THE ENVIRONMENTAL BENEFITS OF GREEN RECYCLED PARTS IN ONTARIO

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September 2023

INTRODUCTION

To reduce the carbon impacts of the automotive industry in response to climate change, most attention to date has been given to switching from fossil-fuel powered internal combustion engine (ICE) vehicles to hybrid and electric vehicles (EVs). A wealth of research has shown the potential reduction in emissions from operating EVs compared to ICE vehicles, and more recent analysis has shown how the emissions over the lifecycle of a vehicle, including manufacture, use, and disposal differ between EVs and ICE vehicles.

However, the same level of investigation into emissions reduction opportunities has not yet been applied to the complementary goods and services related to motor vehicles once they are placed in the market (i.e., the post-dealership servicing of vehicles), where huge volumes of components, parts, and consumables for vehicles are traded. For simplification, in this report this market will be referred to as the auto parts industry.

$20 billion

Canadian post-dealership servicing market

The auto parts industry is one of Canada's largest retail markets, valued at over CAD 20 billion. Significant opportunities for emissions reduction and decarbonisation of the automotive space also exist in the auto parts market, and the industry is beginning to understand and explore this.

This study aims to:

- show the potential environmental impacts of using green recycled parts instead of new parts for replacement in vehicle repairs in Ontario.
- identify potential actions that different market actors can take for supporting the growth of green recycled parts in Ontario.

The first part of the report focuses on the Canadian and Ontario auto dismantling industry, outlining the volumes and market dynamics that rule this space. This part also identifies the different drivers for actors in the green recycled parts market.

The second part explores the evidence for the environmental impact that individual parts can have when reused. The individual parts reviewed includes the 13 top selling parts, as provided by the Ontario Automotive Recycling Association (OARA), who commissioned this study. This part estimates the total environmental impacts of the green recycled parts supplied in Ontario.

The third part of the report uses the evidence gathered in the research to map the knowledge gaps for better understanding the impacts of green recycled parts; the opportunities to grow the market for green recycled pasts, and recommendations for the different actors in the market to support this.

Figure 1 below shows the current routes for vehicles once they reach the end of their life. The figure shows the different operations and key actors within the market. Although multiple routes provide feedstock to automotive recyclers, not all vehicles end up at authorised dismantlers. This study does not model the flow of materials through each route, but it does identify flows of end-of-life vehicles (ELVs) that limit the further supply of recycled green parts.

Understanding alternative flows of ELVs (the grey market) in Ontario, and the factors the influence these streams, allows us to explore potential actions that could mitigate this risk. A key enabler of these alternative "grey" streams is that at auction houses, non-accredited dismantlers can bid on these vehicles. Oftentimes, non-accredited dismantlers are not operating in line with the rigorous standards, and parts reuse, of the OARA membership.

When assessing the market for green recycled parts, key factors considered include market demand, inventory levels, and recent sales information. On average, 72 parts are inventoried from high salvage 'parts' vehicles, compared to just 11 parts for low salvage 'scrap' vehicles. Parts are removed or kept in the vehicle to be retired when needed [1].

While parts may be identified as viable for removal, that does not mean that they will always be reused. Parts not sold within a reasonable amount of time can be sent for different end-of-life fates, such as sale to parts rebuilders or metal recyclers. Later in the study, we explore the opportunities to reduce this gap between dismantled for reuse and actual demand within the market.

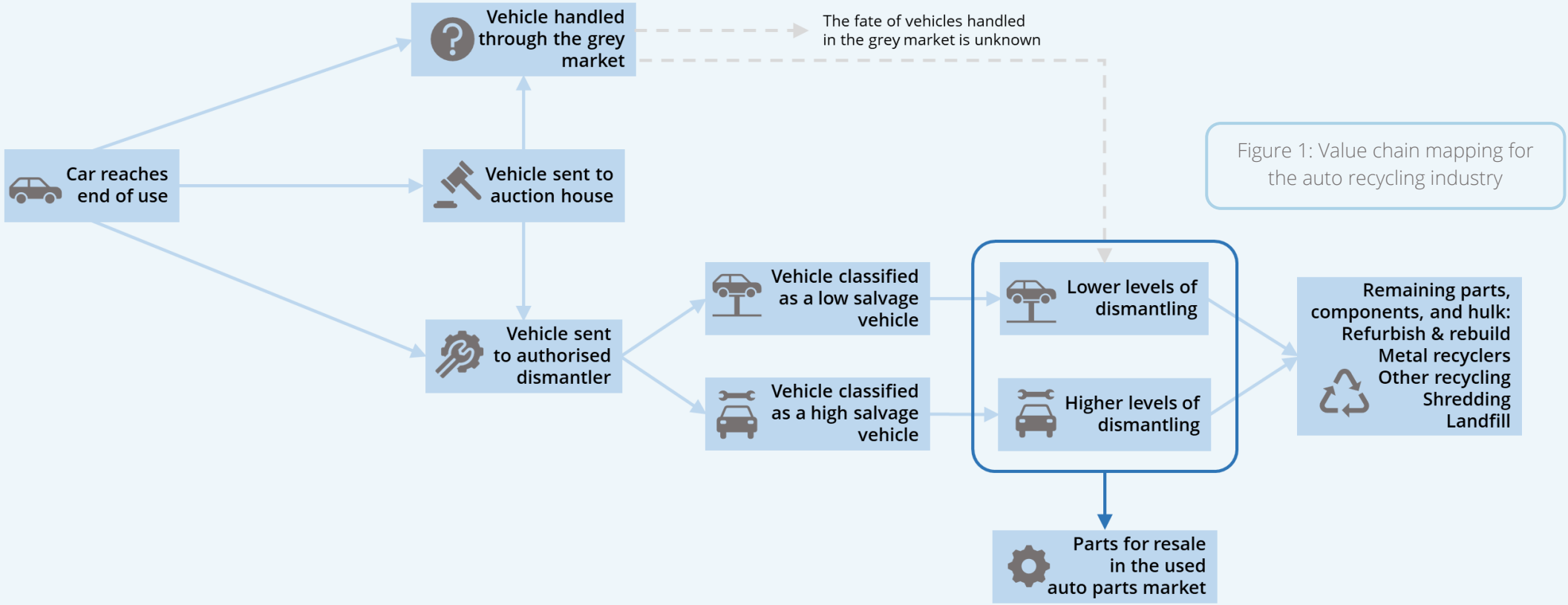


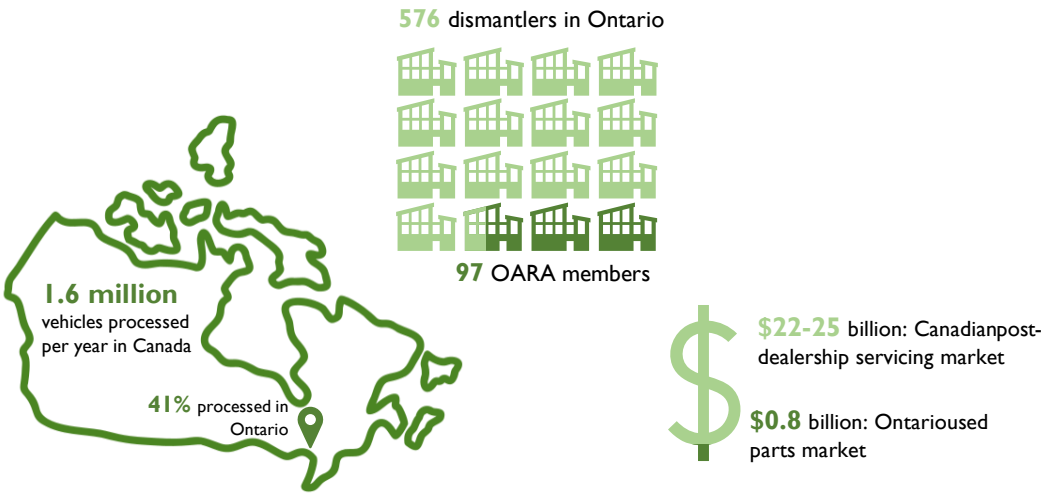
Figure 1: Value chain mapping for the auto recycling industry

MARKET OVERVIEW

In Canada, the current vehicle dismantling market size sits at an estimated 1.6 million vehicles processed per year, 41% of them in the Province of Ontario. Although the Ontario market is significant, the market size seems to be reducing, which does not align with theoretical assumptions: In theory, the market size is dependent on the new vehicle sales around 10 years prior, which increased yearly between 2011 and 2017. Therefore, we would expect the used parts market to be growing with the inflow of these ELVs.

However, the arisings of ELVs are influenced by variables such as the expected lifetime of newer vehicles (e.g., newer cars may contain parts with longer lifetimes) and macroeconomic trends (e.g., rising living costs may encourage vehicle owners to keep them for longer).

The Ontario dismantling market is served by an estimated 576 companies, from which 17% (97) are affiliated to OARA. It is believed that OARA members represent the larger companies in the province, and they sell most of the used parts sold. Analysis conducted for this study estimates that the used parts market in Ontario is just under CAD 806 million. With different sources placing the Canadian auto parts industry between CAD 22 [2] and CAD 25 [3] billion, this means that used parts in Ontario account for roughly 3-4% of Canadian auto parts revenue.



‘Parts’ vehicles and ‘scrap’ vehicles

Vehicle dismantling can be broadly separated in two main economic activities: dismantling for parts and dismantling for the hulk. This is evidenced in the results of the OARA members survey conducted for this study. Figure 2 shows how revenue is distributed between different streams in a vehicle that was purchased for its parts (a ‘parts’ vehicle) versus a vehicle that was purchased mainly for the sale of its hulk, metals, and some salvageable parts (a ‘scrap’ vehicle).

For a parts vehicle, over 70% of the revenue comes from the sale of the parts; while for a scrap vehicle, 49% of the revenue comes from the sale of the hulk. Furthermore, if the hulk of a parts vehicle can be sold at a similar price as a scrap vehicle, it would mean that the revenue from a parts car, is on average 5.7 times greater than that of a scrap vehicle. Even in a scrap vehicle, the sale of the parts represents over 20% of the total revenue from the car. This shows the economic importance of used parts in the dismantling industry.

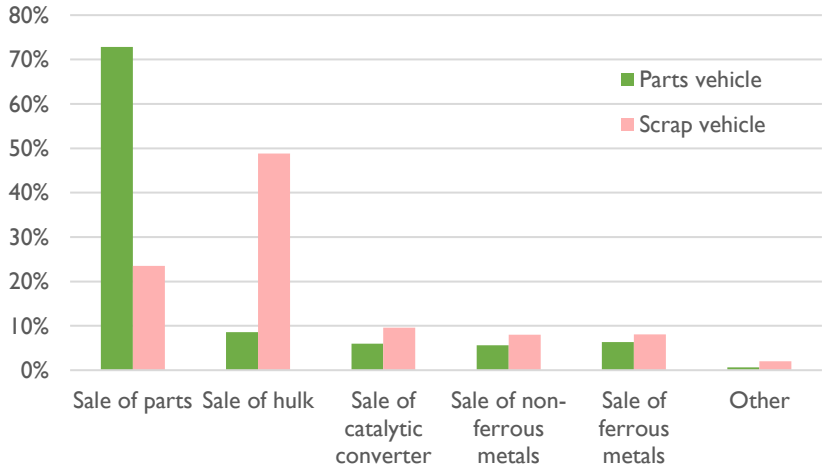
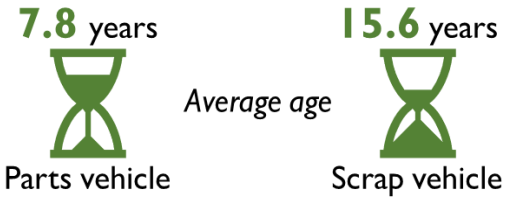


Figure 2: Distribution of revenue by different streams for parts and scrap vehicles. Data from OARA member survey.

Another important difference between the two categories of vehicles is their average age. Vehicles that are purchased for their parts tend to be newer: their parts are still demanded on the market, and their condition will likely be better.

The average age for a parts vehicle in 2023 according to the OARA member survey is 7.8 years, in contrast to 15.6 years for a scrap vehicle.



Additionally, 41% of the vehicles purchased by OARA members are parts vehicles, while the remaining 59% are scrap vehicles. Due to the nature of the companies surveyed, the real proportion of parts vehicles for OARA members may be smaller than 41%, and the proportion for the rest of market players (non-OARA) is likely to be even lower. This implies that, in general, larger players have the tools, access, and capital to purchase parts vehicles, while smaller companies have the flexibility and granularity to buy scrap vehicles directly from the public.

VEHICLE SOURCING

One of the challenges for accessing more vehicles suitable for extracting valuable parts is the naturally limited supply of vehicles and the intense competition for them. To map the different sources of vehicles, the OARA member survey asked where members acquire their vehicles. The split is shown in Figure 3.

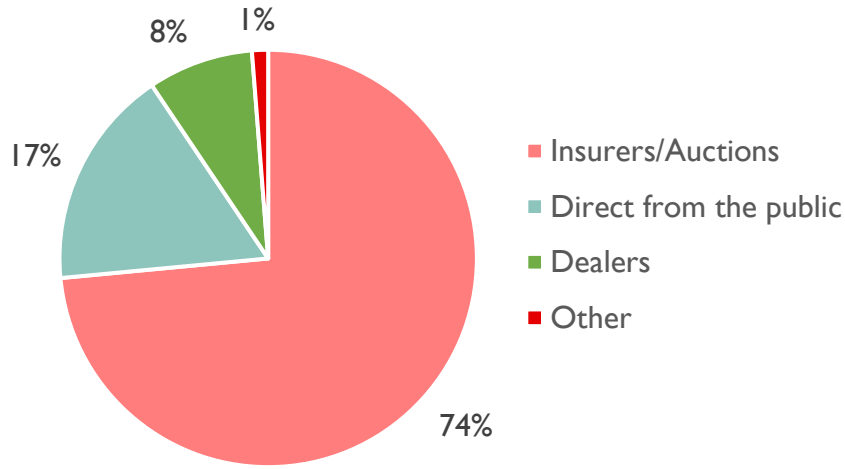


Figure 3: Percentages of vehicles sourced from different channels for respondents of the OARA member survey 2023.

However, as the survey respondents are thought to be some of OARA's largest members, this may not be an accurate reflection of the true dynamics of vehicle sourcing for all OARA members. On interviews and workshops, it was mentioned that Direct from the Public is a more common way of purchasing vehicles for smaller companies than the 17% in the survey results.

To validate this hypothesis, previous OARA research from a member survey in 2013 was reviewed. The 2013 research contained more data points, and also contained the number of vehicles processed by each respondent. This enabled us to test the hypothesis that scrap-oriented companies purchase more vehicles directly from previous owners, and parts-oriented companies resort to auctions from insurers (or insurance companies' partners), which are highly competitive.

Much has changed in the marketplace over the previous 10 years. From discussions with a cross-section of OARA members, it appears that the as the volume of vehicles processed increases, the reliance on scrap revenue also increases. Another way of stating this is that as the number of vehicles processed decreases, the reliance on, and perhaps even the ability to recover and sell parts, increases.

Factors such as the increasing complexity of vehicles, the continuing trend towards larger vehicles on the road (i.e., SUVs and pickups, which can be more profitable to dismantle while also more time consuming), rising ELV prices, and the complexity of maintaining adequate and trained staffing levels, have all affected how auto recyclers bid for ELVs.

CLIENT SEGMENTATION

The different types of clients for the dismantling market were identified from relevant literature and discussions with industry representatives. Figure 4 below shows an estimated percentage split of the market, with an evaluation of the market drivers and current landscape of each customer below.

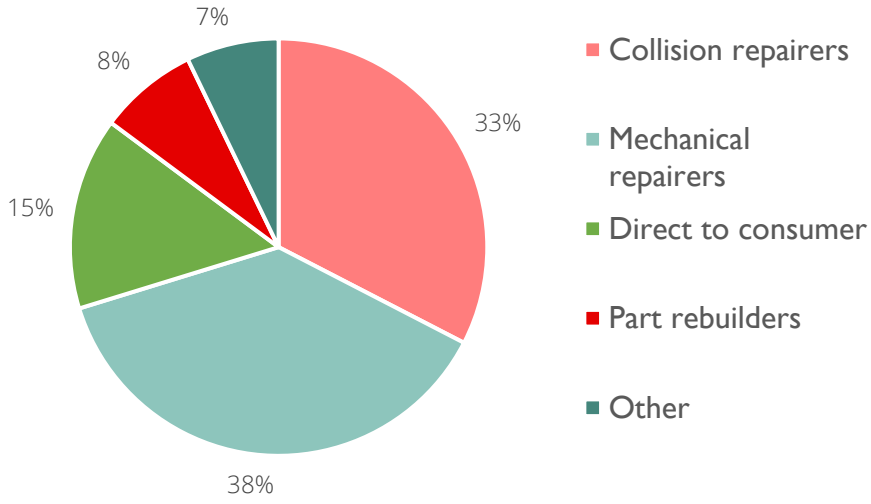


Figure 4: Percentages of parts sold to different types of clients for respondents of the OARA member survey 2023.

Mechanical repairers

Repair garages are often small organisations with high levels of autonomy. Their key objectives usually centre around delivering quality and the economic viability of their services. The environmental implications of repair parts are often not considered at this stage. Given that mechanical repair shops are usually hired directly by the consumer, the reduced wait time associated with green recycled parts could be seen as a drive for increased demand. However, a potential barrier is that while there are standard procedures associated with recycled parts, safety and knowledge concerns may be a limiting factor in mechanical repairers encouraging the use of green recycled parts.

Collision repairers

Although the functionality of collision repairers is like that of mechanical repairers, the main difference is the integration with insurance companies, with less influence from the public. This means that collision repairers are strongly influenced by the insurers and the strategic direction of these organisations. At present, action from the insurance industry varies, but there is increasing interest in green recycled parts from organisations such as Aviva Canada and Intact Insurance.

The Mitchel 2023 trends report states:

"Auto insurers are under increasing pressure from government to implement sustainability practices as part of a larger ESG program" [4].

Direct to consumer

An important factor in direct-to-consumer sales is the long-term transition towards conscious consumerism. For vehicle parts this may be the key influencing factor regarding the choice of replacement parts. In the short-term, consumers are currently facing increased financial pressures associated with the cost-of-living crisis. These factors combined could be seen to encourage increase purchasing of green recycled parts. However, this also suggests that in an upturn of economic circumstances in the country, demand for green recycled parts could drop significantly; this is both a challenge and an opportunity for including environmental impact as a driver in part selection for consumers.

Parts rebuilder

Parts rebuilders remanufacture or refurbish used parts to sell in the auto parts market. Parts rebuilders have a unique relationship with dismantlers as they act as both a customer (buying used parts) and a competitor (selling reman/refurbished parts). Parts rebuilders represent a relatively small market, but there are signs of growth within Europe for the automotive industry, and across other sectors in the US such as machinery and rail. The activities of parts rebuilders can enable a second life for parts not suitable for direct reuse.

Type of client	Drivers
Mechanical repairers	Cost Trust Lead time Their client → Consumer
Collision repairers	Trust Compliance with regulation and other initiatives Lead time Quality Assurance Their client → Insurance companies
Direct to consumer	Cost as a proxy of macroeconomic pressures Lead time Trust
Parts rebuilder	Efficiency between sourcing and remanufacturing costs Focus on the more in demand parts

COSTS OF DISMANTLING

Although this study is focused on the environmental benefit of green recycled parts, we have also examined the cost categories for the dismantling process because in the absence of other data, cost data is often used as a proxy for the environmental impacts.

For example, if we do not know the fuel usage associated with towing a vehicle, but we know the cost, we can use the cost data as a proxy as the cost will be strongly related to the fuel consumption.

As with the sources of revenue, the costs of processing parts and scrap vehicles are mostly similar, but with some marked differences.

From the example cost breakdown shared by some OARA members, towing and other costs are similar for both parts and scrap vehicles. The differences are in the cost of parts recovery and depollution. Parts recovery, as it would be expected, represents a higher cost for parts vehicles (>60% of costs), while in scrap vehicles, it is 37%. This is particularly interesting when compared to the average number of parts recovered for both types of vehicles: parts recovery costs for parts vehicles are less than twice that of scrap vehicles, but the number of parts inventoried is over 6 times higher. This does not account for the types and value of parts recovered in each case but does suggest parts recovery is more efficient when processing parts vehicles rather than scrap vehicles.

Depollution, on the other hand, represents the higher cost for scrap vehicles, at 45%, almost double the proportion it does on parts vehicles which is placed at 21%.

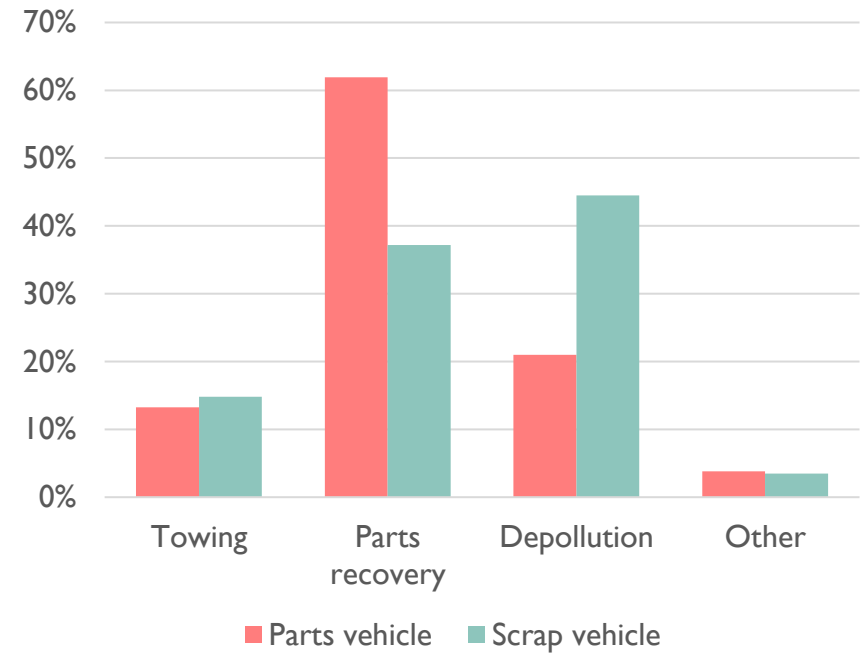


Figure 5: Breakdown of example costs for parts and scrap vehicles from OARA members.

MARKET DYNAMICS

There are different factors within the market that influence the green recycled parts market. In this study, we held a workshop with some of the OARA members to identify and categorise important factors, looking at factors related to politics, economics, society, technology, legislation, and the environment. The full list of factors identified can be found in the Appendix, but we explore some of the key factors raised below:

Regulation

The Canadian Government has set a Net-Zero by 2050 target. Although Ontario has not set a Net-Zero target, Toronto has aligned to the national target of 2050. The Canadian Government has also set an enhanced Paris agreement target to reduce emissions by 40-45% from 2005 levels by 2030 [5].

» Use of green recycled parts could contribute towards emissions reduction in Canada.

The Canadian Government has set a 2030 emission reduction plan which addresses the need for infrastructure development to ease the barriers to increased EV use. But the plan does not directly mention the end-of-life management of current ICE vehicles or future EVs.

As part of the emissions reduction plan, the government is also offering a Net-Zero accelerator fund, which provides funding for sectors to move away from GHG-intensive activities and develop and adopt low-intensity processes and products. The program focuses on sector-wide impacts.

» The promotion of lower impact products would support the uptake of green recycled parts.

Environment and Climate Change Canada (ECCC) has commissioned studies exploring value retention processes, which include the use of green recycled parts in the automotive sector. This work is being used to inform the development of a national strategy to encourage remanufacturing and value retention processes in Canada [6].

» A national value retention strategy would likely support the uptake of green recycled parts.

Competition

Within the auto recycling industry, we can think about competition in terms of both supply and demand. On the supply side, there is a limited supply of ELV vehicles available, but multiple stakeholders competing for the stock. Key players include autobody shops, exporters, and parts rebuilders. Actors operating in the "grey market" operate via unaccredited management of ELVs and parts and can reduce the availability of used parts to accredited suppliers. The restricted availability of green recycled parts arising from the diversion of used parts to grey market activities can negatively impact consumer views on the green recycled parts industry. In extreme cases, ELVs designated as Parts Only may be exported and resold as second-hand vehicles in other countries (e.g., a Tesla marked for parts in North America was observed to be offered online as a second-hand vehicle in Ukraine [7]). These exported vehicle parts are made unavailable in Canada.

» Competition for parts from the grey market may limit the uptake of green recycled parts.

Parts rebuilders, alongside the original equipment manufacturers (OEMs), represent the core demand competition within the market. From an OEM perspective, there has been some pushback in recent years to become more competitive in the post-dealership servicing market. This has been through mechanisms such as price reductions and price matching for their OEM parts, and extending warranty on vehicles, limiting demand for recycled parts.

» Competition for customers from OEMs and parts builders limits the market penetration of green recycled parts in the post-dealership servicing market.

EV transition

The Government of Canada is committing to a mandatory sales target for zero-emissions vehicles, targeting 100% by 2035 for all new light duty vehicles [8], and interim targets for 2026 (>20% sales) and 2030 (>60% sales). The transition to electric vehicles and away from ICE vehicles will have a significant impact on the future supply and demand for green recycled parts. Some commonly recycled parts, such as engines and transmissions, are very different in EVs, while alternative parts such as the electric battery, inverters, and multiple electric motors will become available.

These parts are generally more complex and therefore potentially more valuable at end-of-life. The fast-paced evolution of EV technology and the supporting electronics may be both an opportunity, through the need to supply legacy parts that may no longer be in production, and also a challenge, through the need to develop need skills and recycling processes.

» The transition to EVs will present new opportunities and challenges for green recycled parts.

Standards

Through the Automotive Recyclers of Canada (ARC) several programs and codes are organised to ensure best practice within the sector.

Gold Seal: This is a voluntary quality assurance accreditation program building on the CAREC required standard (see right). The standard is modelled after the USA-based Automotive Recyclers Associations' Gold Seal program. Industry standards are one way to build consumer trust in the industry and differentiate from grey market, and other lower quality activities.

» Industry standards can help build consumer trust in green recycled parts.

GOLD SEAL
AUTOMOTIVE RECYCLERS OF CANADA

CAREC

The Canadian Auto Recyclers Environmental Code (CAREC) began in 2009 as the National Code of Practice to support Environment Canada's National Vehicle Scrappage Program (NVSP, aka Retire Your Ride). Although the purpose of the NVSP was to reduce air pollution from older vehicles, Environment Canada recognised the potential adverse effects of incorrect depollution processes.

To mitigate this, Environment Canada commissioned the Automotive Recyclers of Canada (ARC) to develop an audit program to ensure best practice for NVSP participants, allowing them to become leaders in the recycling industry. In 2012, this program enforcement became part of ARC and was renamed CAREC.

ARC ensures that all members are signed up to CAREC and encourages continual improvements by benchmarking members scorings and required improvements per audit visit (every 2 to 3 years). The program has seen great success and has been used as a guidance document for several provincial auto recycling laws.

CAREC showed both industry and government that common rules are required for anyone processing end-of-life vehicles, and that compliance can be achieved by any responsible business, no matter where they are located, their size or whether they are dismantling vehicles for their parts' reuse or simply metal recovery.

Retire your Ride
Canada's Vehicle Recycling Program

MARKET PLAYERS: EXAMPLES OF COMMITMENT TO NET-ZERO

With the increasing business and political focus on achieving Net-Zero, many organisations are making commitments outlining their targets and emissions-reduction plans. The table below shows just a few examples of stakeholders relevant to the green recycled parts market and their commitments to Net-Zero:

Environment and Climate Change Canada *Government*	**Aviva Canada** *Insurer*	**IAA** *Service provider for used vehicles market*
• Government of Canada target to be Net-Zero by 2050 [5] • Government of Canada 2030 40-45% reduction target, supported by an emissions reduction plan	• Net-Zero operations and supply chain by 2030 [9] • Net-Zero for all three scopes by 2040 • Aims to reach Net-Zero supply chain by reducing environmental impact of insurance claims by increasing repair and restoration and working with suppliers	• UK subsidiary, SYNETIQ submitted reduction targets to the Science Based Targets initiative (SBTi) [10] • Other branches currently calculating greenhouse gas inventory (including Canada)
Ford *Vehicle manufacturer*	**Toyota** *Vehicle manufacturer*	**Intact** *Insurer*
• Companywide 2050 carbon neutrality target [11] • Supplier Net-Zero by 2035 target • No mention of green recycled parts	• Net-Zero across global manufacturing facilities [12] • Zero Carbon building at Canadian facility [13]	• Part of Intact Financial Corporation, which offers grants to help communities adapt to the effects of climate change. [14] • Intact has a 2050 Net-Zero 2050 target, and an interim 2030 target to halve emissions, compared to a 2019 baseline. [15]

REVIEWING THE LITERATURE

For this study, we have reviewed the literature available on the environmental benefits of using green recycled parts. Greenhouse gas (GHG) emissions are the most widely studied metric for environmental impact and we have focussed on the emissions associated with the use of green recycled parts when they are used in place of newly manufactured parts.

This area of study is currently still in development, with limited research available. However, by assessing what studies already exist we can begin to understand the GHG emissions associated with green recycled parts in Ontario.

Over the last decade there has been a large growth in interest and research into the environmental impacts of the automotive sector [16]. Most research has focused on the relative impacts of new technologies (e.g., gasoline vs battery electric vehicles) with only a limited number of investigations focussing on the end-of-life treatment of vehicles.

The aim of our study is to investigate the GHG impact of the 13 top-selling reused parts in Ontario.

These are:

To do this, we need to understand the existing evidence for GHG emissions from the reuse of single parts, before scaling these impacts to reflect the emissions throughout Ontario. Of the few existing studies of automotive reuse that we identified, even fewer consider individual parts: many studies instead choose to group parts into categories based on material composition such as 'steel and aluminium components' or 'exterior components' [17] [18].

A summary of the four studies we have found that investigated the impacts of reuse of specific car parts is shown in Figure 6. Each of these studies seek to quantify the potential emissions avoided when a reused part is used in the place of a new part and use broadly similar approaches for their analysis. Each study uses a Life Cycle Assessment (LCA) or carbon footprinting approach to estimate the impact of new manufacturing as a basis for understanding the benefits of reuse.

LCA and carbon footprinting

At a very high level, the LCA/carbon footprinting process involves the creation of a list (inventory) of all the material and energy inputs required to produce a new part.

Then emission factors (average factors that estimate the typical emissions from the production of materials/energy) are used to calculate the total emissions associated with the production of a new part.

Before creating the list of materials, each study will first set a 'boundary' which sets limits on which materials and energy sources will be considered.

For example, some studies might include the factory building within their boundary, which means that their inventory list will include a portion of the bricks, timber, concrete etc., required to build the factory.

Studies may also include or omit different processes (e.g., painting) or lifecycle stages (e.g., transportation) for a variety of reasons, such as data availability, or comparability with other analysis.

Study description	**Energy and CO_2 Benefit Assessment of Reused Vehicle Parts through a Material Flow Approach.** [22] *The Society of Automotive Engineers of Japan. 2018.* An investigation into the energy and carbon impact of reused parts from a typical Japanese passenger	**Environmental & Socioeconomic Assessment of the Quebec Autoparts Recycling Sector.** [19] *ARPAC. 2013.* LCA to investigate the environmental and socioeconomic impacts of new OEM, new aftermarket, and reused parts for the repair of a typical passenger vehicle in Quebec.	**Assessing the Environmental Impact of Automotive Recyclers of Massachusetts.** [24] *Siddiq, M. et al. 2017.* An investigation of the production of the four most commonly recovered (reused) parts in Massachusetts.	**The Economic and Ecological Impacts of Dismantling End-of-Life Vehicles in Romania.** [23] *Rovinaru, F. et al. 2019.* An investigation into the benefits of part reuse in Romania, using a typical passenger car.
Study vehicle	Honda Accord 2011	Typical Passenger Car – GREET Model. [26]	Honda Accord 2011	Opel Astra H 2010
Impact indicator	Carbon dioxide emissions	GWP100 (IPCC AR.4)	GWP100 (IPCC AR.4)	GWP100 (IPCC AR.4)
Modelled processes	Raw Material Extraction Manufacturing & Assembly Use & Maintenance Dismantling Second Use & Maintenance End-of-life Treatment	Raw Material Extraction Manufacturing & Assembly Use & Maintenance Dismantling Second Use & Maintenance End-of-life Treatment	Raw Material Extraction Manufacturing & Assembly Use & Maintenance Dismantling Second Use & Maintenance End-of-life Treatment	Raw Material Extraction Manufacturing & Assembly Use & Maintenance Dismantling Second Use & Maintenance End-of-life Treatment

Figure 6: Summary of key studies into the GHG emissions associated with part reuse.

When comparing studies, it is useful to understand how well the study boundaries and approach match. As Figure 6 shows, the four studies we found have some similarities, for example, three of the studies used the same 2007 global warming impact factors for different GHGs set by the IPCC. However, there are also differences in the boundaries and emissions factors used within each study, which make it difficult to directly compare results.

Examples of some of these differences include:

- CO_2 versus CO_{2e} emissions factors: CO_{2e} emissions factors will include the impacts of the emissions of many other GHGs that will have a global warming impact (e.g., methane). Considering only CO_2 would likely result in an underestimate of the impact of processes.
- Materials analysed: one study only accounts for the avoided manufacturing impacts of virgin steel and aluminium, whereas other studies account for more material inputs and sources of emissions. Quantifying the impacts of fewer materials would likely result in an underestimate of the impact of new manufacturing avoided by part reuse.
- Impact of reuse activities: not all of the studies evaluated the emissions impacts of reuse activities, e.g., dismantling, cleaning. This would likely result in an overestimate of the environmental benefits of parts reuse.

Additionally, only one of these studies examines the impacts of reuse in Canada (and this study focuses on Quebec). Emissions factors related to study location, such as the emissions factors for local electricity, will be different. When using these studies to estimate the environmental benefits of green recycled parts in Ontario, we will need to consider how these differences will influence the results.

QUANTIFYING REUSE IMPACTS

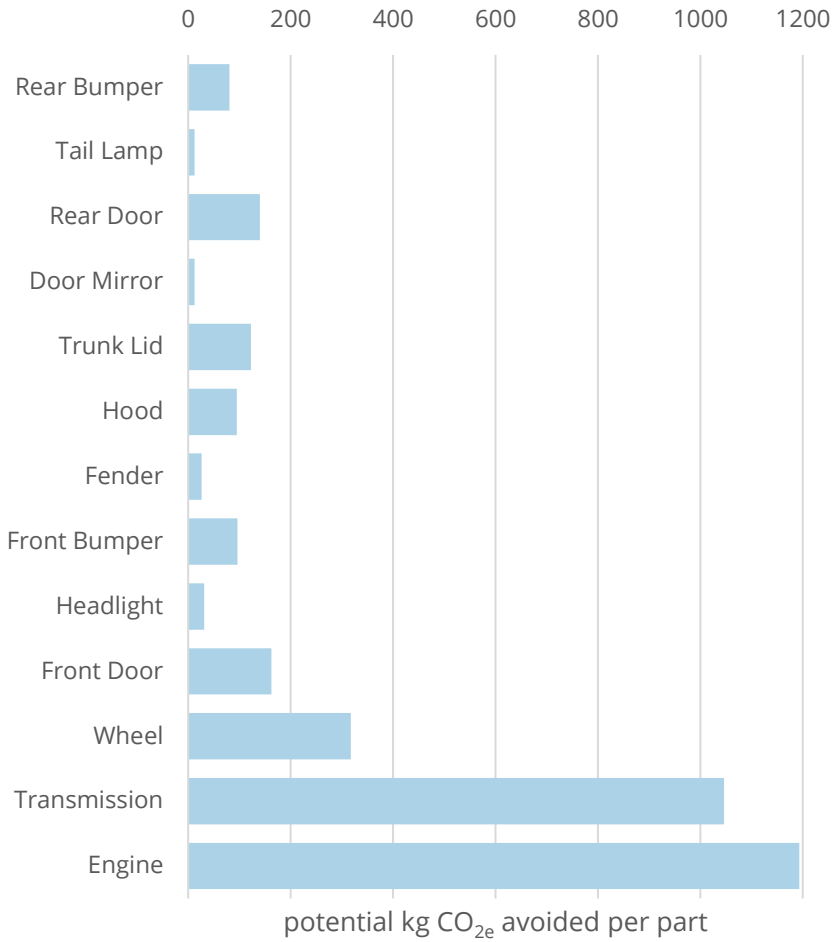


Figure 7: Average CO_{2e} impact of using a green recycled part, taken from literature sources.

The average CO_{2e} impact for a single reused part has been plotted in Figure 7 for each of the top 13 parts. While the graph shows average impact, the range of results from the different studies for some parts, like engines and transmissions, was quite large reflecting the differences between studies (e.g., part characteristics, emissions factors, etc.).

Green recycled parts are most often a direct substitute for new spare parts, and this is the approach taken in the four studies we reviewed. While this will not always be the case, for example when a damaged part is repaired, instead of being replaced with a reused part, this is less common, and would have a different environmental impact.

The most robust analysis of the benefits of parts reuse will include the impact of the processes to prepare a part for reuse (transport, dismantling, packaging). Studies have found the emissions associated with preparation for reuse range from 3% of the impact of manufacturing an engine – up to 66% of new manufacturing for a headlight [19] [20]. This reflects a general trend where the impact of preparation for reuse is proportionally less significant for larger parts such as engines and transmissions, than for smaller parts, as shown in Figure 8.

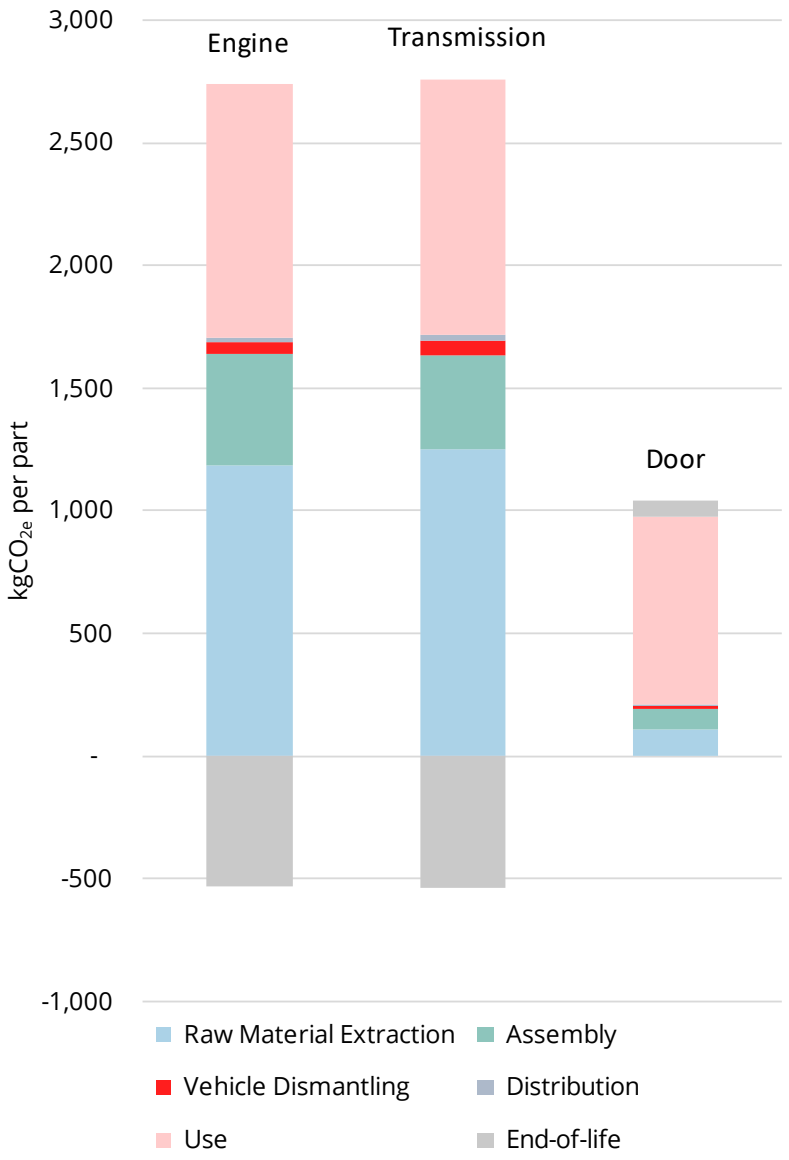
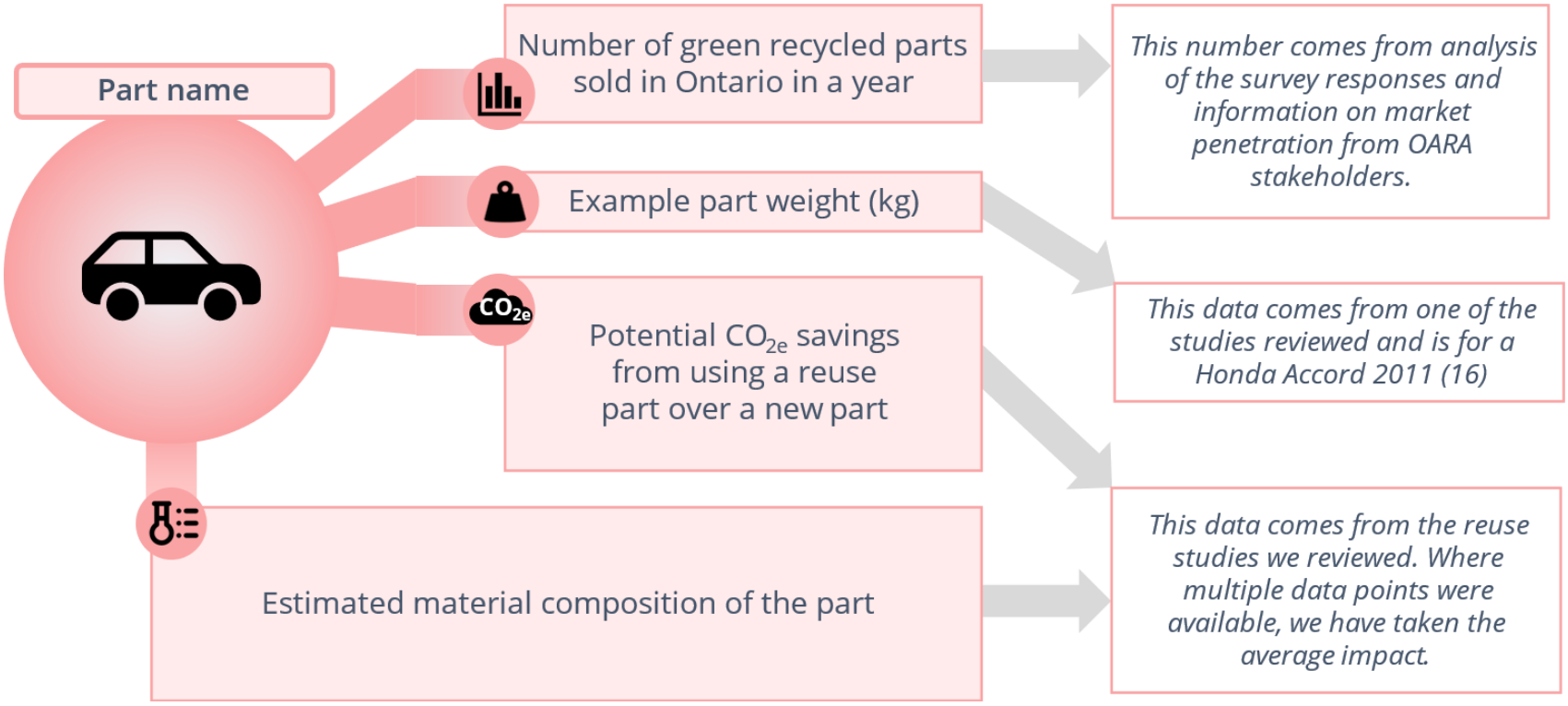


Figure 8: CO_{2e} impact per lifecycle stage for three parts [19] – Partially extracted using Web Plot Digitizer.

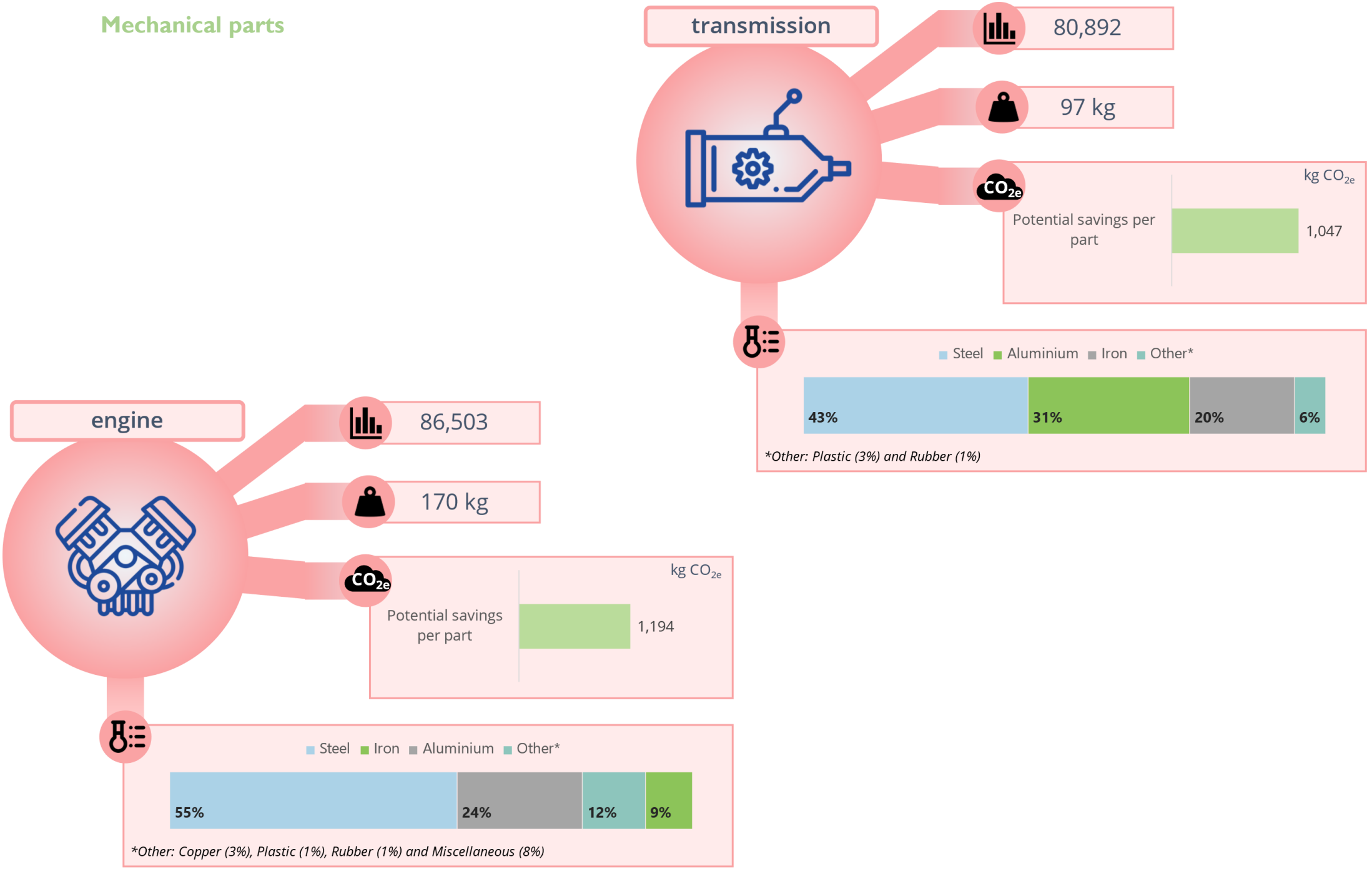
IMPACTS BY PART

The following infographics show the key information about each of the top 13 reused parts. For each part, key information is shown, as illustrated in the example below.

Infographic key

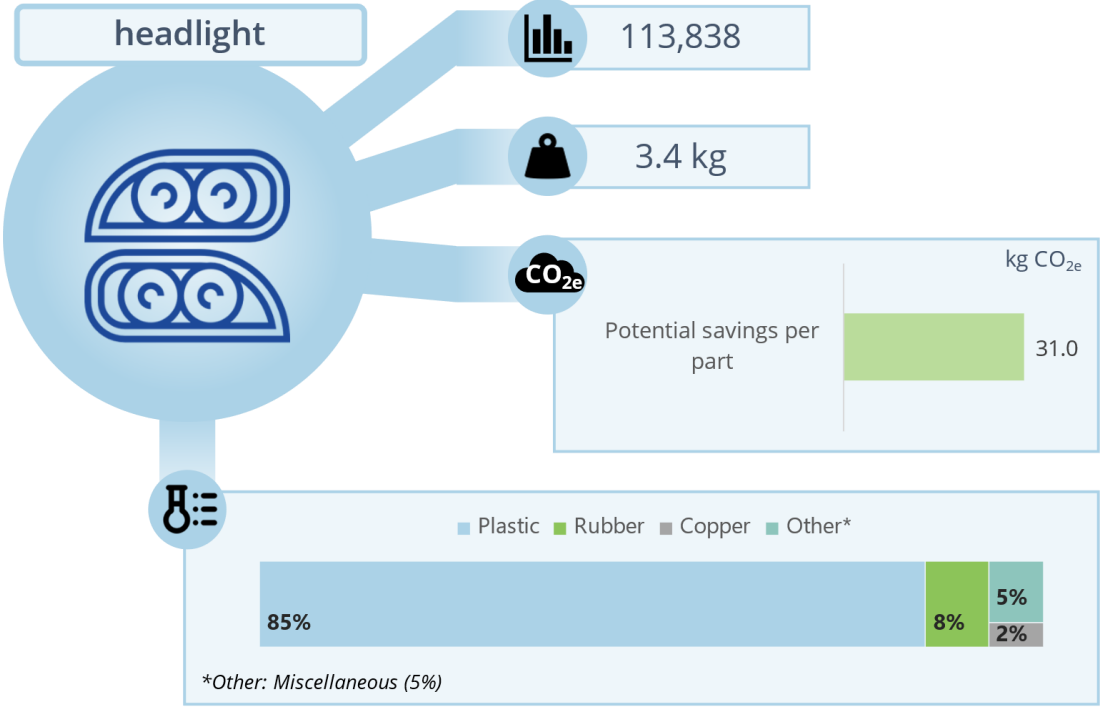


Mechanical parts

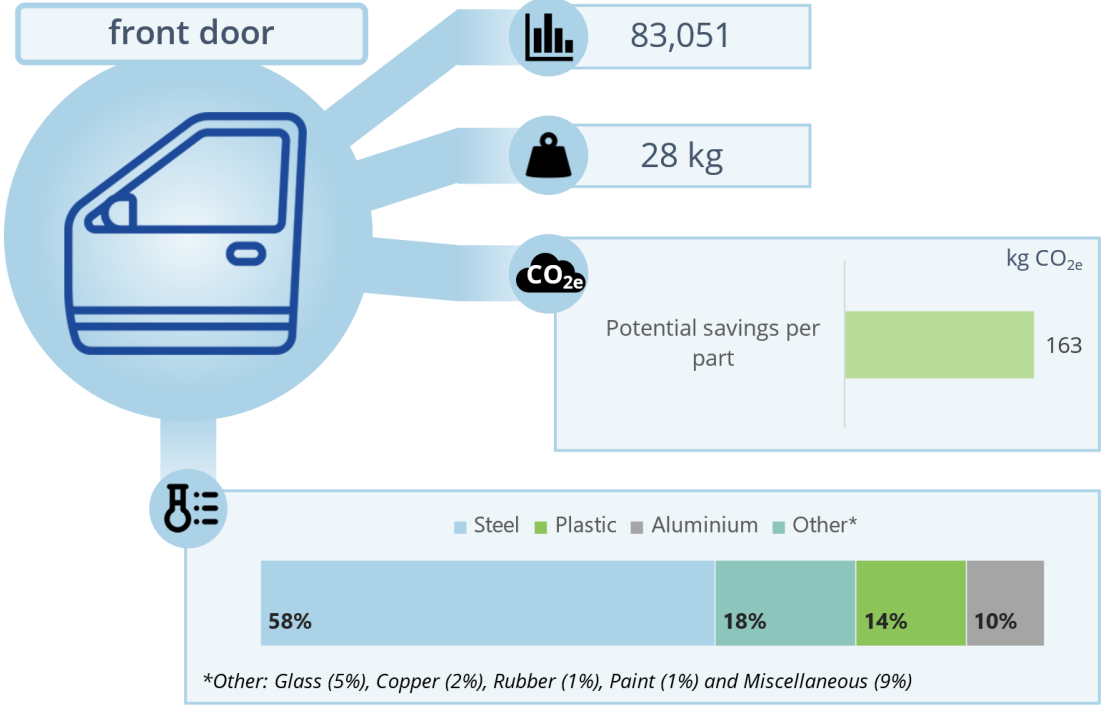


Body parts

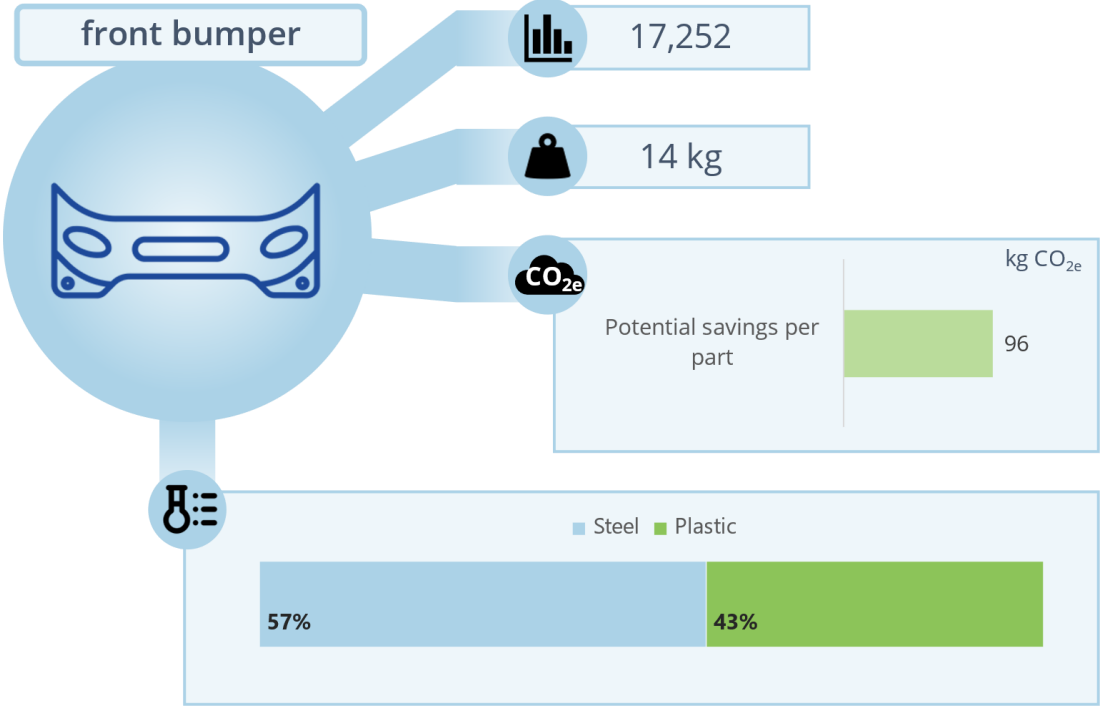
headlight



front door



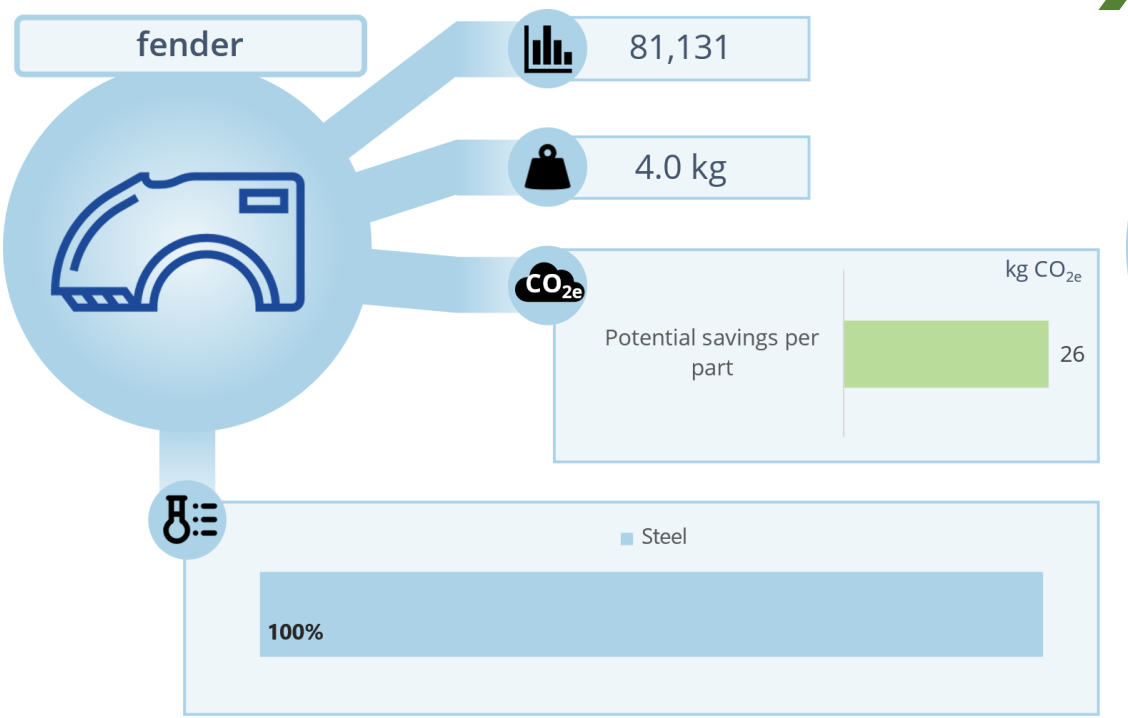
front bumper



fender

81,131

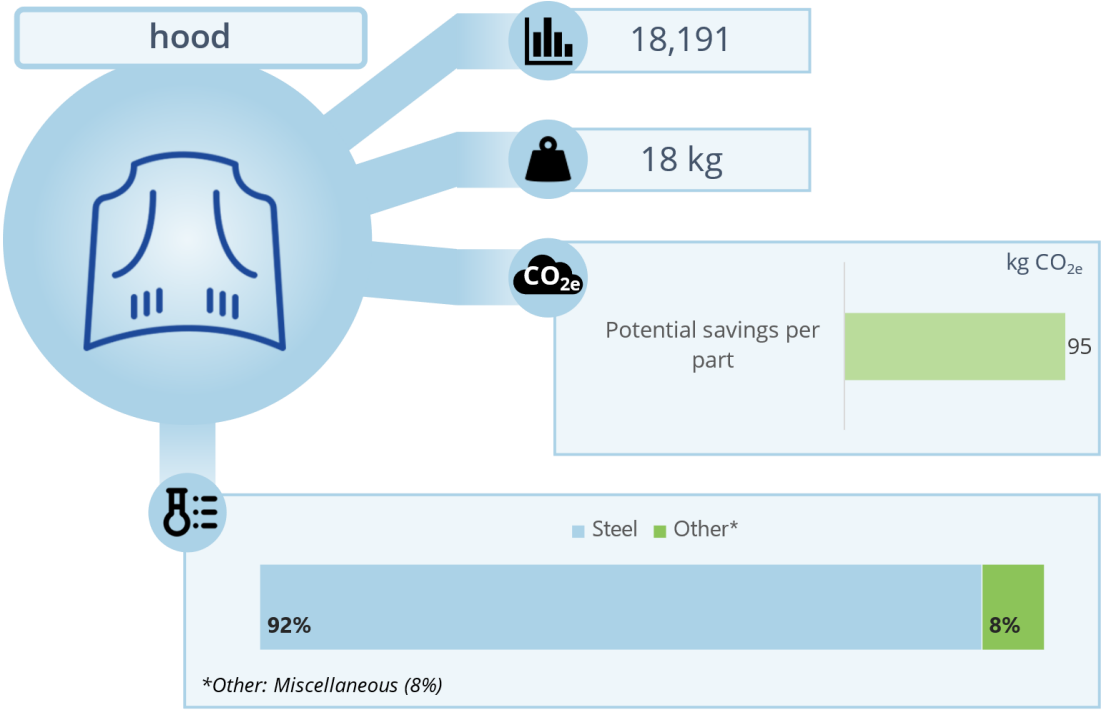
4.0 kg



hood

18,191

18 kg

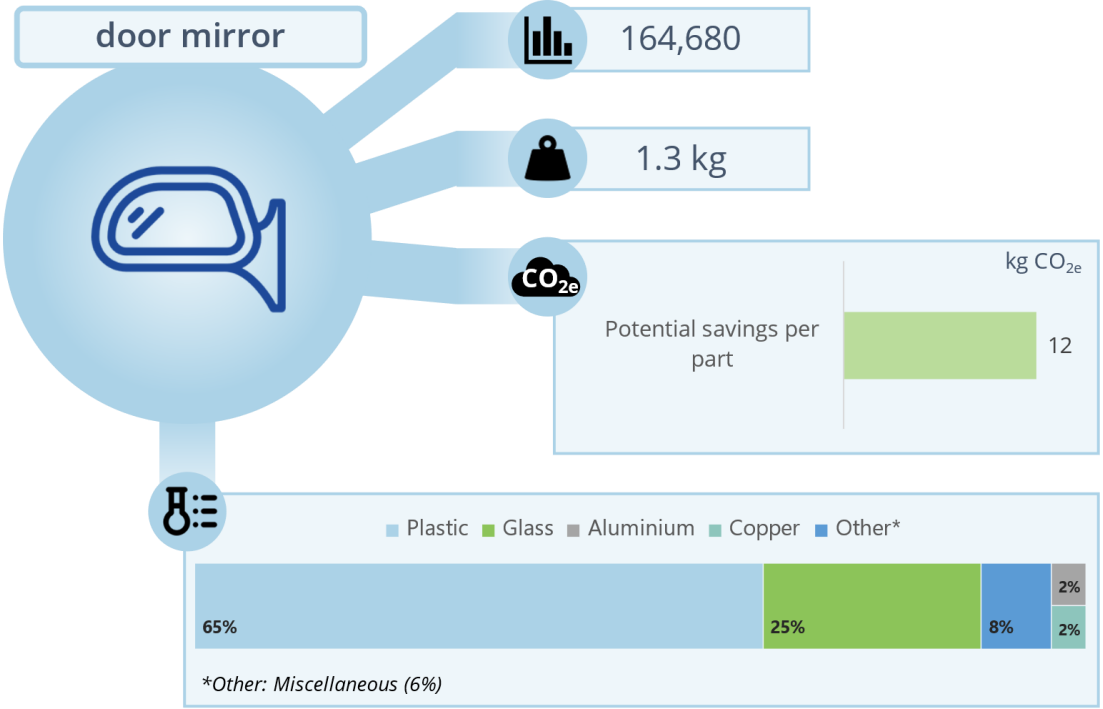


*Other: Miscellaneous (8%)

door mirror

164,680

1.3 kg

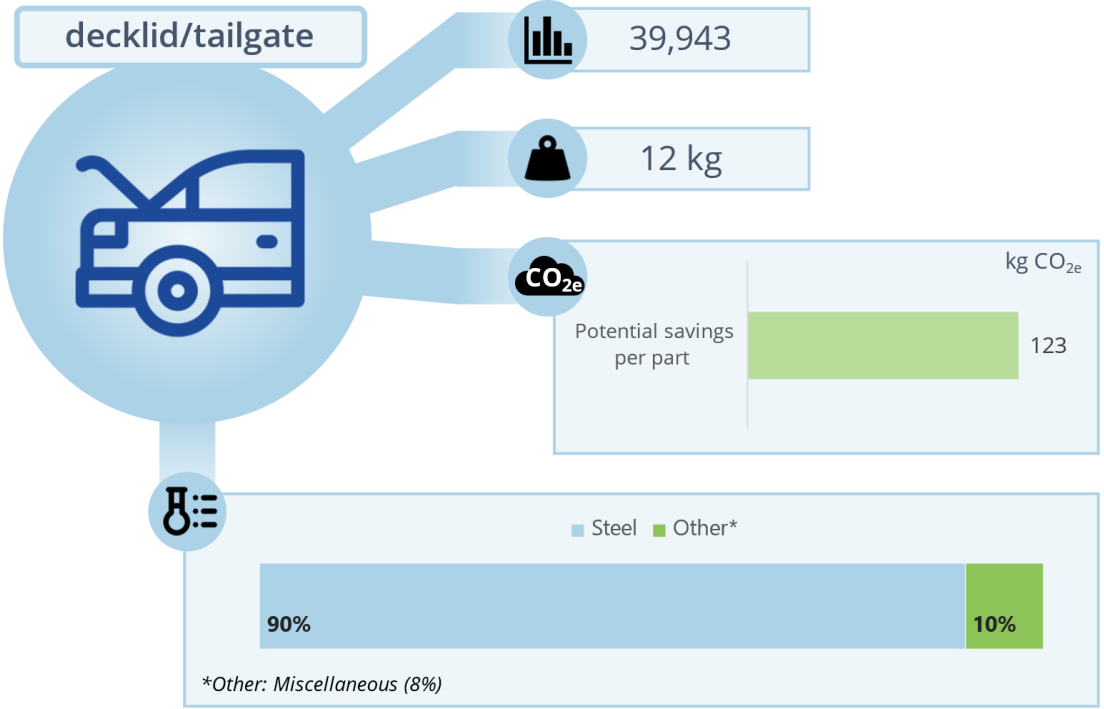


*Other: Miscellaneous (6%)

decklid/tailgate

39,943

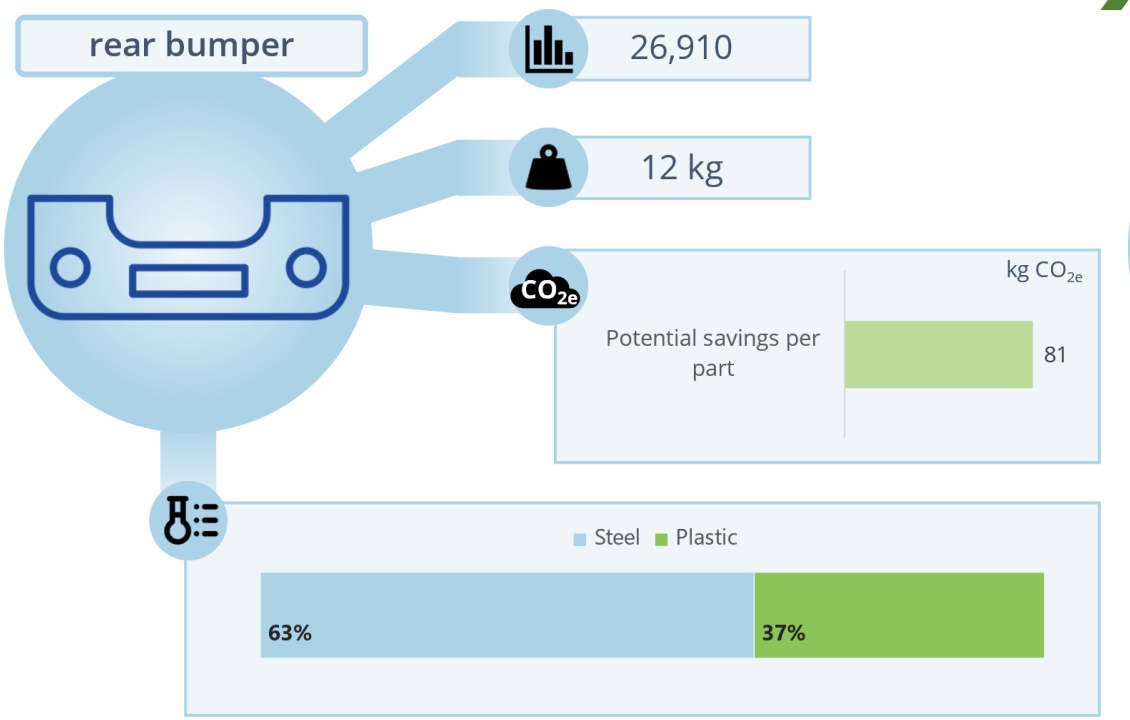
12 kg



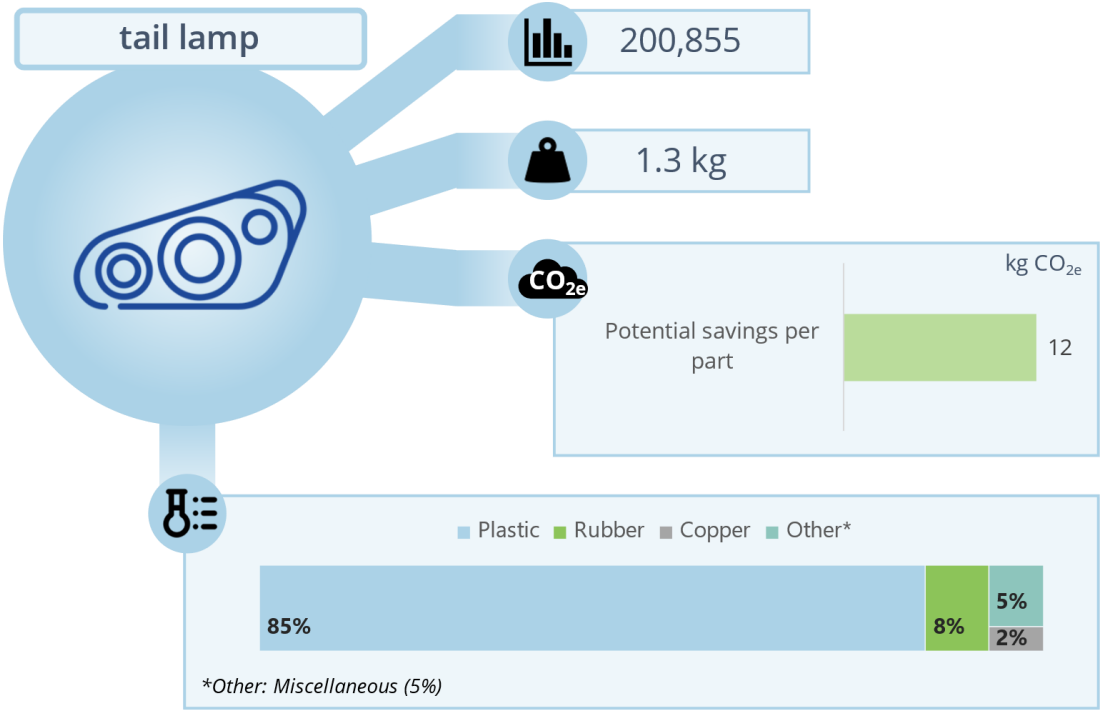
*Other: Miscellaneous (8%)

ENVIRONMENTAL BENEFITS

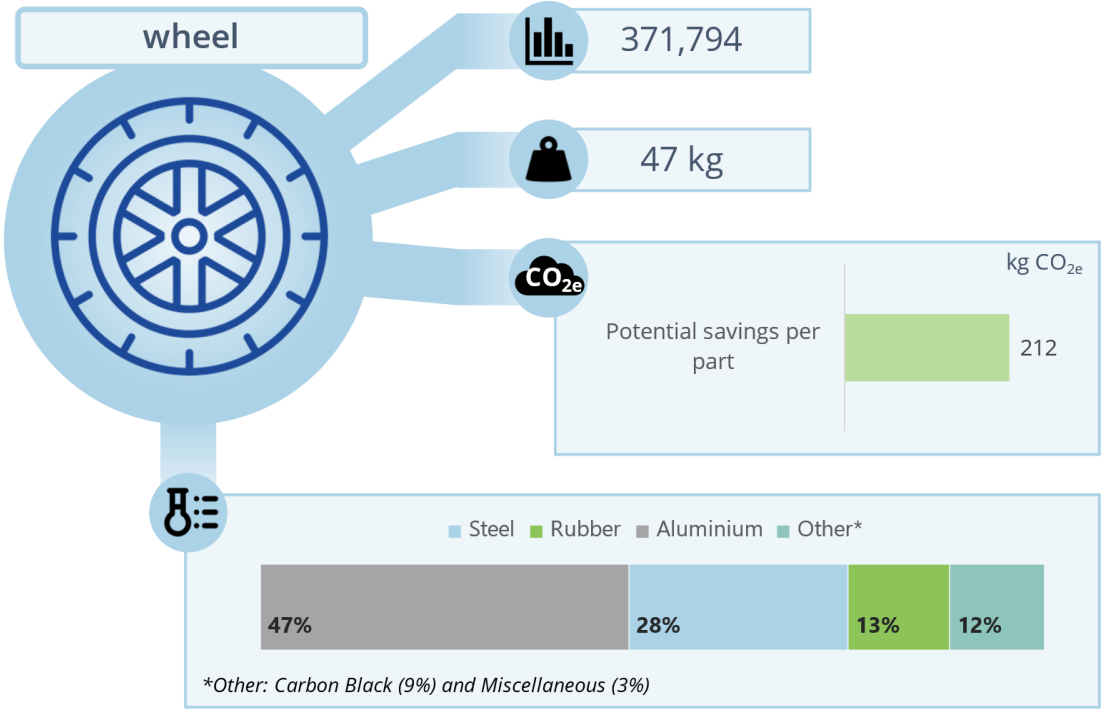
rear bumper



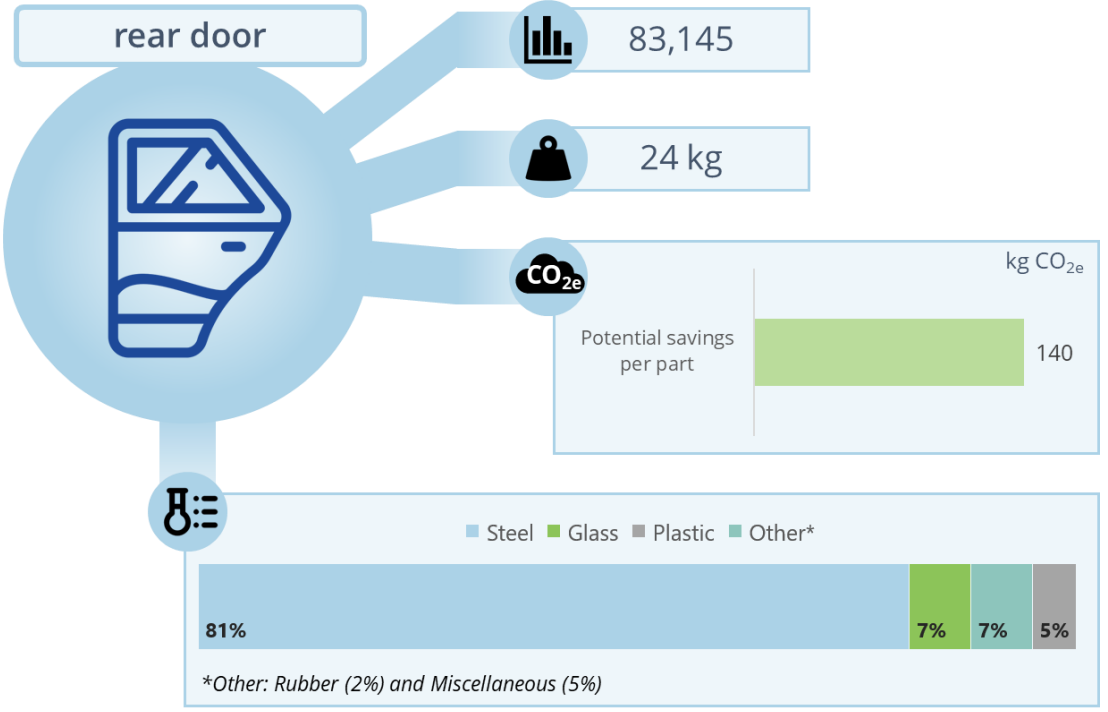
tail lamp



wheel



rear door



TOTAL ENVIRONMENTAL BENEFITS

From the data compiled in this study, we can calculate the potential environmental benefits of the top 13 green recycled parts used in Ontario. The benefit of reusing each single part is scaled up by the total number of parts sold in Ontario per year:

Total impact of green recycled parts = **Potential CO_{2e} avoided per part** x **Parts sold per year**

The impact of each of the top 13 green recycled parts is shown in the figure below:

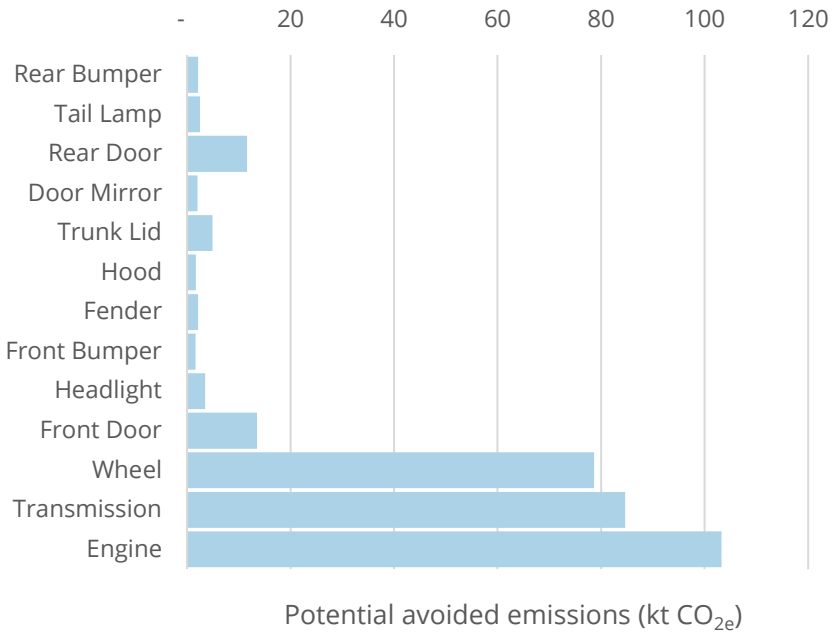


Figure 9: Potential avoided emissions in kt CO_{2e} from using green recycled parts in Ontario.

By summing the impact for each of the top 13 parts, we can calculate that the environmental impact of using green recycled parts in Ontario is approximately:

~310 kt CO_{2e} avoided

~47 kt diverted from end-of-life treatment

These figures represent an initial estimate of the environmental impact; the available evidence was used to estimate both the number of parts sold per year and the calculations of potential CO_{2e} avoided, which rely on emissions factors that are not specific to Ontario. Our calculations have used the average emissions impact for reusing parts from the literature; if the lowest and highest emissions impact factors were used in our calculations, the estimated CO_{2e} avoided from the green recycled parts sold in Ontario would vary between about 190 kt CO_{2e} avoided and about 420 kt CO_{2e} avoided per year.

While these calculations contain could be refined to become more accurate through further analysis, the overarching message remains the same:

The green recycled parts market in Ontario diverts significant volumes of parts from end-of-life treatment, extending the life of these components, and avoiding significant emissions* of greenhouse gas emissions associated with manufacturing new parts.

*As an illustrative example, the avoided emissions from using green recycled parts is equivalent to the annual per capita emissions of over 30,000 Ontario residents.

DRIVERS AND BARRIERS

During the study, the workshop with several OARA members explored and prioritized the drivers and barriers that would support or constrain market growth in green recycled parts in Ontario.

Drivers

The top market drivers for growth identified during the workshop were:

- Increased pressure on OEMs/insurers to adopt ESG practices to align with the 2050 Net Zero target in Canada
- The lower cost of green recycled parts is attractive during the cost-of-living crisis
- Increased societal trends towards green purchasing and conscious consumerism
- Increased interest from insurers looking to quantify and reduce the carbon impact of their claims process
- Other cost drivers, such as the increase of total losses in insurance and increasing repair costs

Barriers

The top market barriers to growth identified during the workshop were:

- Competition for feedstock as parts are diverted to alternative markets
- Lack of enforcement within the grey market reducing the inflow of vehicles and reducing trust in recycled parts

GAP ANALYSIS BY STAKEHOLDER

We have conducted a gap analysis, differentiating between different stakeholder groups, to identify where there might be opportunities to either address the key barriers identified, or build upon drivers for the growth of the green recycled parts market in Ontario.

We have distinguished between the following stakeholder groups:

DATA GAP: There is limited North American-specific data on potential emission abatement through using green recycled parts.

LCA is an evolving field, and although there are increasing studies on the impact of manufacturing new automotive parts, there is limited focus on the end-of-life management, partly due to the complexity around different end-of-life options (reuse, rebuild, disposal, etc.), and the lack of data available on this stage of the part's life.

Existing studies are often not representative for Canada (or Ontario) as they are dependent on the energy supply and common vehicles associated with the study location.

AWARENESS GAP: There is limited communication to customers, especially collision repairers, on the carbon abatement potential of green recycled parts.

DEMAND GAP: There is limited demand for green recycled parts from insurers. However, demand is expected to increase as insurers face increased pressure regarding implementing their ESG strategies.

POLICY GAP: Current Government strategies within the automotive industry focus on the manufacturing of cars (e.g., electric vehicles) and not the end-of-life, reducing the focus on policy to support market forces to encourage use of green recycled parts.

AWARENESS GAP: There is a lack of public awareness of the cost benefit of green recycled parts for both consumers and mechanics.

AWARENESS GAP: There is limited communication of the often-lower wait time for green recycled parts versus new parts.

AWARENESS GAP: There is a lack of public awareness of the environmental benefits associated with using green recycled parts, which could motivate greater demand. While cost is a primary factor in purchasing decisions, consumers are increasingly expecting businesses to address sustainability concerns in the products and services they offer.

TRUST GAP There is a lack of trust in the reliability and safety of green recycled parts reducing demand from customers.

REGULATION GAP The incorrect branding of total loss vehicles at auction reduces the opportunities for dismantlers to purchase vehicles (i.e., Parts Only vehicles designated as Salvage or Brand None). This is particularly relevant for parts vehicles, of which almost 70% are sourced from auction houses, in contrast to scrap vehicles, where a significant percentage are sourced straight from dealerships and the public.

This current system of procurement through auction houses with a significant pool of accredited and un-accredited bidders is inflating the cost of ELV high-salvage parts vehicles and also limiting the supply of vehicles to auto recyclers.

STAKEHOLDER RECOMMENDATIONS

STAKEHOLDER	INSIGHT / GAP	RECOMMENDATION / ANALYISIS
Auto recyclers (OARA)	Consumers prefer green recycled parts mainly for their discounted price when compared to a new part rather than because of their environmental benefits.	This consumer attitude towards green recycled parts makes the market susceptible to macroeconomic upturns (if the economy goes well, people will shift to new parts). For mitigating this, the industry should work on communicating to end users the environmental advantages of using green recycled parts.
Government	The automotive post-dealership servicing market is one of Canada's largest retail markets, at over CAD 20 million.	Decarbonisation of vehicle transportation should not be solely focused on emissions reduction from replacing ICE vehicles with electric or hybrid ones. The use of green recycled parts is a tool that is tested for reducing the lifecycle impacts of existing ICE vehicles. Therefore government should explicitly support its use and help industry with governance and oversight.
Government	There is concern within the market for competition in acquiring used vehicles and the fate of some vehicles. The export of used vehicles to other countries can restrict the supply of used parts within Canada.	Government should provide oversight of ELV grading to only allow authorised dismantlers to procure vehicles that are only suitable for this treatment. This would help minimise grey market actors, control used vehicle exports, and improve supply of ELVs for the domestic used parts market.
Auto recyclers (OARA)	If between 35% and 46% of parts purchased (as vehicles) are being sold on, it means the remainder is being used or disposed in other ways.	For a continuous mapping of the environmental impact of the industry, OARA should try to characterise the use or fate of the 'unsold' parts, to determine what end of life treatment they might have.
Auto recyclers (OARA)	The revenue from a parts car can be about 5.7 times greater than that of a scrap car. Additionally, parts recovery seems to be more economically efficient in a parts vehicle than a scrap one.	This can play in two ways for OARA. On the one hand, the increased revenue from parts vehicles may draw more companies to try and focus on parts vehicles and make them more likely to join the association. On the other hand, it could place even more pressure in the sourcing of parts vehicles, increasing their costs and displacing smaller members from the market.
Insurance companies	For auto recyclers who focus on parts, the share of vehicles procured from auctions/insurers has increased over the past 10 years and is now placed at approximately 74%.	Insurance companies are some of the most interested in the use of green recycled parts to tackle their scope 3 emissions, lead times, and cost. Therefore, they should directly liaise with recyclers to ensure appropriate and fair practices in the procuring of vehicles, and thus enable a reliable supply of used parts.
Mechanic repairers	Although green recycled parts have the advantage of price and availability, there may still be concerns from consumers around trust and safety.	Mechanic repairers should actively participate in efforts from OARA and the recycling industry to portray green recycled parts as a safe alternative. Technical studies or assessments could be needed to drive this point. This also applies to collision repairers, although these are more likely to be influenced by insurers
All	Either directly, through their mechanic repairer, or their insurer, consumers usually hold great power in deciding if green recycled parts should be used in their repairs.	The category of auto parts has usually been left out of the discussions about environmental concerns of consumption. As this type of information becomes more available and prevalent for all purchase choices, consumers will demand clear data for making informed choices. The recycling industry, insurers and repairers need to share and be transparent with the information they hold about environmental impact of green recycled parts and devise a way of sharing it effectively with consumers.

STUDY AUTHORS

As a science-led sustainability and circular economy consultancy, Oakdene Hollins has been delivering strategic, practical solutions to support clients to be leaders in their field since 1994. Traditionally focusing on waste streams and recycling, our expertise now addresses broader aspects of sustainability, working towards a circular economy and a net zero future.

As a dedicated team, we envision a future where planetary boundaries are respected and the circular economy prevails, enabling the environment and society to thrive. We enjoy working collaboratively with our clients and networks, tailoring our support to help our partners achieve long-term success, capturing value through creative, tangible solutions.

www.oakdenehollins.com

COMMISSIONED BY

The Ontario Automotive Recyclers Association (OARA) is a voluntary industry association representing professional auto recyclers in Ontario. Members acquire end-of-life vehicles (ELVs) and responsibly manage their retirement by recovering auto parts for reuse and materials for recycling. All Members are audited by a third-party to the Canadian Auto Recyclers Environmental Code (CAREC), which was developed for Environment Canada. The Code establishes minimum regulatory compliance plus a wide variety of industry best practices and commitments to continual improvement.

In addition, all Members are registered with the Ministry of Environment, Conservation and Parks as an ELV Waste Disposal Site. OARA was instrumental in creating the Green Recycled Parts industry branding initiative, along with the development of the national vehicle retirement programs Car Heaven and Retire Your Ride. OARA is a founding Member of the national association - the Automotive Recyclers of Canada (ARC).

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www.oara.com | www.carec.ca | www.carheaven.ca | www.retireyourride.ca | www.autorecyclers.ca

This appendix summarises the outputs of the workshop held with a group of OARA members exploring the drivers and barriers to growing the market for green recycled parts, using the PESTLE framework.

Drivers to growing the market

Political drivers

- Increased pressure on OEMs and insurers to adopt ESG practices to align with the Canadian net-zero target of 2050.
- The Canadian government are currently researching the potential implementation of a value retention strategy, which may promote reuse.

Economic drivers

- On average the cost of a green recycled part is lower than that of a new OEM part, incentivising demand.
- Lower-cost green recycled parts are particularly attractive with the ongoing cost-of-living crisis.
- On average, the energy intensity of dismantling and restoring a green recycled part is lower than that of manufacturing a new part.
- The income stream opportunities for dismantlers from parts resale vs. shredding are significantly higher.
- Insurance companies are demonstrating an increasing interest in the carbon impact of the claims process and strategies to mitigate this. Examples of this include the LCA studies on repair vs. replacement parts in Europe by Allianz, and the Net-Zero supply chain for Aviva for insurance claims handling.
- Increasing standardisation of the dismantling process makes it more economical.
- Cost of new vehicles as a percentage of income are high, incentivising people to keep their vehicles for longer.
- Parts recyclers often benefit from a lower supply time to customers compared to OEMs.

Social drivers

- Higher purchasing power of the public to request green recycled parts for repairs at mechanic shop.
- Barriers to EV uptake maintaining use of combustion engine vehicles (cost, interest, trust). Although there has been a shift in Ontario in the types of powertrains people want to purchase next by 22%, ICE vehicles are still key at 48% of the total market in 2021 [21].
- Societal motivation for green purchasing and conscious consumerism.
- Increasing average age of vehicles in use.
- Population growth rate across Canada, primarily through net migration, increasing demand for vehicles and subsequently car parts.

Technological drivers

- Increased design for vehicle disassembly in new vehicles
- Innovation in disassembly tools/practices for dismantlers
- Increased standardisation/consolidation of software tools for parts inventory tracking/trading

Legal drivers

- Gold Seal program for accredited ARC members
- CAREC with key benefits such as standardisation of dismantling equipment and high volume of membership for Ontario specifically

Environmental drivers

- Anticipated carbon savings associated with recycled parts.
- Anticipated waste savings associated with recycled parts.
- Increased circularity by extending the use phase of a product.
- Reduced use of raw materials as reduced demand (and expected production) of OEM parts.

Barriers to growing the market

Political barriers

- Zoning by-law site usage restrictions prohibiting the outdoor storage of parts/materials,
- Lack of awareness of the industry, resulting in limited policy support
- Policies are often aligned with US policies limiting ambition
- Overall government engagement in the reuse of parts

Economic barriers

- OEM competition and pushback, through mechanisms such as reduction in price of OEM parts, price matching, or extended warranty of vehicles.
- Competition for feedstock as parts are diverted to remanufacturing.
- Cost of a vehicle for dismantling is significantly higher for Ontario compared to other provinces.
- It is recognised within the market that some stakeholders may use minimal dismantling due to the highly manual process associated, which demonstrates high labour costs within the market[(1)].
- Lack of material inflows.
- Limited storage on site.
- High transportation (hauling) costs.
- Incorrect branding for total loss vehicles at auction reducing procurement opportunities for auto recyclers.

Social barriers

- Lack of knowledge of benefits/availability of green recycled parts.
- Safety concerns regarding green recycled parts.

Technological barriers

- Use of electronics in different parts, e.g., software keys needed for proper operation of the parts and may need OEM intervention.
- Technological advances currently focused on battery recycling and automotive shredder residue use – diverting interest from dismantling and reuse opportunities.
- Lack of understanding/transparency of OEM part production/testing processes.

Legal barriers

- High levels of compliance across the industry diverts interest for additional laws regarding reuse.
- Lack of enforcement within the grey market reducing the inflow or vehicles and reducing trust in recycled parts. (1)

Environmental barriers

- Limited resilience to climate change events at dismantling sites e.g., if CAREC stipulate vehicle recycling operations are not permitted in designated flood zone regions.
- Second life performance of recycled parts vs. OEM parts.

REFERENCES

1. **Sawyer-Beaulieu, Susan S.** *Gate-to-gate life cycle inventory assessment of North American end-of-life.* 2009. Electronic Theses and Dissertations. 8084.

2. **Reogma.** Automotive aftermarket in Canada worth US$ 20.92B by 2025. *Reogma - Business Analytics for SMEs.* [Online] 2020. [Cited: 09 01, 2023.] https://www.reogma.com/industry-reports/automotive-aftermarket-in-canada-worth-us-20-92b-by-2025/.

3. **International Trade Administration.** Canada - Country Commercial Guide, Automotive. *trade.gov.* [Online] 03 08, 2022. [Cited: 09 01, 2023.] https://www.trade.gov/country-commercial-guides/canada-automotive#:~:text=In%20addition%20to%20new%20auto,now%20lower%20than%20total%20imports..

4. **Mitchell.** *Trends in the Auto Recycling, Collision Repair, and Insurance Sectors.* s.l. : Enlyte Group, 2023.

5. **Government of Canada.** Net-Zero Emissions by 2050. *Canada.ca.* [Online] Jul 11, 2023. [Cited: Sep 26, 2023.] https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html.

6. **Hollins, Oakdene.** *Executive Summary of the Socio-Economic and Environmental Study of the Canadian Remanufacturing Sector and Other Value-Retention Processes in the Context of a Circular Economy.*

7. **CNBC.** [Online] https://www.cnbc.com/2023/08/10/how-totaled-tesla-sold-for-parts-in-us-came-back-online-in-ukraine.html.

8. **Transport Canada.** Canada's Zero-Emission Vehicle (ZEV) sales targets. *Government of Canada.* [Online] November 22, 2022. [Cited: September 11, 2023.] https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/canada-s-zero-emission-vehicle-zev-sales-targets.

9. **Aviva Canada.** Taking Climate Action to Become Net-Zero by 2040. *Aviva.ca.* [Online] [Cited: Sep 26, 2023.] https://www.aviva.ca/en/about-aviva/sustainability/climate-action/.

10. **Synetiq.** Synetiq commits to setting Science based targets as part of ongoing sustainability drive. *Synetiq.co.uk.* [Online] Dec 21, 2021. [Cited: Sep 26, 2023.] https://www.synetiq.co.uk/synetiq-commits-to-setting-science-based-targets-as-part-of-ongoing-sustainability-drive/.

11. **Ford.** Ford expands climate change goals, sets target to become carbon neutral by 2050: Annual Sustainability Report. *Ford Media Center.* [Online] Jun 24, 2020. [Cited: Sep 26, 2023.] https://media.ford.com/content/fordmedia/fna/us/en/news/2020/06/24/ford-expands-climate-change-goals.html.

12. **Toyota.** Toyota Environmental Challenge 2050: zero CO2 emissions from all production facilities. *Toyota UK Magazine.* [Online] Jun 19, 2017. [Cited: Sep 19, 2023.] https://mag.toyota.co.uk/toyota-environmental-challenge-2050-zero-co2-emissions-from-all-production-facilities/.

13. —. Environment & Sustainability. *Toyota Canada Newsroom.* [Online] [Cited: Sep 26, 2023.] https://media.toyota.ca/en/environmental-sustainability.html.

14. **Intact Insurance.** Climate Resilience. *Intact.* [Online] [Cited: Sep 26, 2023.] https://www.intactfc.com/in-the-community/climate-resilience.

15. —. Intact Financial Corporation announces five-part climate transition plan. *Intact.* [Online] Apr 14, 2022. [Cited: Sep 26, 2023.] https://www.intactfc.com/press-releases/1/intact-financial-corporation-announces-five-part-climate-transition-plan.

16. **Oda, Hiroma, Noguchi, Hiroki and Fuse, Masaaki.** *Review of life cycle assessment for automobiles:.* s.l. : Elsevier, 2022.

17. **Accardo, Antonella, et al.** *End-of-Life Impact on the Cradle-to-Grave LCA of Light-Duty Commercial Vehicles in Europe.* Basel : MDPI, 2023.

18. **The European Commission.** *Study to Support the Impact Assessment for the Review of Directive 2000/53/EC on End-of-Life Vehicles.* Luxembourg : The European Commission, 2023.

19. **L'Association des recycleurs de pièces d'autos (ARPAC).** *Environmental and Socioeconomic Life Cycle Assessment of the Quebec Auto Parts Recycling Sector - Final Translated Report.* s.l. : ARPAC, 2013.

20. **SYNETIQ.** Carbon Labelling at SYNETIQ. *SYNETIQ.co.uk.* [Online] SYNETIQ, 2022. [Cited: August 31, 2023.] https://www.synetiq.co.uk/carbon-labelling/.

21. **Deloitte.** *2021 Ontario automotive consumer study.*

22. **The Automotive Engineers of Japan.** *Energy and CO2 Benefit Assessment of Reused Vehicle Parts through a Material Flow Approach.* s.l. : The International Journal of Automotive Engineering, 2018.

23. **Rovinaru, Flavius Ioan, Rovinaru, Mihaela Daciana and Rus, Adina Viorica.** *The Economic and Ecological Impacts of Dismantling End-of-Life Vehicles in Romania.* s.l. : Sustainability, 2019.

24. **Siddiq, Muhammad, et al.** *Assessing the Environmental Impact of Automotive Recyclers of Massachusetts.* s.l. : The Worcester Polytechnic Institute, 2017.

25. **Automeris.** Web Plot Digitizer - Version 4.6. *Automeris.IO.* [Online] Automeris, 2023. [Cited: 09 01, 2023.] https://automeris.io/WebPlotDigitizer/.

26. **The Argonne National Laboratory.** *The Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) Model.* Chicago : The Argonne National Laboratory.

27. ***Information from discussion with OARA members.***