able to return their WEEE labelled electronics to easily accessible "take-back locations" without a charge, a key contributor to the success of the program.[52] WEEE is not a "one-size-fits-all" initiative. The directive recognizes that different products require different treatment and has divided applicable electronics into eleven categories (e.g. laptops vs. refrigerators), each with different recycling rate targets.[53] The WEEE directive stipulates that member states must collect a certain percentage of per-capita household electronic waste per annum. A target that will become binding in 2016, has been set at, "65% of the average weight of products placed on the market in the two preceding years."[54] WEEE makes individual producers responsible for the whole lifecycle of their products, thereby incentivizing them to invest in product re-design for more easily recyclable and less environmentally toxic products. The directive focuses on disposing end-of-life electronics in an environmentally sound manner and it encourages this environmental stewardship through requiring manufacturers to take initiative on "take back" schemes.[55]

The Restriction of the use of Hazardous Substances (RoHS) directive, established in 2002 places restrictions on producers and manufacturers of electronic equipment in terms of the levels of certain components in new materials. For example, producers cannot release new electrical equipment into the European market if it contains, "more

[52] McKerlie et al. 2006, 616.
[53] A. Atasu and L. Wassenhove, "An Operations Perspective on Product Take-Back Legislation for E-Waste: Theory, Practice, and Research Needs," *Production and Operations Management* 21, no. 3 (2012), 407.
[54] Ongondo et al. 2011, 717.
[55] McKerlie et al 2006, 616.

than the agreed levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants."[56] While the WEEE directive works more towards influencing producers' and manufactures' product design through placing strict restrictions on the end-of-life management of electronics, the RoHS initiative directly targets upstream product design to reduce waste.

Although the directives have faced obstacles in terms of implementation, together, the WEEE and RoHS directives have managed to use market-based strategies as well as regulatory standards to target both upstream and downstream areas of the electronic equipment market and to diminish the amount of waste produced and deal with existing waste in an environmentally sound manner. The fact that the European Union has required all of its member states to implement the same legislation in regards to WEEE and RoHS is significant in that it has allowed for a more unified stance across the member states regarding the process by which end-of-life electronics are managed. The European example is recognized as a standard to follow because of its success in standardizing policies and reducing the amount of waste deposited in landfills.

Canada would be prudent to follow in the steps of the EU and tailor similar policies to target e-waste management. Although Canada has significantly more land that it can put aside for landfills, the economic and environmental impacts of neglecting to properly design and recycle electronics are too important to ignore. Waste management remains a lingering issue, worldwide. The similarities between Canada's federalist system and the way in which the EU has organized its environmental policies, especially the WEEE and RoHS directives, provides a template for similar policy development in Canada.

Justification for Federal Action and General Approaches

Canada has a number of different legislations and policies to deal with e-waste management at the provincial level. Some provinces have excelled in creating a viable

[56] Ongondo, et al. 2011, 716.

waste management and product stewardship framework that can be replicated nationally. For example, through its electronics-recycling program, which began in 2004, Alberta Recycling has recycled over five million units of computer and television equipment. "This includes more than 1.5 million computers, 940,000 printers, 1.4 million monitors and 1.1 million TVs that have been diverted from landfills."[57] Encorp in British Columbia has also been recognized for its success through its *Encorp Pacific Beverage Container Stewardship Program*. Encorp is a not-for-profit organization recognized by the federal government for its efforts in encouraging product stewardship.[58] The plan was established in 2007 and was given power through British Columbia's Recycling Regulation, under the Environmental Management Act. The program uses "Return-it" locations, which are specified "take-back locations" where consumers are reimbursed for returning their empty beverage containers. This plan has made product stewardship the norm in the British Columbia beverage industry. Encorp has translated this take-back strategy into electronics recycling. It has power through British Columbia's Recycling Regulation to identify "obligated producers" as well as to give certain recyclers and firms the power to recycle electronics in BC. Recyclers must pass an environmental audit by Encorp, after which they are designated "primary recyclers."[59]

Although Alberta and BC provide some examples of the effectiveness of provincial strategies, the fact that e-waste has multi-jurisdictional environmental implications underscores the necessity of federal action. Furthermore, the varying levels of responsibility in provincial recycling schemes, in terms of who has the power to designate and certify recyclers and collection facilities, is not necessarily as timely or cost effective as it could be. As emphasized earlier, the widespread negative environmental impacts associated with improperly disposing electronics cannot be

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[57] Alberta Recycling Management Authority. "Electronics Recycling Program." *Alberta Recycling*, (2013). http://www.albertarecycling.ca/electronics-recycling-program (accessed 20/08 2013)

[58] Encorp Return-It "What is Encorp?" *Encorp (*2013). Web. http://www.return-it.ca/about/ (accessed 20/08 2013)

[59] Encorp Return-It. "The Electronics Recycling Process." Encorp (2013). http://www.return-it.ca/electronics/recycling/productrecycling/ (accessed 20/08 2013)

confined to a single jurisdiction, thus justifying federal action. It is also difficult to establish the benefactors of the economic profits associated with recovering and reusing the valuable components because of the vast distribution of consumer electronics across Canada. A federal presence in strategy formation and policy implementation can also be justified by the potential increased cost savings faced by suppliers and producers, as well as consumers hoping to recycle their electronics. It is easier and likely more cost effective for suppliers and producers to deal with a single regulatory body at the national level than to deal with the bureaucratic process and different regulations across provinces and jurisdictions. A federal approach to e-waste management would also be more aligned with Canada's current federal regulations against the export of hazardous wastes.

Moving away from the multi-government regulations towards a streamlined national approach has the potential to increase Canada's contribution towards resolving the worldwide e-waste problem. Furthermore, a national strategy would be easier for international investors to follow, instead of having to abide by different policies in different provinces. Recyclable electronics are often traded between Canada and the US, along with other countries, depending on different recycling capabilities and specializations. This trade would be much easier to facilitate if it were completely regulated at the national level. In a similar study of US policies on e-waste, the authors concluded that there are both pros and cons to jurisdictional e-waste regulations.

> "It is good that these laws respond to a real problem, and some action is better than none. Also, with each new state that takes notice, a critical mass is developing that will influence federal legislators to take action. A primary reason that federal legislators will be influenced by state action is because of the downsides of state action: it creates patchwork policies. The incoherence can be difficult to navigate from a business perspective, and it creates burdensome compliance costs which are passed on to consumers."[60]

[60] Boon 2005.

Following the lead of the EU, Canada should take steps to develop national policies that relate to both the economic and materials cycle of the components found in electronics as well as the environmental and downstream impacts these products have once they reach the end of their productive lives. It should be noted that the EU WEEE and RoHS Directives are not 'regulations' and therefore provide more flexibility to the member states, and perhaps some unnecessary overlap or inefficiencies.[61] In developing its own national policies, Canada should be aware that flexibility is important, but also that the purpose of a national policy is to harmonize the actions of the provinces so as to produce the most effective and efficient result, in this case, the environmentally sound management of end-of-life consumer electronics. Although waste management should be a major focus of policies and regulations in the Canadian system, policies should be focused on encouraging producer stewardship with the directive to reduce downstream waste. Policy makers should also keep in mind that enforcement of regulations and standards requires standardization across provinces as well. Enforcement needs to be uniformly applied in order to encourage national compliance and cooperation. This will also enable industry and producers to operate more easily and effectively within whichever jurisdiction they choose, as operating rules and regulations as well as product standards will be uniform.

A combination of market-based initiatives and government regulation would attempt to provide an adequate solution to the dilemma faced by electronic producers and consumers when it comes to product design and safe disposal. However, as the role played by industry in creating an effective solution to e-waste management is significant, it is important to indentify the extent to which producers and industry remain involved in product lifecycles.

"Effective change results when it is within the interests of the stakeholders to do so. It is within the interests of governments, and above all, industry, to move toward a more uniform e-waste policy." (Boon 2005, 20)

[61] Ibid.

Government will need to encourage industry to take an active and leading role in mitigating e-waste and educating consumers. Producer Stewardship and Extended Producer Responsibility are two terms used by policy makers to establish directives on waste management, in particular e-waste management. Although both policies are similar in the sense that they seek to ensure that producers remain somewhat responsible for the lifecycle and subsequent impacts of their products, the concepts differ in their approach. Extended Producer Responsibility (EPR) holds "producers physically and financially responsible for the environmental impact of their products after the end-of-life."[62] The concept of EPR attempts to encourage or incentivize producers to diminish downstream waste by investing in greener product design and manufacture. On the other hand, Product Stewardship is "an environmental management strategy that means whoever designs, produces, sells, or uses a product takes responsibility for minimizing the products environmental impact through all stages of the products lifecycle."[63] Although producer stewardship attempts to divide responsibility throughout the product lifecycle, critics argue that it is more inefficient than EPR because it can lead to ambiguity and confusion between manufacturers, producers, consumers and those who manage disposal. The fact that responsibility is shared limits the financial burden and therefore provides incentive for a single actor or producer to ensure that products are produced efficiently and disposed of effectively.[64]

Both strategies seek to make producers and manufacturers more accountable for the environmental impact of their products. These strategies both modify the behaviour of producers and various stakeholders and therefore must be implemented carefully so as to change behaviour in an environmentally positive and economically efficient manner. There are two possible ways that producer stewardship and responsibility ensure the collection of e-waste. Producers and manufacturers can either collectively gather or recycle products, or producers can individually collect their own

[62] Atasu and Wassenhove, 2012, 410.
[63] S. Nicol and S. Thompson. "Policy Options to Reduce Consumer Waste to Zero: Comparing Product Stewardship and Extended Producer Responsibility for Refrigerator Waste." *Waste Management and Research* 25 (2007), 230.
[64] Ibid, 227.

products and recycle them. Collectively gathering products may be more economically efficient in the end, however it may reduce the individual responsibility felt by producers and therefore not provide adequate incentive for producers to invest in greener technologies and product design. However, although individual collection and product management would incentivize individual producers to invest time and finances into green product design, the strategy is somewhat inefficient in that it does not allow for the development of economies of scale.[65] In either case, government regulation is required to ensure that producers remain responsible for their products to some degree.[66]

Policy Recommendations

Product stewardship programs place the burden on the producer to establish collection facilities and infrastructure. Consumers therefore pay higher prices for products to reflect this investment. The main role for the government is to ensure that all producers are held responsible to an equal degree through setting standards.[67] As outlined above, industry in Canada has taken a leadership role in some provinces to establish collection facilities for waste management. However, the fact that this has not happened nation-wide highlights a gap in Canadian legislation that would require industry and producers operating in all provinces to prevent and safely manage e-waste sources. Currently, the major driver for overseeing a national presence in providing an e-waste management framework is that of the EPSC and CCME, both of which are voluntary. Most provinces in Canada have some sort of strategy to deal with e-waste and encourage product stewardship, however there is not yet a functional national regulatory process and therefore some provinces can be classified as 'free-riding' on the positive externalities created by the recycling done in other jurisdictions.

Canadian waste management policies should focus on the economic and environmental incentives associated with controlling and managing electronic product

[65] Atasu and Wassenhove 2012.
[66] Nicol and Thompson 2010.
[67] Ibid 2010, 227.

consumption and disposal. This could be attained through policies directed at increasing producer responsibility and stewardship as well as through standardized regulations that govern downstream waste management within provinces. The European example of the WEEE and RoHS directives provides a good framework that Canadian policymakers can imitate and tailor for the Canadian system. Identifying key policy priorities and analysing the incentive structure and tools needed to achieve results is an important first step. Furthermore, a logical step would be strengthening the role of EPSC and its established conditions of non-prescriptive regulation which embody the concepts of an industry-led, phased approach, a leveraging of existing infrastructure and flexible funding mechanisms. National industry standards are perhaps the most obvious policy tool to encourage producers to take initiative in e-waste management. Nationwide industry standards regarding acceptable product components are already fairly homogeneous across Canada, however they could be improved and re-directed to more specifically target the electronics industry. Policy tools mandating producers to comply with accepted industry standards, such as labelling their products with a recycling logos and having established easily accessible "take back locations" would be very effective and would be in keeping with current WEE directives. These strategies are essential components in effecting an "Extended Producer Responsibility", and if employed would encourage Canadian electronics producers and manufacturers as well as importers and exporters of electronics to take control over entire product lifecycles – thereby giving industry a vested interest in the life time impacts of their goods. In order to encourage industry to take a leadership role and to facilitate EPR, a Canada-wide tax on new electronics would be advisable. Currently, across the provincial spectrum there are many differing taxation policies regulating electronic recycling programs. Not only would a standardized tax system be easier to administer and monitor, and it would be more attractive for industry to abide by. An emphasis on consumer education and awareness is perhaps one of the most important factors in mitigating the harmful effects of e-waste and it would engender greater public understanding of the severity of the e-waste problem both in Canada and

abroad. Priority should be give by both government and other stakeholders to educate consumers and encourage them to take more responsibility in the handling and disposing of end-of-life electronics.

The EPSC should play a significant role in policy development around e-waste management and in encouraging producer and industry responsibility. It has already made progress through developing four prescriptions for effective waste management that identify non prescriptive regulation, an industry led approach, leveraging existing infrastructure and flexible funding as the key elements in an effective national waste management program.

Non-prescriptive regulation

Non-prescriptive regulation implies minimal government involvement. Although it is important that government is involved in establishing industry standards and in facilitating waste collection at the municipal level, regulations should not be so stringent as to deter innovation and efficient business practices in industry. Instead, government regulation could focus on strengthening the role of EPSC in terms of its ability to audit and monitor industry, as well as regulate upstream production so as to avoid unnecessary downstream waste. In this case, a viable solution for Canada would be to adopt more of a watchdog presence regarding production and manufacturing. This would be in line with the RoHS directive, whereby producers are regulated with respect to their "input" into the manufacturing process. By implementing a fee or tax on inputs at the upper level, downstream waste would be reduced and producers would have incentive to re-design products. Industry should also be encouraged at the downstream level to establish "take-back facilities" for end-of-life products, such as is already an accepted practice in the recyclable bottle industry. A harmonized and national approach would reduce the free-rider effect because industry and provincial involvement would be necessary. Implementing standards and regulations upstream would force producers to become product stewards and to invest in greener technologies. It would not be prescriptive in the sense that producers would still be able to manufacture their goods in Canada, or import them, although with some

standards overseeing the components and materials used in production. In addition to setting standards, it would be important for the federal government to assist producers in setting up "take-back facilities" as well as use fees collected from manufacturers to fund recycling facilities to invest in the additional infrastructure needed to process e-waste. As outlined above, a government initiated standardized tax on new electronics would be a helpful policy tool to encourage producers to develop take-back facilities and educate consumers.

Industry led, phased approach

An industry led approach would allow policy makers to determine the most effective and efficient waste management strategies through input and conversation with industry actors and experts. Engaging industry would ensure that the influential players were on board with any type of waste management framework. As industry arguably makes up a larger proportion of stakeholders that would be affected by e-waste regulations, it is important that producers and manufacturers are consulted throughout the process and that their input is given deserved attention. Due to the sheer amount of consumer electronic products currently on the market, a phased approach would be necessary for recycling infrastructure to develop, as well as for industry to have time to accommodate design changes and recycling labels as suggested in the WEEE directive. Policy makers could set deadlines for a phased approach, outlining when and how industry should comply with new regulations and rules.

Leverage existing infrastructure

Leveraging existing infrastructure is perhaps the most important initiative in the beginning stages of developing e-waste management policies. Using existing collection sites as well as modifying recycling infrastructure to accommodate for e-waste components would be an important time and cost saver. Furthermore, it could lead to specialization in recycling, where some provinces or jurisdictions with specialized infrastructure would be able to accept specific types of waste. Industry would be

encouraged to specialize and this could have the possibility of creating economies of scale in e-waste recycling.

Collecting e-waste at the municipal level and then sorting it to different destinations, depending on its recycling characteristics, could be an effective way to manage collection. By mimicking the WEEE directive in separating products into different categories, different products could be collected and sorted at the municipal level and sent to appropriate jurisdictions depending on their characteristics for recycling. In many instances collection facilities and infrastructure already exist at the municipal level and therefore additional infrastructure would not need to be built. A portion of federally set fees charged to producers for manufacturing, importing and selling electronics in Canada would be diverted to fund these municipal collection facilities. The fees charged to producers would likely be passed on to consumers, however if production standards were also set, producers would still be motivated to invest in green design. Disparities across Canada regarding the number of certified recyclers presently operating, the types of e-waste they will accept and fees charged should all be equalized to some degree. A critical step in developing a national strategy is obviously to accurately assess current existing provincial capabilities in terms of available infrastructure and expertise.

An alternative option would be to mimic the bottle-deposit return model that many provinces already have. Electronic producers have to some extent already accomplished this by way of a fee charged to consumers at point of purchase. However, this process could be further improved by reimbursing consumers for returning e-waste after use, much like the model used in the bottle return industry. If instead of charging consumers a recycling fee at the end of use phase of product consumption, a process whereby consumers were reimbursed a small portion of the original purchase price, then there would be built in incentive to recycle. This would encourage the return of electronics to legitimate recycling stations and this would impede the selling of e-waste to illegitimate exporters. The reimbursement of consumers, together with nation wide easily accessible and publically designated drop off locations would encourage and

support consumers in complying with an effective and environmentally responsible process for disposing of end of life electronic products. .

Funding flexibility – Industry determined funding

Recycling e-waste is an expensive endeavour, which at present, is mainly funded through fees charged to consumers at purchase or through fees charged to consumers when they drop off e-waste to existing recyclers. Industry, namely electronics producers and recyclers, will inherently be aware and knowledgeable about the actual costs of recycling and as a result they are well positioned to advise regarding how these costs should best be implemented. The EPSC and government should act as facilitators to aid industry in setting appropriate fees and establishing payment mechanisms. These fees will need to be standardized across Canada to ensure fairness to both producers and consumers. A transparent tax/fee system will obviously require cooperation between industry and policy makers.

Conclusion

Through establishing a comprehensive federal framework on e-waste management and producer responsibility, Canada will be able to make strides in ameliorating its environmental footprint with regards to e-waste pollution. A strengthened federal framework encouraging domestic recycling and waste management will also support established initiatives from the CEPA and the Basel Convention to help mitigate the illegal and highly unethical export of e-waste and other hazardous waste to non-OECD countries. Many provinces have recognized the importance of electronic waste management and have implemented sustainable and viable solutions to the problem. However, the fact that not all provinces have standards and regulations has led to mismatched policies at the national level and the possible emergence of free riders.

To confront this problem, a national strategy that manages Canadian e-waste disposal and recycling should be implemented. Stringent federal regulations regarding

product design and extended producer responsibility are essential to this process. The EPSC has provided a viable framework upon which a national strategy may be built and this is important as the framework explicitly entails a close working relationship with industry. It is essential that industry be recognised as a major player in the recycling process. Federally imposed and monitored fees and standards, that are homogeneous across Canada, would enable industry to operate more effectively and efficiently. This, in turn, would encourage industry to be more responsible for the environmental impacts of their products. A combination of upstream and downstream targets of acceptable components in electronics, as well as acceptable levels of downstream end-of-life waste, would be an effective solution to the problem of e-waste management. Essentially, a hybrid of the EU model for e-waste management, which focuses on the role of industry and producers as well as market incentives, coupled with the framework set up by the EPSC would provide a significant step forward for domestic e-waste policy in Canada. This would expand and improve a process that Canadian recyclers and industry presently are already in partial agreement with. Such an inclusive approach would assure more cooperation and the eventual success of a comprehensive waste management system that will sustain the environment for present and future generations. It will be important to monitor and assess, on an evolving basis, the impacts any changes in regulation and policy have on producer and consumer behaviour and to continue to guide this behaviour through national directives toward favourable outcomes for the common good. That this is a realistic possible outcome is supported by the success that provincial initiatives in Canada have witnessed to date, A cost effective, environmentally responsible and nationally regulated e-waste recycling program is an imperative for our future.

Appendix 1: Canada Wide Principles for Electronics Product Stewardship[68]

1. Responsibilities associated with management of e-waste are primarily borne by producers of the products, where "producer(s)" means the manufacturer, brand-owner or first importer of the product who sells or offers for sale the product in each jurisdiction.
2. Costs of program management are not borne by general taxpayers.
3. Environmental and human health impacts are minimized throughout the product life-cycle, from design to end-of-life management.
4. Management of e-waste is environmentally sound and consistent with the 4**R** waste management hierarchy:
    a. **R**educe, including reduction in toxicity and redesign of products for improved reusability or recyclability
    b. **R**euse
    c. **R**ecycle
    d. **R**ecovery, of materials and/or energy from the mixed e-waste stream
5. Consumers have reasonable access to collection systems without change.
6. Education and awareness programs ensure that consumers, retailers and other stakeholders have sufficient information on program design and knowledge of their roles.
7. Program design and implementation will strive for equity and consistency for consumers, particularly between those who live in adjacent jurisdictions and between those who live in small, rural and remote communities and large urban centres.
8. Adjacent jurisdictions will strive for consistency in e-waste products collected.
9. Programs will include residential, commercial, historic and orphan products.
10. Programs will report on performance, specify objectives and targets, and be transparent in financial management.
11. E-waste is managed in the most economically and logistically feasible manner, while striving to maximize local economic and social benefits.
12. E-waste is exported from Canada for recycling only at facilities with a documented commitment to environmentally sound management and fair labour practices.

[68] Canadian Council of Ministers of Environment, "Canada Wide Principles for Electronics Product Stewardship" *CCME* (2004), 1-2.

Appendix 2: Provincial E-waste Regulation[69]

Jurisdiction	Legislation	Responsible Organization	Industry led, non-profit or government	Regulated Products
Alberta	Regulations under Environmental Protection and Enhancement Act Electronics Recycling Bylaw	Alberta Recycling Management Authority (ARMA)	Non-Profit	- Televisions - Desktop Computer - Computer Monitors - Laptops and Notebooks - Printers
British Columbia	Recycling (Regulation under Environmental Management Act) Electronic Stewardship Association of BC Stewardship Plan Canadian wireless and Telecommunication Association Stewardship Plan Call2Recycle Stewardship Plan	Electronic Stewardship Association of BC (Encorp) Canadian Wireless and Telecommuni-cation Association	Industry Run, non-profit	- Televisions - Computers that are designed for desktop use by an individual, for desktop use as a server, or to be portable - Desktop printers and fax machines - Computer scanners and copy equipment - Telephones and telephone answering systems - Mobile devices designed primarily to connect to a cellular or paging network, including, without limitation, phones, cellular personal digital assistants and pagers Electronic or electrical audio visual and consumer equipment, including without limitation, radio sets, cameras and video recorders designed for non-professional use, projectors, audio players, recorders, headphones, microphones, amplifiers,

[69] Source: Fishlock, Robert. *"Summary of Electronic Waste Regulations in Canada*." Canada: *Blake, Cassels and Graydon LLP*. (2011).

Jurisdiction	Legislation	Responsible Organization	Industry-led, non-profit or government	Regulated Products
				equalizers and speakers - Fluorescent light bulbs and lamps sold for residential use - Thermostats - Batteries for use in phase 1 or 2 electrical or electrical products, including primary and rechargeable batteries - Small electronic or electrical appliances - Smoke detectors - Batteries for use in small electronic or electrical appliances
Manitoba	Electrical and Electronic Equipment Stewardship Regulation (Waste Reduction and Prevention Act)	No Stewardship Program Electronic Products Stewardship Canada (EPSC) overseas administration	Non-Profit	- Televisions - Desktop computers, laptops and other portable computers - Desktop computer monitors - Computer printers - Peripherals for desktop computers, laptops and other portable computers, and computer printers - Personal digital assistants and other similar hand-held devices - Cellular telephones and other telephones primarily intended for personal use - Microwave ovens - Video display equipment - Video cassette recorders and players - Digital video players and recorders - Audio equipment - Facsimile machines - Photocopy machines - Digital cameras

Province	Regulation	Responsible organization	Industry-led, non-profit or government	Regulated Products
Nova Scotia	Solid Waste-Resource Management Regulations under Environment Act ACES Nova Scotia Electronics Recycling Plan (NSERP)	Atlantic Canada Electronics Stewardship (ACES)	Industry led, non-profit	- Analog and digital video cameras - Televisions - Desktop, laptop and notebook computers, including CPUs, keyboards, mouse, cables and other components in the computer - Computer monitors - Computer printers, including printers that have scanning and fax capabilities, or both - Computer scanners - Audio and video playback and recording systems - Telephones and fax machines - Cell phones and other wireless devices
Ontario	Waste Electrical and Electronic Equipment Regulation under the Waste Diversion Act Waste Electrical and Electronic Equipment Program Plan	Ontario Electronic Stewardship	Industry led, Non-profit	- Desktop computers - Portable computers - Computer peripherals including modems - Monitors - Televisions - Printing devices including copiers, scanners, typewriters - Telephones (physical and accessories) - Cellular phones - PDAs and pagers - Audio and video players - Cameras - Equalizers/(pre)amplifiers - Radios - Receivers - Speakers - Tuners - Turntable - Video players/projectors - Video recorders - Personal hand-held computers

Province	Regulation	Responsible Organization	Industry-led, non-profit or government	Regulated Products
PEI	Materials Recycling Regulation under the Environmental Protection Act ACES P.E.I. Electronic Stewardship Plan	Atlantic Canada Electronics Stewardship (ACES)	Industry led, non-profit	- Televisions - Desktop, laptop and notebook computers, including CPUs, keyboards, mouse, and cables - Computer monitors - Computer desktop printers, including printers that have scanning or fax capabilities, or both - Desktop scanners - Audio and video playback and recording systems - Telephones and fax machines - Cell phones and other wireless devices
Quebec	Regulation respecting the recovery and reclamation of products by enterprises under the Environmental Quality Act	Non-existent	Businesses subject to the Regulation "must develop a recovery and reclamation program unless it is a member of an organization that will do so for it."	- Desktop computers - Laptop computers, electronic pads and e-book readers - Computer screens and television sets - Printers, scanners, fax machines and photocopiers - Cellular and satellite telephones - Wireless and conventional telephones, pagers and answering machines - Keyboards, mouses, cables, connectors, chargers and remote controls designed to be used with a product covered by this division Video game consoles and their peripherals, projectors designed to be used with electronic equipment, readers, recorders, burners or sound, image and wave storage devices, amplifiers, equalizers, digital receivers and speakers designed to be used with an audio video system the types of products referred to in this subcategory include those marketed as part of a set such as home theatre systems

Province	Regulation	Responsible Organization	Industry-led, non-profit or government	Regulated Products
				- Portable digital players, radio receivers, docking stations for portable digital players and other portable devices, walkie-talkies, digital cameras, digital photo frames, camcorders and global positioning systems - Routers, servers, hard drives, memory cards, USB keys, speakers, webcams, earphones, wireless device and other accessories and spare parts not covered by another subcategory provided for in this section and designed to be used with a product covered by this category
Saskatchewan	Waste Electronic Equipment Regulations under the Environmental Management and Protection Act, 2002	Saskatchewan Waste Electrical Equipment Program (SWEEP)	Non-profit (est. by manufacturers, retailers and stakeholders)	- Desktop computers - Portable computers - Computer peripherals - Monitors - Televisions/display devices - Printers and fax machines - Personal/portable audio/visual playback and recording systems - Home audio/visual playback and recording systems - Home theatre in a box systems - Vehicle audio/video systems (aftermarket) - Non-cellular telephones - Answering machines

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