Roadmap to Increase Recycling of Auto Plastics from End-of-Life Vehicles in Canada

Prepared for

Automotive Recyclers of Canada

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1 Introduction to the Automotive Plastics Roadmap

The purpose of this Roadmap is to guide activities in automotive plastics reuse and recycling research and developments in Canada over the next 8 years (i.e., 2022 to 2030) in order to reach higher future plastics diversion goals for Canada.

The long-term vision for automotive plastics (2030) is the development of circular plastics for the automotive sector whereby:

- through design, no molecule is wasted;
- performance, safety and environmental standards are continuously improved; and
- value is added throughout the Canadian automotive supply chain.

The American Chemistry Council has proposed ***six core principles of a Circular Economy for Plastics****:*

- Design materials, products and systems to be circular – e.g., design for disassembly and recovery;
- Reduce demand for finite raw materials;
- Reuse recovered materials in new products;
- Recover and recycle materials at the end of their usable life;
- Refurbish and remanufacture products to extend useful services lifecycles; and
- Eliminate in-process scrap production.

The long-term goal of the Automotive Recyclers of Canada is to use enhanced training, knowledge development and appropriate/necessary incentives to:

- Facilitate greater reuse and recycling of auto plastics;
- Improve the environmental benefits of vehicle dismantling (both internal combustion engines (ICE) and electric vehicles (EVs)); and
- Reduce overall end of life (EOL)automotive waste in Canada, including waste auto plastics.

The auto sector is the third highest user of plastics representing about 12% (by weight) of total plastics; behind packaging (by far the largest use of plastics) and construction.[1] As described in this Report, the amount of plastics in future vehicles is expected to grow due to increasing efforts to reduce vehicle weight and thus improve efficiency. For this (and other reasons), attention on the reduction of waste plastics from the automotive (and other) sectors is increasing - e.g., as part of the federal government's Zero Plastic waste target for 2030.

[1] Deloitte and Cheminfo (2019); Economic Study of the Canadian Plastics Industry

Only about 9%[2] of plastics generated each year in Canada are recycled with the balance going to landfill, with a small - but high profile - percentage going into the natural environment. An estimated 300-400 kt of auto plastics are discarded[3] each year in Canada often as part of automotive shredder residue (ASR), a mix of non-ferrous metals as well as non-metallic materials remaining after end-of-life vehicles (ELVs) are shredded to remove ferrous metals. ASR is often used as daily cover material at landfill sites.

To date, the automotive industry has been a recycling success story. In Canada, there are approximately 1.6 million end-of-life vehicles (ELVs) generated every year and 95% of ELVs are recovered. Nearly 83% of the ELVs are recyclable or re-usable (metals, tires, bumpers, etc.) and technologies are being developed to improve material recovery from ASR.[4]

The next chapter in this story is to improve the diversion of auto waste in general, and auto waste plastics in particular, though enhanced plastic waste reduction, reuse and recycling measures; in support of a long-term goal of zero plastic waste in Canada.

[2] Deloitte, ibid.
[3] Plastics challenge: Diverting end of life vehicles from landfills, Government of Canada
[4] Automotive Recyclers of Canada (ARC); Pre-Budget Submission; February 19,2021

2. Federal Plastics Waste Reduction Mandate

The federal government of Canada has set an ambitious target to achieve "*Zero Plastic Waste by 2030*" driven by:

- growing concern about plastic pollution in the natural environment;
- historically poor overall plastics recycling and reuse performance; and
- broad citizen support for action on plastic waste at all levels of government and businesses.

While the initial federal (and provincial) governments' primary focus is on reducing plastics packaging waste, the long-term target is to reduce all plastic waste, including automotive plastics.

2.1 Canada's Zero Plastic Waste Target and Policy

On Thursday, December 16, 2021, the Prime Minister publicly shared 38 mandate letters, one to each Cabinet Minister. In his letter to Environment and Climate Change Minister Guilbeault, the mandate letter highlighted eight specific measures to "achieve Zero Plastic Waste by 2030":[5]

- Continue to implement the national ban on harmful single-use plastics;
- Require that all plastic packaging in Canada contain at least 50 percent recycled content by 2030;
- Accelerate the implementation of the zero plastic waste action plan, in partnership with provinces and territories;
- Continue to work with provinces and territories to ensure that producers, not taxpayers, are responsible for the cost of managing their plastic waste;
- Work with provinces and territories to implement and enforce an ambitious recycling target of 90 percent - aligned with Quebec and the European Union - for plastics beverage containers;
- Introduce labelling rules that prohibit the use of the chasing-arrows symbol unless 80% of Canada's recycling facilities accept and have reliable markets for these products;
- Support provincial and territorial producer responsibility efforts by establishing a federal public registry and requiring producers to report annually on plastics in the Canadian economy; and
- Work with the Minister of Innovation, Science and Industry on the creation of a new infrastructure and innovation fund that will scale-up and commercialize made-in-Canada technologies and solutions for the reuse and recycling of plastics.

[5] Recycling Council of Alberta; Prime Minister of Canada Releases New Ministerial Mandate Letters; Connector December 2021

Furthermore, in conjunction with these eight measures, mandate letters (that cover six different federal departments) outline four additional supportive actions where federal departments are directed to work collaboratively, specifically to:

- The Minister of Innovation, Science and Industry to *work with the Minister of Environment and Climate Change (ECCC) 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*;
- The President of the Treasury Board to *accelerate our Greening Government commitment to electrify the entire federal fleet of light duty vehicles by 2030*;
- The Minister of Innovation Science and Technology to *lead the implementation of the Net Zero Accelerator Initiative…a clear long-term investment strategy to support the strategic review of large-scale investments targeting key industrial sectors…in order to drive industrial transition and significant reductions in GHG emissions; and*
- The Minister of Innovation, Science and Technology to *work with the Minister of Trade, Export Promotion, Small Business and Economic Development, helping to drive the development of Canadian clean technology companies and small and medium sized enterprises working in the area of de-carbonization*[6]

It is notable that new federal funding programs are a key component of the proposed federal actions on plastics.

2.2 Federal Actions to Date

Four recent federal actions demonstrate the strong federal commitment to work towards "Zero Plastic Waste by 2030".

On December 25, 2021, the proposed *Single-Use Plastics Prohibition Regulations* were published in the Canada Gazette, Part 1 initiating a 70-day public consultation period on the proposed Regulations. The proposed Regulations (that have been under development since the fall of 2018) would prohibit the manufacture, import and sale of six categories of single use plastic items: check out bags, cutlery, foodservice ware made from or containing problematic plastics, ring carriers, stir sticks and straws. In a press release in the spring of 2019, the Prime Minister acknowledged that Canada's single use plastic bans were modelled after the European wide-ranging bans that are just beginning to come into effect. He also noted then that the federal government will "work with provinces and territories to introduce standards and targets for companies that manufacture plastic products or sell items with plastic packaging so they become responsible for their plastic waste".[7]

In May 2021, "plastic manufactured items" was added to Schedule 1 to the *Canadian Environmental Protection Act, 1999 (CEPA)*. This means that the Government of Canada can "take regulatory and other actions in support of reaching Canada's zero plastic waste goal and setting the conditions for circular

[6] Ibid, New Ministerial Mandate letters; pp 1-7
[7] June 10, 2019 ECCC Press Release

plastics".[8] While provinces, territories and municipalities are the recognized leaders in the recovery and recycling of plastics, the federal government has committed to work to strengthen existing programs and increase Canada's capacity to reuse and recover more plastics. This includes collaboration among all levels of government to develop pan-Canadian targets to ensure that rules are consistent and transparent across the country, and to make producers and sellers of plastic products responsible for collecting them.[9]

On February 12, 2022, the Government of Canada published a Notice of Intent in the Canada Gazette Part 1 and a Technical Issues paper on the development of proposed regulations that would set minimum recycled content requirements for certain plastic manufactured items. Comments will be considered until March 14, 2022 as the proposed new regulations are developed.

Finally, in November 2018, through the Canadian Council of Ministers of the Environment (CCME) the federal, provincial and territorial governments approved in principle a *Canada-wide Strategy on Zero Plastic Waste*. The Strategy takes a circular economy approach to plastics and contains ten priority "result areas" for action:

1. All plastic products are designed for greater durability, reuse and recycling;
2. The responsible use and recycling of SUPs (single use plastics) is significantly increased;
3. Expanded collection systems keep all plastic products in the economy and out of the environment;
4. Strong domestic markets and varied end uses drive demand for recycled plastics;
5. Canada's recycling capacity is world-leading and can process and recover value from all types of plastic waste;
6. Canadian households, businesses and institutions are empowered to prevent and manage plastic waste responsibly;
7. Plastic pollution generated by aquatic activities is significantly reduced;
8. Effective research and monitoring systems inform decision-making and measure performance;
9. Effective capture and clean-up of plastic pollution protects Canada's environment, shorelines and waterways; and
10. Canadian leadership has accelerated global action to address marine liter and plastic pollution.

2.3 CCME Activities on Zero Plastic

The Canadian Council of Ministers of the Environment (CCME) consists of the 14 federal, provincial and territorial ministers with the environment in their portfolio. This intergovernmental forum meets at least once a year to discuss collective action on national and international environmental issues. CCME is the

[8] Zero plastic waste; Policies and regulations; ECCC fact sheet
[9] "A proposed integrated management approach to plastic products to prevent waste and pollution – Discussion Paper"; released by Environment and Climate Change Canada, October 7, 2020.

forum where much of the collaboration, planning and actions have occurred regarding measures to reduce plastic waste across Canada.

In June 2019, CCME issued its Phase 1 report on priority actions to be taken to implement the *Canada-wide Action Plan on Zero Plastic Waste*. Six priority actions were identified:

i) CCME will facilitate consistent Extended Producer Responsibility (EPR) programs for plastics;

ii) National performance requirements and standards will be developed;

iii) Incentives will be established to help create a circular economy;

iv) Infrastructure and innovation investments will be made;

v) Public procurement and green operations will be supported; and

vi) A roadmap to address priority single-use and disposable plastic products will be written.

CCME's *Phase 2 Action Plan on Zero Plastic Waste* was released in 2020 and targeted the remaining result areas of the Strategy that address actions to reduce plastic pollution and serve as enablers to achieve the CCME's goal of zero plastic waste. Its six priority areas are: information exchange and awareness; management of waste from aquatic activities; fishing and aquaculture; capture and clean-up; research; and global leadership.

2.4 Canada's Plastic Pact and Circular Plastics

October 1, 2020 The Natural Step, a not-for-profit organization based in Ottawa and the leading founder of the industry-led Canada Plastics Pact (CPP), announced that Canada joined the network of nine other national-regional Plastic Pacts now in place around the world. This is one of the key outcomes of the UK based Ellen McArthur Foundation's global vision of a Circular Economy for Plastics. CPP is initially focused on plastics packaging but with the intention of expanding beyond packaging to other types of plastic waste in the future. The Canada Plastics Pact[10], consistent with the commitments of the other Pacts in the global network, has set four targets:

1. Define a list of plastic packaging that is to be designated as problematic or unnecessary and take measures to eliminate them by 2025;

2. Support efforts towards designing 100% of plastic packaging to be reusable, recyclable or compostable by 2025;

3. Undertake ambitious actions to ensure that at least 50% of plastic packaging is effectively recycled or composted by 2025; and

[10] Canada Plastics Pact Information package; October 5, 2020; www.plasticspact.ca

4. Ensure an average of at least 30% recycled content across all plastic packaging (by weight) by 2025.[11]

CPP unites businesses, government and non-government organization in identifying the systemic barriers to circular plastics be addressed that cannot be solved in isolation, namely:

- Recycled plastics being uncompetitive with virgin plastics in terms of pricing;
- Fragmentation between various actors in the plastics life cycle;
- Technical and policy barriers that block the adoption of new circular economy practices at scale; and
- Unpriced and unmitigated externalities effectively subsidizing the status quo[12].

In July, 2021 CPP announced its (voluntary) Nine Golden Design Rules to redesign plastics packaging for circularity. The key objectives for the Rules are to eliminate unnecessary or challenging-to-recycle packaging, increase the recycling value for both packaging that is currently recycled at scale as well as packaging types that will be recycled at scale in the future, improve environmental performance of business-to-business packaging and improve consumer communications.[13] The Rules are voluntary and include:

1. Increase value in polyethylene terephthalate (PET) recycling – PET bottles represent 13 % of plastic packaging;
2. Remove problematic elements from packaging – e.g., polyvinyl chloride (PVC) and expanded polystyrene (EPS);
3. Eliminate excess headspace - to reduce package size/plastics packaging;
4. Reduce plastic overwraps – e.g., from tinned food and beverages;
5. Increase recycling value for PET thermoformed trays – e.g., use un-coloured PET;
6. Increase recycling value in flexible packaging – e.g., maximize polyolefin content;
7. Increase recycling value in rigid HDPE & PP - e.g., use compatible closures;
8. Reduce virgin plastic use in business- to- business packaging – e.g., switch to reuse models or post-consumer recycled film; and
9. Use on-pack recycling instructions – i.e., include recycling and reuse instructions on consumer packaging.

These kinds of design rules for plastics products and packaging can dramatically reduce the plastics generated not only from the packaging stream but also be adapted to reduce plastics waste from other waste streams, including automotive plastic waste.

[11] Ibid. p. 4
[12] Ibid. p. 4
[13] Circular innovation Council Press release re The Golden Design Rules for Plastics Packaging; July 21, 2021

3 Barriers to Auto Plastic Recycling

Understanding the barriers to auto plastics reuse/recycling is an important part of preparing an eight year Roadmap on how to move forward on diverting more auto plastic waste across Canada. This section addresses three types of barriers:

- Economic barriers;
- Technical barriers; and
- Regulatory/Institutional barriers.

Information on current barriers was collected through the industry survey and interviews with auto recyclers and plastics recyclers, as well as a review of literature and other research on the topic as summarized in Technical Memorandum #1 of this project.

3.1 Economic Barriers to Increased Auto Plastics Recycling and Reuse in Canada

#1 - The low cost of virgin plastics

While the Covid pandemic has had a de-stabilizing impact on the price of virgin plastic over the past two years, the general trend has been that the cost of many virgin plastics has been at historic lows (due in part to lower fossil fuel demand, particularly from the transportation sector). By contrast, the market price for recycled PET (one of the most recycled resins due to extensive plastics bottle recovery programs in many parts of the world, including Canada) was almost twice the price of virgin PET in 2020.[14]

The price of recycled PET containers in 2021 increased almost 30% over the course of 2021.[15] Due to plastics recycled content requirements for plastics packaging already in place in the EU, planned for Canada (as described above) and now increasing across the US (California, Washington Stare, New Jersey), there is high global demand for clean, high quality recycled post-consumer resins by consumer packaging companies (especially clean PET; High Density Polyethylene – HDPE; and Polypropylene - PP).

Polypropylene is the plastic resin most used in automobiles. In October 2021, post-consumer PP was selling for 32.69 cents US per pound whereas PP was selling for 5.63 cents per pound in the US one year prior.

[14] A Reuters Special report – The Plastics pandemic 2020
[15] Plastics Recycling Update

#2: High cost of collecting, transporting, processing, cleaning and pelletizing recycled plastics

This research project examined in some detail the time and attention required to "harvest" plastics for reuse and recycling from ELVs. One of the advantages of using plastics in manufacturing vehicles is their light weight. While plastics generally represent 10% of a vehicle's weight, they can be about 50% of thevolume[16].

Both the weight and mass of plastics in new vehicles going forward are expected to increase by 15% or more by 2030 (in part due to the projected global growth of electric vehicles); consequently, the importance of improving auto plastics recovery is only going to increase with time.

The cost of transporting light plastics to recyclers for grinding, cleaning and pelletizing can be prohibitive. The lack of supply to meet the demand for clean, high quality specific resins from both post-consumer and industrial sources is an important barrier for all industrial plastics users, including vehicle manufacturers and their key suppliers.

#3: Current lack of demand for recycled auto plastics

As there is currently neither robust recycling activity nor a current strong market for EOL automotive plastics in Canada (other than for bumpers according to the research for this Report), there is no clear indication as to what the price differentials might be for selected automotive plastics produced from recycled sources.

For most industrial plastics recyclers in Canada, auto plastics are generally only a small portion of what they process and the auto plastics they do process is primarily manufacturing scrap from OEMs and OEM parts suppliers.

Cost differences between the chemical recycling of plastic packaging waste and virgin costs in Europe are noted as in the region of €400/tonne more expensive than virgin production[17]. This presents an additional challenge for the growth of ASR processing technologies (including chemical recycling) becoming cost competitive with virgin plastics supply.

Only 2% of auto recycler respondents to the on-line survey research for this project said that current markets for auto plastics are stable or good; 75% said markets are poor. 77% of auto recyclers said the main reason for not recycling auto plastics is simply that "no one wants to buy" (although 70% of respondents said they "could" recover plastics under the right conditions).

#4: Low cost of waste disposal

An historic barrier to waste diversion for virtually all materials (including plastics) and across all sectors is the comparatively low cost of waste disposal across most of North America. The American Chemistry Council has noted that tipping fees in the US averaged $US 52.09 per US ton in 2019. Landfill tipping fees vary across Canada but are generally $80-$120/tonne in large urban areas and less, or minimal in rural

[16] https://www.plasticmakers.org/news/driving-a-more-sustainable-future-for-the-auto-industry/
[17] From comments by the CEO of APChem during a Planet tracker webinar

areas. The cost of disposal is significantly higher in Europe, where waste diversion regulations and performance are generally well ahead of North America, and landfill taxes are added to tipping fees to make the cost of disposal up to $300-$400/tonne or more. One auto recycler interviewed for this study stated that some shredders in Quebec are actually paid $25/tonne for their ASR at landfills as it is a good daily cover material. In Ontario, shredders reportedly dispose of ASR at landfills at a discounted tipping fee.

For the foreseeable future, it is unlikely that overall plastics waste diversion will be driven in Canada (or the US) by recycling or reuse being the low-cost waste management option.

3.2 Technical Barriers to Increased Auto Plastics Reuse and Recycling in Canada

Lack of Automotive Plastic "Design for the Environment" Considerations

Strong interest in increasing plastic waste diversion in general and automotive plastics in particular is reasonably recent. Early interest in producer responsibility programs for packaging began in Germany in the early 1990. EPR (Extended Producer Responsibility) for packaging had (and still has) two main thrusts:

- requiring producers to pay for the cost of managing consumer packaging waste; and
- requiring more attention to the design of packaging to make it increasingly more recyclable, reusable and/or compostable.

Progress on the first of these EPR requirements has been considerable in the packaging stream (at least in the EU and Canada). Progress has been slower on packaging re-design for recyclability/reuse/ compostability.

The same applies to auto plastics. As suggested throughout this Report, more can and needs to be done regarding auto plastics recycling and reuse; but equal (if not more) attention is needed on automotive design for greater reuse and recycling if significantly more auto plastic waste diversion is going to happen globally and in Canada in the future.

The teardown/time and motion study carried out for this research project (documented in Technical Memorandum #2) identifies many examples where it was difficult or impossible to get plastics out of ELVs because of all the nuts and screws that were in place and had to be opened to release the plastic component. Designing the vehicle for eventual recovery of plastic at end-of-life is one solution to reducing plastics to disposal. However, even if this effort started today, it would be a number of years before the vehicles involved would reach the auto recycler, therefore this element would be part of a long-term strategy.

Automotive Plastics Contamination

For most businesses, clean, single polymer post-industrial plastics (i.e., before reaching the consumer) are the recycled plastics of choice when (for whatever reasons) recycled plastics are to be used in an industrial manufacturing process.

Clean, post-consumer plastics are also an option but, as noted above, due partly to regulatory requirements, demand for those materials is high especially from consumer goods companies.

Re-integrating ELV plastics back into new vehicle manufacturing is a desired outcome and OEMs around the world are spending considerable research and development effort and are making progress in that regard as summarized in Technical Memorandum #3.

Recycling ELV auto plastics is challenging because of contamination from other materials (e.g., polyurethane foam stuck to metal door panels; metal tags on some plastic components, etc.). Odours can also be an issue - for example odours from recycled plastic gas tanks, as well as the residual fuel contained after the tank is emptied.

Polymer Separation

To be of any real value in the marketplace, polymers in the auto sector and in post-consumer and or industrial/commercial/institutional waste management systems need to be separated by chemical group – e.g., polyolefins, polyamides and styrenics. Mixed plastic recyclates have limited and low value uses.

Plastics additives (e.g., added for strength, heat tolerance, etc.) can also make plastics of the same family different enough that they may not be able to be suitable for the same end use application.

Recyclate Performance Requirements

Throughout the auto industry, vehicle safely and performance “trumps” all other considerations. Plastics properties degrade over time and through the recycling process. Because of this, recycled automotive plastics (e.g., TPO used to make bumpers) are recycled back into lower performance applications without structural requirements, such as cup holders in vehicles but also lawn chairs, parking blocks, pallets, black pipes, cell phone cases storage bins, shelving, etc. One recycler indicated that a recent and growing market for their recycled pellets is electric vehicle parts. Of course, the highest value end use for top quality used bumpers is re-use facilitated by dismantlers.

To date, recycled plastics are not being used for the car engine in new vehicles (see OEM innovation examples in Technical Memorandum #3) but can and are being used under the hood for less critical (e.g., sound-proofing and insulating) applications.

Plastics Separation from Auto Shredder Residue (ASR) is Technically Challenging and Costly

Most of the focus to date on ASR re-processing has been on increasing metals recovery post shredding. Metals in ASR generally range from 5-16% of ASR weight whereas plastics represent about 40% by weight of ASR (See Technical Memorandum #3 for more detail on ASR recovery technologies).

R&D efforts to increase plastics recovery from ASR (e.g., through some form of chemical recycling process or advanced optical sorting technology) are becoming more of a priority especially in Europe as the proposed new *EU End-of-Life Vehicle (ELV) Directive* is to be finalized in 2022. Some environmental organizations are critical of the fact that a significant share of auto plastics (especially in Europe to meet diversion targets) is still directed to energy recovery and landfill.

3.3 Regulatory and Institutional Barriers

Lack of Regulatory Pressure in Canada

Waste management is primarily an area of provincial responsibility in Canada (except for interprovincial/international movement of waste).

Recent federal action on plastics through CEPA (described earlier in this Report) is an important exception, as is the level of federal – provincial collaboration on the plan for Zero Plastic Waste by 2030 (through CCME, again as described earlier).

Almost all of the current federal/provincial collaboration on plastics to date has focused on plastics packaging. Auto plastics waste reduction, reuse and recycling is not yet top of mind – not for governments, nor automakers, dismantlers nor auto shredders. There is no End-of-Life Vehicle Directive in Canada for example, as there is in Europe; nor is one expected.

Even in Europe – with the most recent version of a new *ELV Directive* still under review – plastics (so far) are "under the radar" - i.e., there is still no regulatory pressure on auto plastics waste reduction. Some critics of the new ELV Directive cite three main concerns with the current draft:

- it does not cover 25% of the overall fleet (trucks >3.5 tonnes, motorcycles, etc.);
- achieving the targets relies too heavily on energy recovery; and
- mass-based targets are not suited to plastics.

There has been some discussion at the European Commission regarding a requirement for the mandatory use of recycled plastics in new vehicles and setting more comprehensive reuse and recycling targets. Adoption of the new ELV Directive by the European Commission is expected in the second quarter of 2022 and will verify the final draft proposal. Thus far, the EU does not appear to be directly linking the issue of a significant increase in electric vehicle demand/sales (which will fundamentally change the design of automobiles and significantly change their end-of-life management) with the opportunity to better address the challenge of designing for "circular plastics" in the auto sector.

As noted earlier, Europe's draft new *ELV Directive* does call for large plastic components such as bumpers and fluid containers to be removed during the dismantling stage for recycling or reuse. It specifies that

the design of vehicles should facilitate reuse and integrate an increasing number of recycled materials (without setting specific recycled-content targets). It also specifies labelling of vehicle plastic components with a mass of more than 100 grams, and of vehicle elastomer components and materials having a mass over 200 grams (that will presumably assist in future dismantling efforts). If passed, each of these measures will help move auto plastics recycling forward. The longer-term auto plastics waste reduction issue to watch for in Europe is recycled content targets.

Poor Enforcement of Provincial EOL Regulations

It has been estimated (by the Automotive Recyclers of Canada - ARC) that about 35% of the 1.6 million ELVs retired each year in Canada get processed by members of ARC.[18] The balance either go directly to shredders (old vehicles with limited value parts to be harvested) or they get processed by companies who are not ARC members and presumably are not operating under the Canadian Auto Recyclers' Environmental Code (CAREC). If plastic auto waste recycling is to be improved (along with on-coming electric vehicle EOL management needs which require a whole new level of dismantlers education and training), stronger enforcement of environmental management and reporting procedures are much needed at the provincial level.

In Ontario for example, in 2006, for the first time, auto recyclers were put under the auspices of the *Ontario Environmental Protection Act* that, through regulation, requires that auto recyclers de-pollute vehicles properly. Prior to this, the auto recycling industry was highly unregulated. ARC has made it a policy that any recycler of any of the provincial associations must be audited by an independent third party and certified to meet the standards of CAREC every two or three years, depending on the score of their previous audit. This kind of oversight will be essential with the growth of end-of-life EVs over the coming years.

Lack of Coordinated Auto Industry Action

A third barrier to increasing auto plastics waste reduction, reuse and recycling is the lack of coordinated auto industry action to address this issue. Technical Memorandum #3 for this project noted some important and laudable innovations and developments within individual Original Equipment Manufacturers (OEMs) in 3 main areas:

- auto plastic reuse (and re-design) measures;
- auto plastics recycling (and recycled content); and
- auto plastics sustainability initiatives.

While there are public commitments by some OEMs to – for example - to increase plastic recycled content, there are no public commitments on recovering and recycling automotive plastics. Currently there is no clear Canadian automotive industry-wide position on reusing and recycling automotive plastics; nor is there any auto plastic reduction target commitment by Canadian OEMs, despite the federal target of zero plastic waste by 2030.

[18] Interview with Steve Fletcher, ARC Executive Director

The current *EU Directive* sets overall EOL recovery targets, but there are - so far- no legal requirements for plastics recovery. There does not appear to be an immediate interest or appetite in moving on any targets for auto plastic recovery in Canada – unless auto plastics are incorporated into the federal/CCME Zero Plastic waste program planning.

Should there be interest in addressing auto plastic recovery, a positive first step might be the formation (or "assignment") of a stakeholder driven organization – with the full participation of OEMs, government and auto recyclers - to focus and drive increased automotive plastic reuse, recycling and waste reduction in Canada.

Poor Auto Plastics Generation, Reuse, Recycling, Disposal and Reduction Data Collection

There is an important maxim in the waste management industry: "You can't manage what you don't measure".

As noted throughout this Report, estimates have been developed to calculate overall plastics generation in Canada (by major end use applications, but not by specific sources) and to estimate residential and industrial, commercial & institutional (IC&I) plastic waste disposal. Partly due to Producer Responsibility requirements for Blue Box/Cart programs across much of Canada, data on total plastics generated and recycled from the residential sector is robust.

However, there is virtually no reliable plastics reuse information (e.g., including by auto dismantlers) except at very local levels; no reliable plastics recycling data from IC&I sources; and only isolated examples of plastics waste reduction activities - e.g., through design for environment changes across the packaging stream and within the auto sector.

It was noted earlier in this Roadmap Report that in his mandate letters to the new ministers, the Prime Minister has directed the new Minister of Environment and Climate Change Canada to "*Support provincial and territorial producer responsibility efforts by establishing a federal public registry and requiring producers to report annually on plastics in the Canadian economy".*

It could be timely for the auto industry to engage in deciding what kind of plastics use, reuse and recycling data industry members are prepared to share in the lead up to the government's target of *Zero Plastic Waste by 2030.*

4 Project Survey and Interview Summaries

4.1 Auto Recycling Sector Survey Summary

Information on current plastic auto part recycling and reuse/resale by auto recyclers was collected during December 2021 through a comprehensive on-line survey of 500 auto recyclers across Canada. The survey link (in French and English) was sent to 350 Automotive Recyclers of Canada members and 150 auto recyclers/shredders who are not ARC members. A total of 92 responses were received, providing a comprehensive view of what is currently happening in the recycling and reuse of plastic auto parts from end-of-life vehicles in Canada. The detailed survey results are presented in the Technical Memorandum #1. Key point summaries from the survey and interviews are presented below.

Number and Age of Vehicles Processed Each Year

- The largest percentage of survey respondents (38%) processed between 200-499 vehicles/year
- 33% of respondents reported that the 5-9 year age category as the vehicles they process the most

Stability of Auto Plastics Recycling Markets And Reasons For Not Recycling Plastic Auto Parts

- About 75% of respondents indicated that current markets for auto plastics are poor; 23% reported that they were fair; only 2% say they are stable or good
- 77% of respondents indicated their reason for not recycling is that “no one wants to buy”; 36% say it takes too much time to pull off materials; 32% reported there are “no recyclers in the area”; 32% also report “not enough storage space” and 14% say it costs too much to ship materials to a recycler

Plastics Auto Parts That Dismantlers Could Reuse/Resell and Parts They Are Currently Being Paid for

- 78% of those surveyed responded to these questions: 70% indicated they could recover specific plastic auto parts; 30 % indicated they could not. Recoverable items (i.e., “yes” or “sometimes “as a response) in rank order were: bumpers (99%); seats (95%); gas tanks (89%); dashboards (88%); steering wheels (86%) and “other plastics” (83%)
- By contrast, when dismantlers were asked what they currently “get paid for”, the list is less positive. In rank order, items that dismantlers reported getting paid for are: gas tanks (37%); seats, steering wheels and other plastics (36 % each); bumpers (30%) and dashboards (23%)

Dismantling Electric Vehicles

- Almost 80% (72 respondents) answered the survey questions about EV’s (indicating a very clear interest in this issue)
- Almost 93% of respondents reported that EVs represent less than 5% of vehicles they receive
- 82% said they were not sure whether EVs contain more or less plastic than traditional vehicles; but only 1 % think EV’s have less plastic

Summary of Key Challenges to Auto Plastics Recycling from the Survey

- Recycling/reusing auto plastics parts involve high labour time/costs and high transportation costs due to the light-weight of plastics
- Contamination both of different types of resins and of different ferrous and non-ferrous metals and textiles used in current vehicles

- Low value of recovered plastics (i.e., for recycling) and poor markets for many salvageable plastics parts

Strengths and Opportunities Identified from the Survey for Increased Auto Plastics Reuse and Recycling

- The skills, experience and adaptability of the Canadian dismantlers work-force
- Dismantlers strong interest in the challenges and opportunities presented by the anticipated growth in electric vehicles
- Both the variety and commonality of ideas presented by survey respondents on how to increase auto plastics diversion
- 34 respondents (37% of those who completed the survey) offered suggestions on areas in which the government of Canada should focus pilot/R&D attention. These suggestions included:
    - Provide bins for plastic collection at each auto recycler site;
    - Provide shredders to shred collected plastic at the auto recycler site to reduce volume before transportation;
    - Provide regional shredders;
    - Provide a bounty to cover labour and full costs for removing auto plastic;
    - Create end markets for the plastic;
    - Create regional processing facilities;
    - Label auto plastics for easy identification of plastic resin;
    - Identify types of plastic and pay per piece recovered; and
    - Provide funding to transport auto plastics to recycler

4.2 Dismantler and Shredder and Follow up Interview Summaries

Based on the positive and, in some cases, detailed responses to the Survey Monkey questionnaire, the Project Team decided it would be informative to interview a number of respondents to probe further about the recycling and reuse of auto plastics. The key findings from the 26 auto recyclers interviewed are summarized below:

- 25 of the 26 companies recovered some undamaged plastic parts from ELVs and sold them for reuse; one company interviewed stated they recover bumpers for recycling (at a cost)
- Recovery of parts for reuse is driven by market demand and cost of removal – if the market price for a part is greater than the cost to remove it, auto recyclers will remove the part for resale
- The most common plastic part recovered for resale was TPO bumpers, followed in no particular order by: headlight and taillight assemblies, dashboards, gas tanks, rearview mirrors, front driver seats, interior door panels, steering wheels, steering columns and front grills
- Plastic parts that could not be sold for reuse were usually left in the vehicle when it was sent to a shredder
- The main reasons given for not recycling any plastic parts were: lack of markets, low market value, difficulty in identifying and separating different plastic resin types contained in a part and the time involved in removing plastic parts for recycling
- Several companies indicated that to make recycling of plastic parts financially viable, stable markets would have to be established or some kind of fee or bounty would have to paid to them for each part that exceeded the net cost to remove the part and ship it to market

Key Findings from Automobile Shredder and Metal Aggregator Interviews

As another way to "round out" the on-line survey, 10 auto shredders and four metal aggregators were also contacted by email and/or phone. Interviews were conducted with four auto shredders and two metal aggregators. The following findings were developed from these interviews:

- All metal shredding facilities shred a wide range of steel and iron scrap in addition to auto bodies and also recycle non-ferrous metals such as copper, aluminum and brass
- None of the ASR sorting technologies installed at shredding facilities in Canada are designed to extract plastic resins
- The shredder interviews showed that all ASR produced by these companies is going to landfill either as waste or as landfill cover. One auto recycler interviewee reported that shredders are being paid $25/tonne for ASR to use it as cover. Extracting plastics from ASR might have to compete with that price.

4.3 Auto Plastics Processors Interviews

The Kelleher Environmental project team interviewed a "long list" of plastics recycling companies across Canada that the team has been in contact with on different research projects over past five years that had indicated that they recycled a range of post-industrial plastics. 30 companies were contacted by email or phone to explore the extent to which they currently recycle auto plastics or would be interested in recycling auto plastics in the future. Most processors elected to answer by personal interview. 26 plastics processors were interviewed; four did not respond to calls or emails. Their detailed responses (and the interview questions) are described in Technical Memorandum #1. Presented below are the key findings from this research.

The 26 industrial plastic processors that were interviewed can be broken into four groups:

- six companies that do not process any auto plastics;
- two that process manufacturing scrap from auto OEMs only;
- eight that primarily process manufacturing scrap from auto OEMs, but are interested in taking ELV plastic in the future; and
- ten that currently process ELV plastics or EOL plastic auto parts primarily from collision shops.

The key findings from these interviews are:

- Several industrial plastics recyclers across Canada focus on processing auto sector OEM manufacturing scrap (including PE, PP, PS, ABS, PC, TPO and PVC) as opposed to EOL plastics because manufacturing scrap is less contaminated with metal parts and other plastic parts.

- TPO bumpers (either painted or unpainted) are the most commonly recycled plastic part because recycled TPO has a comparatively high market value and bumpers are relatively easy to remove compared to other plastic parts.
- Most end-of-life bumpers that are recycled are collected from collision shops as opposed to auto recyclers because collision shops have a financial incentive to avoid landfill disposal fees.
- Some plastics recyclers used to be able to send a range of recycled plastic materials to Asia, but are not able to do so any longer since China clamped down on quality requirements for imported waste material, specifically including waste plastics.
- Some plastics recyclers indicated that they used to recycle gas tanks but are no longer able to find companies to buy them.
- Only two plastic processors (indicated that they were adding capacity in 2022, although not specifically for auto plastics. One plastic recycler stated that they were adding 3 to 4 million kg of annual processing capacity in 2022. A second plastic recycler is expanding their facility in 2022 to add 35 million lbs. of capacity.
- The Quebec Association of Automobile Insurers (GAA) requires all auto insurance companies in the province to pay collision shops an allowance of $1.79 per vehicle repaired to offset fees charged by plastic processors to collect and recycle damaged bumpers and other recyclable auto plastics
- In addition to bumpers, some of the other auto plastics parts mentioned for possible inclusion in an expanded auto plastic recovery project by plastics processors include:
    - injection-molded PP interior door panels (with all ABS removed);
    - dashboards;
    - nylon hub caps;
    - PP A-pillars on either side of windshields;
    - PC headlight and tail-light lenses;
    - PP/HDPE gas tanks;
    - TPO wheel well liners;
    - ABS spoilers; and
    - Gaskets
- Recycled auto plastics pellets/flake are sometimes used for: new bumpers; centre console beverage holders; lawn chairs; parking blocks; pallets; spools for wire; black pipes; cell phone cases; air intake ducts; filter containers; storage bins; shelving; shovels; construction industry parts; electric vehicle parts; auto floor boards; flower pots; and clothing hooks

There was significant interest from the majority of plastic processors interviewed to view the photos of the plastic parts removed in the tear down/time and motion study conducted at Standard Auto Wreckers in Port Hope, ON for further research. Additional information on this research results are contained in Technical Memorandum #1.

5 Tear Down/Time and Motion (TDTM) Study Key Findings

5.1 Time Required to Remove Plastics from ELVs

The main purpose of the "tear down/time and motion" component of this project was to determine how practical it is to recover auto plastics pre-shredder. The study team spent five days (January 24-28, 2022) at an auto dismantlers facility in Port Hope Ontario to measure the time it takes to remove reasonably accessible plastic parts from a sample of five end-of-life vehicles. Each plastics part was removed, weighed and identified by plastic resin type. Plastic recyclers/processors were also contacted to determine their level of interest in recycling end of life auto plastics that were delivered to them. The key results of the tear down study are summarized in the following two tables and set of key findings. The full tear down study report is described in some detail in this project's Technical Memorandum #2.

Table 1: ELV Plastic Weight and Time Summary From Tear Down Time in Motion Study

Vehicle	Total Weight (kg)	Total Time (mins)	ELV Auto Plastic Removed Per Hour (kg)
Ford F150	75.0	274.7	16.4
Dodge Caravan	104.9	175.6	35.8
Toyota Corolla	87.5	162.7	32.3
KIA Soul	77.5	148.2	31.4
Average	**86.2**	**190.3**	**29.0**

Table 2: Consolidated Tear Down 4 Vehicle Plastic Volume Summary

Resin	Time	% Time	Weight	% Weight
PUR-E/PP	0.3 min.	0%	0.8 KG	0.2%
GFPP30	0.3 min.	0%	1.4 KG	0.4%
PVC, PTT	1.8 min.	0%	1.9 KG	0.5%
TPE	0.7 min.	0%	3.4 KG	1.0%
ASA & Mix	11.0 min.	1%	6.0 KG	1.7%
PET	10.3 min.	1%	6.6 KG	1.9%
TPO & Mixes	6.0 min.	1%	8.2 KG	2.4%
PA6 & Mixes	3.5 min.	0%	9.1 KG	2.7%
PE-HD	110.3 min.	14%	11.3 KG	3.3%
PC & Mixes	41.6 min.	5%	13.1 KG	3.8%
ABS	30.3 min.	4%	14.7 KG	4.3%
ABS Mix	60.0 min.	8%	15.8 KG	4.6%
PET & Mixes	24.6 min.	3%	16.2 KG	4.7%
PMMA & Mixes	37.0 min.	5%	16.7 KG	4.8%
PS & Mixes	35.1 min.	5%	17.7 KG	5.1%
TEO & Mixes	64.1 min.	8%	23.8 KG	6.9%
PE-HD Mixes	18.8 min.	2%	27.9 KG	8.1%
TPO	33.4 min.	4%	34.1 KG	9.9%
PP	142.1 min.	19%	55.5 KG	16.1%
PP & Mixes	130.0 min.	17%	60.8 KG	17.6%
	761.1 min.	**100%**	**344.9 KG**	**100.0%**

5.2 Tear Down and Baseline Studies - Key Findings and Conclusions

Results from the TDTM (tear down/time and motion) study combined with the results of the baseline research are summarized below:

- Vehicles contain 175kg plastics on average. Many different resins were identified and some of these were complex resins containing a mixture of different plastic resins and additives
- Plastics recyclers are generally most interested in clean, uncontaminated, single resin loads and don't generally like ELV plastics because they are usually contaminated with metal clips, etc.
- The most important element of auto recycler business is to remove specific parts carefully/surgically so that no damage occurs and the part can be resold
- Auto plastics removal is very labour intensive; it is economically prohibitive to remove auto plastics pre-shredder within existing business models
- A number of possible approaches to increase auto plastic recycling were identified:
    - Target bumper cover removal – easy to get bumper covers off some vehicles; made of TPO for which recycling options exist

- Gas tanks need to be removed anyway for de-pollution; develop gas tank program (other tanks – e.g.; windshield washer fluid and radiator overflow tanks, etc. could also be included. Recycling gas tanks will be challenging because they are made of laminated HDPE/PP.
- There may be an opportunity to also recycle (with some separation) head light and taillight assemblies for recycling
- Separate plastic bin
- Plastics are removed anyway to get at valuable parts – a separate bin could be provided for mixed auto plastics- i.e., either treated as a mixed plastic load or separated into different resins.
- Provide on-site shredders or mobile shredders on collection trucks to reduce transportation costs and make loads more consolidated

6 Auto Plastics Recycling Research, Demonstration and Development Project Recommendations

6.1 Introduction to the Auto Plastics RRD&D Recommendations

Roadmap reports commonly contain (among other key elements) a set of specific goals, targets and detailed timelines for the plan or program being proposed. Currently, the only public goal regarding auto plastics waste reduction for Canada is the federal/CCME aspirational target of "Zero Plastic Waste by 2030".

As noted throughout this Report, individual auto manufacturers have set (and will be measuring performance against) an impressive array of current and future environmental and sustainability goals, including timelines and including plastics. As yet however, there is no industry-wide goal in Canada for auto plastics waste reduction.

This Roadmap has not set specific short, medium or long term timelines for auto plastics waste reduction for the simple reason that the data on current auto plastics reuse, recycling and reduction are too poor to build from. Until current specific auto plastics generation, disposal, reuse, (mechanical and chemical) recycling and overall auto plastics diversion are better measured and reported on, setting targets now would be a futile effort.

But actions should be taken - starting now - if there are to be reasonable efforts to work towards zero plastics waste from the Canadian auto sector by 2030. Environment and Climate Change Canada (ECCC) is asking to "begin a conversation" with the Automotive Manufacturing Working Group and Vehicle Sector Working Group members on "identifying industry-based solutions to move towards zero plastic waste"[19].

Five short term research, demonstration and development projects are described below that could be implemented in the short term to support opportunities for industry-based solutions towards zero auto plastic waste. These projects are intended to provide the Government of Canada and key stakeholders in the Canadian auto manufacturing and EOL management industries with a set of activities and projects that will meet the following objectives:

- **Objective #1:** Establish a reliable baseline of information on auto plastics use/generation, reuse, recycling, recovery and disposal and track system changes over the next three years, in part to support a process to set future mid and long term auto plastics waste diversion targets for the Canadian auto sector
- **Objective #2:** Help determine the "optimal" level of pre-shredder reuse and recycling for "comparatively easy to access" targeted auto plastics parts available at auto recycler sites - e.g., bumper covers, selected tanks and light lenses (based on the "tear-down" study described in Technical Memorandum #2 and described in Section 5 of this document);

[19] ECCC Background materials for Feb 25, 2022 Joint Automotive Manufacturing Working Group (AMWG) and Vehicle Sector Working Group

- **Objective #3:** Determine the product specific range of costs/incentives needed for harvesting (i.e., labour and overhead costs), shipping, processing and marketing recovered plastic auto products/materials for reuse/recycling;

- **Objective #4:** Determine through research if there are other logical points further up the auto parts value chain where additional auto plastics currently destined for disposal can be recovered for recycling (they will likely be too damaged for any reuse application), and

- **Objective #5**: Explore opportunities for auto sector manufacturers to introduce auto sector (and other) recycled plastics i.e., opportunities to increase recycled content into new vehicles; and

6.2 Short Term (2022-2025) RRD&D Project Recommendations

Six different auto plastics recycling projects are being proposed:

A. An Auto Plastics Data Management project (Auto Plastics Waste Reduction Project #1);
B. A research project to quantify recyclable auto plastics available through the collision repair sector across Canada (Auto Plastics Waste Reduction Project #2);
C. Bounty-driven Enhanced Recycling programs for TPO bumper covers (Auto Plastics Waste Reduction Project #3);
D. Research Program to identify markets for PP/HDPE plastic gas tanks, and establish a bounty driven collection system when the end market is established (Auto Plastics Waste Reduction Project #4);
E. An Action Research study on collection, processing and end markets for mixed auto plastics streams (similar to the Toyota Highlander example discussed in Technical Memorandum #2) (Auto Plastics Waste Reduction Project #5) and
F. Explore the viability of collecting and dismantling PC light lenses to recover valuable resins (that the "tear down" indicated can be removed without significant new effort, but the time required for dismantling of the PC light lenses to market specifications needs to be addressed through separate research) (Auto Plastics Waste Reduction Project #6).

Each of these is described in more detail in the following sections.

6.2.1 Auto Plastics Database Development – Auto Plastics Waste Reduction Project #1

It is recommended that ECCC (and other private sector funding partners) enter into a three year contract with the Automotive Recyclers of Canada (ARC) or another suitable organization to establish and manage a *Canadian Auto Plastics Management Database*.

The proposed *Canadian Auto Plastics Management Database* will:

1. Assemble through automotive manufacturers and dismantlers baseline information on the weight and resin type of mid to large size auto plastics components in the main types/categories of vehicles
2. Track changes in plastics used in auto manufacturing over time, including changes brought about by the rapidly growing electric vehicle segment of new car sales (up to 50% of new vehicle sales in Canada are expected to be EVs by 2030)
3. Estimate current annual auto plastic waste generation, auto sector plastic recycling and reuse and overall auto sector plastics diversion starting with a baseline of 2022 for comparison against subsequent years

Rationale - As noted earlier, a primary objective of the proposed auto plastics database development is to enable and support government and private sector stakeholders to set future, meaningful mid and long term targets towards the goal of zero auto plastic waste by 2030.

Cost, estimated timeframe and other considerations – Establish a Secretariat within ARC by mid-2022 to begin the database development. Also establish a public and private sector stakeholder over-sight committee (perhaps including members from AMWG and VSWG as noted above or through the End of Life Vehicle Sector Council which has not been active in recent years) to guide the database development and analysis. The oversight committee would meet quarterly. Project manager, data manager, support staff and overhead costs are estimated to be $450K/year (for 3 years). The amount for Year 1 is set at half of the annual total.

6.2.2 Collision Repair Sector Research - Auto Plastics Waste Reduction Project #2

It is recommended that ECCC support a research project in 2022 which would survey and interview the collision repair sector across Canada (1,500 locations) to identify the types of auto plastic that are typically disposed today, and follow up with site visits to quantify the auto plastics generated at collision repair centres by amount per year and resin type.

Rationale – Research carried out for this Roadmap project identified a few plastic recyclers that have relationships with collision repair shops to accept TPO plastic bumpers for recycling. The recyclers are generally paid for transportation costs from the collision repair shop to the recycler. Some bumper cover recyclers interviewed for this project are currently able to collect, process and resell TPO bumper covers for recycling for $2-5/unit (or $0.20 - $0.50 per kg). One recycler has been able to secure an auto part end market for TPO as centre console material. There are an estimated 1,500 collision repair facilities across Canada. These are further up the auto parts value chain than the auto recyclers who were the focus of the Roadmap, but might be a sector with concentrated amounts of auto plastics which could be recycled rather than disposed, in particular bumper covers as these are generally damaged in accidents and are not suitable to be reused. A research project to quantify the amount of potential auto plastic involved, and identify the logistics of collecting the plastic from 1,500 collision repair shops and delivering it to plastic recyclers would provide valuable input to the potential of increasing the recycling of auto plastics in Canada, contributing to the target of zero plastic waste to landfill by 2030.

Cost, estimated timeframe and other considerations – the research study can be carried out in FY 2022/2023, with results feeding into other components of the RR&D plan (e.g the Database and the Bumper Bounty Program described below. An amount of up to $150,000 is recommended for budgeting purposes as the project is anticipated to require a number of site visits across Canada, in addition to surveys, interviews, development of a collection cost and logistics model and identification of local TPO markets across Canada.

6.2.3 Bumper Recycling Enhancement Program - Auto Plastics Waste Reduction Project #3

It is recommended that ECCC (and other private sector funding partners) establish a *Plastic Bumper Recycling Enhancement Program* to be launched in Q1 2023, that will offer a bounty to incent Canadian dismantlers to double the number of TPO bumpers recycled over the next 2 years (i.e., to the end of 2025).

Rationale – at an average weight of 5-6 kg, two bumpers per ELV and 1.6 million ELVs in Canada each year, bumpers can account for 16,000-19,000 tonnes/year of EOL auto plastics if all were recovered. The mechanical recycling of thermoplastic polyolefin (TPO) bumper covers is currently the only reasonably well-established EOL plastic auto part recycling program in the country. ARC has estimated that about 10%[20] of EOL bumper covers in Canada are refurbished for resale or sold for recycling. It is hoped that establishment of the Database described in Project #1 will be able to firm up those estimates over time. Dismantlers will continue to refurbish and sell bumper covers. This "bounty" on old bumpers is targeted to double bumper recycling across Canada over the next 2 years.

Bounties have been effectively used in various energy efficiency and waste diversion programs for over 30 years. Many provinces used bounties to get "beer fridges" out of basements and reduce the power load on the electrical grid. Various EPR programs across Canada increase diversion by providing diversion incentives to encourage more collection of materials that include tires and used electronics.

If approved in concept, further research would be needed in 2022 to identify the various costs involved and to set the right bounty level to demonstrate "proof of concept" potentially for a longer term auto plastics reuse/recycling support program.

Cost, estimated timeframe and other considerations – As discussed in Project #2 above, ome bumper cover recyclers interviewed for this project are currently able to collect, process and resell TPO bumper covers for recycling for $2-5/unit (or $0.20 - $0.50 per kg). One recycler has been able to secure an auto part end market for TPO as centre console material. Higher incentives might be required to incent recovery of bumper covers from auto recyclers in remote parts of the country. The bounty would need to be designed to guard against fraud (e.g., importing old bumpers from other countries) through a registry system. The bounty could be increased over time if recovery is not proceeding at the planned level. The incentive could be reviewed for changes/cancellation after 2 years (depending on its success and assessed performance). In addition to auto recyclers which were the focus of this research study, collision shops

are another good source of damaged plastic bumpers – this sector is identified as a research target in Research Project #2. An outreach program to collision shops should be included in the bounty program.

The initial bounty should be established through consultation with auto recyclers and plastics recyclers to determine a reasonable value to move the market but not be open to fraud. Some budget is included in Year 1 of the program to cover the research and analysis associated with establishing the amount of the bounty, and the financial controls needed for bounty management.

6.2.4. Plastic Gas Tank Recycling Research program - Auto Plastics Waste Reduction Project #4

It is recommended that ECCC (and other private sector funding partners) establish an Auto Plastics PE Tank Recycling Research program to be launched in Q3-4 2022, to explore the viability of recycling plastic gas tanks removed from ELVs

Rationale –Most gas tanks are plastic, with some metal depending on the model and year of the ELV. Gas tanks have to be removed for de-pollution anyway, and therefore the labour cost of removing them is effectively zero to any auto plastic recycling program. The interviews carried out for this study indicate that the gas tanks are generally put back in the vehicle and go to the metal shredder where they end up in ASR. Gas tanks weigh 7kg on average, therefore recovery of all gas tanks from ELVs in Canada would divert a maximum of 11,200 tonnes of auto plastic from disposal.

Auto gas tanks have reportedly been recycled or sent to energy recovery technologies sporadically by dismantlers over the past several years. It is estimated that about 75% of gas tanks from EOL vehicles in Canada are laminated PP/HDPE. They must be removed by certified dismantlers as part of the de-pollution process, so there would be no added cost for their removal (though they will incur additional collection and transportation costs). A number of dismantlers indicated in their ARC on-line survey responses that there were markets in Asia for gas tanks in the past. There was also a market in New York State where gas tanks from Southern Ontario were sent for incineration in either an energy from waste facility or a chemical recycling facility for a brief period of time a few years ago. No dismantlers that responded to the survey reported currently recycling other tanks during dismantling. The tear down study did indicate however, that other tanks are readily recoverable for recycling. A Research program is needed to identify and develop domestic end markets for ELV plastic gas tanks in Canada. One of the challenges is that the gas tanks are a mixture of plastic resins, and are contaminated with gasoline, which makes the end market processing challenging. However, many chemical recycling and pyrolysis/thermal options currently in the exploratory phase, potentially through the Plastics Innovation Challenge or other research programs, may be able to handle this material.

Cost, estimated timeframe and other considerations –

The costs included for this research task cover the initial exploration phase to identify researchers working on this particular material, or who could potentially add the gas tank material to their current or proposed research programs. The second phase funding anticipates exploring pilot and demonstration scale projects over the next two years. When the technology is proven, the collection logistics and costs need to be identified and an overall bounty system may be one incentive to encourage auto recyclers to

participate in recovery of plastic gas tanks. It is anticipated that a technology and market are unlikely to be developed sooner than 2025 for this particular option.

6.2.5 Mixed Auto Plastics Research and Market Development - Auto Plastics Waste Reduction Project #5

It is recommended that ECCC (and other private sector funding partners) enter into a three year contract with the Automotive Recyclers of Canada (ARC) or another suitable organization to oversee a *Research and Market Development Program* to be delivered through universities and/or not-for profit research organizations to assess the viability of collecting and processing mixed auto plastics waste.

Rationale – Many other large plastics auto parts are theoretically recoverable from ELVs (dashboards, side panels, roof racks, wheel well guards, carpeting, etc.) but do not have sufficient value/markets to warrant dedicated recovery, transportation, processing and sale. If however zero auto plastic waste is to be taken seriously and if chemical recycling does not advance (in time) to make a significant contribution to auto plastics diversion, on-going research is needed to look at cost effective ways that low value mixed (and perhaps contaminated) plastics might be processed for low value applications in new vehicles – e.g., plastic under-panels to protect the engine and/or gas tanks. If zero auto plastic waste is to be achieved, some other applications will need to be developed to "consume" an array of low value mixed plastics auto parts. Universities and research organizations could make a contribution to this effort. Research during the tear down study (Tech Memo #2) identified the fact that plastics could be harvested from EOL vehicles, but at a high labour cost of 3-4.5 hours (See table below). However, all dismantling involves removal of some plastic, and this could be collected in a separate bin and be the target for a recovery program to reduce ELV auto plastic disposal (see Toyota Highlander example below).

Table 3: Tear Down/Time and Motion Study – ELV Auto Plastic Weight and Time Summary

Vehicle	Total Weight (kg)	Total Time (minutes)	Kg /hr Total
Ford F150	75.0	274.7	16.4
Dodge Caravan	104.9	175.6	35.8
Toyota Corolla	87.5	162.7	32.3
KIA Soul	77.5	148.2	31.4
Toyota Highlander	28.5	0 – part of regular operation	

Auto recyclers usually put the auto plastic from ELVs into a garbage dumpster at the site (located beside their work station). This research project proposes a comprehensive feasibility study to assess the practicality of targeting mixed plastics from auto dismantlers. Using an average of 28kg/vehicle, this project when rolled out full scale, would target some % of the 45,000 tonnes of auto plastic removed in the normal course of business at auto recyclers. It would explore the potential to have auto recyclers put the plastic in a separate bin; find markets for the mixed plastics bin of material produced at all auto recyclers; identify the on-site preparation requirements; explore collection logistics, whether an on-site shredder or compactor would make collection more economical, and identify the economics of the

program. Whereas the logistics and other components can be estimated and scoped out, the slowest part of this program is likely to be finding end markets and technologies to treat the collected auto plastics. Conservatively it has been assumed that all of the elements of the program would not be complete until 2024/2025.

Cost, estimated timeframe and other considerations – As a "place holder", $500,000 per year over 3 years is recommended as an initial investment in mixed auto plastics collection, processing and marketing (preferably back into the auto sector) research and development. A call for proposals could be sent out in Q4 2022 with Year 1 awards in Q1 2023. The fund would be managed directly by ECCC with support from the oversight committee noted earlier for the other four projects and programs described above. ARC could provide technical over-sight regarding each research project's technical activities.

6.2.6 Light Lens Recycling Enhancement Program - Auto Plastics Waste Reduction Project #6

It is recommended that ECCC (and other private sector funding partners) establish a *Plastic Head and Tail-light Recycling Research Program* to be launched in Q1 2023, to first research markets for the plastics recovered and the time involved in dismantling to recover the plastics, and then design a program that will offer a bounty to incent Canadian dismantlers to measurably increase the number of auto plastic light assemblies recycled over the next two years (i.e., to the end of 2025)

Rationale – One Canadian plastics recycler currently collects headlights and taillights from collision shops and manually disassembles them to remove the PC lenses and PP housing for recycling. These parts are generally relatively easy to access and remove. However, it apparently takes at least 30 minutes to remove a PC lense from a headlight assembly, therefore while the parts are easy to remove, it is slow to separate out the plastic of interest. Therefore this idea needs some pilot testing. Like the program for bumpers and PE tanks – this program would likely require separate collection and shipping containers for shipping to processors

Headlight and tail light assemblies generally weigh 5kg/vehicle, therefore if successful, the program could recover some % of the 8,000 tonnes/year of auto plastic in ELVs. This idea merits piloting for at least one year. If the response is low, consideration should be given to increasing the bounty before cancelling the incentive.

Cost, estimated timeframe and other considerations l. When the time required for dismantling and the markets for the recovered materials are established, the initial bounty should be established through consultation with auto recyclers and plastics recyclers to determine a reasonable value to move the market but not lead to fraud. As this program is essentially a pilot, it should be reviewed each year for bounty level changes or other improvements prior to cancellation.

6.3 Projected Costs and Budget for 2022-2024 Roadmap Activities

As discussed earlier, a number of components need to be put in place to get the *ARC Auto Plastics Roadmap* started. It is recommended that a 3-year program be initiated which firstly puts a data collection system in place so that the quantities and flow of ELV auto plastic can be tracked properly. You cannot manage what you cannot measure, and therefore measurement systems are the most important foundation stone for the Roadmap as the initial step.

The Roadmap then suggests a three year research program which supports the establishment of auto plastics diversion programs for bumpers, gas tanks, headlight assembles and mixed plastics.

It is recommended that the Roadmap be reviewed and updated sometime in 2024 when better data is available, and the level of success with each of the proposed research projects and bounty programs is known.

A good measurement and tracking system is required for all of these programs to ensure that invested $ are being allocated and spent efficiently and effectively.

Table 4 presents the estimated budget for the first three years of the Roadmap implementation. An evaluation is recommended in 2024 to determine the appropriate activities for 2025 to 2030.

Table 4: ARC Auto Plastics Roadmap - Estimated Budget For Three-Year Auto Plastics Research, Demonstration and Development Projects

	Target Total Auto Plastic in ELVs	2022	2023	2024
#1 – Auto Plastics Database Development	Will quantify flow of auto plastics more accurately	$200,000 (assumes mid-2022 start up through ARC)	$400,000	$400,000
#2 Collision Repair Sector Research Project	To be determined through research	$150,000		
#3 – Bumper Recycling Enhancement	16,000 to 19,000	$100,000 for program design	$1,000,000	$1,000,000
#4 –Gas Tank Research and Program Development	11,000	$100,000	$500,000	$500,000
#5 – Mixed Auto Waste Plastics Research & Development	45,000	$200,000	$500,000	$500,000
#6 – Vehicle Lights Recycling Enhancement	8,000	$40,000	$300,000	$300,000
Total Estimates	Some % of target 83, 000 tonnes	$790,000	$2,700,000	$2,700 000
Evaluation of 2022-2024 Research and Performance – Identify Activities for 2025 to 2030			$150,000	
Three Year RRD&D Funding Estimate	Some portion (to be determined through research projects) of 83,000 tonnes	$790,000	$2,700,000	$2,850,000

The total estimated budget for Roadmap activities for 2022-2024 is $6,340,000.

While these investments represent a reasonable next step in addressing the issue of reducing waste plastics from the Canadian auto sector, it is clear that - longer term - circularity is not achievable without design as the first step.

6.4 Funding Program Key Design Elements

Some key program design elements are recommended for consideration as part of Roadmap to increase recycling of auto plastics from end-of-life vehicles in Canada:

- the logistics involved in building out the infrastructure to increase auto plastics recycling;
- partners and funding sources needed for research, pilot and demonstration projects; and
- roles and responsibility in making the vision of "circular plastics for the auto industry" a reality

6.4.1 Auto Plastics Infrastructure to Increase Plastics Recycling

The Automotive Recyclers of Canada (ARC) is the sponsoring agency for this Roadmap.

As noted earlier, a long term goal of ARC is to incorporate greater reuse and recycling of auto plastics to improve the environmental benefits of vehicle dismantling and to reduce end-of-life automotive waste in Canada, including waste plastics.

The auto dismantling (and shredding) infrastructures are well established across Canada. The main challenge for dismantlers with regard to increased auto plastics recycling is the economics of diverting more plastics.

Dismantlers have the facilities, equipment, tools, staff and knowledge to divert more auto plastics if incentives were provided to make it economical. ARC members are also well positioned to re-tool as needed and train staff to meet the future challenge of safely dismantling the anticipated wave of electric vehicles coming into the Canadian marketplace in the future. Developing markets for more diverted auto plastics will also require attention as part of the economic challenge of increased auto plastics diversion.

6.4.2 Partners and Funding Sources

Funding for increased auto plastics recycling needs to:

- be adequate to make an impact and test out new ideas;
- flexible to be adapted to meet the program's objectives as the program is rolled out; and
- include all key stakeholders.

The two recommended primary funding partners for the proposed increased auto plastics recycling programs and research are the Government of Canada (the lead proponent of zero plastic waste by 2030) and automotive manufacturers and their key suppliers.

Some of the other key players in the overall waste auto plastic reduction initiative include:

- auto recyclers (as service providers);
- auto plastic processors;
- collision repair facilities;
- auto shredders (for EOL cars that bypass dismantlers and go directly to shredders);
- universities and other institutions with the necessary research skills and capacity;
- provincial government members of CCME; and
- other plastics-engaged organizations such as the Chemical Industry Association of Canada[21] and the Canada Plastics Pact.

It has been recommended that an overall steering committee be established comprised of both the proposed equal funding partners (the government of Canada) and vehicle manufacturers/key suppliers that would meet quarterly to provide over-sight and guidance to the proposed auto plastics Recycling Research, Demonstration and Development programs.

6.4.3 Making the Vision of Circular Plastics for the Auto Industry a Reality

The long-term vision for automotive plastics proposed in this Roadmap is:

"*the development of circular plastics for the automotive sector whereby, through design, no molecule is wasted; performance, safety and environmental standards are continuously improved; and value is added throughout the Canadian automotive supply chain*".

The leaders to make this happen are the global and Canadian auto manufacturers and their key suppliers. Governments have a key supportive role to play, as do auto recyclers. But leadership needs to come from the highest levels of the auto industry.

The international nature of the auto sector is both a challenge and opportunity. It's a challenge because Canadian and US auto manufacturing are highly integrated and the government of Canada can't enforce zero auto plastics waste beyond its own border.

However, zero plastic auto sector waste is also an opportunity that fits well with the massive re-tooling the global auto industry is undergoing towards electric/carbon neutral vehicles of tomorrow -i.e., this is the best possible time for the auto sector to begin to more actively look at "designing out" auto waste plastic and "designing in" enhanced auto plastics reuse and recycling.

[21] https://canadianchemistry.ca/

7 Actions for a Move Towards a More Circular Economy for Automotive Plastics

The federal government of Canada (in collaboration with its provincial and territorial government partners through the Canadian Council of Ministers of the Environment) has set an ambitious target of "Zero Plastic Waste by 2030". Making automotive plastics more circular is a significant challenge. The following suggested actions support the initiation and development of a process in Canada to begin to move towards a more circular economy for automotive plastics over the next decade.

Action #1: Clarify the federal government and CCME's plans and actions to achieve zero plastic waste by 2030.

As described in section 1.2 of this Roadmap, the federal government (and leading consumer goods companies, plastic packaging suppliers and non-governmental organizations working through the Canada Plastics Pact) have begun to act decisively on measures to reduce plastics waste from the packaging sector - e.g., selected plastic packaging bans, recycled content standard development plans and actions, identifying long term infrastructure investment needs to divert more waste plastics from households and Industrial, Commercial and Institutional (IC&I) sources, etc. Provinces have also become very actively engaged in the development of Extended Producer Responsibility (EPR) programs for a wide range of (mainly residential) printed paper and packaging, including a wide range of plastic packaging.

Having set a target of *Zero Plastic Waste by 2030*, it is clear that the federal and provincial/territorial levels of government are referring to all plastic waste. An estimated 12% of waste plastic is currently generated through the auto sector; that percentage is expected to increase with the increase in the use of plastics particularly in electric vehicles where overall weight is critical to future designs and efficiency.

Only 9% of plastics generated each year in Canada are currently recycled or reused; automotive plastics represent a very small portion of plastics currently being diverted (i.e., well less than 1%). To date, there has been little government or joint auto industry direction or leadership in Canada on how to begin address the complex issue of making auto plastics more circular. Those discussions are now starting to take place; and they need to involve all the key players in the auto industry, including current and future automotive recyclers across Canada.

Action #2: Engage the Canadian automotive industry to become leaders in policies, plans and actions to increase automotive plastics reuse (e.g., dismantling) recycling and recovery (i.e., from auto shredding processes) and to reduce overall automotive plastic waste generation.

As noted in this project's three Technical Memoranda, to date the automotive industry has been a recycling success story for ferrous metals in particular. In Canada, there are approximately 1.6 million end-of-life vehicles (ELVs) generated every year and 95% of ELVs are recovered. Nearly 83% of the ELVs are

recyclable or re-usable (metals, tires, batteries, bumpers, etc.) and technologies are being developed to improve material recovery from Auto Shredder Residue (ASR). Each Technical Memorandum describes and informs some of the "state of the art" of auto plastics reuse and recycling in Canada. A very small percentage of auto plastics is currently reused and recycled, although no one currently knows the number (reuse is especially hard to track on a national, provincial or even local level), because this information is not currently measured and tracked.

Presumably, the automotive industry in Canada agrees that auto plastics reuse and recycling have important future roles to play in helping to reduce auto plastic waste in Canada – i.e., regardless of how effective future chemical recycling for ASR becomes, the GHG and environmental benefits of "optimal" reuse and recycling will continue into the future. Presumably, the industry as a whole also agrees that they need to take on the responsibility - particularly with a national "Zero Plastics Waste" goal in place - to provide the necessary leadership and financial support to significantly improve auto plastics waste diversion over both the short and long terms. If the current Canadian auto plastics reuse/recycling framework is not improved upon, there is no evidence that members of the Automotive Recyclers of Canada will take on that burden on their own. Incentives are required to improve the current system's performance.

Original Equipment Manufacturers (OEMs) and their key suppliers have the central role to play in the future of auto plastics waste reduction, reuse and recycling. This Report has highlighted a wide array of impressive innovations in auto plastics diversion including:

- leading edge "Design for Environment"/ disassembly innovations;
- auto plastics recycling and recycled content measures (especially in Europe); and
- auto plastic environmental sustainability measures.

However, many of these actions are effectively "one of" changes and innovations. No targets or measurement of current overall auto plastic diversion performance are in place. There is currently no public, auto industry-wide commitment in Canada to work towards a timeframe for a zero auto plastic waste future.

Action #3: Measure and track reliable data on current auto plastic waste generation, reuse, recycling and auto plastics waste diversion

An industry can't manage what it doesn't measure. While good data (and results) are generally available for overall auto recycling performance in Canada (and elsewhere) - mainly because of the high value of metal recovered through shredding - good data on auto plastics reuse (i.e., through dismantlers) and auto plastic (parts) recycling generally don't exist. Without solid data, increased auto plastics diversion targets and performance cannot reliably be established or measured.

The preferred solution to this problem would be for Canadian OEMs to work with their other automotive industry partners (i.e., including automotive recyclers) to determine and establish a process that, respecting the confidential nature of the information, would become a reliable source of current and

future auto plastics generation, reuse, recycling, recovery and waste generation. If the federal government is determined to work towards a zero plastic waste future, the collection and oversight of this information may be required in the future. The industry should get ahead of the issue by establishing a reliable data tracking system now.

7.1 Action #4: Establish a multi-stakeholder body to focus on automotive plastics and other after-market critical issues

For all of the reasons cited above, it would seem timely to establish an after-market Working Group (that also involves OEMs and key government agencies) to address current issues such as auto plastic waste reduction and emerging priorities like zero emission vehicles, especially the safe management of "end-of-first-use" electric vehicle batteries. There is a broad dialogue underway on a national level for getting faster adoption of zero emission vehicle (ZEVs). This includes consumer education, recycler training, communications, inventory management, charging infrastructure etc. as well as figuring out the recycling options, again for especially for electric vehicle batteries.

There are gaps in information, communication, leadership and organization in the post-dealer environment. Once someone purchases a ZEV, the discussion on how to maintain, service, repair, reuse, dismantle, recover, re-purpose and finally recycle the battery is lacking. Much of the post-sale activity happens at very localized level, among small businesses and often siloed industries.[22]

The auto sector has represented the traditional "design-build use-dispose" economic model for several decades. As Canada moves to recognizing a Circular Economy as a better use of limited resources, encouraging collaboration amongst all stakeholders will facilitate readiness to support the new ZEVs that will be entering the marketplace. Better management of automotive plastics in the future is also a key element of circular economy thinking and acting.

Action 5: Investments in auto plastics reuse/recycling innovations, collection and processing infrastructure and skills training are critically needed.

There are several gaps that need to be addressed in Canada to start moving towards zero auto plastic waste by 2030, including:

- Identifying specific actions to be taken (both short and long term) to make disassembly, sorting and recycling auto plastics economically rewarding;
- Begin to address the current lack of capacity to provide high quality secondary resins for future use in the automotive sector;
- Continue with enhanced ASR research and development as a complement to "optimal" auto plastics reuse and recycling;
- Identify areas/resins where recovery and recycling could be scaled more successfully short term. The tear-down field research for this report suggests that bumper recycling in particular and

automotive PP in general - the most commonly used resin in the auto sector - might be the best short term target;

- Understanding "lessons learned" from successes (and failures) in plastics sorting and recycling in other sectors (e.g., packaging). As an example, some post-consumer packaging (e.g., recycled PET bottles) is being used in selected carpet applications in the auto sector;
- Recycled content targets for auto plastics parts might be a good mid-term approach to stimulating the demand side of plastics recycling in the auto sector. Europe is already moving in this direction; and
- On-going skill training for increased auto plastics recovery (perhaps linked to a critical need for skill training related to safe electric vehicle dismantling) should also be considered as a key Canadian infrastructure need.

Generally speaking, investments in auto plastics recycling need to be linked to achievable auto reuse and recycling targets. Once a baseline of current diversion performance is established, a target of doubling current auto plastics reduction, reuse and recycling might be a goal worth pursuing if Zero Plastic Waste of the auto sector is to be achieved by 2030.

Action #6: The Canadian and global automotive sector is undergoing profound and positive changes. The "re-make" of the industry towards electric vehicles presents a unique opportunity to begin to design new EV products with "Design for Environment", allowing for easy removal of plastics for reuse and recycling in mind.

Current electric vehicle sales are about 55,000 units/year (3-4 % of total sales). Canada is committed to mandating that all new light-duty vehicles sold be zero emission by 2035, with an interim sales target of 50% by 2030. Electric vehicles are profoundly changing the ways OEMs make, sell and deal with end-of-life vehicles; electric vehicles are also changing the way dismantlers do their jobs.

This Roadmap has identified both challenges and opportunities for making automotive plastics more circular. A key barrier to greater reuse and recycling during the dismantling process is that - historically - vehicles have not been designed for disassembly with reuse or recycling in mind (commonly called "Designed for the Environment").

This Roadmap suggests that the changes in the auto sector as a result of anticipated growth in EV sales in Canada (and globally) present the ideal opportunity for the auto sector to implement design for environment considerations that will also support the long term goal of zero auto plastic waste. Policy and infrastructure alignment between Canada and the US on the issue of "Design for the Environment" for electric vehicles in general and auto plastics in particular is a once in a lifetime opportunity to make auto plastics more circular.