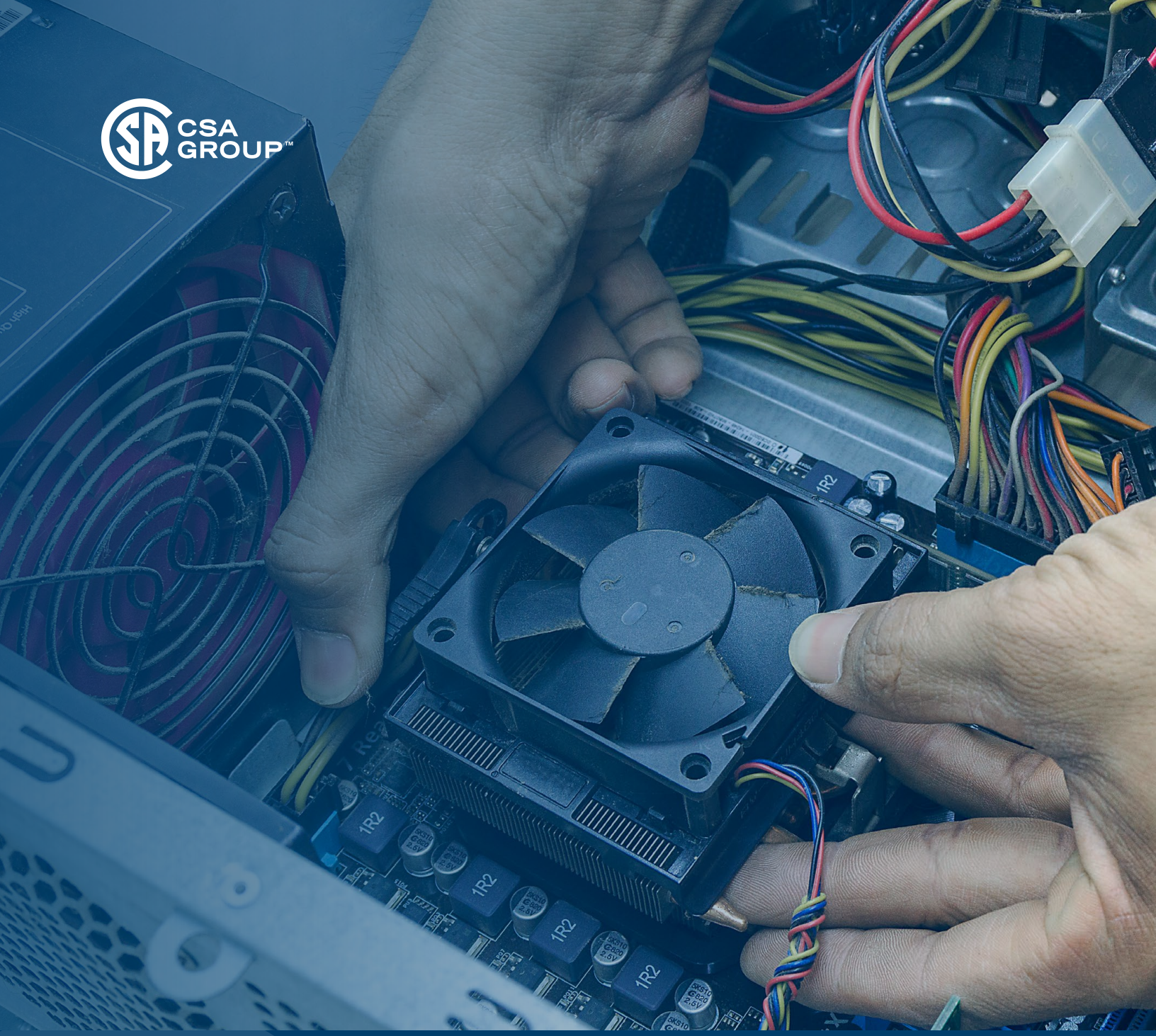

STANDARDS RESEARCH

Landscape Review of Repairability in Canada

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Table of Contents

Executive Summary

Current linear models of production and consumption (i.e., take–make–waste) have proven to be unsustainable. Many products are designed and used with a limited life and diminishing value, and the environmental and social costs are not factored into the purchase price. Canada's resource-based economy depends on the ability to preserve the value of finite resources and natural capital for success. A circular economy is built on production and consumption models that redefine value and include environmental protection, social well-being, and economic health. Core to activating a circular economy is extending the useful lifespan of products and the materials inherent to them [1].

The opportunity that repairability presents—to extend product life, facilitate reuse, and prevent usable goods and their parts from being lost to disposal—is gathering significant attention as Canada transitions to a circular economy. Value-retention processes (VRPs), which include arranging direct reuse, repair, refurbishment, and remanufacturing, are critical activities that must be prioritized and encouraged. Although the benefits that product repairability contributes to the environment and economy in Canada are significant, there are barriers to participation in repair activities.

This report explores the current landscape of repair in Canada and provides a summary of the intervention options to encourage increased participation in repair activities and better repairability of products. This research was undertaken through a literature review and stakeholder interviews with experts from government, industry, academia, and consumer advocacy organizations.

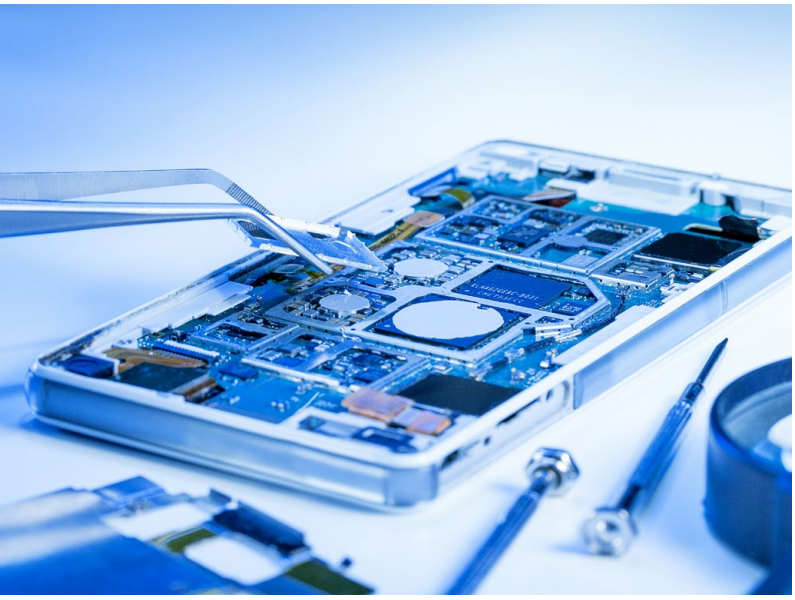
Four product categories were selected for this research: automotive, agricultural, home appliances, and consumer electronics. These categories represent a wide array of consumer-facing products where improved access to repair can have impactful environmental, social and economic outcomes. Further, these product categories are often at the forefront of right to repair movements, regulatory amendments, and standards development.

The literature review and stakeholder interviews revealed that product repair is hindered by three key barriers:

1. Consumer perceptions and willingness to participate in repair activities;
2. Availability of tools, parts, and technical knowledge to execute repairs; and
3. Technical barriers that are inherent to the products themselves.

Interventions for improved repairability include standards development and regulatory interventions. Standards-based tools can provide a benchmark for repairability of a product so consumers can make informed choices at the point of purchase. Standards can also help support product design that considers technical barriers to repair. Regulatory interventions can help increase repairability by reducing product design barriers, enhancing consumer protections, and promoting competitive fairness. They have been introduced at international, national, state, and provincial/territorial levels. In Canada, the federal government has included commitments to encourage and facilitate repair in mandate letters to the Minister of Environment and Climate Change, the Minister of Innovation, Science and Industry, and the Minister of Finance [2].

Addressing existing barriers and providing standardized tools with supporting regulations can encourage product repairability and help to advance a circular economy, ultimately leading to increased efficiency in material and energy use, reduced emissions and waste, growth in secondary markets for products that would have been discarded, and support for community-based repair services, training, and solutions.



"Repair is an important value retention activity in advancing the transition from a linear to a circular economy."

1 Introduction

1.1 Background

Value-retention processes (VRPs) are activities that extend the useful life of products and "aim to retain the value of a product within the economic system and help to increase both economic and environmental sustainability" [3]. VRPs include reuse, remanufacturing, refurbishment, and repair [3].

Repair is an important value retention activity in advancing the transition from a linear to a circular economy. Its goal is to improve the value of products by extending their life and use, and by doing so, reduce the environmental impacts of manufacturing new products and those associated with end-of-life disposal.

Environment and Climate Change Canada (ECCC) is currently developing a national strategy to encourage VRPs in Canada. This strategy will also contribute to the government's comprehensive circular economy approach to meet its climate change and zero plastic waste goals by 2030 [3]. According to an ECCC study based on 2019 data, "each year, VRPs prevent approximately 1.6 million tonnes of carbon dioxide equivalent (CO2e) from entering the atmosphere and avoid the use of 470 kilotonnes of virgin materials" [4].

VRPs also contribute significant direct economic benefits, such as employment opportunities, reduction of production costs for manufacturers, and cheaper products for consumers. According to the ECCC study, VRPs support more than 371,000 direct jobs and are worth approximately $56 billion annually, with refurbishment and repair representing 65%, or $37 billion, of this total [4]. Economic projections show that VRP activities could create 23,000 new jobs and generate a least $3 billion in additional revenues [3].

Repair is also a superior approach to recycling at end of life, particularly when product life extension is considered in the design process and repairability is made easily accessible. This is particularly true when it comes to high-value and resource-intensive products, as product repair keeps materials in service longer, increases their overall lifetime value and reduces the need for virgin resources for new manufacturing. Although the benefits that product repairability contributes to the environment and economy in Canada are significant, there are barriers to broader participation in repair activities. If the barriers to repairability are not addressed, many goods, including consumer electronics, home appliances, automobiles, and agricultural equipment, will continue to experience shortened lifespans, increased disposability, and be subject to planned obsolescence.

1.2 Research Objective

The objective of this research was to gain an understanding of the current state of product repair in Canada. This was undertaken through a literature review, environmental scan, and stakeholder interviews to determine gaps, barriers, opportunities, and recommendations.

This report synthesizes the findings and provides preliminary guidance on the potential development of a national guideline and/or standard to support broader uptake and access to product repair and improved repairability of products.

1.3 Definitions

The research revealed that any repair guideline or standard should include clear definitions of the term "repair" to differentiate it from other VRP activities and to facilitate universal understanding across sectors and between stakeholders. To demonstrate, a set of definitions gathered from the literature is included in Table 1.

Table 1: Categories, Definitions, and Examples of Products

Term	Definition
Durability	"Refers to how long a product will last under normal use" [5, pp. 217].
Refurbishment	"Refurbishment can be characterized as exceeding the level of material replacement and renewal activity achieved during product repair, but not meeting the level of structure, industrialization or quality expected from comprehensive refurbishment activities. Refurbishment can be further distinguished from repair activities by the fact that they modify the product unit as such that the usable product life can extend past the designed lifespan" [4, pp. 4]. But it does not result in a full new service life like remanufacturing.
Remanufacture	"Remanufacturing is a full service life VRP that yields products that are 'as good as' or 'better than' new. To qualify as remanufacturing, products must be at a minimum, disassembled, cleaned, tested and documented . . . these products must be also sold with the guarantee that they are in the afore-mentioned 'as good as' or 'better than' new condition" [4, pp. 3].
Repair	"Fixing of a specified fault in an object that is a waste or a product and/or replacing defective components, in order to make the waste or product a fully functional product to be used for its originally intended purpose" [6, pp. 25–26].
Repairability	"The ease with which a product can be repaired" [5, pp. 217].
Value-retention processes (VRPs)	"Activities, typically production-type activities, that enable the completion of, and/or potentially extend a product's service life beyond traditional expected service life. These processes include arranging direct reuse, repair, refurbishment, comprehensive refurbishment and remanufacturing" [6, pp. 26].

2 Research Methods

A literature review and 15 stakeholder interviews were conducted for this report in order to provide a comprehensive examination of product repair across the following five assessment categories:

1. **Regulatory and policy landscape:** A review of regulatory and policy developments about advancing repair, including the current regulatory landscape in Canada, with a focus on the intersection between federal and provincial jurisdictional responsibilities.
2. **Consumer perceptions:** An assessment of the opportunities to improve access to, and increase consumer participation in, product repair activities.
3. **Technical barriers to repairability:** An assessment of the barriers inherent to the design and function of products that limit or impede repairability.
4. **Specific product sector analysis:** An examination of four priority product categories,[1] including consumer electronics, automotive, agricultural equipment, and home appliances (see Table 2), which were selected based on an existing repair ecosystem, how access and options to repair were most likely to be limited, and where improved access to and uptake of repair could provide the most impactful environmental, social, and economic outcomes. A detailed analysis on repair issues specific to each sector is provided.

1 The preliminary list also included aerospace, construction, extraction and refining, health care, textiles and apparel, utilities, and energy.

5. **Outcomes of advancing repair:** Identification, definition, and quantification, where possible, of how repair can advance circular outcomes, including the economic, environmental, and social benefits of repair.

2.1 Literature Review

The literature review included technical and academic papers, policy documents, repairability score cards, and position papers. Website references were sourced from local and international sources, such as news organizations, governments, and peer reviewed journal articles. Relevant literature was also provided by members of the Project Advisory Panel and other experts. Online sources were considered credible if the information was relevant, recent, and objective. Such resources were found through internet search engines (Google and Google Scholar). Keywords used in searches included "repairability", "linear economy", "circular economy", "regulations", "product-as-a-service", "consumer behaviour", "benchmarks", "standards", "competition", "consumer protection", "agriculture industry", "electronics design", "circular design", "manufacturing", "critical minerals", "right to repair", "consumer choice", "carbon emissions", "waste", and "planned obsolescence".

2.2 Stakeholder Interviews

In parallel with the literature review, semi-structured one-on-one interviews were conducted with key stakeholders and experts who could contextualize supporting research around the technical, market, policy, and legal considerations for repair.

Interviews were approximately 1.5 hours in length. Interviewees were selected through consultation with the Project Advisory Panel. Each interviewee was provided with background documents describing the scope and objectives of this research and were also given interview questions in advance (Appendix 1). Each interviewee provided consent for their input, experience, and recommendations to be included in this report.

A total of 15 interviews were conducted with subject matter experts from Canada, the US, and Europe. For a balance of perspectives, at least two interviews were conducted for each product category included in this research (automotive, agricultural, consumer electronics, and home appliances). In addition, three stakeholders from academia were interviewed and provided context on consumer perceptions to repair, broader repair ecosystems, and the technical and policy advancements affecting repairability. Two repair-focused advocacy organizations were also interviewed to provide perspective and background on the consumer right to repair movement. Finally, two policy-makers from the Government of Canada were interviewed to provide input on Canada's mandate to advance VRPs. The detailed questionnaire that was presented to each interviewee is provided in Appendix A.

Table 2: Repair Terminology and Definitions

Product Category	Definition	Examples
Automotive	Motor vehicle that is designed for individual/ personal use on highways and streets	Passenger cars, trucks, minivans, on-the-road vehicles
Agricultural Equipment	Agricultural machinery used in farming or other agriculture	Tractors, combines, planters, tillers, sprayers
Consumer Electronics	Electronic devices bought for personal rather than commercial use	Televisions, computers, smartphones, gaming equipment
Home Appliances	Home appliances, traditionally referred to as white goods, are larger appliances that perform domestic functions like cooking and cleaning	Refrigerators, stoves and ovens, washers, and dryers

3 Right to Repair and Consumer Perceptions

3.1 Right to Repair

Right to repair is a consumer advocacy movement that was once confined to grassroots organizations, DIY enthusiasts, and environmental organizations, but is now gaining the attention of lawmakers, industry, and the broader marketplace in Canada. Right to repair ensures that consumers and repairers are not restricted in their abilities to perform repairs on goods by ensuring they have access to the tools, parts, manuals, and information necessary to conduct repair or offer repair services.

The right to repair movement comes at a time when consumer goods are becoming increasingly digitized and access to the necessary tools, parts, and knowledge for repairability is sometimes restricted. In Canada, policy-makers are introducing regulatory interventions at the federal level to begin to address these issues. For example, Bill C-272 is a private member's bill introduced in February 2021 that proposes to amend the Copyright Act to allow Canadians to repair devices that have digital components, such as smartphones and farm equipment [7], [8]. Furthermore, the issue of improved access to repair and better product repairability was included in several ministerial mandate letters to new legislators in early 2022 [2].

In 2019, the repair advocacy group iFixit commissioned a consumer survey, which found that 75 percent of respondents would support right to repair legislation, while just three percent would oppose it. The survey also revealed that the more familiar people are with right to repair policy, the higher their level of support [9].

It is increasingly complex to advance product repairability because many products have become dependent on embedded software, and internet connectivity is a standard feature. There is now a heightened intersection between repairability, data privacy, security, and intellectual property rights.

Often, the information necessary to diagnose a fault is embedded in technology-reliant products, but it is typically held behind digital locks and may require passwords or special tools to access [5]. Right to repair advocates have identified access to the diagnostic software necessary for repair as a high priority issue.

The expansion of digital dependence was also cited by interviewees as creating increasingly closed ecosystems that reduce consumer choice in terms of the availability of repair options. This type of dependence often restricts consumers to original equipment manufacturer (OEM) repair ecosystems, contributing to concerns that some OEMs are using their dominant marketplace positions in repair markets to restrict competition.

3.2 Consumer Perceptions

It was noted in the stakeholder interviews that repair is one of the most impactful activities individuals can undertake to advance a circular economy. However, without consumer awareness of and willingness to participate in repair activities, the opportunities presented by product repair will not be realized. Public perceptions, attitudes, and motivations are dependent on several factors, including:

- Cost of repair;
- Availability and access to repair options;
- Cost and ease of replacement over repair; and
- Perceived value of the product [4], [5], [6].

A consumer's decision to repair or replace a broken product may be primarily driven by price, but there are other influencing factors, such as the consumer's values and emotional attachment. The inconvenience of repair, extra effort, opportunity cost, and consumer preferences for up-to-date products are also likely to make repair less appealing [5], [9], [10], [11]. Moreover, previous experiences with repair also influence the likelihood that someone will be open to repair in the future.

In the Australian Government's Productivity Commission Inquiry Report, "Right to Repair" [5], consumer products were categorized as follows:

- **Up-to-date:** "The product has important technological and/or fashionable features" [5, pp 58]. Examples include smartphones, clothing, décor.
- **Workhorse:** A product that is "purchased for functionality and reliability" [5, pp. 58]. Examples include washing machines, refrigerators.
- **Investment:** "Products that are expensive, high quality, and purchased with an 'investment' mindset" [5, pp. 58]. Examples include high-end appliances.

The report indicates that consumers may be more willing to repair high-value workhorse products, such as washing machines and dishwashers, than up-to-date products [5]. Furthermore, "people's preference for new technologies and features can make replacement more appealing, whereas people who are more concerned about the environment may prefer to repair" [5, pp. 51].

The stakeholders consulted for this report identified the cost of repair, regardless of product category, as an important factor in the decision to repair or replace a product. The literature review also revealed a connection between the willingness to repair more expensive products and the relative cost of that repair [5], [12]. For example, consumers may be more willing to repair a car at a lower repair-to-replacement ratio than they would a mobile phone.

For some less expensive items, like small household appliances, replacement can be seen as an easier and less expensive option for consumers. In addition, products whose designs are continuously evolving, such as consumer electronics, can be more difficult to repair than products that have remained relatively consistent in design [10], [12].

3.3 Barriers to Accessing Repair

For those facing loss of functionality of their product, engaging in the repair system can be prohibited by the following barriers:

- Belief that their warranty could be void if they participate in 'non-authorized' repairs [5];
- Knowledge of repair options and the ease with which they can access these services;
- Geographic location (distance to repair);
- Socioeconomic factors, including the ability to choose replacement even if repair is the more economical option; and
- Technical knowledge of a consumer, which influences their likelihood to participate in DIY repair activities.

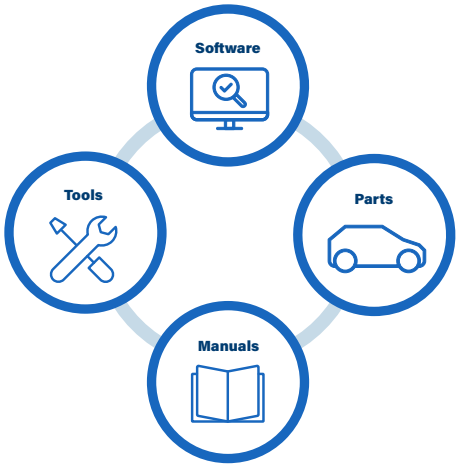
Figure 1 and Figure 2 highlight what is necessary to address these barriers so consumers can participate in repair.

Figure 1: What consumers need to participate in repair.

For customers to participate in repair activities they must possess:

Figure 2: Access requirements for consumers choosing to repair.

For customers who choose repair or those offering repair services, they must have access to:



3.4 Outcomes for Improved Access to Repair

Interviews with right to repair advocates provided the following insights about the possible outcomes of improved access to repair:

- Encourages competition within repair businesses;
- Increases consumer choice for repair services;
- Discourages dominant OEMs from restricting or limiting repair services and replacement parts;
- Emboldens consumers to engage in DIY repair where appropriate and safe to do so; and
- Spurs product design innovation by removing technological barriers such as digital locks.

"With the growing global awareness on the benefits of product repair, there is a corresponding need to introduce policies and regulations for repairability that set parameters for manufacturers and sellers, and that support consumer protections."

In light of consumer perceptions around product repair, allowing consumers to make informed choices about the repair of their products and increasing consumer access to product repair are necessary components to drive change in this area of the circular economy. Such changes can be supported through the regulatory landscape.

4 Regulatory Landscape

With the growing global awareness on the benefits of product repair, there is a corresponding need to introduce policies and regulations for repairability that set parameters for manufacturers and sellers, and that support consumer protections. Several regulatory interventions have been introduced at the international, national, state, and provincial/territorial levels. In some cases, regulations have been introduced as stand-alone measures, while in others, they have been connected to consumer protection, competition, and product warranty policies.

4.1 International

4.1.1 United States

Since 2018, 40 US states have introduced right to repair legislation, including 27 states with active bills in 2021 [13]. In May 2021, in response to a Congressional directive, the Federal Trade Commission (FTC) released "Nixing the Fix: An FTC Report to Congress on Repair Restrictions" [14], which examined consumer protection and antitrust issues related to repair restrictions. As a result, President Biden issued an executive order in July 2021 aimed at promoting competition, which encouraged the FTC to make it easier and cheaper for consumers to repair items. The FTC limited manufacturers from barring self-repairs or third-party repairs of their products and issued rules against anti-competitive behaviour in the repair of consumer products [15].

The State of Massachusetts' Right to Repair Act, introduced in 2013, is based on a guarantee that every vehicle owner should have the right to have it serviced at the facility of their choice [16]. The Act requires that vehicle manufacturers make the same service information and tools available to independent repair shops that they provide to franchised dealers [17]. Initially, the Act and the agreement between the auto repair and OEMs excluded access to telematics,[2] a function that is common in almost all vehicles sold today. In November 2020, the Act was amended to require manufacturers to allow owners/consumers access to telematics or online systems so they may have their vehicle serviced at the repair shop of their choice [16].

4.1.1.1 Warranties

Some regulators examining right to repair issues have made direct linkages between product warranties and consumer repair limitations, probing issues of competitive fairness. As early as 1979, the US enacted the Magnuson-Moss Warranty Act (MMWA), which

2 Real-time diagnostic data and information that is transmitted wirelessly from the vehicle to the manufacturer.

includes provisions that prohibit OEMs or brand holders from using access to warranty coverage as a way of obstructing consumers' abilities to have their products maintained or repaired using third-party repairers [18].

In the "Nixing the Fix" report [14], the FTC acknowledged that the MMWA may not be keeping pace with the evolving consumer goods repair market given the various mechanisms currently used by OEMs to limit or restrict repair, including:

- Product designs that complicate DIY repair;
- Unavailability of parts and repair information;
- Designs that make independent repair less safe;
- Policies or statements that steer consumers to manufacturer repair networks;
- Application of patent rights and enforcement of trademarks;
- Disparagement of non-OEM parts and independent repair;
- Software locks and firmware updates; and
- End User License Agreements (EULA) [14].

4.1.2 European Union

The European Union's repair legislation is housed within the European Commission's Circular Economy Action Plan [19], which includes the Ecodesign for Sustainable Products Regulation and the Ecodesign Directive 2009/125/EC [20]. The Directive sets out the minimum mandatory requirements for energy efficiency as well the repairability, upgradability, durability, and recyclability for certain products [19]. Initially, the repairability aspects of the Directive required manufacturers of household appliances to make select spare parts available to professional repairers for a minimum of seven or ten years, along with repair and maintenance information. The scope of the requirements includes products such as washing machines, washer-dryers, refrigerators, televisions, and other electronic displays [19].

Additionally, the European Committee for Standardization (CEN) established the Material Efficiency Aspects for Ecodesign Joint Technical Committee (CEN-CLC/JTC 10), which produced a group of eight standards with general principles for addressing the material efficiency of energy-related products targeted by the Directive [21].

One of the eight standards focuses on repairability: CSN EN 45554, *General methods for the assessment of the ability to repair, reuse and upgrade energy-related products* [22]. CSN EN 45554 was adopted to support compliance to the Directive and includes methods and criteria to assess whether a product can be repaired, reused, or upgraded. It includes both product and service-related criteria and it guides product evaluation to assess repairability. CSN EN 45554's criteria are:

- Disassembly depth;
- Fasteners and connectors;
- Tools;
- Working environment;
- Skills level required to perform repair;
- Diagnostic support and interface;
- Spare parts availability; and
- Information availability [22].

Similar to Massachusetts' Right to Repair Act [16], the EU also has also established a policy for "right to repair" [23] and has committed to strengthening consumer protection.

4.1.2.1 France

France was the first country in Europe to implement a repairability index (Indice de réparabilité) targeted to five categories of electronic devices: smartphones, laptops, televisions, washing machines, and lawnmowers [24]. Introduced in 2021, its objective is to encourage and educate consumers to choose more repairable products at the point of purchase. Manufacturers are required to calculate and declare a score for each of the targeted products in order to transparently demonstrate the extent to which they can be repaired [24]. The index assesses five criteria: documentation, disassembly, availability of spare parts, price of spare parts, and product-specific aspects. Each criterion is given an initial score out of 20, then the scores on the five criteria are aggregated and converted to a score out of 10. Manufacturers must complete the calculations for each product and submit them to the government. Sellers must display the score and the accompanying colour-coded index shown in Figure 3 near where the products are displayed [24].

Figure 3: Colour-coded index marks for repairability scores in France [24].

4.1.2.2 Spain

Spain has also announced its intention to develop a repairability index and right to repair legislation [25]. In 2021, they began drafting a law that will include information campaigns, labels, and detailed catalogues of criteria for its repairability index, which will begin with electrical and electronic products. Similar to France, manufacturers and importers will be required to calculate and self-report the index in accordance with parameters established in the law [25].

4.1.3 Australia

The Australian Consumer Law [26] provides consumers with rights to obtain a repair, replacement, or refund for defective products through consumer guarantees [27]. While early evaluations demonstrate that the guarantees generally work, concerns remain around the uncertainty of how provisions in the law are interpreted, particularly the term "reasonable" as it relates to:

- Defining any given product's durability or lifespan;
- Availability of spare parts and how long parts and repair facilities should be made available; and
- Whether the guarantees cover software updates [5].

4.2 Canada

Currently, ECCC is developing a strategy to encourage remanufacturing and other VRP activities as part of its work to support a circular economy approach for the management of products and waste, and to advance the agenda on zero plastic waste [4].

In 2021, the federal government also included commitments to encourage and facilitate repair in mandate letters to the Minister of Environment and Climate Change, the Minister of Innovation, Science and Industry, and the Minister of Finance. The following are excerpts from those letters:

- Minister of Environment and Climate Change: "Work with the Minister of Innovation, Science and Industry to implement a "right to repair" to extend the life of home appliances, particularly electronics, and require businesses to inform Canadians of the environmental impacts of consumer products" [2].
- Minister of Innovation, Science and Industry: "Work with the Minister of Environment and Climate Change to implement a 'right to repair' to extend the life of home appliances, particularly electronics, by requiring manufacturers to supply repair manuals and spare parts, and by amending the Copyright Act to allow for the repair of digital devices and systems" [2].
- Deputy Prime Minister and Minister of Finance: "To extend the life of home appliances, introduce a 15 per cent tax credit of up to $500 to cover the cost of repairs performed by technicians" [2].

The issue of repair is directly and indirectly linked to several existing regulations that fall under federal or provincial jurisdiction, including copyright, extended producer responsibility (EPR), and consumer protection.

4.2.1 Copyright Act

In Canada, the Copyright Act [28] is federal legislation aimed at protecting owners and their original creation or works by prohibiting anyone from copying those works. In most contexts, the Copyright Act contemplates creations in art and music, but it also includes protections for computer software, which creates a primary barrier to repair in many product categories [28].

Widespread computerization of products has led to the proliferation of digital locks and technical restrictions that lock out or exclude users from accessing device firmware. Access to firmware is often needed to carry out diagnostics and repair activities. In some cases, these digital locks can completely disable a product where repair is not condoned by the manufacturer. Under the Copyright Act, any attempts to circumvent digital locks without the manufacturer's consent are subject to penalties [28].

4.2.2 Extended Producer Responsibility (EPR)

EPR is a provincial or territorial regulation designed to transfer the financial and operational responsibility of end-of-life management from local governments to producers of goods and packaging. These regulations are intended to incent manufacturers that have direct influence in product design to improve durability, recyclability, and repairability. In Canada, EPR regulations have been introduced for consumer electronics and home appliances.

EPR regulations continue to be adopted and expanded across Canada, but due to their focus on recycling, they generally do not provide sufficient incentives to encourage manufacturers to move up the waste hierarchy, to encourage the design of products that are more durable, or to incentivize reuse activities through repair of products [29].

4.2.3 Consumer Protection

Consumer protection legislation is enacted at the provincial and territorial level of government and is intended to protect consumers from unethical business practices, including false claims. Consumer protection is connected to the idea of consumer rights and choice. Awareness of that protection encourages businesses to employ fair practices and drives transparency, innovation, and, ultimately, quality products and services.

Some provincial governments are beginning to examine the intersection between consumer protection and right to repair. Debates and draft policies have been introduced that contemplate a requirement for manufacturers to ensure consumers have access to parts, tools, and repair services at reasonable costs as part of consumer protection requirements. For example, in 2019, Bill 72, Consumer Protection Amendment Act (Right to Repair Electronic Products) was introduced in the Ontario legislature as a private member's Bill. It includes obligations for manufacturers to uphold warranties on products repaired by independent technicians [30].

A similar Bill was introduced in Quebec in April 2019 to amend the Consumer Protection Act to fight planned obsolesce and assert the right to repair [31]. Under the Bill, a merchant or manufacturer may not refuse to perform a warranty on the grounds that a good was repaired by someone other than the merchant, the manufacturer, or a third person designated to perform the warranty, if the repair was done by a repairer certified by the Office de la protection du consommateur. The Bill institutes an offence for persons who deliberately engage in the practice of planned obsolescence, with offenders being subject to a minimum fine of $10,000 [31].

5 Technical Barriers to Repairability

The results presented in this section are barriers that correlate to the inherent characteristics of a product, and how these features can impede repairability. These are differentiated from the barriers related to consumer access to repair and the regulatory barriers outlined in sections 3 and 4.

Many of the barriers to improved repairability identified in this research, and shown in Figure 4, were consistent across the four product categories (automotive, agricultural, home appliances, and consumer electronics) that were examined. A detailed product category analysis is provided in Section 6, with more specific examples and context related to repairability within each category.

Figure 4: Barriers to repairability.

5.1 Physical Barriers

Physical barriers, which can take a variety of forms, limit the ability to open devices or physically remove and replace component parts [14]. Restrictions can include:

- Highly specialized nuts and bolts that require unique screwheads to open a device or machine;
- Use of glue to close device cases or chassis or secure component parts within a device;
- Use of soldering on motherboards and other technical components that restrict the ability of consumers to replace or upgrade individual components of a product;
- Welding the exterior of products closed, which eliminates the ability to open a device and perform repairs [14].

5.2 Availability of Parts and Repair Manuals

Repairs may be difficult or impossible to perform for individuals or independent repairers without access to specialized or standardized parts, as well as brand and product-specific service manuals.

When parts are controlled through a closed system, justified by OEMs as intellectual property protection or safety/liability concerns, the decision to repair or replace is held by the OEM and not the consumer.

OEMs often have large vertically integrated repair service operations, promoting their own parts and affiliate repair networks over independent repair options [14].

When provided, service manuals offer instructions and guidance on how to fix components that may be broken or not functioning properly, or techniques for troubleshooting other issues [14]. Several repair advocates interviewed noted that manufacturers can limit both the availability of service manuals and the timeframe that spare parts are available, which can further discourage repair.

5.3 Access to Diagnostic Software

Stakeholders identified limited access to diagnostic software as one of the key mechanisms by which repair is discouraged or impeded by OEMs across each product sector covered in this report.

Embedded software and locked diagnostic tools may also force consumers to have maintenance and repair of their products performed only by the manufacturers' authorized service networks [14]. This was noted by right to repair advocates as a significant emerging barrier to access repair services.

5.4 Digital Rights Management (DRM) and Technical Protection Measures (TPM)

DRM and TPM are software access control technologies implemented by OEMs [14]. Similar to providing access to physical service manuals or repair instructions, OEMs claim that software access control mechanisms are necessary to protect their intellectual property and copyrighted products or services. However, these claims of intellectual property or copyright protection are often misapplied in the context of the protection of parts and manuals and do not reflect the intended purpose of these regulations.

Furthermore, to conduct repairs on many consumer goods, it is necessary to access embedded software. For example, while consumers may own their phone hardware, they do not own the software that is necessary for it to function. OEMs require consumers to agree to the terms of a EULA to access this software, and OEMs can then use the EULA terms to restrict access to repair options by locking the software and preventing its modification.

5.5 Design Barriers

Product design is another factor that can play a significant role in preventing repair. It often takes the form of designing products with low-quality material that results in low durability and limited options for repair.

Many challenges for repairability result from decisions at the design phase, including the increased use of customized parts, glue and fasteners, and the related inventory of parts [32]. These design-phase decisions restrict access, disassembly, and reassembly actions. If it cannot be taken apart, it cannot be fixed.

It may be difficult to directly influence design and repair options for domestic markets when the design and manufacturing of products within the four categories studied in this report are not limited by Canadian borders. However, stakeholders noted during the interviews that consumer pressure or choice for better repairability in all markets could indirectly influence design.

"The environmental benefits of reducing turnover and replacement in consumer electronics are significant, and include reducing solid waste, increasing materials recovery, and decreasing non-renewable materials via more robust recovery and recycling systems."

5.6 Accessing Batteries

There are considerable challenges in replacing batteries for most consumer goods. This simple repair, which can be the easiest way to extend the useful life of a product, is often frustrated by the use of glue and other fasteners that prevent access. The type of battery used and how it is joined to the product can also lead to safety issues [14]. Furthermore, the use of glue to fasten polymer cells into mobile phones and other devices increases the risk that the cells will be punctured when they are removed or removed with incorrect tools [14].

5.7 Claims of Safety, Privacy, and Liability

Manufacturers may be cautious and protective of their repair infrastructure (e.g., tools, parts, and manuals) due to claims of safety or fears that they may be held legally liable for any issues, safety, or harm that arise due to unqualified service technicians or DIY repairs.

OEMs may also claim to limit access to repair infrastructure to prevent security risks in order to protect consumers. "In particular, they argue that unauthorised repair or replacement of device components can disable key hardware or software security features, or impede firmware updates for device security or system integrity" [5, pp. 128].

6 Product Sector Analysis

In this section, a sector-specific analysis pertaining to access to repair and the repairability of products is presented for the four product categories studied in this report: consumer electronics, automotive, agricultural equipment, and home appliances.

6.1 Consumer Electronics

In this report, consumer electronics are defined as electronic devices, such as televisions, computers, or smartphones, bought for personal rather than commercial use. However, it should be noted that smartphones were cited and referred to in the literature review and stakeholder interviews more frequently, and were the device most often discussed in the context of the right to repair movement.

The environmental benefits of reducing turnover and replacement in consumer electronics are significant, and include reducing solid waste, increasing materials recovery, and decreasing non-renewable materials via more robust recovery and recycling systems.

In the US, smartphones are replaced approximately every three years [33]. However, data from Statistics Canada suggests that:

> *"Canadian households are retaining their cell phones and computers longer in recent years than they were a decade ago, as evidenced by a decrease in the proportion of households having one of these devices to dispose of while ownership levels remained fairly steady" [34, pp. 8].*

There was consensus from the academic stakeholders that access to parts, tools, and manuals was critical to improving repairability for consumer electronics.

However, consumer advocacy groups noted that, even when parts, tools, and the necessary knowledge to repair products exist, some consumers believe that replacement is a better, faster, and more economical option than repair. For some low-cost consumer electronics, replacement may be the preferred or only option for consumers.

For consumer electronics that rely on software for their primary functionality (e.g., smartphones), consumers purchase the hardware and are granted access to the software through EULAs. These access controls could narrow market competition and potentially increase the costs for consumers to perform repairs.

Unlike home appliances or automotive products, the barriers to replacement for consumer electronics are often lower and this can present a challenge to encouraging repair. It was noted that design barriers were more persistent in restricting access to repair for consumer electronics than for any other product category.

6.2 Home Appliances

Home appliances, traditionally referred to as white goods, include larger appliances such as refrigerators, stoves, washers, and dryers. Appliance repair currently contributes $922 million annually to the Canadian economy and includes 3,330 jobs, with a labour income of approximately $192 million [35].

In Canada, OEMs have a robust network of approved service providers that they access to conduct in-home repairs. Unlike other consumer products, large home appliances often have repair instructions, parts inventories, and manuals embedded within the equipment.

Embedded software and internet capability is becoming more normalized for home appliances, which is creating similar issues to those seen in consumer electronics. This is largely due to the limitations around accessing diagnostic software that are put in place by OEMs. Having more complicated electronic equipment embedded in home appliances can be necessary for their proper function and is increasing the need for—and frequency of—repair.

Unlike other consumer products, the repair of home appliances is often conducted within the home and involves service technicians that must be qualified by certain regulatory bodies to safely manage water, electrical, and gas hookups. It was noted in the interviews that OEMs in this category often point to safety issues as a reason to restrict access to repair options to qualified service professionals within their network.

Barriers to improved repairability in the home appliance sector often revolve around the high cost of replacement parts and the cost of labour for repairs that fall outside of a warranty. Furthermore, as technological advances are made in this product category, it may be more environmentally beneficial in some cases to replace an appliance rather than repair, even when repair is a viable option. For example, an older refrigerator may rely on restricted or unavailable refrigerants, or it may demand more energy to operate. Even though it could be repaired, the environmental outcomes may be better served by replacing the product with one that is more energy efficient and uses fewer toxic components.

Home appliances are often considered workhorse products by consumers [5]. As such, they might be best suited for the uptake of a repairability standard of all the sectors studied [5]. Home appliances are often only replaced when they experience a loss of functionality; at this point, repairability might then be top of mind for consumers. A standard or product repairability assessment tool would help consumers make repair-savvy buying decisions between products at the point of purchase.

6.3 Automotive

Automobiles are frequently repaired by consumers due to their value, higher purchase price, normalized repair behaviour, and the infrastructure available to facilitate repair. This is supported by a robust repair and maintenance industry that makes up the largest share of aftermarket repair and maintenance activity in Canada. Automotive mechanic services contributed an estimated $10 billion to the economy in 2021 [36].

The automotive industry demonstrates that in certain contexts, aftermarkets can significantly increase consumers' repair options, while other industries have not adopted such robust open market options [14].

The automotive industry also has greater standardization of parts compared to the other sectors studied for this report, likely because of the required maintenance for continued operability and safety of automobiles. However, repair and availability of parts is becoming more complex as vehicles are increasingly computerized [5]. Telematics, which collect information on the operation and status of a vehicle and wirelessly relay it to a central location, are often controlled by the OEM or dealer of the vehicle.

Easy and clear access to information on vehicle repair and maintenance is critical to guaranteeing open competition on the vehicle repair aftermarket. For aftermarkets to be successful, independent operators must have restriction-free and standardized access to information for repair and maintenance of vehicles. Discrimination of authorized dealers and independent repairers should be avoided [37].

Auto mechanics also contend that there is limited incentive to work on electric vehicle (EV) equipment because of the complexity in dealing with diagnostics systems and the relatively lower number of EV vehicles currently in use [38]. Moreover, the need for complicated software diagnostic tools with EVs also increases the cost of repair. By comparison, the average cost of repairs is nearly three percent higher for a small EV compared to a small internal-combustion engine car [39].

Given that EV technology is still relatively new, the availability of service technicians who are trained to operate and service EV vehicles is still limited. Access to, and standardization of, diagnostic software and tools was identified by the interviewees as the most critical intervention to improving repair options. Consumers are often restricted to accessing repair options through OEM ecosystems. It was noted that if the repair industry and options for consumers do not keep pace with the growing market-share of EV vehicles, repairability for consumers outside of OEM ecosystems will be greatly diminished.

6.4 Agricultural Equipment

In 2021, the Canadian agriculture and agri-food sector employed 2.1 million people, meaning that it accounted for one in nine jobs in Canada, and the sector generated $134.9 billion (approximately 6.8%) of Canada's gross domestic product [40]. Farm equipment can be divided into two broad categories: large machinery, such as tractors and harvesters, and smaller equipment, such as tillage, planting, and haying equipment.

The agricultural sector has experienced increasing consolidation and is transitioning toward more complex and costly machinery that is increasingly automated [5]. Similar to the increasing reliance on embedded software for proper functionality in automobiles, newer agricultural equipment requires software to diagnose issues when conducting repair.

When agricultural equipment fails, the timeframe for repair is critical. Timely access to diagnostic equipment, tools, and expertise to engage in repair is essential for the industry [5], where economic losses are compounded by the environmental impacts of food loss and waste caused by downtime. Furthermore, given the rural nature of agriculture, having to travel long distances to access repair services is not ideal from an economic or environmental perspective.

In response to increasing wait time for repairs, stakeholders noted that farmers are increasingly substituting away from high-tech, software-enabled equipment and returning to older equipment that may be more easily repaired by the farmer or by a qualified local technician, even if the purchase price points are comparable to new.

Once loyal to a particular brand of large equipment manufacturers, farmers are now selecting equipment from manufacturers that allow them to select add-on equipment that can be adapted and more easily repaired, has better interoperability, and is less likely to commit them to a particular software ecosystem.

In addition, data collected through software-enabled equipment is neither owned nor controlled by the farmers, which presents significant issues in terms of accessing the diagnostic data necessary to predict or conduct repairs. It was noted by industry experts that given its business-to-business nature and the continuing consolidation of the industry, improving repair in the agricultural sector will likely require regulatory interventions.

7 Environmental, Social, and Economic Outcomes

VRPs, including repair, support a circular economy for the management of products and waste and advance the comprehensive federal agenda on climate change and zero plastic waste [3]. Although consumer rights are directly implicated and impacted by measures to improve the repairability of products and access to repair services, VRPs are being considered in Canada for their ability to achieve environmental, social, and circular economic gains. The most significant gains are described in this section.

7.1 Environmental

The environmental gains from product repair should be considered from many perspectives, including natural resource extraction and conservation of rare earth metals, biodiversity loss, embedded carbon, energy use, and end-of-life disposal. Effective product design and the reuse of materials facilitated by repair, which would otherwise end up in disposal, can help to reduce the detrimental environmental impact caused by excess mining of non-renewable resources, the corresponding biodiversity loss, and the premature disposal of products [5].

7.1.1 Resource Recovery and E-Waste

Electronic waste (e-waste) refers to electrical or electronic equipment that is no longer wanted, and includes smart devices, used cables, batteries, and fluorescent lights [41]. Many of the materials and minerals contained in the electronic components of products cannot be recovered through recycling. Due to the fragility of the global supply chains for rare earth metals, this is a topic of interest in many countries and is becoming a primary motivator for increasing repair and reuse in products that contain these materials [42].

Consumer electronics contain many finite resources, are typically resource-intensive, and often have global supply chains with significant carbon footprints. According to a study by the Borderstep Institute, "about 1.8 to 3.2 percent of global greenhouse gas emissions are due to the manufacture and operation of digital devices and infrastructure" [43].

The management of e-waste can have significant global environmental and social impacts. In 2019, 53.6 million metric tonnes of e-waste was produced globally, and it is one of the fastest growing waste streams in the world [44]. In 2017, Canada alone generated 638,300 tonnes of e-waste from electronic and electrical equipment, and that amount is expected to increase [45]. It is estimated that Canada and the US will cumulatively generate 9.25 million metric tonnes of e-waste in 2025 [45].

7.1.2 Climate Change

The 2019 ECCC study found that VRPs are already generating environmental benefits in materials savings and in global warming potential (GWP) avoidance through reduced production. In 2019, it was estimated that VRPs were reducing emissions by 1.6 metric tonne per year in the six sectors that ECCC studied (aerospace, automotive, heavy-duty and off-road equipment, electronics, home appliances and furniture), with repair accounting for 33 percent of the reduction [4].

Moreover, repair can offset 80 to 95 percent of embedded carbon (kg CO2e/unit) by what would be incurred through replacement because it offsets a significant portion of the upstream production supply chain. In other words, repair reduces greenhouse gas impacts by preventing the need to make new products [6]. Of all VRP activities, repair has the greatest impact on reducing the requirements for new materials [4].

7.2 Social and Economic

The social benefits of repair are numerous and often intersect and complement the environmental and economic gains. Community-based repair can educate Canadians about the ways that sharing and repairing advance circular economies, and it can provide new skill development opportunities [11].

By fostering competitive, local, open access to repair, communities and consumers benefit significantly through improvements to:

- Affordability and consumer choice;
- Training and innovation; and
- Expanded community-based services.

7.2.1 Affordability and Consumer Choice

Lower-cost consumer goods and lower-cost repair services generate increased affordability for consumers. Better access to repair and repairability supports these lower costs. According to right to repair advocates, fostering local community-based access to repair services extends the useful life of goods and provides access to lower-cost repaired or refurbished items. A healthy aftermarket repair economy also drives costs down when consumers are not restricted to OEM repair services and can select among repair options. The standardization and increased availability and access to spare parts can also significantly reduce costs associated with repairing commonly malfunctioning components, such as device screens and batteries.

7.2.2 Training and Innovation

When repair provides low-cost options, it has the added benefit of expanding and facilitating skilled trades, training, and innovation. By removing the constraints that currently hinder most repair options for consumer goods, both skilled trade and DIY can innovate around better repair options and processes, offering lower-cost parts and tools.

7.2.3 Community-Based Access

Some rural communities rely on local repair services, especially for vehicle and agricultural equipment. Access to repair can be critical for small and rural communities, where businesses and livelihoods depend on the proper function of equipment. As mentioned in Section 6.4, when farmers do not have access to locally-based repair technicians, lengthy repair times can be detrimental to their economic viability.

Some urban communities face similar constraints due to a decline in the number of local repair shops. Locally-based repair options can spur community development through repair cafés, community events, and opportunities for organizations that repair and refurbish goods to support charitable activities. Supports for local repair shops would promote such community development.

7.2.4 Economic Benefits

VRPs contribute approximately $56 billion to Canada's economy, predominately through reuse and repair but also through refurbishment, with remanufacturing and comprehensive refurbishment contributing between $5 to $6 billion of this total [4]. Moreover, VRP activities support more than 371,000 direct jobs in Canada [4].

There are many contributions repair industries can make to smaller communities by facilitating better access to repair for consumers. Increased repair can also foster secondary markets for goods that would otherwise be disposed of. As repair is incentivized, more service providers can enter the market to provide higher levels of competition and drive lower costs for consumers [46]. Extending product lifetime through repair provides consumers with monetary savings as well as access to products at lower price points. Companies that adopt circular economic business models that include repair may benefit from market expansion opportunities and growing loyalty from their consumers.

8 Opportunities for Circular Outcomes

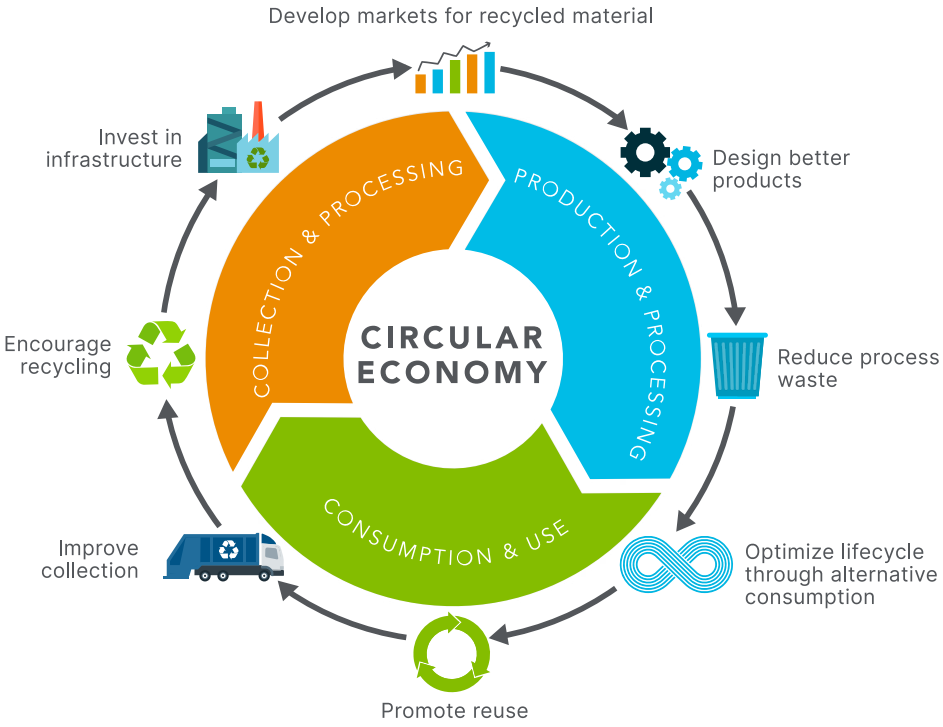
As shown in Figure 5, the circular economy is a regenerative closed-loop system, where everything is valued, resources are used more efficiently, waste is minimized, and everything is seen as a resource that can be fed back into production cycles [1].

Many strategies and business models have been proposed to support the transition to a circular economy, and in most cases, circular design and product life-extension practices specify repair as an essential element [32]. Improved access to repair and better repairability of products underpin and advance circular economies through reuse, repair, and refurbishment [47].

8.1 Designing for Circularity

Circular design optimizes product value by prolonging use and maximizing utility by keeping products in circulation and functioning for as long as possible. Circularity is significantly increased through activities—such as reuse, repair, remanufacture, or refurbishment—that extend the product's lifecycle and improve resource productivity [48].

Figure 5: The critical components of a circular economy.



Note. Reproduced with permission from the Circular Innovation Council.

In terms of repairability, designing for circularity can address many of the physical barriers and design restrictions that limit or prevent repair, as described in Section 5. Proposed changes to current practices include:

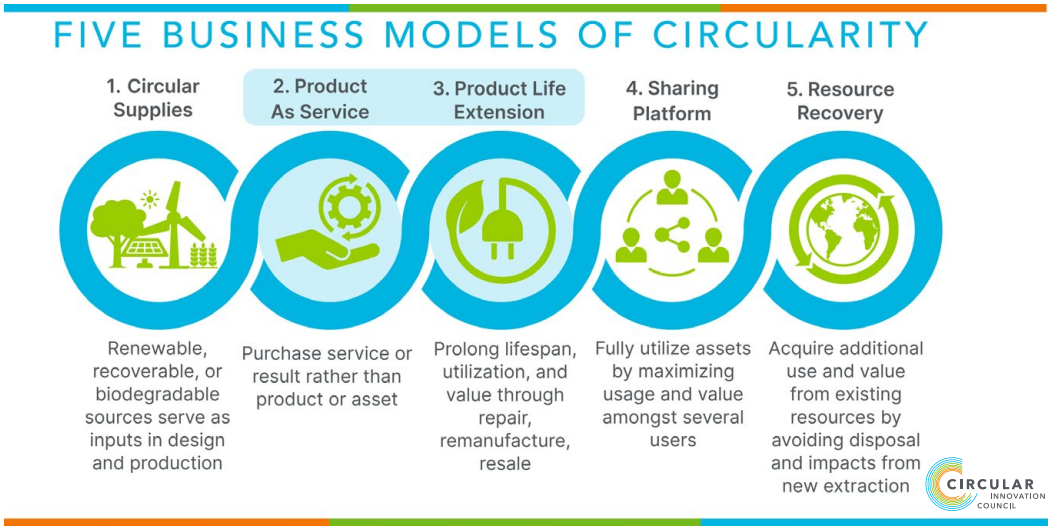
- Restricting the use of customized parts, including proprietary software;
- Discontinuing the use of glue and fasteners;
- Ensuring an available inventory of spare and standardized replacement parts;
- Limiting the use of highly specialized nuts and bolts; and
- Avoiding welding or soldering products closed, which eliminates the ability to open a device and perform repairs.

Many of the existing and proposed regulations and standards for increasing repairability at the product level are focused on evaluating product design for circularity. For example, the repairability index in France uses evaluation criteria to rate a product's design in the context of the consumer's capacity to repair the device or have it repaired [24]. The resulting score is meant to inform and influence consumer choice to consider repairability at the point of sale. The score also acts as a feedback loop to brand holders by offering information and incentives to improve product design for repairability.

8.2 Leveraging Circular Business Models

Redefining value through innovative and transformative circular business models will ensure that materials retain their highest utility and value throughout their

Figure 6: Five circular business models for a circular economy.



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lifecycles. VRPs, including repair, create positive outcomes through efficiency gains in material and energy use and by reducing emissions and waste [4].

Circular business models represent key activities required to transition to a more resource efficient and circular economy, which they do by modifying the pattern of product and material flows through the economy [49]. The Circular Innovation Council promotes five circular business models to represent the breadth of activity in this ecosystem, as shown in Figure 6. When considering repair, two of these models can facilitate expanded repairability and repair options of products: Product Life Extension and Product as a Service. These models are described in more detail in the following sections.

8.2.1 Product Life Extension

When designing for circularity, one of the intended outcomes is to extend a product's useful life for each original user and between multiple users. In the interviews, stakeholders often noted planned obsolescence and related research as a key barrier to repair [5], [11], especially when the cost of repair was greater than replacement. The Product Life Extension circular business model links directly to design for circularity, and is grounded in the capacity of a product or asset to last and continue to function as intended.

Designing goods for durability and therefore long life incents manufacturers to work with higher added-value materials. This, coupled with an extended relationship with consumers based on continued and expanded services, means direct and stronger, more loyal relationships, and potential increased profitability [50].

Business modelling that is based on product life extension requires significant adjustments to the traditional models that are currently in place. Product life extension is based on quality over quantity, with a focus on design for repair and access to spare parts and instructions. Given the local nature of repair activities, manufacturers delivering on product life extension objectives would be required to invest in a local ecosystem of repair capacity, which would provide local economic development benefits, including jobs and training.

8.2.2 Product as a Service

Circular economic concepts emphasize that the value of a product is its function, not the product itself. Many of the products discussed in this report are underutilized for the majority of their lifecycles and are therefore ideal candidates for products offered to consumers as a service. Automobiles are a prime example, as most cars spend more than 95 percent of their time sitting idle in garages or driveways [51].

The Product as a Service circular business model has been used in some industries for a long time (e.g., laundromats and libraries), but it has recently taken hold in new product categories with expanded innovative focus, such as lighting as a service, and car and bike sharing services. Expanding this service model in the marketplace will require a shift for consumers from the conventional buy-to-own model to pay-for-use. Instead of a one-time purchase, the product or asset is transitioned to a service, where value is based on access and performance rather than on the physical asset. The costs and risks of ownership therefore rest with the manufacturer or seller, encouraging a refocus on durability and repairability of products as well as the opportunity to strengthen and prolong relationships with consumers. This shift in ownership means that there is greater incentive for OEMs and their supply chains to ensure durability, facilitate repair, and integrate end-of-life management back into production. These considerations and improvements have the potential to maximize products and their functionality. As a result, focus is shifted to optimizing the use—and therefore value—of a product and maximizing its end-of-life value [52].

Product as a Service is also designed to shift the consumer's understanding of value. In many cases, ownership may not be a desired outcome, but it is seen as necessary to access a function of the product. When products are offered as a service, consumers benefit from having no responsibility for managing the product at end of life or for maintenance during use, but they have access to a product that they may not otherwise be able to afford [52].

Businesses that can adapt to the Product as a Service model can extract greater value from each product by charging for its multiple use. Optimizing the use of one product among several consumers rather than producing individual products for each consumer mean less extraction, less rare resource use, reduced production costs, new revenue opportunities through membership or loyalty programs, and improved consumer relationships.

The Product as a Service circular business model is in its infancy for many of the product categories examined in this report, and its growth will depend on consumer interest. For products and product categories where it is offered, issues related to repair will change over time, as manufacturers and brand owners take on the responsibility from their consumers.

9 Intervention Opportunities to Improve Access to Repair and Repairability

Supporting repair activities is critical to Canada's transition from a linear to a circular economy and to realize the benefits discussed in this report. There are several opportunities for market interventions to improve access to repair and product repairability, including setting benchmarks and guiding consumers so they can understand and account for repairability at the point of purchase. For certain sectors, regulatory interventions may be necessary to address systemic or industry-wide trends toward limiting repair that are embedded in competition or consumer protection concerns. Given their inherent differences, the type of intervention best suited to each product category is dependent on each of their circumstances. The difference between access to repair and the repairability of products must also be understood when considering any interventions.

9.1 Regulatory Interventions

There is a growing trend to use regulatory interventions that are designed to promote repair activities and options in the marketplace and to protect consumers. The approaches to regulatory design interventions vary by jurisdiction and generally fall into one of two categories:

1. Creating regulations that take a product or product sector approach, in which specific criteria are developed and implemented through a scorecard or index, such as France's repairability index [24].
2. Integrating policy changes into existing regulations, such as consumer protection, antitrust, and warranties.

Regulatory interventions seem to be most effective when competition is eroding or has the potential to diminish consumer choice. This approach can affect both access to repair and repairability of products. While they may vary in design, these regulatory interventions are intended to provide meaningful information and protection to consumers while setting guidelines for OEMs.

9.2 Standards-Based Approach

The literature review conducted for this report supports the conclusion that many of the barriers to repairability are common across the different product categories. Therefore, it may be possible to address many of these barriers with one common standard. This is particularly true for the related technical barriers outlined in Section 5.

Standards that are introduced for sectors where consumers have limited choice are not likely to be as effective without regulations in which the standards are referenced. This is evident in the agriculture sector, where manufacturers who hold dominant market positions may be less motivated to adhere to voluntary standards. In addition, agricultural equipment is typically purchased with the long-term in mind, and repair activities during its functional life are expected, so OEMs may be motivated to extend or even require repair services as part of the purchase arrangement. Widespread digitization of agricultural equipment is also facilitating more OEM control over repair, making it less likely that a voluntary standard focused on improved repairability or better access to repair markets would be adopted in this sector.

Conversely, a voluntary standard in a product sector such as consumer electronics, which is a highly competitive industry with an abundance of consumer choice, could be effective in informing and influencing consumer behaviour at the point of purchase. This would be most effective when a product is labelled with a mark certifying that it has met certain criteria for repairability. Another intended outcome of this approach is that OEMs may have to compete on repairability as a key function of their product offering.

9.2.1 Options for a Standards-Based Approach

The intended outcome in developing a standard to support repairability is to provide guidance or requirements for manufacturers through a set of criteria for each product or product category. In turn, the adoption and implementation of such a standard will inform and influence consumer choice. A standard to improve product repairability in Canada could take one of the following forms:

1. The development of a standard with a baseline set of required and/or recommended criteria.
2. The development of a guideline that includes a checklist of repairability criteria with associated scores or levels of attainability.

Either of these approaches could be applied at the product or product sector level, or be designed as a common standard with criteria that relates to any and all product sectors or product types to address common barriers.

To complement a common standard and to address the variables that exist between product categories, a specific product-level standard could also be valuable. These product-specific standards could address the variances in repairability between products.

9.2.2 Standards-Based Considerations

The literature review revealed the following factors, which should be considered when developing standard related to repairability, whether product specific or common:

- Competitiveness of the sector and consumer choice;
- Existence of a repair ecosystem;
- Potential environmental, social, and economic benefits or losses;
- Availability of component parts and tools;
- Availability of manuals and instructions;
- Design barriers, such as access, disassembly and reassembly, glues, fasteners, and proprietary parts;
- Access to software available to all repair technicians or consumers;
- Warranty offerings that do not preclude or limit repair; and
- Consumer health and safety concerns are addressed.

The issue of consumer safety and other liabilities will need to be considered and examined with the development of any standard or guideline. The level of complexity varies between product types, so the appropriateness and level of access granted to consumers to perform DIY repairs must be considered.

For example, replacing the battery on a mobile phone would not carry the same type of liability as repairing farm equipment or the electrical system of a washing machine. Consumer health and safety and access to repair are not necessarily at odds, but they must be considered together.

10 Conclusions

Examining opportunities to expand repair in Canada is important and timely. There is growing global interest in expanding repairability, and Canada has a commitment to transition to a circular economy that protects resources and reduces carbon emissions, energy use, and waste.

The literature review and stakeholder interviews identified several broad barriers to repair that must be addressed to realize the benefits that repair can offer, including barriers related to consumer perceptions about participating in repair activities and technical barriers to product repairability. Regardless of the product category, the following requirements were identified for achieving better repairability:

- Access to tools, including software to access the equipment and tools to diagnose and perform repair;
- Availability of parts; and
- Access to manuals and knowledge.

Improved repair could be achieved through thoughtful implementation of standards, consumer reporting tools/indices, and regulatory interventions—or a combination of these. Repair is positioned to play a critical role in the economy as OEMs and suppliers expand their knowledge of, and see value in, engaging in circular business models. Expanding and protecting repair will also become a significant rallying point for consumers as their support for Product as a Service and Product Life Extension circular business models grows. Repair also offers many environmental, social, and economic opportunities and is a critical strategy to advance the circular economic and sustainable development goals that Canada has committed to.

There are many factors to consider to prioritize what type of market intervention is needed to support better repairability for products. As discussed in this report, competitiveness and consumer protection through choice should be central to what is prioritized.

Specific standards and associated criteria could be referenced in regulatory frameworks. Additionally, guidance tools could be introduced to inform and support the usage of standards, to manage compliance, or to engage in best practices. This could further inform consumer choice and introduce additional market benchmarks or incentives.

Given the variations in approaches taken in other jurisdictions, additional research to supplement this report would be useful to inform Canada's approach, including:

- A more detailed market analysis of the four product sector categories discussed in this report that identifies which barriers to repairability are common to all and which are unique to each sector.
- A determination of which intervention type is best to expand or protect repairability for each of the product sector categories.
- An examination of existing regulations or standards that could be adapted to support more repair in each of the product sector categories.
- A legal review of the issues of intellectual property rights, consumer protection under warranties, and competition laws.
- A feasibility study of adapting existing standards that could include repairability benchmarks for a specific product sector or product type.

The intervention type and which product or product sector categories to focus on should be examined in the context of a variety of economic, social, and environmental factors. Standards developers and policy-makers would benefit from gathering the outcomes, opportunities, and challenges that have been learned from other jurisdictional leaders and, where possible, utilizing similar criteria for global harmonization.

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Appendix A – Stakeholder Interview Questions

General Questions

Landscape Review of Repairability in Canada

Interview Context: The Circular Innovation Council (CIC) has been contracted by CSA Group to undertake research on the current landscape on repairability and provide guidance on the potential development of a standard or standards that would support more advanced repairability options and access across Canada. The research will identify sector specific issues as well as market and policy levers necessary to advance access to, and acceptance of, repairability. To support and compliment the research activities of this study, CIC will also be conducting interviews with relevant stakeholder and experts who can support and contextualize the supporting research around technical, market, policy, and legal conditions.

Interviewee:	
Title:	
Company/Organization:	
Date/Time of Interview:	

Interviewee Background:

- Describe your current work/study in the area of repairability or VRPs.
- Broadly, how would you categorize or summarize the current drivers of repairability in Canada?

Barriers:

- What would you consider to be the most significant barriers (policy, market, technical, consumer perception) to advancing repairability in Canada?
- Are there different product sectors that lend themselves to be more challenging for activating repairability?
- How would you gauge consumer perceptions in terms of a barrier to repairability uptake?

Opportunities:

- What are some of the most achievable opportunities/solutions to increase repairability options for consumers in Canada?
- Are there best practices in other jurisdictions you can point to that would be applicable in the Canadian context?
- Considering global supply chains and markets, where would market interventions be most effective or possible in a Canadian/NA context?

Repairability in Supporting Circular Economies

- Are there any quantitative studies or examples you can point to that support:
  - Repairability and product life extension in terms of GHG reduction opportunities?
  - Economic value in repairability to support advancement?

OEM Specific Interview Questions

Organizational Information:

- Generally, how is repairability considered for the products you manufacture from the perspective of:
  - Product design?
  - Customer services/retention?
  - What factors influence repairability options given your suite of product offerings?
  - How does your organization facilitate and/or influence access and options for repairability of your products by either offering parts and services and/or access to repair technicians?
  - Do you offer repair services for your products outside of the warranty time frame?
  - How do your leverage or work with third-party repair options in terms of providing the above supports?
  - Does your organization assign either an ROI or cost implications to providing access to repair options/parts storage/replacement options?

Product Design

- Is repairability considered at the product design stage, what are some of these design factors?
- Are their products/product lines that lend themself to better repairability? Is the opposite true?
- What product/product segments do you see that are most in need of repair through their use phase?

Barriers:

- What would you consider to be the most significant barriers (policy, market, technical, consumer perception, liability issues) to advancing repairability?
- Are there different products that lend themselves to be more challenging for activating repairability?
- How would you gauge your consumers perceptions in terms of a barrier to repairability uptake?

Opportunities:

- Considering global supply chains and markets, where would market interventions be most effective or possible in a Canadian/international context?
- Does your organization align repairability options with any internal ESG or sustainability metrics?
- How has your organization responded/adapted to repairability score requirements like those coming out of the EU?

CSA Group Research

In order to encourage the use of consensus-based standards solutions to promote safety and encourage innovation, CSA Group supports and conducts research in areas that address new or emerging industries, as well as topics and issues that impact a broad base of current and potential stakeholders. The output of our research programs will support the development of future standards solutions, provide interim guidance to industries on the development and adoption of new technologies, and help to demonstrate our on-going commitment to building a better, safer, more sustainable world.

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