DESIGN for ENVIRONMENT REPORT

2017

epsc.ca

Electronics Product Stewardship Canada

Message from Electronics Product Stewardship Canada (EPSC)

EPSC is pleased to release our 9th Design for Environment Report.

Building on previous reports, EPSC Design for Environment Report 2017 demonstrates how electronics products are doing ***more with less***.

The main story this year is that the weight of electronics going into the marketplace and available in households for recycling, is significantly decreasing. At the same time, the functionality of these lighter devices is increasing. The total weight of products discarded at the end of their useful life for recycling is also declining. In fact, electronics are the largest declining product in the municipal waste stream.

Designing with less material, eliminating chemicals of concern, improving energy efficiency and providing consumers with increased product functionality, is having a very positive impact on our environment and resource use.

Jeff Van Damme
Chair of the Board
Samsung Electronics Canada Inc.

Shelagh Kerr
President and CEO
EPSC

The 3 R's (Reduce, Reuse, Recycle) in Electronics Design

Reduce

More with Less. Electronics design is continually improving while using less material.

The material footprint of electronics has shrunk over the decades. Devices have evolved into being multifunctional, light weight, and smaller due to new materials and technologies. To illustrate this point, we created a timeline of the material footprint of three popular electronic products: the personal computer, phone and television. Since the 1970s, the weight of personal computers has decreased by 95%, phones by 94%, and televisions by 60%. The significant reduction in weight is a result of new technologies. For example, televisions have gone from using CRT (cathode ray tube) leaded glass technology in the 1970s to Plasma in the 1990s to DLP (digital light processing) and LED (light-emitting diode) in the 2000s to OLED (organic light-emitting diode) today.

Wearable Technology

Wearable technology has a very small material footprint. For example, smartwatches are packed with many features, they function as a telephone (receiving calls and texts), computer (accessing emails), GPS (providing directions and maps) and fitness tracker (monitoring heart rate and body activity). Through internet or Bluetooth connectivity, wearable electronic devices are enabled. The smartphone is the hub for most wearable technologies.

Reducing Substances of Concern

Electronics manufacturers are continuously reducing, removing, and sourcing materials that are safer for workers and the environment, while still delivering functionality. EPSC members support harmonized international regulations, and voluntary phase out of substances of concern in electronics products.

International and Government Restrictions

Chemicals are very tightly controlled through regulations. The Canadian Environmental Protection Act, (CEPA) provides the regulatory authority for the Chemicals Management Plan (CMP) which assesses and manages environmental and health risks posed by substances[1].

Procurement Policies

Electronic manufacturers actively manage their supply chains to inform their procurement policies.

GreenScreen® for Safer Chemicals is a publicly available and transparent chemical hazard assessment tool for identifying chemicals of high concern and safer alternatives.

GreenScreen® is now 10 years old and has become a widely-recognized tool for assessing chemical hazards, identifying chemicals of concern, and selecting safer chemicals.

GreenScreen® is on the path to being part of EPEAT (for more information on EPEAT, see page 12).

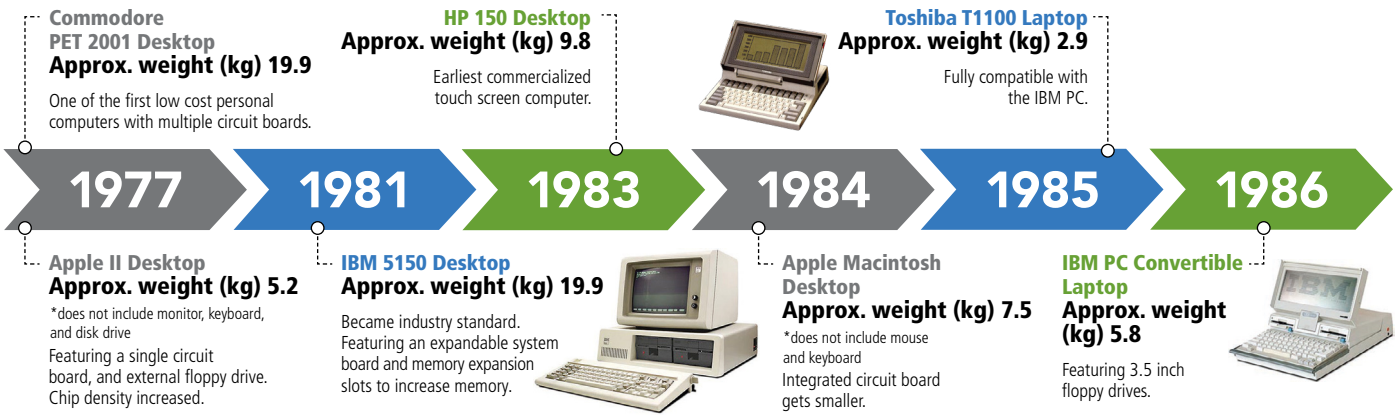
Dell and **HP** support the use of the GreenScreen® methodology.[2]

Voluntary Phasing Out Substances of Concern

Beyond regulations, manufacturers are committed to identifying and removing substances from their devices that are proven to be harmful to the environment or the safety of workers. The table below shows examples of substances removed from electronics. Manufacturers continue to identify suitable alternatives that meet technological, quality, environment, health and safety requirements.

SUBSTANCES REMOVED	USE	SAFER ALTERNATIVE SUBSTANCE OR TECHNOLOGIES
BFRs (Brominated Flame Retardants)	enclosures, circuit boards, connectors, anything that generates heat that might cause fires	metal hydroxides and phosphorus compounds
Mercury	lamps and batteries	LED display technology that is made from inorganic semiconductor materials that are not hazardous
PVC (Polyvinyl chloride) and Phthalates	power cords, headphones, cables	thermostatic elastomers

TIMELINE OF PERSONAL COMPUTERS (1977 - 1986)



Full Material Disclosure Program

Apple has a Full Material Disclosure Program that identifies all substances used in their products. They identified all the substances present in more than 20,000 individual components to understand their effect on human health and the environment. The assessment process occurs early in the design and manufacturing phase to allow appropriate actions to remove or replacing hazardous chemicals.

After four years of testing various formulas, Apple found the right blend of durability, safety, and environmental performance in their PVC replacement materials: non-chlorinated and non-brominated thermoplastic elastomers.[3]

Panasonic PT-RZ12K Series. Courtesy of Panasonic Canada Inc.

Reducing the Use of Hazardous Substances

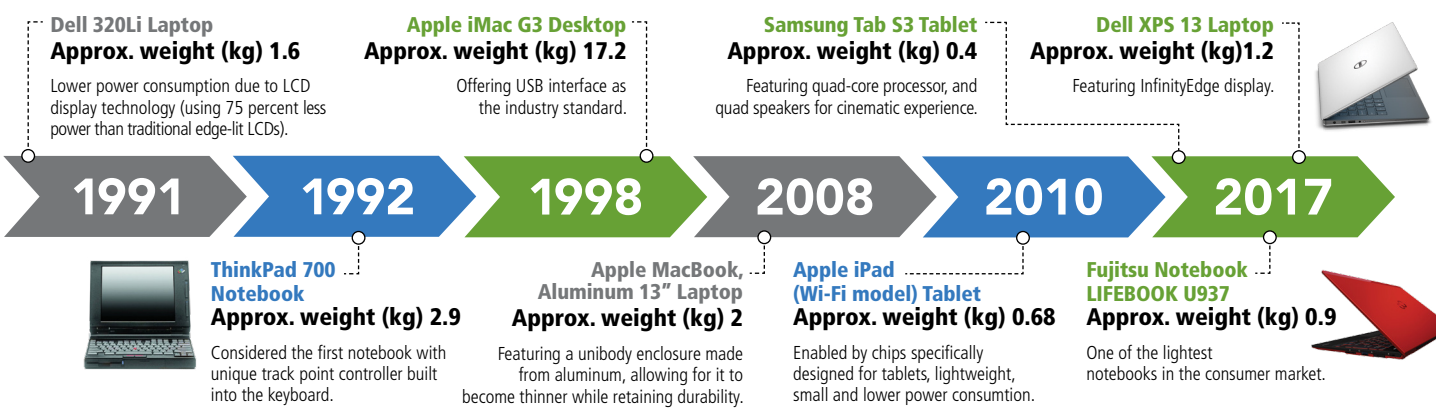
Panasonic's PT-RZ12K Series projectors provide high luminosity by employing a high-output semiconductor laser light source module and a heat-resistant phosphor wheel. The casing material does not use halogenated flame retardant, making the projector an eco-conscious product that contributes to reducing the use of hazardous substances.[4]

Electronics in Canadian Households

Natural Resources Canada's latest figures show that the number of Canadian households has increased from 10 to 14 million from 1990 to 2013[5]. During this time, small consumer electronics such as TVs, VCRs, DVDs, stereos and personal computers grew 178%[6]. The weight of these devices was reduced dramatically during the same period.

Study results from a 1990-2015 review of the material footprint of consumer technology used in U.S. households confirms that, although electronic devices increased in sales, the total weight has dropped. The study, conducted by Rochester Institute of Technology and supported by Staples and the Consumer Technology Association (CTA), shows that the mass of electronic products (desktop computers, laptops, TVs phones, entertainment

TIMELINE OF PERSONAL COMPUTERS (1991 - 2017)



devices, etc.) stored in U.S. households has been declining since 2006[7]. If we size this US data to the Canadian market, we see in Figure 1 that consumer electronics stored in households show total weights declining to 1998 levels. This pattern of weight reduction for electronics is a result of both technological progress and consumer demand. This is particularly true for televisions where display technology has transited away from heavy CRT televisions to lightweight LED technology. The introduction of multi-functional devices such as smartphones has also had a significant impact. The study data also shows that the weight of consumer electronics sold into the market has decreased from a peak in 2000 down to 1993 levels, despite the increase in the number of units sold.

Electronics Stored in Canadian Households

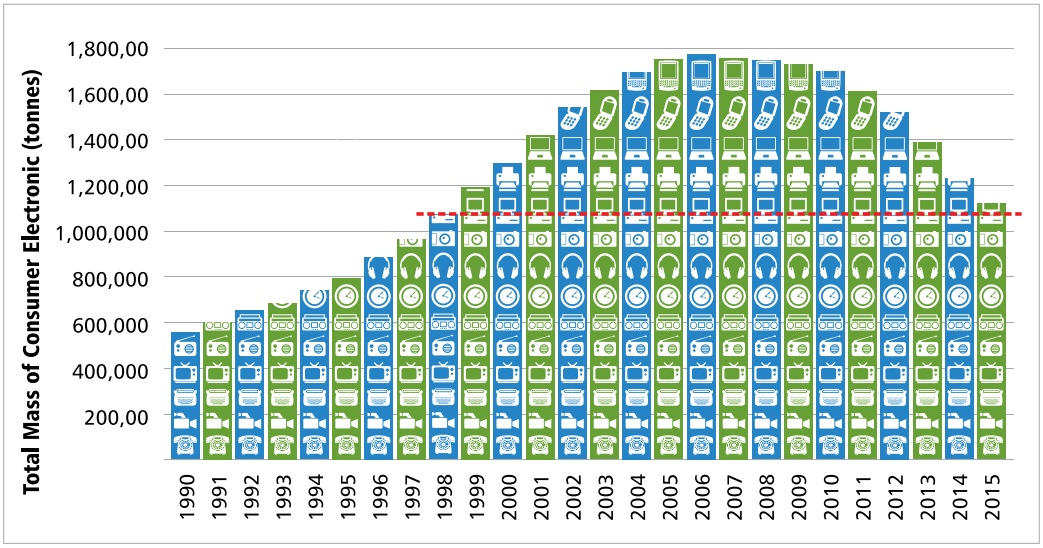
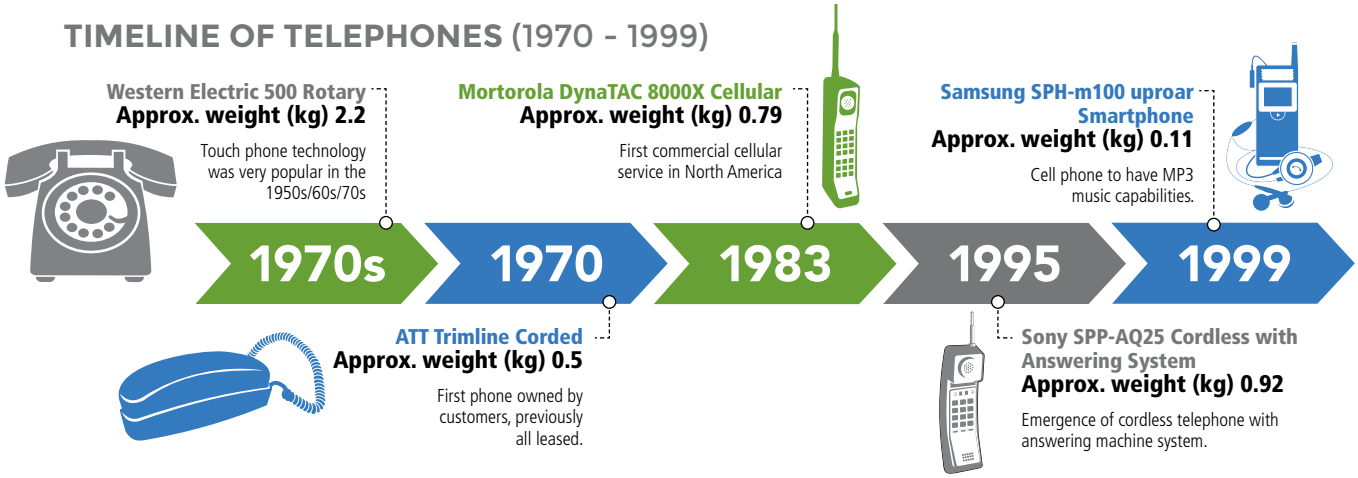


Figure 1: Estimated Weight of Consumer Electronics Used or Stored in Canadian Households (1990-2015). Extrapolated from US household data (Babbitt, C.W., Althaf, S., and Chen., R. (2017).

Canadian households phasing out old electronics with newer, lighter devices is further confirmed by Statistics Canada. In a short period of time from 2007 to 2011, Canadians replaced older heavier CRT televisions in favour of newer flat screen technologies (i.e. LCD, DLP, LED) (Figure 2)[8].



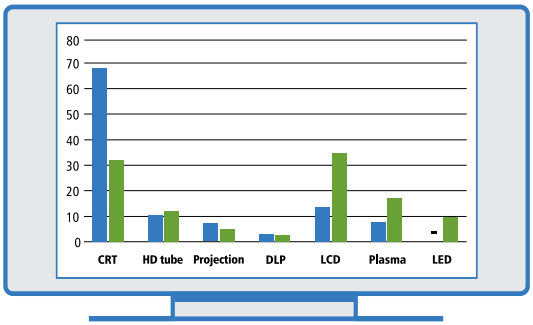


Figure 2: Types of Televisions Used, 2007 and 2011 (Statistics Canada, 2016).

Reuse

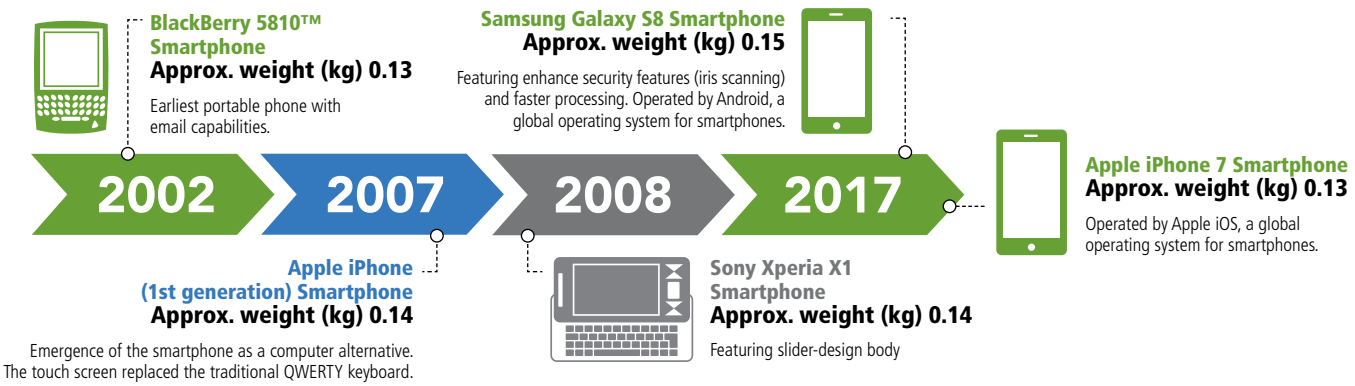
Electronics manufacturers recognize that product lifespan or durability can be extended through refurbishment and support of repair services.

Reuse and refurbishment "represents the greatest value recovery opportunity from used devices."[9] Lease-back or take-back contracts that often include equipment refurbishment and resale of parts is a viable business. Deloitte Global predicted that consumers would sell or trade approximately 120 million used smart phones in 2016 calling it "the $17 billion market you may never have heard of."[10] This global market is expected to accelerate through 2020, as both consumers and suppliers increasingly embrace selling and buying used smartphones.[11]

A key resource for determining the value of used electronics and recovered materials is the Sage BlueBook (www.sagebluebook.com). It is an online resource providing current market value of used electronics.[12] Companies and consumers can learn about the value of their devices and how they can increase value through repair and recycling.

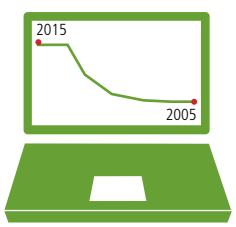
When looking at material recovery opportunities for used electronics, the Sustainability Consortium in collaboration with the US National Center for Electronics share an important finding. By comparing the manufacturer suggested retail price to today's retail price, the value of the selected devices quickly declines over time (see Figure 3).[13] Mobile phones lose their value within two years, whereas laptops hold their value for a longer period, three to four years. The results show that for a viable reuse market, devices need to be collected close to the time of their sale to be reused or refurbished profitably.[14]

TIMELINE OF TELEPHONES (2002 - 2017)



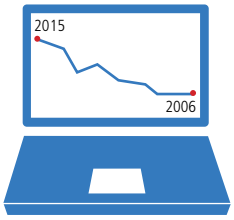
Device Resale Value Over Time

Figure 3: Value of Select Laptop Computers and Mobile Phones (Mars, C., Nafe, C., and Linnell, J, 2016).



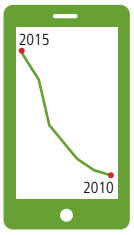
Dell Latitude

Retained Value
2015 - 60%
2005 - 5%



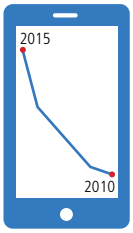
Apple MacBook Pro

Retained Value
2015 - 80%
2006 - 14%



Apple iPhone

Retained Value
2015 - 92%
2010 - 14%



Samsung Galaxy

Retained Value
2015 - 86%
2010 - 21%

Key examples of initiatives that aim to extend the life of used electronics.

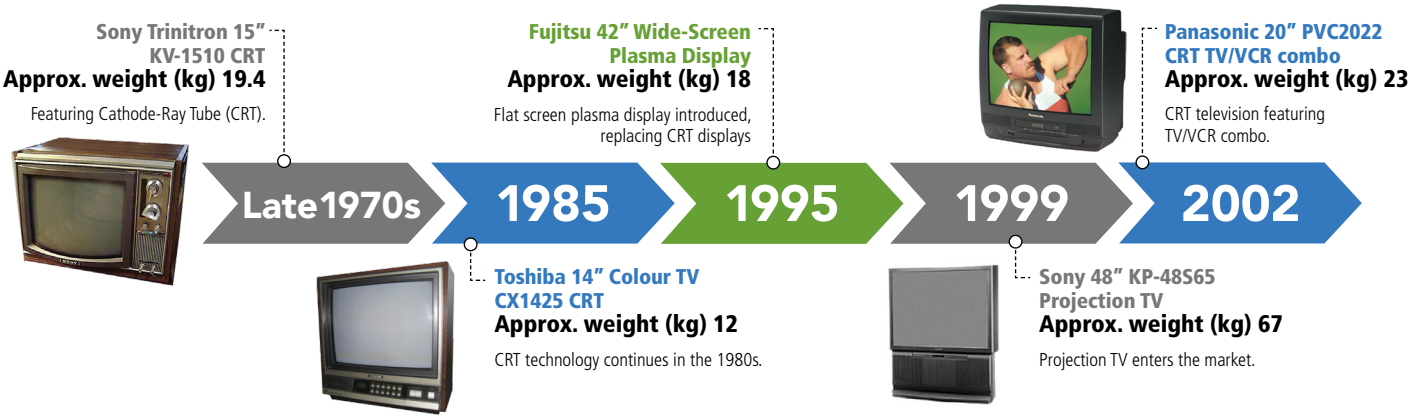
Microsoft Authorized Refurbisher (MAR) Program

The MAR program provides professionally refurbished computers with pre-installed Microsoft software for resale and reuse, often benefitting non-profit organizations and schools. The MAR program allows for consumers, businesses and institutions to purchase high quality refurbished computers.[15]

Computer for Schools

Computer for Schools (CFS), co-founded by Industry Canada and the Telecom Pioneers, is led by the federal government and works with various partners (non-for-profit organizations, federal departments, provincial and territorial governments, schools, and the volunteer sector). The program helps to extend the lifespan of donated computers and distributes them to various communities.[16] Since its inception in 1993, over 1.4 million computers have been refurbished and donated nationwide.[17]

TIMELINE OF TELEVISIONS (1970's - 2003)



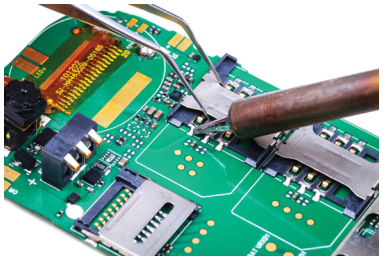
HP PartSurfer

HP PartSurfer is designed to help customers upgrade products and replace missing or damaged PC and printer parts. Once customers know their specific part number, they can order it through HP's PartSurfer website. In addition, HP YouTube support videos offer customers tutorials and instructions on how to keep PCs and printers in peak condition.[18]

In 2015, Canada diverted over 137,000 tonnes of electronics from landfill through regulated e-waste recycling programs.

Reuse and Refurbishment of Electronics in Canada

In 2014, Canadian electronics manufacturers themselves took back approximately 6,000 tonnes of electronics products for reuse and refurbishment. Reuse and refurbishment activities provide higher value than recycling. To encourage refurbishment, reuse and parts harvesting, IC&I (industrial, commercial and institutional) electronics should not be regulated under provincial recycling regulations.



Recycle

Electronic devices are being designed with recyclability in mind.

Product Design Criteria for Recycling

Many electronic manufacturers have their own criteria for incorporating recyclability into product design. This can result in faster, less expensive dismantling while making it easier to identify material types to maximize value.

TIMELINE OF TELEVISIONS (2006 - 2017)

2003

Sony 30" XBR® LCD WEGA® TV
Approx. weight (kg) 27.2
Emergence of flat screen LCD (liquid crystal display) TVs.

2006

Samsung 50" HL-S5087W DLP TV
Approx. weight (kg) 30.3
Emergence of DLP (digital light processing) TVs.

2009

Samsung 46" B8000 LED TV
Approx. weight (kg) 18
Emergence of LED (light emitting diode) TVs.

Panasonic Smart Viera® 47" WT50 HD 3D LED TV
Approx. weight (kg) 13
Rise of Smart TVs, requiring processing and software systems, capable of video processing, multiple screens, and web browsing.

2012

LG Ultra Short Throw LED Home Theater Projector
Approx. weight (kg) 2.1
Able to connect to video source to play with no mounting brackets.

2016

LG Signature 65" OLED TV W, 4K HDR Smart TV
Approx. weight (kg) 7.6
Emergence of OLED (organic light emitting diode) TVs.

2017

Transparent OLED TV displays (Invisible TV)
Approx. weight (kg) n/a
Manufacturers are developing prototypes for transparent TV displays.

Product Design Criteria of Manufacturers

DELL	Dell considers the environment at every stage of the product lifecycle, starting with how a product is designed. For example, glues and adhesives can create processing challenges for recyclers, so they have come up with other methods, such as innovative snap-fits, to accomplish the same design goals. [19]
LENOVO	Lenovo products are designed to minimize the types of plastics they contain, and avoid plastic contamination by paints, glues or welded connections.[20]
SONY	To make it easier to recycle products after disposal, ease of disassembly is included in Sony's product design criteria. This means reducing the number of screws, and labelling the material type of plastic use in parts to make it easier to extract resources during recycling.[21]
SAMSUNG	Samsung is reducing the use of screws in their TVs, in favour of snap connections which allow a faster and easier disassembly of their devices. In addition, display sets are being marked with a mercury free symbol to indicate that they can be recycled mechanically.[22]

Employees disassemble an LCD television. Courtesy of Sony of Canada Ltd.

Design Workshops to Support Recycling

Since 2006, **Sony** has regularly held workshops on recyclability with product designers, mechanical designers, and other employees. The workshops aim to reaffirm the importance of and need for considering recyclability in product designs, and to ensure those ideas are later applied when creating products.[23]

Recycled Materials in Electronic Devices

Dell Latitude 3000 Series Laptop. Courtesy of Dell Inc.

In 2016, **Dell** introduced recycled carbon fiber into two products (Alienware and Latitude laptops). As an industry first, they partnered with their supplier SABIC to recycle excess, scrap carbon fiber into material used for enclosure parts.[24]

Canon strives for recycling-conscious designs in their products. For example, certain components of Canon's image RUNNER ADVANCE series multifunctional devices (C5051F-R, C5035F-R, and C9065 PRO) are designed with 100% recycled plastic and bio-based plastic.[25]

Canon has been collecting and recycling ink cartridges used in various devices, such as inkjet printers, for the past two decades. In 2014, Canon Ecology Industry Inc., Canon's recycling hub in Japan, began operation of an automated recycling system for used ink cartridges called CARS-I (Canon Automated Recycling System for Ink Cartridges). This technology has enabled them not only to significantly boost its recycling processing capacity but also increase its material recycle yield.[26]

Apple melted down iPhone 6 aluminum enclosures, recovered from their disassembly robot Liam, to make Mac mini computers for use in their factories. Apple is also transitioning to 100 percent recycled tin solder on the main logic board of iPhone 6s.[27]

Panasonic jointly with **Toshiba** Corporation established Ecology Net Co., Ltd., a geographically dispersed recycling network in Japan. Their recycling factories conduct research to improve their recycling processes for more efficient treatment of home appliances, and for the recovery and supply of more resources. In 2016, two facilities, (Panasonic Eco Technology Kanto Co., Ltd (PETECK), and Chubu Eco Technology Co., Ltd (CETEC), installed automatic screw removers in the disassembly process to improve recycling productivity of discarded flat screen TVs.[28]

Canadians removed approximately 82,300 tonnes of CO_2 equivalents by recycling e-waste. This amount equates to the removal of 17,377 passenger vehicles from the roads annually.

Recycling Diverts E-Waste from Landfill which Contributes to GHG Reductions

Greenhouse gas (GHG) emissions are reduced by e-waste recycling. Responsible recycling of electronic devices diverts materials from landfill while creating a second life for valuable materials and at the same time, reducing reliance on virgin resources.

Figure 4 presents the total of CO_2 equivalents avoided and WEEE (Waste Electrical and Electronic Equipment) collected from Canadian recycling programs over the past six years. In 2015, Canada recycled over 137,000 tonnes of electronics, as reported by Electronics Product Recycling Association (EPRA), Ontario Electronics Stewardship (OES) and Alberta Recycling Management Authority (ARMA).

Using a formula developed by PRé Consulting, in the Netherlands, and combining it with US EPA factors for distances, Canadians removed approximately 82,300 tonnes of CO_2 equivalents by recycling e-waste[29]. This equates to the removal of 17,377 passenger vehicles from the roads annually.[30]

Avoided GHG Emissions

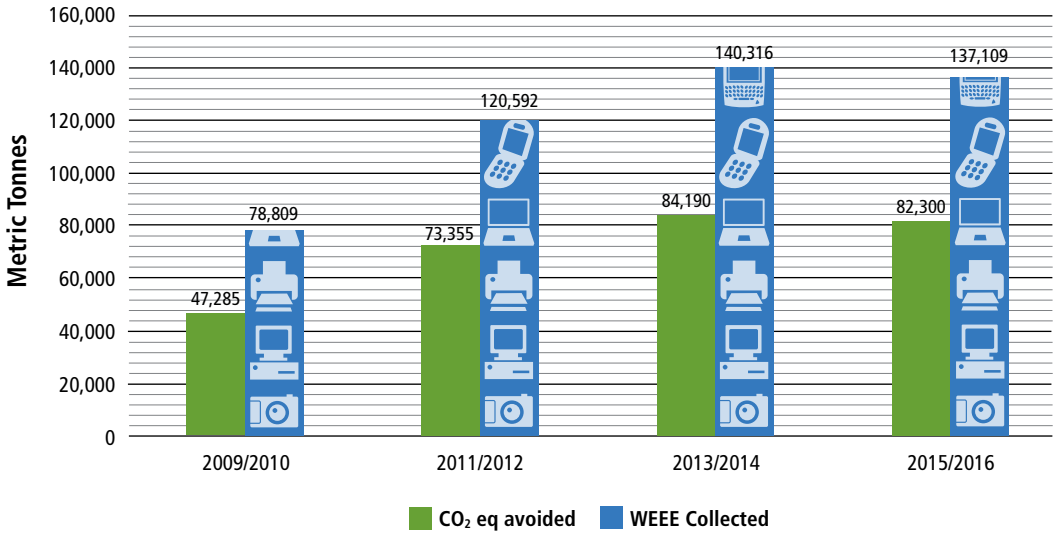


Figure 4: Total of CO_2 equivalents avoided and WEEE collected from Canadian Recycling Programs (2009-2016).

Managing Industrial, Commercial, and Institutional (IC&I) Electronics

IC&I products lend themselves to an extended life. Many are on lease arrangements or have multiple units coming back for refurbishment. Because of their inherent value, IC&I products need to be treated differently and not included in waste diversion regulations. When IC&I products are included in recycling regulations, incentives are placed on recycling over reuse.

Canon imageRUNNER ADVANCE C9065 PRO, an example of IC&I equipment. Courtesy of Canon Canada Inc.

IC&I equipment (floor standing printers, photocopiers, multifunctional devices, computer and monitors) are often leased on plans of 3-5 years to government offices, banks, large companies, schools, and other institutions.

Compared to consumer electronics, IC&I products have significant value in the refurbishment and recycling markets. The equipment can be refurbished and sold into secondary markets or harvested for parts, ultimately providing a viable revenue generating business.

EPSC supports the competitive market for extracting the maximum value from end of life electronics. The responsibility of IC&I products should continue with the generators, who manage discarded equipment through commercial lease and take-back services.

Manufacturers often have their own programs to take back IC&I equipment. Information is available on company websites.

Environmental Education and Standards

Environmental education and standards help meet a growing demand for information on sustainable electronic products, while ensuring products meet strict environmental criteria.

For large-scale purchasers (i.e. governments, schools, and other institutions, who are increasingly requesting sustainable products, certifications and ecolabels offer easy access to electronic products that meet environmental standards.

Electronic Product Environment Assessment Tool (EPEAT)

EPEAT is an environmental product rating system for electronic devices. Products are rated against a range of environmental performance criteria covering the lifecycle of a product. Products must meet all required criteria to be registered. The criteria are based on the Institute of Electrical and Electronics Engineers (IEEE) 1680 standards for performance criteria for the design of electronic products, which are developed through an open consensus-based multi-stakeholder process. The EPEAT ecolabel offers purchasers a single, credible performance rating to identify leaders in sustainable IT supply chain.

EPEAT Registered Products in Canada

161 EPEAT
Bronze-rated products

901 EPEAT
Silver-rated products

769 EPEAT
Gold-rated products

EPEAT's Environmental Performance Criteria (for PC and Displays)

Assessment Criteria	Required	Optional
Reduction/elimination of environmental sensitive materials	✔ Compliance with provisions of European ROHs Directive ✔ Reporting on amount of mercury used in light sources ✔ Elimination of intentionally added SCCP flame retardants and plasticizers in certain applications	✔ Elimination of intentionally added cadmium, mercury, lead, hexavalent chromium (in certain applications) ✔ Low threshold for amount of mercury used in light sources ✔ Large plastic parts free of certain flame retardants ✔ Batteries free of lead, cadmium, and mercury ✔ Large plastic parts free of PVC
Materials selection	✔ Declaration of postconsumer recycled plastic content ✔ Declaration of renewable/bio-based plastic materials content ✔ Declaration of product weight	✔ Minimum content of postconsumer recycled plastic ✔ Higher content of postconsumer recycled plastic ✔ Minimum content of renewable/bio-based plastic material
Design for end of life	✔ Identification of materials with special handling needs ✔ Elimination of paints or coatings that are not compatible with recycling or reuse ✔ Easy disassembly of external enclosure ✔ Marking of plastic components ✔ Identification and removal of components containing hazardous materials ✔ Minimum 65 percent reusable/recyclable	✔ Reduced number of plastic material types ✔ Molded/glued in metal eliminated or removable ✔ Minimum 90 percent reusable/recyclable ✔ Manual separation of plastics ✔ Marking of plastics
Product longevity/life cycle extension	✔ Availability of additional 3 year warranty or service agreement ✔ Upgradeable with common tools	✔ Modular design ✔ Availability of replacement parts
Energy conservation	✔ ENERGY STAR® label	✔ Early adoption of new ENERGY STAR® specification ✔ Renewable energy accessory available
End of life management	✔ Provision of product take-back service ✔ Provision of rechargeable battery take-back service	✔ Auditing of recycling vendors
Corporate performance	✔ Demonstration of corporate environmental policy consistent with ISO 14001 ✔ Self-certified environmental management system for design and manufacturing	✔ Third-party certified environmental management system for design and manufacturing organizations ✔ Corporate report based on GRI
Packaging	✔ Reduction/elimination of intentionally added toxics in packaging ✔ Separable packing materials ✔ Declaration of recycled content in packaging	✔ Packaging 90% recyclable and plastic labeled ✔ Minimum postconsumer content guidelines ✔ Provision of take-back program for packaging ✔ Documentation of reusable packaging

Products are measured against both Required and Optional criteria, and fall under three rating categories:

- EPEAT Bronze-rated products: must meet all of the Required criteria in its category.
- EPEAT Silver-rated products: must meet all Required criteria and at least 50% of the Optional criteria.
- EPEAT Gold-rated products: must meet all Required criteria and at least 75% of the Optional criteria.

Specific criteria on material selection and design are helping to drive the demand for recycled materials in electronic devices.[31] Currently, there are 1,831 electronic products registered in Canada, with products being continuously added to the Registry. Products include: computers, notebooks, tablets, multifunction devices, printers, and scanners.[32]

For more details of the specific products and manufacturers registered under EPEAT, please visit: http://ww2.epeat.net/searchoptions.aspx.

The following Canadian governments and educational institutions include EPEAT requirements in their purchasing specifications:

Government
Canadian Government
Province of Nova Scotia
Province of Quebec
City of Vancouver, BC

Schools
Concordia University
Dalhousie University
Fleming College
George Brown College
Loyalist College
McGill University
Nova Scotia Community College
Thompson Rivers University
Université Laval
Université de Montréal
University of Ontario Institute of Technology
University of Regina
University of Victoria
University of Winnipeg
Western University (University of Western Ontario)
York University

TCO Certification

TCO Certified is an international third-party sustainability certification for IT products. Products are verified to criteria in all life cycle phases of the device, from manufacturing through use, to end of life. The criteria are based on research and international dialog with multiple stakeholders representing users, industry, interest organizations and independent experts.[33]

For more information on the specific products and manufacturers registered under TCO, please visit: http://tcocertified.com/tco-certified/.

Improving Energy Efficiency

The electronics industry supports energy efficiency standards. Manufacturers are continually improving the energy performance in their products.

Driving reduction in product energy use is viewed as a key design objective for electronic manufacturers. New models of electronic products are more energy efficient than older models. Page 15 provides examples of improved energy performance of electronic devices.

Improvements in Product Energy Efficiency

APPLE	Since 2008, Apple has reduced the average energy consumed by Apple products by 70 percent. MacBook Pro consumes 15 percent less energy than the previous MacBook Pro models. iMac consumes 97 percent less energy in sleep mode than the first generation. Mac mini consumes 40 percent less power when idle than the previous generation.[34]
DELL	Since 2011, Dell has reduced the average energy intensity of the entire product line by 43 percent, with a goal of reducing it by 80 percent by the year 2020. As an example, a Dell laptop purchased in 2015 only cost approximately US $3.10 per year to power, compared to US $7.03 per year in 2010.[35]
HP	Due in part to its slimmer size, the HP EliteDesk 800 G2 Desktop Mini uses 31% less energy than its predecessor and 92% less energy than the EliteDesk 800 G1 Ultra-Slim Desktop. Since 2010, HP has reduced the energy consumption of their personal system portfolio by 25% on average.[36]
IBM	In 2015, IBM released five models of their power systems servers (the one-socket S812LC; the two-socket S822L, S822LC and S824L; and the four-socket E850). These Power Systems servers continue to use 80 PLUS Platinum certified power supplies, one grade above ENERGY STAR requirements and two grades above requirements under the European Union Directive 2009/12/EC, which provides eco-design requirements for computer servers.[37]

ENERGY STAR®

The voluntary and globally aligned ENERGY STAR program, administrated by Natural Resources Canada, was established to identify and promote energy efficient products to consumers. The ENERGY STAR label indicates that a product meets or exceeds high energy efficiency standards.

Electronic products that are eligible for ENERGY STAR include: computers, display devices (monitors), imaging equipment, small network equipment, televisions, audio/video products (DVD, MP3 speaker docks, sound bars), cordless phones, set-top boxes, and televisions.

The full list of qualified electronic products can be viewed on the Natural Resources Canada website.[38]

In 2017, ENERGY STAR introduced ENERGY STAR Most Efficient 2017, a new distinction that recognizes products that deliver cutting edge energy efficiency along with the latest technological innovation. It is an award that represents the best of ENERGY STAR. Under monitors, the following companies' products were listed: **Asus, BenQ, Dell, Fujitsu, HP, LG, Lenovo, Philips** and **Samsung**.[39]

Improving Manufacturing and Operation Facilities

Responsible manufacturing and operations includes identifying opportunities to reduce energy and water consumption.

Devices instrumented to monitor energy data, as a part of Cisco's energy reduction pilot program. Courtesy of Cisco Systems, Inc. Unauthorized use not permitted.[42]

Reducing Energy Use During Manufacturing

In 2015, **Cisco** launched an energy reduction pilot program. Approximately 1,300 devices were installed in one of their Malaysian manufacturing plants to measure energy data on assembly lines, test floors, equipment (temperature chambers, chillers, heaters, compressors) and on the specialized energy use of nitrogen flow. Their energy management solution is a cloud-based software and analytics package that measures, monitors, and manages the energy consumption of any connected device. This initiative is estimated to save 20 to 30 percent in energy usage, and reduce greenhouse gas emissions in the supply chain. Cisco is looking to expand the program globally in 2017 by sharing best practices and establishing goals for technological adoption.[40, 41]

Increasing Use of Renewable Energy

In 2016, 96 percent of the electricity used at **Apple**'s global facilities came from renewable energy, reducing their carbon emissions by nearly 585,000 metric tons. Apple is also helping their suppliers switch to renewable energy. Ibiden, which produces Apple's integrated circuit packaging substrates, has committed to generating renewable energy by developing one of the largest floating solar projects in Japan. Ibiden's floating solar project will help it reach its 100 percent renewable energy goal for Apple by the end of 2018.[43]

Reducing Water Consumption During Manufacturing

IBM introduced its first water conservation goal in 2000, focusing on water use in microelectronics manufacturing operations. IBM's Watson Research Center in Yorktown Heights, New York, implemented a rooftop rainwater harvesting system that captures more than 1 million gallons of water for reuse in the site's cooling towers annually. Overall, from 2000 to 2015, IBM's conservation efforts avoided the use of 21.3 million cubic meters of water in its manufacturing operations.[44]

Improving Packaging Innovation and Efficiency

Packaging design is constantly being improved to minimize the use of materials, energy resources, and transport emissions.

Cisco incorporated the reduction of packaging into their Design for Environment principles. With guided consumer input, Cisco launched Pack It Green 2.0, an initiative to limit packaging waste and reduce unwanted/redundant items that are often included in a typical shipment. With this Pack It Green 2.0 initiative, approximately 1,368 cumulative metric tonnes of material (corrugated board, plastic, wood, CDs/DVDs, cables, and other materials) and 7,432 cumulative metric tonnes of CO_2 were avoided in Cisco's fiscal year 2016. The CO_2 emissions were avoided through reduced material and freight weight reduction.[45]

Lenovo reduces their overall volume of packaging material by using recycled and recyclable materials, smaller-sized boxes, and reusable bulk packaging. In 2015, they refined their ThinkPad X250 packaging design by increasing the pallet density from 84 units per pallet to 90.

Dell's packaging material for the XPS 13 2-In-1 laptop made from recycled ocean plastics. Courtesy of Dell Canada.

Ocean Plastics in Packaging

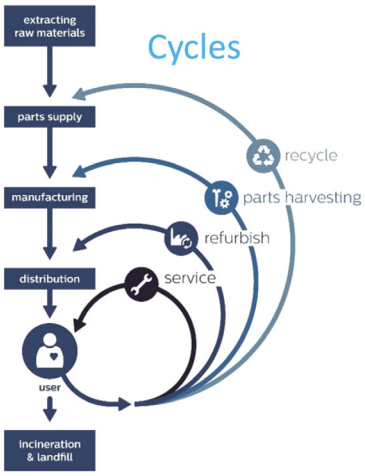
Dell is creating the first commercial-scale global ocean plastics supply chain. They are processing plastics collected from beaches, waterways and coastal areas and using them as part of a new packaging system for the XPS 13 2-In-1 laptop, globally. This project will help keep 7,260 kg (16,000 pounds) of plastics out of the ocean.[46]

By the end of 2016, 72 percent of Dell's flat-panel monitor shipments and 65 percent of desktop/all-in-one shipments were packaged entirely in sustainability sourced materials.[47]

Building a Circular Economy

The electronics industry is embracing the circular economy.

Industry leaders are currently introducing the principles of a circular economy approach into their product design, supply chain, and operations. Unlike traditional linear models of "take, make, waste", the circular economy approach as defined by the Ellen MacArthur Foundation strives to be "*restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times.*"[48]



Circular Economy Model (adapted from Ellen MacArthur Foundation). Courtesy of Philips.

For the electronics industry, a circular economy model promotes existing principles of environmental design that aim to achieve:

- closed-loop recycling systems
- service offerings to increase product longevity
- energy and water conservation of manufacturing and operating facilities

To support the transition into a circular economic model, manufacturers such as, **Apple, Cisco, Dell, HP, IBM, Lexmark** and **Philips** are members of the Ellen MacArthur Foundation's (EMF) Circular Economy 100 (CE100). The Foundation provides a platform for businesses to develop circular economy initiatives and to address challenges to implement them.[49]

From manufacturing to end of life, the electronics industry is highly intertwined and dependent on international streams of materials for reuse and recycling activities. Ultimately, pursuits to implement a circular economy strategy is a global endeavor.

Recycling as a Closed-Loop System

Dell operates a third-party certified, closed-loop plastics supply chain. The initiative incorporates plastics from electronics recovered through their takeback services and partners. The plastics are collected, sorted, and processed for shipment to Asia where they become blended with virgin materials and formed into new parts. The closed-loop plastics are used in 48 Dell products such as flat panel monitors and desktops.[50]

3D Printing Technology: A Facilitator of the Circular Economy

Launched in 2016, **HP**'s 3D printing solution, Jet Fusion, is an important enabler of the circular economy. This technology facilitates efficient materials use by streamlining the prototyping processes, improving the economics of short-run manufacturing, and avoiding waste associated with mass production.[51]

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About EPSC

Electronics Product Stewardship Canada (EPSC) is a not-for-profit, industry-led organization working to represent the interests of electronics manufacturers for innovation in enhanced end of life solutions for electronic products in Canada.

EPSC members have shown environmental leadership by working with stakeholders to create effective environmental stewardship programs across Canada, by investing in design improvements to their products and processes, and by establishing an innovative standard for the responsible handling of end of life electronics.

Responsible electronics manufacturers are members of EPSC:

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- Canon Canada Inc.
- Cisco Systems Inc.
- Dell Canada Inc.
- HP Canada Co.
- IBM Canada Ltd.
- Lenovo Canada Inc.
- Panasonic Canada Inc.
- Samsung Electronics Canada Inc.
- Sony of Canada Ltd.

Associate Members

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- BenQ America Corp.
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- Oracle America Inc.
- MMD-Philips
- Ricoh Canada Inc.
- Toshiba of Canada Ltd.
- Vizio Inc.
- Xerox Canada Ltd.

Sustainability Reports from EPSC Members

Apple Canada Inc. – https://images.apple.com/ca/environment/pdf/Apple_Environmental_Responsibility_Report_2017.pdf
Canon Canada Inc. – http://www.canon.com/csr/report/pdf/canon-sus-2016-e.pdf
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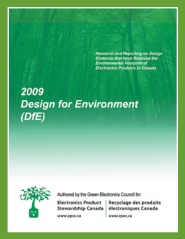

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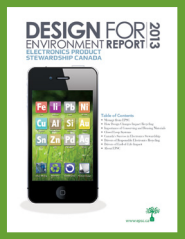

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