CIRCULAR ECONOMY GLOBAL SECTOR BEST PRACTICES SERIES

BACKGROUND MATERIALS FOR CIRCULAR ECONOMY SECTORAL ROADMAPS

ELECTRONICS

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Smart Prosperity Institute

About Smart Prosperity Institute

Smart Prosperity Institute is a national research network and policy think tank based at the University of Ottawa. We deliver world-class research and work with public and private partners – all to advance practical policies and market solutions for a stronger, cleaner economy.
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ABOUT THE CIRCULAR ECONOMY GLOBAL SECTOR BEST PRACTICES

This publication series aims to provide a starting point in the journey towards a circular economy. These materials are intended to be used as a background resource and rich reference source for future efforts to engage Canadian firms and innovators in this transition, and to build sector-based roadmaps to a circular economy in Canada.

Twelve core strategies for *rethinking* resource consumption and *optimizing* the use of resources to transition to a circular economy are detailed in the Introduction to the series. Real-world practices supporting these strategies are being catalogued for seven sectors, each profiled in its own document:

1. Minerals and Metals
2. Electronics
3. Agri-food
4. Construction
5. Plastics
6. Bio-economy
7. Automotive

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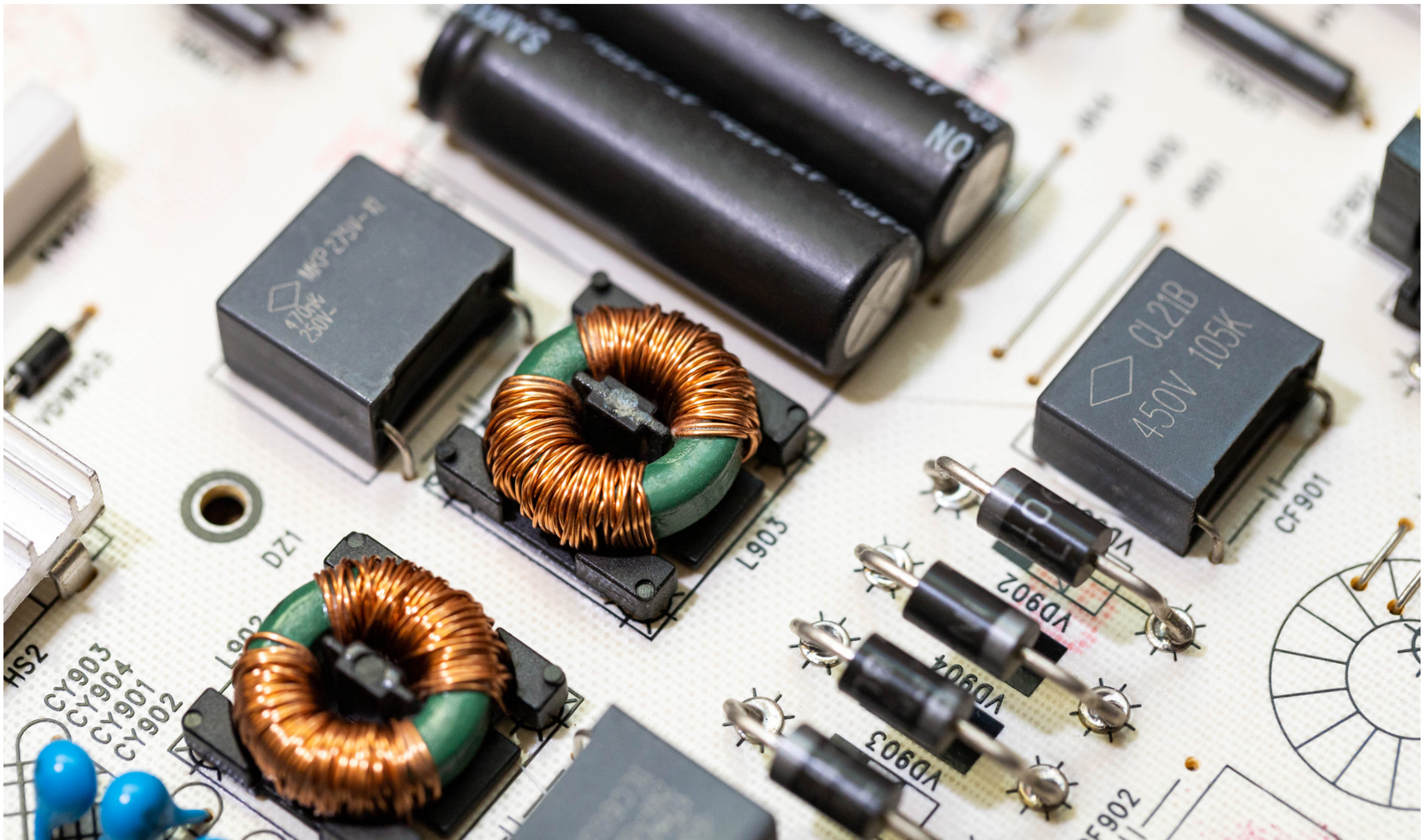


ELECTRONICS

2.1. Introduction to Electronics

The Circular Economy Global Sector Best Practices series aims to provide a starting point, background resource, and rich reference source for future efforts to engage Canadian firms and innovators in the journey towards a circular economy, and to build sector-based roadmaps to a circular economy in Canada.

The electronics sector is explored in this report. It begins with an outline of the economic and environmental importance of the sector, including data on economic potential of waste resources where available. It then profiles the existing circular practices that were identified in the sector, organized according to a common framework for circular economy approaches and strategies developed in 2018 by L'Institut EDDEC in collaboration with RECYC-QUÉBEC, and described in the Introduction to the series. This profile begins with a high-level summary of the circular practices found in each sector, and snapshots of these practices in application, and then moves on to list applied, real world examples for each of these strategies and practices. It provides a list of additional resources for researchers, practitioners, and policy-makers, as well as selected global public policies, and an annotated bibliography of key reports specific to circularity for electronics.

2.2. Background

The world will likely experience significant growth in the use of electronic and electrical products, with much of the growth occurring in emerging economies alongside continued consumption in Global North economies. For example, the consumer electronics market alone is expected to grow by 7% annually between 2020 and 2026.[1] With growing use of consumer electronics (already a one trillion-dollar market)[2] and the pace of technological obsolescence in this sector, the management of electronic waste ('e-waste') is of increasing importance.

E-waste is waste from any electronic product, including consumer electronics like smartphones and computers, household appliances like toasters and fridges, and heating and cooling equipment.[3] In 2018, 50 million metric tons of e-waste was generated globally;[4] by 2021, global per capita e-waste production will reach 6.8 kg per person;[5] and if nothing changes, global e-waste will more than double by 2050, to 120 million tonnes annually.[6] In 2016, half of global e-waste came from personal devices like smartphones, tablets, laptops, computers and TVs, including 435 tonnes of mobile phones.[7] Canada and the United States generated 20 kg of e-waste per capita in 2016.[8]

Globally, only 20% of e-waste is properly recycled.[9] This rises to 35% in the EU, the world leader in e-waste recycling.[10] The balance is discarded along with other residual waste, dumped, or otherwise improperly treated.[11]

Compared to other forms of waste, recycling e-waste is challenging given the complexity of electronic products. For instance smartphones, can each contain over 1000 different materials and up to 60 different periodic elements.[12] Additionally, e-waste contains hazardous substances that pose a threat to workers and the environment when handled improperly.[13]

Improper handling of e-waste results in a loss of valuable raw materials, including precious metals and rare earth metals, whose primary extraction has large environmental impacts.[14] The material value of raw materials in e-waste globally was worth an estimated C$80 billion in 2016, signifying there are significant recoveries to be made in this sector.[15] Each tonne of mobile phones contains 100 times more gold than one tonne of gold ore, and up to 7% of the world's gold might now be contained in e-waste.[16] Recovery of the materials from devices in the C$195 billion per year global smartphone market would be worth C$15 billion.[17]

Amid concerns about future material scarcity, recovery of the materials in e-waste could ensure availability of materials to meet demand, while reducing the sector's environmental footprint. Recycled metals are 2 to 10 times more energy efficient than primary metal extraction.[18] For example, recovering gold from e-waste results in 80% lower carbon dioxide emissions per unit of gold compared to primary extraction.[19]

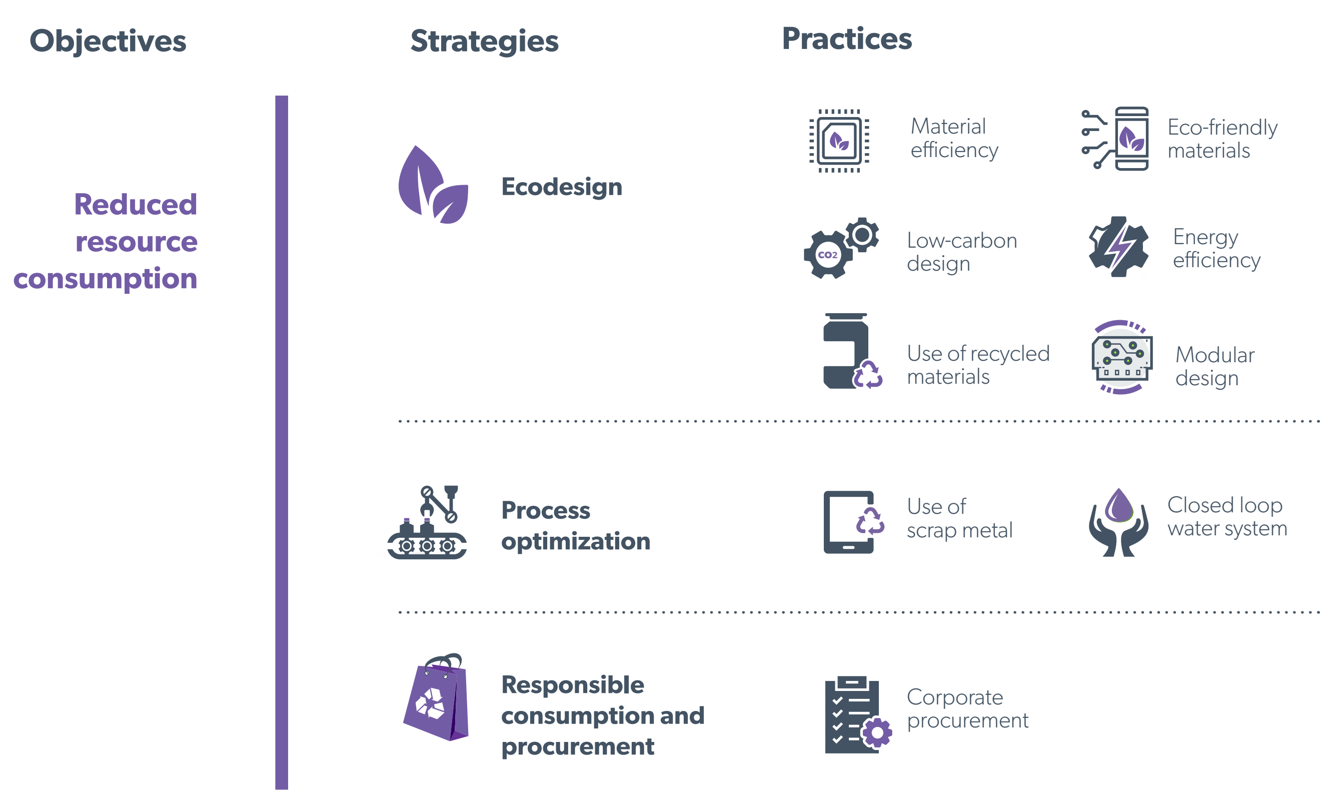
2.3. Overview of Circular Economy Practices in the Electronics Sector

Electronics companies have begun to invest in researching and implementing circular solutions. These investments are being made to help address the sector's greatest challenges, such as increasing efficiency, reducing waste, and recycling post-consumer products to reclaim valuable materials. Figure 2-1 summarizes the specific practices employed in the electonics sector, organized according to the four objectives for a circular economy and twelve core supporting strategies described in the Introduction to this publication series. Some of these are highlighted below. This is followed by a listing of applied examples of these strategies and practices, with hyperlinks to additional information. Canadian examples are denoted by a red superscript (CDN).

Objectives, Strategies, and Practices

Both electronic products and their related packaging consume resources, and many practices in this sector focus on **REDUCED** resource consumption. **Ecodesign** focuses on avoiding impacts at the design stage, for example through **material efficiency** by reducing the use of silicon in the production of circuit boards, through low-carbon design of products and appliances to use less energy, or through increased **use of recycled materials** in both the products and packaging. **Process optimization** approaches include powering entire production lines with low-carbon energy, and **closed loop systems**, where the materials used, like water, are reused in that same system.

Figure 2-1. Circular economy objectives, strategies and practices found in the electronics sector



Intensified product use

Sharing economy	None found	
Short-term renting	Product subscription	Temporary use agreement

Extending life of products and components

Maintenance and repair	Ease of repair	User-directed product re-appropriation
	Accessible repair services	Accessible software updates
Donating and reselling	Secondary marketplace	Trade-in/buy-back program
	Upgrade program	Data sanitisation
	Surplus IT asset management	
Refurbishing	Refurbishment of personal devices	Use of refurbished components
Performance economy	Product as a service	

Giving resources new life

Industrial ecology	None found	
Recycling and composting	Take-Back Program	Closed loop recycling system
	Urban mining	Environmental handling or recycling fee
	Recycling robot	Zero-waste
Energy recovery	None found	

Under **responsible consumption and procurement**, the development of corporate practices for greater accountability in sourcing allows companies to hold their suppliers to higher environmental standards.

Other practices in this sector look to **OPTIMIZE** resource use through **intensified use of products**. For example, some corporations are now offering **short-term rentals** of their products to consumers instead of outright sales.

Extending the life of products and their components is another approach to optimizing resource use. Strategies include offering **maintenance and repair** services, thereby extending product life and reducing items sent to the landfill. For example, **ease of repair** can be incorporated into the design of electronics so faulty parts can be replaced with easily accessible products. **User maintenance** of products can be encouraged through the development of **accessible software updates** to keep products running efficiently. Another practice to extend the life of products is to **donate or resell** surplus products, which might otherwise be destined for recycling or landfill. This can be done by creating **secondary markets** for direct resale of excess components by companies, or where consumers can sell to one another. Yet another practice is to offer **trade-in or upgrade programs**, where consumers can bring back older electronics to receive gifts cards or newer devices. These older electronics can then be repaired and reintroduced to the market as **refurbished** products. Additionally, instead of purchasing electronics outright, consumers can opt to utilize **products as a service** which allows greater flexibility for the consumer and provides greater accountability from the provider.

Finally, giving the materials in electronics a **new life** through strategies such as **recycling** is particularly important given the value of the embedded precious metals and rare earth metals, as discussed above. **Urban mining** relies on practices such as **take-back programs, environmental handling fees**, and **recycling robots** that disassemble electronics to capture valuable materials that would otherwise be destined for landfill.

Google: Zero Waste Data Center

Google uses data centres located all around the world to facilitate the running of their extensive service offerings, including the Google search engine, Gmail, and their G-Suite software among much else. These house millions of servers. Google's data centre in Mayes County, Oklahoma achieved its zero waste to landfill goal in 2016,[20] and they have committed to this goal for all of their data centres. This goal is being implemented through the use of four Rs:

- Repair: failed components are replaced using a mix of new and refurbished parts;
- Refurbish/Remanufacture: decommissioned servers are de-kitted to their usable components. After, refurbished components are put back into inventory and are used in server remanufacturing;
- Reuse/Redistribute: commercially useful excess component inventory is redistributed, and materials are resold rather than sent to landfill; and
- Recycle: if servers cannot be repaired and their components cannot be resold or refurbished, they are broken down to the component level for recycling. However, hard drives are destroyed for data safety.[21]

Environmental Products Recycling Association (EPRA)

Canada's Environmental Products Recycling Association (EPRA) is an industry-led not-for-profit working with over 7,000 Canadian manufacturers, distributors, and retailers of electronic goods in nine provinces to ensure the safe recycling of end-of-life electronics. Collection and recycling costs are funded through environmental handling fees on designated new electronics. Over 2,400 drop off locations and 52 return-to-retail partnership locations across Canada make recycling of e-waste accessible for as many Canadians as possible. EPRA works with recyclers who have been verified for sound environmental management practices, worker health and safety controls, data security measures, and downstream processing accountability under the national Electronics Recycling Standard. After collection and recycling, the recovered resources are returned into the manufacturing chain.[23]

Fairphone: Modular Mobile Phones

Based in the Netherlands, Fairphone is a social enterprise that produces ethical and environmentally-friendly smartphones. This venture began from an interest to build a phone using conflict-free materials and led to the development of a phone that is robust, durable, easily repairable by the user, and that can be recycled with ease. Fairphone gathers scrap phones and supplies the recycled materials into world markets, and uses highly traceable minerals throughout their supply chain. They use a truly modular design, with thick glass, high quality components, and minimal material diversity. Fairphone also encourages consumers to carry out their own repairs while offering in-house repairs for more complex situations. [22]

Specific Examples: Objective 1, Reduced Resource Consumption

Ecodesign

Material efficiency

- Apple[24] is seeking to reduce the amount of silicon used in integrated circuits while maximizing circuit performance (less silicone use led to 4.8 million fewer metric tons of CO_2 in 2018). Apple is also seeking to reduce the amount of gold used in printed circuit boards.

Eco-friendly materials

- Samsung[25] is introducing plastics containing stone flour into all of its products (ranging from mobile phones and tablets to home appliances). This is expected to result in a 15% drop in CO_2 emissions. Samsung is also replacing plastic packaging with paper and other environmentally sustainable elements for all of its products.[26]

- Apple[27] uses 100% responsibly sourced wood fiber in all retail packaging.

Low-carbon design

- Apple[28] is transitioning product materials, manufacturing processes, and operating systems to low-carbon alternatives.

Energy efficiency

- Apple[29] is designing its products to use less energy (which maximizes battery life). They have achieved a 70% decrease in average product energy use in the past 10 years.

- Sierra Wireless[30] introduced new wireless modules with ultra-low power consumption for use on LTE-M networks in Japan and the US. This has allowed customers to achieve a battery life of up to a decade.

Use of recycled materials

- Apple[31] is using 100% recycled aluminum enclosures for its MacBook Air and Mac mini, 100% recycled tin in the solder on main logic boards in 11 products (preventing the mining of 29,000 metric tons of tin in 2019), and recycled cobalt in the batteries of new products. The company uses recycled plastic for 82 components across products (38% recycled plastic content) and uses recycled paper in their paper products.

- Samsung[32] is using recycled cobalt in their products' batteries, recycled copper for a wide range of applications, and recycled plastic for its smart device chargers (20% recycled plastic content), as a part of their effort to reduce their use of virgin resources and raw materials

- HP[33] shipped 48 products made with closed loop plastics in 2016. Their HP Envy printer and ink cartridges are all made with closed loop plastic.

- Lexmark[34] cartridges are made with an industry-leading 10% by weight of PCR plastic content

Modular design

- AIAIAI[35] lets users build their own headphones from modular parts, allowing a personalised sound profile and components to be easily replaced.

The Ideal

- Continued growth in each of these practices for more products and components.
- Improved material traceability of minerals along supply chain to improve recyclability.

Process optimization

Closed loop water system

- SMTC[36] Manufacturing Innovators have developed a closed-loop water recycling system for their Florida manufacturing facility. They save three million gallons of water per year by reusing water up to three times in their electronics manufacturing before using it to flush the facility's toilets.

Use of scrap metal

- Samsung[37] is reducing the use of virgin natural resources and raw materials by maximizing the re-use of scrap metals from the manufacturing stage.

The Ideal

- Continued growth in closed-loop manufacturing processes.
- Little to no waste is produced by the manufacturing process.
- Production is streamlined to reduce the time of production (and in turn, the amount of resources needed).
- Smaller manufacturing batches to reduce excess inventory.

Responsible consumption and procurement

Corporate procurement

- Bell[38] CDN implements principles of responsible procurement through their purchasing activities on items including wireless devices, information technology, business telecommunication products and more.

The Ideal

- Consumer expectations of a product lifetime is equivalent to actual product lifetime (consumers tend to greatly undervalue product lifetimes).
- Extended warranties are cheap or included with product purchase (because consumers base product lifetime on length of warranty).
- Consumers are encouraged to consume 'less' by investing in more durable products or refurbished/recycled products.

Specific Examples: Objective 2, Intensified Product Use

Sharing economy

Sharing economy is not significantly addressed by the sector

The Ideal

- An online platform where consumers could directly trade, sell, buy, borrow, and share electronic devices and goods with minimal interference by the host company. This will likely be difficult for the electronics sector to achieve, given the need for data security and quality assurance.

Short-term renting

Product subscription

Commown[39] offers Fairphones and ecological personal computers to private users on a monthly subscription. Upgrades, continuous support, and repairs are included in the subscription at no extra cost. More than 900 devices were in service in 2020.

Temporary Use Agreement

- Xerox[40] CDN offers the option to rent printers for short periods (3 days to one year) for events, peak periods of workload, and short-term projects.

The Ideal

- Continued growth in each of these practices, especially for larger appliances.
- More options for length of rental period and cheaper plan options.

Specific Examples: Objective 3, Extending Life of Products and Components

Maintenance and repair

Ease of repair

- HP's[41] EliteBook 800 G5 Business Notebook series is one of the most easily repairable laptops on the market. Its use of simple Phillips screws and flat design gives access to all the commonly replaced items: battery, display, USB port, RAM, SSD, and wireless cards.

User-directed product re-appropriation

- Samsung's Galaxy Upcycling[42] program in Seoul allows customers to transform phones into smart devices (users can customize functionality and receive necessary software changes).

Accessible repair services

- Samsung[43 CDN] has a broad range of service partners across Canada and the US that can repair their personal electronic devices (UbreakIFix, Mobileklinik, Cellzone, Cell Mechanics, Phone MD & Fonelab).
- Apple[44] offers over 5,000 repair locations worldwide (a combination of Apple stores and authorized service providers).

Accessible software updates

- Apple's[45] software update mechanism can update older devices with new capabilities, which maximizes a device's useful lifetime.

The Ideal

- Product maintenance is accessible and cheap.
- Users can maintain their electronics themselves using available and resources and are encouraged to do so.
- Products are upgradeable (improves product durability).

Donating and reselling

Secondary marketplace

- Google[46] sells excess component inventory in secondary markets. The main components they sell are memory modules, hard drives, and OEM Networking equipment.
- Swappa[47] is a marketplace for buying and selling mobile devices, including phones and tablets. Anybody can use the platform to sell their used devices.
- Volpy[48] is an app that allows users in France to switch from a smartphone to another, whether new or refurbished. If users chose to trade in their smartphones, they must only pay the difference between the value of their current phone and the value of the phone they want to trade for. Users can also choose to sell their smartphones for its market value. Volpy has achieved more than 1 million downloads.

Trade-in/buy-back program

- Best Buy[49 CDN] offers device trade-ins for store gift cards in Canada and the US. They accept laptops, phones, desktop computers, gaming consoles, and wearable tech from a wide range of brands.
- Amazon[50] offers device trade-ins for upgrades to a new Amazon device. They accept Kindle readers, cell phones, gaming appliances, tablets, Bluetooth speakers, and streaming media players.
- Apple[51] offers product trade-in for store gift cards in-store or online. If the product is not available for credit (i.e., cannot be refurbished) Apple sends it for recycling.

Upgrade program

- Samsung's[52] upgrade program provides users with a new Galaxy phone every year for a monthly fee. Phones that are returned in good condition are resold by Samsung.
- Apple's[53] upgrade program provides users with a new iPhone every year for a monthly fee. Improves product recovery and provides users with the most up to date tech. Phones from the upgrade program are resold by Apple.

Data sanitisation

- HP[54] CDN offers a stand-alone data sanitization service for Canadian and American customers. This is especially useful for customers looking to resell their devices themselves.

Surplus IT asset management

- Sage Sustainable Electronics[55] helps American businesses refurbish and redistribute their surplus IT assets. Businesses can choose to donate, sell, or redeploy these refurbished IT assets.

The Ideal

- Continued growth in each of these practices.
- Used products are cheaper and are widely-perceived to be of the same quality as new goods (and are of matching quality).

Refurbishing

Refurbishment of whole products

- Apple[56] sells refurbished smartphones that are given the same warranty as new products (one year). Apple sold more than 7.8 million refurbished devices in 2018.

- Samsung[57] sells 'Certified Pre-Owned' refurbished smartphones with a one year warranty attached.

Use of refurbished components

- Google[58] uses refurbished parts in hard drive and server upgrades and repairs.

The Ideal

- Every electronic good can be refurbished with relative ease, whilst the use of refurbished components is maximized.
- A greater ease of disassembly and more durable product components to lower costs of 'production' for refurbished goods.

Performance economy

Product as a service

- Dell PC as a Service[59] CDN combines hardware, software, lifecycle services, and financing into one all-encompassing solution. Customers can pay a monthly fee for lifecycle management support for 20 – 300 units.

The Ideal

- Continued growth of offering electronics as a service.
- Increasing producer responsibility for electronic products and choice for consumers

Specific Examples: Objective 4, Giving Resources New Life

Industrial ecology

Industrial ecology is not significantly addressed by the sector

The Ideal

- Clusters of manufacturers, both downstream and upstream along the supply chain, that use each other's waste products as resource inputs.

Recycling and composting

Take-back program

- Lexmark[60] offers a take back program for used cartridges and offers prepaid shipping labels for customers. Customers have returned more than 1 in 3 of cartridges sold by Lexmark. Lexmark sends all of these cartridges for recycling or reuse.

- Apple[61] partners with Best Buy in the U.S. and KPN in the Netherlands to collect iPhones that are then sent to Daisy (disassembly robot). Apple also accepts Apple devices for recycling at their store locations.

- Samsung Re+[62] is a global e-waste take-back program. Consumers can drop off their e-waste in collection bins at no cost. They are aiming to collect 3.8 million tons of e-waste by 2020 (3.12 million tons collected between 2009-2017).

Closed loop recycling system

- Samsung's Asan Recycling Center[63] in South Korea processes larger appliances and sends all recovered metal and plastic for direct re-use in Samsung electronics. In 2017, it processed 347,000 units of refrigerators, washing machines, air conditioners, and IT devices. It supplied 1,500 tons of renewed plastic and 25 tons of major metals in 2017.

Urban mining (extraction of minerals and metals from e-waste)

- SungEel HiTech[64] is South Korea's largest battery recycler. It is part of a global supply chain for major battery makers (including Samsung and LG Chem). Processes about 8,000 tonnes (metric tons) per year of spent lithium-ion batteries and metal scraps, and extracts 830 tonnes of lithium phosphate, 1,000 tonnes of cobalt metal equivalent and 600 tonnes of nickel.

Environmental handling or recycling fee

- Ecotrel[65] is an organization in Luxembourg of which 600 companies representing different sector activities are a part of. Ecotrel places a consumer-paid recycling fee on all electronic and electric goods. This fee is used to fund the collection and recycling of electronics.

- Environmental Products Recycling Association[66] CDN (EPRA) operates recycling programs across Canada. Since all new designated electronic products sold must be recycled, they are subject to an environmental handling fee that varies by province to cover collection and recycling costs.

Recycling robot

- Apple's[67] disassembly robot, Daisy, is able to disassemble 15 iPhone models and recover rare earth metals, including steel, tin, tungsten, lithium, tantalum, and zinc.

Zero-waste

- Apple[68] is pursuing a goal of Zero Waste to Landfill at its corporate facilities, retail stores, and data centers. In 2018, Apple diverted 74% of the 74,000 tons of waste it generated from landfill through recycling and composting.

The Ideal

- Continued growth in each of these practices.
- Minimizing material diversity of products to ensure easy material separation.
- Improving speed of material separation.

Industrial ecology

Energy recovery: is not significantly addressed by the sector.

The Ideal

- End of life electronics that cannot be recycled are used to generate energy in the form of electricity, heat, or fuel. Given the toxicity of materials used in electronics, this is likely an unrealistic strategy for the sector.

2.4. Additional Resources

The following are additional resources that researchers, practitioners, and policy-makers can draw on to further advance awareness and understanding of opportunities for circularity for Canada's electronics sector.

Selected Global Public Policies Supporting Electronics Circularity

- *Europe's EcoDesign Directive:* provides consistent EU-wide rules and minimum mandatory requirements for the energy efficiency of products like household appliances, information and communication technologies, or engineering.[69]
- *Environmental Labels*: certifies products (including electronics) with reduced environmental impact. Examples: Europe's Eco-Label,[70] Germany's Blue Angel Label,[71] Nordic Swan Label,[72] Canada's EcoLogo[73].
- *Extended Consumer Guarantees for Electronics:* France[74] has a 2-year guarantee, Norway[75] has a 2-5 year guarantee. Norway has found that the policy increases product durability and delays product disposal[76].
- *Canada's Extended Producer Responsibility*: implemented Canada-wide at the provincial level, mandates producer responsibility for electronics' end of life. Gave rise to environmental handling fees for electronics. [77]

Selected Documents on Circular Economy and Electronics Sector

Understanding the global electronics sector

Ellen MacArthur Foundation. (2018). *Circular Consumer Electronics: An Initial Exploration*. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/Circular-Consumer-Electronics-FV.pdf

Based on interviews with companies and researchers, this report provides extensive data about global electronic waste, its environmental impacts, and the economic opportunities provided by circular strategies. It also presents a vision of consumer electronics within a global circular economy in which electronic devices are used for longer, materials and components are recovered from devices after use, and consumers are connected easily to second-hand devices that suit their changing needs. The report identifies key industry actions to accelerate the transition: designing products for circularity; embracing cloud computing, which could reduce hardware obsolescence; supporting the market for second-hand devices; and increasing product disassembly and refurbishment through automation.

World Economic Forum. (2019). *A New Circular Vision for Electronics – Time for a Global Reboot*. Retrieved from http://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

This report provides global data and research about e-waste flows, climate impacts, future trends in demand, and the economic value of e-waste. Key issues identified are growing consumer use of electronics, low recycling rates for electronics, which is challenging due to the multi-material (often hazardous material) nature of electronics; labour, health, and environmental issues associated with recycling; and lack of legislation regulating e-waste in many countries, particularly in Africa, Latin America, and South-East Asia. To build a circular economy for electronics, the report highlights key strategies of product design for reuse, durability, and recycling; reintegrating manufacturing scrap into the manufacturing process; ensuring second and third lives for products through repair and durability; and effective product end-of-life management through collection and recycling. Dematerialization (product as a service) is another promising strategy, giving the manufacturer an incentive to ensure resources are used optimally over a product's lifetime.

Baldé, C. P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2017). Global E-Waste Monitor. *United Nations University*, *International Telecommunication Union* and *International Solid Waste Association*. Retrieved from https://collections.unu.edu/eserv/UNU:6341/Global-E-waste_Monitor_2017__electronic_single_pages_.pdf

This report provides a comprehensive overview of the available data on the status of and trends in e-waste and its flows, including global e-waste projections (total amount, and amount per person) until 2021, proportion of the global population living in the 67 countries with e-waste legislation in 2017, global e-waste collection methods in 2016, and trends in each category of e-waste. With the goal of improving availability of e-waste statistics, the report outlines methodologies for classifying and measuring e-waste using a common standardized framework. It provides a regional analysis of the state of e-waste, relevant legislation, and challenges associated with e-waste for five regions. The report notes that a better understanding of e-waste will contribute towards the achievement of Sustainable Development Goals relating to health, the environment, employment, and economic growth.

Understanding the Canadian electronics sector

Dewis, G., &Van Wesenbeeck, P. (2016). *Trash talking : Dealing with Canadian household e-waste.* Statistics Canada. Retrieved from https://www150.statcan.gc.ca/n1/pub/16-002-x/2016001/article/14570-eng.htm

Using data collected from household surveys, the authors provide a snapshot of Canadian household use of and disposal methods for televisions, video cassette recorders, computers, and cell phones until 2012. The article concludes that e-waste diversion in Canada has increased over the period studied, coinciding with an increased access to waste diversion programs, curbside pick-up, and take-it-back programs.

VanderPol, M. (2014). *Overview of E-waste Management in Canada*. Environment Canada. Retrieved from https://www.epa.gov/sites/production/files/2014-08/documents/canada_country_presentation.pdf

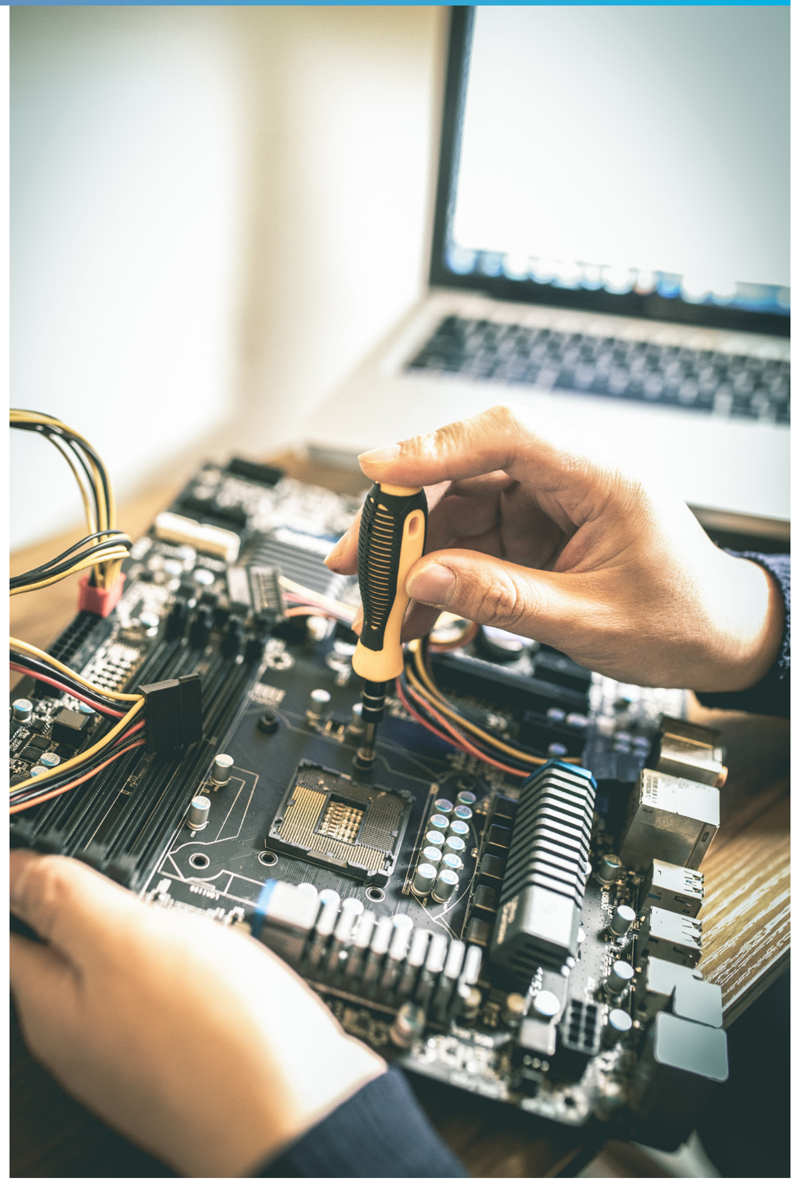
Although some of the content on international conventions is now outdated, this presentation provides a useful overview of e-waste governance in Canada. It outlines the roles of different levels of Canadian governments in managing e-waste; Environment Canada's strategies to reduce e-waste, including regulatory controls and substance content restrictions; the status of extended producer responsibility schemes across Canada; and an overview of organizations coordinating e-waste disposal programs.

A snapshot of industry actions to accelerate the circular economy of electronics

Electronics Product Stewardship Canada. (2019). 2019 Design for Environment Report. Retrieved from https://epsc.ca/wp-content/uploads/EPSC_Report_2019_Web_Final.pdf

Since 2011, the industry-led Electronics Product Stewardship Canada has produced annual reports focussing on environmentally-friendly electronics design. The 2019 report features dozens of industry actions aiming to reduce the environmental impact of electronics, through strategies including improved energy efficiency, use of recycled materials, and closed loop recycling in electronics products. This report also explains how cloud computing can lower Canadian energy demand, reduce material use, and extend the life of electronic products.

2.5. Conclusion to Electronics



This global scan of best circular economy practices in the electronics sector reveals that selected firms and operations are already implementing a wide range of practices that support circular economy objectives and strategies, whether or not these practices are explicitly identified as circular. More wide-spread adoption of such strategies and practices will be key to reducing the resource consumption associated with the rapid growth in electronic and electrical products, using them more intensely once they have been produced, and recovering valuable precious metals and rare earth metals. However, with only 35% of e-waste recycled even within leading jurisdictions such as the EU, the sector still has a long way to go in mainstreaming circular thinking, recapturing lost economic value and overcoming the challenges of ever-growing volumes of e-waste.

In cataloguing these examples, our intent is to demonstrate real-world strategies and practices that offer a starting point in the journey towards a circular economy. This information is offered as a background resource and reference source for future efforts to engage Canadian firms and innovators in the journey towards a circular economy, and — ideally — to begin building a Canadian electronics sector roadmap to a circular economy.

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