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

Appendix C -Technical Memorandum #3

Technical and Policy Research on Increasing the Recovery of Auto Plastics from End-of Life-Vehicles (ELVs)

Prepared for

Automotive Recyclers of Canada

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C.1 Introduction and Approach

The research project involved four main tasks, each described in separate Technical Memoranda which are appendices to the Roadmap:

- Task 1: Baseline Data Research (Tech Memo #1);
- Task 2: Time and Motion/ Tear Down Research (Tech Memo #2);
- Task 3: Technical and Policy Research (Tech Memo #3), and
- Task 4: Roadmap to Increasing Recycling of Pre-Shredder Auto Plastics in Canada.

This appendix presents the findings of the Task 3 research which addresses leading edge policies and approaches by governments and OEMS to increase auto plastic recycling as well as practices and technologies to manage both pre-shredder auto plastics from ELVs and ASR produced after shredders.

The research in this Technical Memorandum was carried out through a combination of a technical, trade and policy literature search and review, as well as selected interviews.

C.2 Policies Targeting Plastics in General

A number of policies target the broad plastics category. While most of these are currently focussed on plastic packaging, products made from plastic are now being considered. Auto parts made from plastic may be addressed at some point in the future. This section describes policies targeted at the broad plastics category.

C.2.1 Canada's Zero Plastic Waste Target and Policy

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.

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":[1]

- 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.

[1] 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*[2]

It is notable that new federal funding programs are a key component of the proposed federal actions on plastics. It is also notable that a Private Member's bill has been introduced in parliament specifically regarding "right to repair" for automobiles.[3]

C.2.2 Federal Actions to Date to Reduce Plastic Waste

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".[4]

[2] Ibid, New Ministerial Mandate letters; pp 1-7
[3] https://www.autoserviceworld.com/right-to repair-bill-introduced-in-canada/
[4] June 10, 2019 ECCC Press Release

In May 2021, "plastic manufactured items" were 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 plastics".[5] 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.[6]

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.

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[5] Zero plastic waste; Policies and regulations; ECCC fact sheet

[6] "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.

C.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 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.

C.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[7], 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;

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

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
4. Ensure an average of at least 30% recycled content across all plastic packaging (by weight) by 2025.[8]

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 lifecycle;
- 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[9].

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.[10] 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.

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

C.3 Policies Related to Auto Plastics Reuse and Recycling

Very few policies are currently in place that specifically focus on auto plastics. Two in particular, the *EU End of Life Vehicle Directive* and the American Chemistry Council *Five Step Roadmap for Circular Plastics in the Auto Sector* address auto plastics and are described in this section.

C3.1 European Union (EU) End-of-Life Vehicle Directive (ELV Directive)

Management of ELVs in EU states has been governed by the European *End-of-life Vehicle Directive (ELV Directive*) (Directive 2000/53/EC on end-of-life vehicles) which came into effect on 18th September, 2000[11]. The original objectives were to:

- make dismantling, recycling and reusing these vehicles more environmentally friendly; and
- push manufacturers to create new vehicles without hazardous substances so that their parts can later be reused.

The Directive set out restrictions on:

- the use of hazardous substances in new vehicles;
- obligations relating to the collection and treatment of ELVs; and
- targets by 2015 for re-use/recovery and re-use/recycling.

Recycling and reuse targets are stated in Clause 2 under Article 7 in *EU Directive 2000/53/EC2* on end-of-life vehicles which reads (in part) as follows:

- *(a) no later than 1 January 2006, for all end-of life vehicles, the reuse and recovery shall be increased to a minimum of 85% by an average weight per vehicle and year. Within the same time limit the reuse and recycling shall be increased to a minimum of 80% by an average weight per vehicle and year; for vehicles produced before 1 January 1980, Member States may lay down lower targets, but not lower than 75% for reuse and recovery and not lower than 70% for reuse and recycling. Member States making use of this subparagraph shall inform the Commission and the other Member States of the reasons therefor;*

- *(b) no later than 1 January 2015, for all end-of life vehicles, the reuse and recovery shall be increased to a minimum of 95% by an average weight per vehicle and year. Within the same time limit, the re-use and recycling shall be increased to a minimum of 85% by an average weight per vehicle and year."*

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[11] https://autorecyclingworld.com/elv-directive-end-of-life-vehicles-evaluating-the-eu-rules/

The targets were not material-specific and as a result it is not surprising that auto shredders focus first on extracting metals (such as copper and aluminum in particular) from auto shredder residue (ASR) rather than plastic resins, given the higher value for recovered metals. However, it may be difficult to meet the most recent 2015 target of 85% reuse and recycling without extracting some plastics from ASR.

The transition to electric vehicles (EVs) which are made of different materials and have significantly less parts than traditional ICE (internal combustion engine) vehicles present many challenges to auto recyclers in the coming years. An article in Auto Recycling World states that

- *"The growing number of electric vehicles in the EU market will further contribute to this trend (of new materials and components) and bring considerable new challenges for the ELV sector. The measures adopted to mitigate the impact of the COVID 19 pandemic on the automotive industry are also likely to accelerate the electric mobility transition"*[12].

Review of *EU ELV Directive* (October, 2021)

The Directive has never been substantially amended since its adoption 20 years ago, but an evaluation was carried out in 2021 to assess how the Directive performed against its original objectives.

The evaluation[13] carried out as part of a regulatory review process shows that the *ELV Directive* has been effective in delivering many of its initial objectives (notably elimination of hazardous substances from vehicles, increase in collection points for ELVs, attainment of the recovery and recycling targets).

However, the major problem in the implementation of the Directive is the large number of "missing vehicles", which represent about 35% of all de-registered vehicles (ELVs) each year.

While around 6.5 million ELVs are reported to be properly managed in accordance with the *ELV Directive*, approximately 4 million vehicles annually are not properly managed. Reasons for this were identified as: the differences and limitations of national vehicle registration systems in different EU member states; the lack of interconnection between the member states on registration and de-registration of vehicles, and illegal treatment and export of ELVs.

The evaluation also concluded that the provisions of the Directive encouraging the design of new vehicles to facilitate their dismantling and recycling, as well as the use of recycled materials, are not "sufficiently detailed, specific and measurable", and therefore had a very limited impact on the design and manufacturing of new vehicles.

The provisions requiring vehicle producers to make available and share information on the materials and components contained in vehicles have been criticized for not providing sufficient detail to help companies in the repair, dismantling and recycling sectors.

Most member states reported that targets for re-use/recovery and re-use/recycling were met, although the reporting systems and data quality vary by member states.

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[12] Auto Recycling World, 16th March, 2021. ELV Directive: End Of Life Vehicles – Evaluating The EU Rules. https://autorecyclingworld.com/elv-directive-end-of-life-vehicles-evaluating-the-eu-rules/

[13] Commission Staff Working Document – the Executive Summary of the Evaluation of Directive (EC) 2000/53 of 18 September 2000 on end-of-life vehicles

The recycling rate is calculated based on the overall weight of vehicles, which does not provide an incentive to recycle materials such as plastic which is light, and focuses on ferrous metals which are heavy and help to meet the targets. This results in suboptimal recovery and recycling of glass, plastics or critical raw materials.

The definition of recycling in the Directive is broader than in other EU legislation and includes backfilling. There is no specific target for reuse.

The Directive does not have any requirements for recovery and recycling of materials such as gold, silver, palladium, tantalum and other rare earth metals contained in the electric and electronic components of ELVs. This is also the case for plastics or carbon-reinforced plastics.

An important challenge for the new Directive being developed is to ensure better coherence with the *European Green Deal* and the *Circular Economy Action Plan*, particularly in:

- the eco-design of vehicles to facilitate re-use, remanufacturing and recycling;
- the promotion of more ambitious and specific targets for reuse and recycling; and
- the use of recycled content materials in the manufacturing of vehicles.

Unlike other waste stream specific legislation in the EU, there is no full extended producer responsibility (EPR) system established by the Directive, and European sources state that the role played by producers in financing the costs of ELV management remains unclear.

Following the review of the Directive in 2021, the European Commission (EC) held a public consultation process for stakeholders with knowledge and/or interest in ELVs to provide input to proposed changes to the Directive.

Shortcomings of the Directive as originally written in 2000 were summarized as:

- Flaws in the national vehicle registration systems, lack of interconnection between the Member States on registration and de-registration of vehicles;
- Need for more detailed provisions of the ELV Directive to support the design of new vehicles to facilitate their dismantling and recycling and the use of recycled materials;
- The absence of separate target for re-use;
- The scope of the ELV Directive leaves out a stock of about 45 million of vehicles, e.g., motor-cycles and trucks;
- The ELV Directive does not incent or require high recovery and recycling levels for gold, silver, palladium, tantalum and other rare earth metals, contained in the electric and electronic components;
- There is no full extended producer responsibility (EPR) system established by the *ELV Directive;* and
- The updated *ELV Directive* must ensure better coherence with the *European Green Deal* and the *Circular Economy Action Plan*, notably in eco-design of vehicles to facilitate re-use, remanufacturing and recycling, promotion of more ambitious and specific targets for reuse and recycling, and use of recycled content materials in manufacturing of vehicles.[14]

[14] http://www.interregeurope.eu/smartwaste/news/news-article/13239/upcoming-new-eu-legislation-on-end-of-life-vehicles/

Provisions on Recycling Auto Plastic in New Draft *ELV Directive*

The draft new *ELV Directive* (expected to adopted later in 2022):

- calls for large plastic components such as bumpers and fluid containers to be removed during the dismantling stage for recycling or reuse[15];
- specifies that the design of vehicle should facilitate reuse and integrate an increasing number of recycled materials[16] (without setting specific recycled-content targets); and
- 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.[17]

Following public consultations that ended in October 2021, the European Commission is currently working on an impact assessment in support of a possible revision of the *ELV Directive*.[18]According to Interreg Europe, the review of the ELV Directive is expected to result in a legislative proposal in 2022.[19]

This new Directive could have a significant impact on long-term vehicle OEM design for reuse and recycling requirements.

C3.2 American Chemistry Council Five Step Roadmap for Circular Plastics in the Auto Sector

The American Chemistry Council (ACC) has developed a five step Roadmap for the future of circular plastics in the auto sector, acknowledging that "the transition towards a circular economy for industrial goods will require the automotive industry and its suppliers to rethink the way vehicles and their materials are designed, constructed, used and handled at end of life."[20] Their Roadmap contains five main action areas that might also be considered for Canada:

1. *Continue to develop advance recycling and recovery technologies* – this might apply especially to the future of ASR management – i.e., the recovery of plastics after auto plastic reuse and recycling have been optimized pre-shredding.

2. *Invest in a robust and coordinated recycling infrastructure* – securing adequate and clean post-consumer and post-industrial recyclates for use in the auto at a reasonable cost will require infrastructure development.

3. *Design high-quality automotive plastics for easier disassembly, refurbishment/reuse and recycling* - Design for Environment and Design for Recycling considerations include but go beyond easier disassembly; it also includes designing plastics that are more recyclable. On-site experience during

[15] ELV Directive Annex 1
[16] ELV Directive Article 4 (1)
[17] International Material Data System Fact Sheet
[18] End-of-life vehicles – revision of EU rules, ec.europa.eu
[19] interregeurope.eu/smartwaste/news/news-article/13239/upcoming-new-eu-legislation-on-end-of-life-vehicles
[20] Transitioning, p. ii

the tear down and time in motion study carried out as part of this research has listed a number of examples where removal of plastic from ELVs is difficult because of the way the vehicle was designed.

4. *Conduct rigorous lifecycle assessments (LCAs) of circular plastics and polymer composites* – LCAs can both boost the development of new automotive applications with high recovered materials content and also support the new business models and collaboration that will be necessary to meet circularity objectives.

5. *Explore new business models that enable profitable circularity* – Establishing new partnerships, investing in novel technology providers and securing access to waste-plastics supplies may be parts of new business approaches need to succeed.[21]

[21] Transitioning, ibid. pp 35-38

C 4 Initiatives by OEMS to Incorporate Plastics or Recycle EOL Auto Plastics

Three key factors are having a strong influence of current and future use of plastics in vehicles globally.

- Climate change pressures related to fossil fuel use are encouraging the transformation of the automotive industry towards a new level of development and growth of electric vehicles. Maintaining high safety and performance standards remain paramount, but light-weighting is increasingly critical to achieve increasingly stringent fuel efficiency standards and has led to more plastic use than in the past in new vehicle manufacturing.
- Governments at all levels (and many citizens) are looking to industries in all sectors of our economy to reduce the quantity of plastics that enters the environment after they have served their intended purpose. Pressure on plastics began first with the packaging industry and that pressure is beginning to migrate into both construction and transportation sectors as the next two largest users of plastics and generators of plastics waste in Canada. In response to this pressure, the government of Canada (in collaboration with all provinces and territories) has set the ambitious goal of "zero plastic waste" by 2030. The current focus is very much on single use plastics in packaging; but the long-term target is to reduce/eliminate all forms of plastic waste – including auto plastic waste.
- The auto sector - and especially the Original Equipment Manufacturers (OEMs) in that sector - is one of the most innovative industrial sectors in the world. Partly because of consumer demand and also to respond to or "get ahead" of potential government regulations to force action, OEMs are actively innovating to improve on the footprint of plastics in the auto sector.

This section briefly profiles selected leading edge and innovative practices regarding OEM plastic recycling/diversion innovations in three areas:

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

C4.1 Auto Plastic Reuse Measures

Automotive parts reuse for all types of materials in vehicles is primarily the domain of auto recyclers known as dismantlers. This report has examined current and potential future innovative practices that drive this vibrant small and medium sized business sector. A key role in the reuse area for OEMs is the effort needed to make reuse easier and more profitable - through better vehicle "design for the environment" (i.e., designed for easier dismantling). Several examples of automotive "design for the environment" (DfE) exist but much more needs to be done specifically in the area of "design for dismantling". Some DfE examples are listed below:

- **BMW** has pledged to replace artificial materials with recycled and sustainable raw materials throughout their entire value chain and has instilled a "Design for Recycling" principle to flow ELV components back into the materials cycle[22]

- **Toyota** is committed to four initiatives related to circularity:

    - use eco-friendly materials,
    - use auto parts longer,
    - develop recycling technologies and
    - manufacture vehicles from ELVs[23]

- **TATA Motors (India)** announced in September, 2020 that its new Sports Utility Vehicle will be the first Indian car to be published on the International Dismantling System (IDIS) as an enabler to carry out dismantling practices in a safe and sustainable manner

- **Renault** is creating a dismantling line in its R3e-Factory in France to capture additional volumes and increase the capacity to source parts. The facility is reportedly "the first circular economy factory in Europe dedicated to mobility"[24]

- **Ford** has invested in a Reclaimed Original Equipment (ROE) program that capture and distributes slightly flawed Ford collision parts that are eligible to be reused in the repair of vehicles[25]

- **Ford's** Go Green Dealer Sustainability Program collects parts such as headlights, bumpers and windshield wiper motors removed during servicing for potential reprocessing and sales from US dealership service centres [26]

- **Indra** is a joint venture between Renault and Suez that has created an ELV dismantling network comprised of 350 dismantlers. Each year, the network dismantles about 300,000 vehicles...with 80% reduction in energy compared to the production of new parts[27]

In 2018, France recycled over 7,000 tonnes of EOL larger auto parts and over 11,400 tonnes were reused (significantly more than any other country).

A Renault re-manufacturing factory in Choisy-le-Roi, France found that remanufactured parts use 80% less energy 88% less water, 92% fewer chemical products and produce 70% less waste. By designing vehicle parts *to* be remanufactured, the cost of remanufactured vehicles can be reduced by 30%-50%.[28]

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[22] Transitioning towards a Circular Economy for Automotive Plastics and Polymer Composites; American Chemistry Council, October 2020, p. 5
[23] Ibid, p. 7
[24] Re-Factory, The Flins site enters the circle of the circular economy – Groupe Renault – 25 November 2020
[25] Ford's ROE pilot program expands, On Target, Winter 2017
[26] Ibid. p. 10
[27] Smart Prosperity, ibid. p. 6
[28] Background Materials for Circular Economy Sectoral Roadmaps, Smart Prosperity Institute, September 2021, p. 3

C4.2 Auto Plastic Recycled Content Commitments by OEMS

Examples of notable practices or policies to re-incorporate recycled auto plastic back into automobiles as an example of circularity include:

- **2019 GMC Sierra Denali** lightweight carbon fiber composite truck bed includes pocket reinforcements made from recycled carbon fibre thermoplastic materials[29]

- **Ford** states its aspiration to only use renewable and recycled plastics materials with lower life cycle impacts, also establishes a target of 20% percent renewable and recycled plastics by 2025 in its *2020 Sustainability Report* [30]

- **Ford** is designing molded plastic engine components using post-consumer nylon carpet[31]

- **Volvo** has set a goal of using 25% recycled plastics in cars in 2025[32]. The Volvo XC60 has over 60 kg of its plastics parts replaced with parts made of recycled materials and seats sewn from two different kinds of textiles, both made from recycled plastic bottles[33]

- **BMW** is reusing CFRP (carbon fibre reinforced plastics) production scraps to manufacture roofs as well as rear seat structures. About 10% of the CFRP used in BMW vehicles is recycled[34]

- **Jaguar** has used recycled feedstock from BASF to manufacture front-end carrier prototypes for its first electric SUV[35]

- **Renault** (with two partners) is developing auto seats using a unique, patented textile product made from safety belts, textile scraps and recycled plastic bottles[36]

- **Renault** is committed to:

  - increasing its use of recycled plastic by 50% by 2022 (compared to 2013)[37];
  - plans to incorporate up to 20% recycled plastics in cars manufactured in Europe [38]; and
  - ensure that 85% of its ELVs are recyclable[39].

- **Renault** uses 52,000 tons of recycled plastic every year by transforming car bumper and wheel arch liners into directly reusable material for new car parts

- **Fiat** has internal standards for the use of recycled PP within its vehicles. rPP is primarily used in bumpers but also in dashboards and body panels.

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[29] Transitioning, p. 5
[30] ibid p. 7
[31] Ibid, p. 20
[32] Ibid, p. 7
[33] Smart Prosperity, ibid. P 7
[34] Transitioning, p. 20
[35] Ibid, p. 20
[36] Ibid, p. 20
[37] Groupe Renault Circular Economy Moving Up a Gear, 31.01.20
[38] EuRIC call for Recycled Plastic Content in Cars, 2020
[39] EMCF short loop recycling of plastics in vehicle manufacturing

- **Toyota** has developed a recyclable plastic that can be used to make car bumpers and other parts that can be recycled repeatedly[40]

- The **Nissan Leaf** uses recycled plastic bottles for the fabric of its seats and arm rests, recycled bumpers for bumpers and fabrics from recycled plastics for its floor insulation[41]

- **Jaguar** will use ocean and landfill plastic waste in floor mats in sustainable luxury vehicle interiors[42]

- **BMW** offers a take-back program that can recycle up to 95% of their vehicles, with 85% of the recovered materials being reused or recycled[43].The company has installed recovery systems for ELVs in 30 countries and offers environmentally friendly vehicle recycling at more than 2,500 recovery centres[44]

- The European Recycling Industries' Confederation (EuRIC) has called for "gradual, achievable and binding recycled content targets" for post-consumer plastics in new cars [45] (25% by 2025, 30% by 2030 and 35% by 2035).

- EuRIC sources estimate that only 2-3% of recycled plastics is currently used in the auto sector in Europe and 20% could be achievable if clean, affordable recycled content plastic supplies were available.

- The European Automobile Manufacturers Association (representing European OEMs) supports voluntary targets only, citing concerns about recycled plastics technical and quality properties and about competition for recycled plastics leading to artificial price hikes.[46]

C4.3 Auto Plastic Environmental Sustainability Measures

It is widely recognized that making plastic in general and automotive plastics in particular circular is a challenge. The American Chemistry Council states the long-term vision well:

- *"Aspirationally, a circular economy is one in which by design, no molecule is wasted while continuing to meet performance requirements and bring value to the supply chain"[47]. Circular plastics thinking requires a broad sustainability lens. At current consumption, GHG emissions from plastics will be 15% of the total global carbon budget by 2050; over 350 million tonnes of plastic waste arise from the transport sector each year.[48]"*

[40] Toyota and the Environment 2019
[41] JRC Best Environmental Management Practice for the Car Manufacturing Sector, 2017
[42] Jaguar Land Rover website, January 2021
[43] Smart Prosperity, ibid., p. 5
[44] Ibid. p. 11
[45] EuRIC call for Recycled content in Cars, 2020
[46] Car industry unconvinced by calls for mandatory recycled plastic target, EURACTIV.com; 2021-12-30
[47] American Chemistry Council, Transitioning towards a Circular Economy for Automotive Plastics and Polymer Composites, p. 2
[48] Zheng, J. &Suh, S. Strategies to reduce the global carbon footprint of Plastics. Nature Climate Change 9, 347- 378 (2019)

OEMS have instituted many sustainability measures that will likely impact auto plastics. Some of these are listed below.

- Automakers like **Ford and Renault** have set up free take-back networks that accept ELVs from owners in countries around the world[49]

- In addition to setting sustainability goals, **General Motors** has committed to increasing the percentage of sustainable materials… in partnership with its suppliers (to) at least 50 percent of the materials in their vehicles being sustainable by 2030.[50]

- **Nissan** has set a target that out of all raw materials used in the production of cars, they will aim for 30% to be material alternatives that do not depend on newly-extracted resources by 2022[51]. No public targets have been set for plastics.

- **Ford** has worked to incorporate different types of renewable feedstocks and in 2018 used about 300 parts made from these biobased materials.[52] Examples of using renewable feedstocks include:
  - soy-based polyurethane foam seat cushions (in over 20 million vehicles over the past 10 years[53]),
  - wheat straw composites in molded interior components,
  - PP reinforced with rice hulks for electrical support brackets and
  - kenaf fiber integrated into PP door bolsters[54].

- In 2018, **BMW** Group covered 79% of the electricity supply for its plants with renewable energy[55]

- **Volvo** aims to reduce its total operational carbon emissions by 25% per car by 2025 compared to 2018. About 80% of its global plants are powered by renewable electricity[56]

- **Tesla** advances sustainability in its supply chain by assessing risks related to conflict minerals such as cobalt from the Democratic Republic of the Congo. Tesla pledges that it uses very little cobalt in its batteries and is working to eliminate it entirely[57]

- **Daimler, BMW, GM and Volvo** all offer car-sharing services that offer a range of access without ownership, limited time use, rentals and subscription services where the OEM takes care of insurance, repairs and maintenance[58]

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[49] Transitioning, p. 6
[50] Ibid, p.7
[51] Ibid, p. 7
[52] ibid. p. 7
[53] Smart Prosperity, ibid. p. 7
[54] Ibid, p. 23
[55] Ibid. p. 8
[56] Ibid. p. 8
[57] Ibid. p. 8
[58] Ibid. p. 9

C4.4 Supplier Partnership

The Supplier Partnership (SP) provides a forum for global automotive manufacturers, their large and small suppliers, the US EPA and other government entities from around the world to work together toward a shared vision of an automotive industry with positive environmental impact[59]. Examples of the use of recycled plastic in new vehicle manufacturing by SP member OEMs include:

- Recycled plastic bottles used as the PET component of the seat material;
- Recycled plastic bottles used in engine insulation;
- Recycled plastic caps and shipping aids used in radiator shrouds;
- Recycled plastic license plate brackets;
- Recycled plastic bottles used for underbody shields on cars and SUVs, and wheel liners on trucks; and
- Recycled plastic bottles used in carpets, wheel liners and fabrics.

Examples of the use of sustainable materials and recycled materials incorporated into new vehicles include:

- Soybean-based foam used in vehicle seating and headliners;
- Post-industrial garment clippings made of cotton and synthetic fibers used in door panel insulation, floor silencer and floor mats;
- Bio-based plastics — plastics derived either wholly or in part from plant materials — used in seat cushions;
- Composites using castor oil, kenaf, wheat straw, rice hulls, coconut and tree fibers, coffee chaff;
- Post-industrial scrap material used as insulation and sound-deadening materials;
- Recycled cardboard used in sound-dampening material in headliner;
- Test tires shredded and used in air and water baffles; and
- Post-industrial textile waste—blue jeans and towels included— used in hood and dashboard insulation.

[59] https://www.supplierspartnership.org/

C5 Practices and Technologies to Recover ELV Plastics Pre Shredder

Auto dismantling and recycling is a highly specialized manual process, which is carried out with precision to extract auto parts which have high value for resale. Many plastics parts are carefully recovered for resale into the reconditioned parts business and are reused. However, there is no estimate of how much reuse of plastics parts occurs and this amount has not been quantified to date.

As shown in the tear down time and motion study carried out at an auto dismantler/recycler site as part of this study research, manually removing plastics from ELVs for recycling is slow and therefore expensive (See Appendix B), and is therefore not done in Canada except for some examples of bumper cover recycling. Some efforts were made to collect and send gas tanks to energy recovery but they were short lived and not successful.

Extensive research carried out for this project did not identify any locations in the U.S. or Europe where companies are currently extracting auto plastics from ELVs for recycling at the pre-shredder stage. The Groupe Renault Re-Factory in Flins, France was launched in November, 2020 and is the only example where an effort is being made to recover auto plastic as part of a much larger circular economy effort involving EVs and well as ICE vehicles.

C5.1 Groupe Renault Re-Factory in Flins, France

The Groupe Renault Re-Factory in Flins, France is Europe's first circular economy factory dedicated to mobility. An industrial and commercial ecosystem created by Groupe Renault, open to start-ups and partnerships. Its objective is to encourage initiatives, develop innovation in the service of the circular economy, and to aim for a negative carbon balance by 2030, in line with our European ambition of zero impact by 2050.

This transformation plan is being deployed gradually between 2021 and 2024. The site is organised around 4 activity centres, each with its own field of expertise:

- **RE-TROFIT:** this division brings together retrofitting and refurbishing of used vehicles. Operational since September 2021, the Factory VO has already reconditioned over 1,500 vehicles. In the next two years, it is planning to increase its capacity and introduce new activities, such as heavy body repair. A retrofit project to convert commercial vehicles to electric vehicles will also be studied by 2023.
- **RE-ENERGY:** this division contributes to the development of applications for the second life of batteries and new energy technologies. With the rise of electric mobility, Gaia, the Group's subsidiary specializing in battery repair, is preparing to change scale: by the end of 2021, 2,000 battery repairs will be carried out and more than 20,000 repairs per year by 2030. In coordination with Mobilize, the Flins site has implemented a stationary energy storage project with a capacity of 15 MWh in 2021. The development of mobile or stationary energy storage systems for multiple uses (construction sites, solar energy storage, on board ships, etc.) will represent a capacity of 30

MWh in 2021 and 2022. Hyvia, the joint venture dedicated to hydrogen mobility, will be involved in fuel cell assembly, recharging stations and hydrogen supply from 2022.

- **RE-CYCLE**: this division brings together recycling and reuse of parts and materials. The gradual arrival between 2021 and 2022 of teams from the Choisy-le-Roi plant, experts in the remanufacturing of mechanical parts, will maximize the use of reused and spare parts within the Factory VO and the Group. Repairing electronic cards (mechatronics) will be included. The division is continuing to implement short loops for recycling materials and parts, such as catalytic converters and bumpers.
- **RE-START:** this is the innovation and training center division incorporating the following activities:
  - an innovation center dedicated to the industry 4.0 in order to develop prototyping,
  - 3D printing
  - retrofitting of robots,
  - a commercial vehicle prototyping unit, and
  - a campus where professional training courses leading to a diploma (offered to Flins employees).

At the beginning of 2022, this center will include an incubator dedicated to research and innovation in the circular economy, as well as new academic training courses with support of local government.

By the end of 2021, the Refactory reportedly had 700 employees (a separate sources states that it has 200 employees with an ultimate plan to have 700)[60]. By 2030, the site plans to employ more than 3,000 people.

The Factory VO is a 100% digitalized, which ensures traceability and real-time monitoring of the refurbishment stages. It is designed to recondition all types of vehicles, of all brands.

Factory VO has a floor area of 11,000 m^2, and is the largest reconditioning site in Europe. Organized into three teams, it can recondition 180 used vehicles per day, i.e., 45,000 vehicles per year by 2023, with the potential to double this number in the medium term.

The site derives its competitiveness from a high productivity rate, drawn from an organization in lines and optimized new vehicle production systems. The Factory VO benefits from short loops of parts and materials from the Group' subsidiaries such as Gaia, Indra, and Choisy in order to limit the replacement of parts as much as possible in favor of repairs. The pooling of logistic flows with new vehicles also makes it possible to cut costs and reduce the impact on the environment.

The Flins Factory VO has 4 production lines. Designed by SGS Automotive Services, the technical control is integrated on the line in order to increase efficiency and reduce delays. The site is equipped with a photo and video studio installed on a turntable to generate automated shots (up to 10 vehicles per hour). This high-resolution scanner gives access to a 360-degree virtual inspection (interior, exterior, underbody and tires). Designed by the specialist Twinner, this tool allows the vehicle to be put back on the market immediately, without waiting for it to return to the dealership. On average, the Factory VO reconditions a vehicle in 8 days instead of 21 days.

[60] https://braiseentrance.com/renault-launches-the-activities-of-its-refactory-in-flins

The reconditioned vehicles benefit from the same quality standards as the production of new vehicles. An independent quality control system is integrated into the system, as well as a battery qualification system for electric vehicles. By 2022, 200 employees will have joined the Factory VO. These internal recruitments at the Flins plant are accompanied by a certified training program, consisting of a common core curriculum (after-sales strategy, sustainability of materials, recycling, etc.) and training courses more specific to the Factory VO (electromechanics, smart repair).

To date Renault has invested 8 million euros to industrialize the refurbishment process for used vehicles, in order to reduce the cost: it takes an average of 6 days, excluding logistics (and 8 in total). Operations started in September, 2021 and the rate quickly rose to 70 cars per day: 1,500 cars have already left the "Factory VO", which today employs 120 people, in two shifts. Starting next year, its workforce should rise to 200 people[61].

Renault's objective is to increase factory throughput to 180 vehicles per day, or 45,000 per year, by 2023, to generate around 200 million euros in annual turnover, generated by dealers who choose to send vehicles to "Factory VO" for reconditioning.

There are plans to replicate the Factory VO model in Seville, Spain.

[61] https://braiseentrance.com/renault-launches-the-activities-of-its-refactory-in-flins

C6 Practices and Technologies to Recover ELV Plastics from Auto Shredder Residue (ASR)

The Canadian government has a target of no plastic waste to landfill by 2030. Canadian ELVs are a significant source of plastic which is currently landfilled as part of ASR (auto shredder residue).

The tear down time and motion study carried out at an auto dismantler/recycler site as part of this study research showed that plastics removal from ELVs manually at the auto dismantling/recycling site is labour intensive, slow and therefore expensive (See Appendix B). It is considered very unlikely that substantial plastics can be recovered for recycling at this point in the supply chain.

Therefore, the only remaining point in the supply chain where plastics can be recovered from ELVs is from auto shredder residue (ASR).

Some metal shredders send their ASR to secondary material recovery but these technologies are designed specifically to recover ferrous and non-ferrous metals. Auto plastics are not recovered through these secondary processes at this time. The processes are designed to recover additional metals like stainless steel (which is not magnetic and is not recovered by the magnets at auto shredders), aluminum and copper. Four shredders in Canada reportedly use Bonfiglioni systems for this purpose.

The remaining ASR is landfilled across Canada today. Some landfills accept ASR at a discounted tip fee, or in some cases the landfills will actually pay the shredders a small fee for the ASR as it has good properties for use as daily landfill cover.

Technologies are in development to make productive use of ASR and some are being designed to recover plastics from ASR. Some of these technologies focus on converting the auto plastics in ASR to fuels or heat, and others chemically recycled back to their original molecules. This section describes some of these technologies

C6.1 ASR Quantities and Composition

Automobile shredder residue (ASR) is the residual fraction remaining from end-of-life vehicles (ELV) after they go through depollution, dismantling, shredding and metal separation. ASR represents approximately 15-30% of the weight of an ELV and is a mixture of residual ferrous and non-ferrous metals, plastics, rubber, textile and fibre material, wood, and glass.

According to an August, 2019 report for Environment and Climate Change Canada (ECCC) by Cheminfo entitled “Auto Shredder Residue Sampling and Testing”, a total of between 320,000 and 448,000 tonnes of ASR is generated annually in Canada at approximately 25 different shredding facilities. The report noted that the shredding operations also shred white goods and other metal products. As a result, the shredder residue produced is not entirely composed of ASR from vehicles only.[62]

[62] Ibid

In Canada, virtually all ASR is either landfilled or used as landfill cover.[63]

The composition of ASR can differ considerably depending on the shredding and post-shredding process that is used, and this is mainly because of differences in processing and sorting efficiency. Table 1 presents the approximate composition of ASR found in three different sources which have compiled information at different locations over a number of years.

Cheminfo analyzed 18 different ASR sampling studies conducted between 1995 and 2013 in their January, 2014 report entitled "Background Study on the Content of Shredder Residue" prepared for Environment Canada. The material composition of ASR from those sampling studies had significant variations. The averages of the 18 studies are presented in Table 1.

Table 1: Composition of Auto Shredder Residue (ASR) From Various Sources

Material	Values From Green Vehicle Disposal (%)[64]	Average Values From 18 Studies in Cheminfo Analysis [65]	Values From Ciacci(2010)[66]
Polyester, polypropylene, polyvinyl chloride, styrene, polyethylene, acrylic	15-25% (includes PUR)	20-45% (average - 30.4%)	32%
Polyurethane Foam (PUR)		0-15% (average - 9%)	16.8%
Metals		5-20%	11%
Inert Material gravel, sand, dirt, etc.	15-25%		
Paper/wood	15-25%	0-5%	
Glass	10-15%	0-20%	
Rubber	10-15%	2-25%	14%
Moisture	10-15%		
Textiles and Fibres		5-30%	13%
Miscellaneous/Undetermined		5-35%	
Fines			14%

The average percentage of plastic in the 18 ASR sampling studies was 30.4%, plus an additional 9% for PUR (polyurethane foam).[67] The Ciacci2010 sampling had a similar value for plastics excluding PUR, and a much higher value for PUR (16.8% than the 18-study average. The values from the Cheminfo study (30% plastics and 9% PUR) are considered the most appropriate to use for this study they incorporated information from 18 different studies.

However, this points to the fact that if ASR is to be a target for future federal government support, an extensive ASR sampling program should be carried out at shredders across Canada to more accurately identify the plastic content of ASR, and the composition by resin. Equipment vendors and shredder owners will need this information to assess the viability of different technologies to recover plastics.

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[63] Cheminfo, "Auto Shredder Residue Sampling and Testing", January 2019

[64] https://greenvehicledisposal.com/what-is-an-end-of-life-vehicle/

[65] Adapted from Source: Cheminfo, "Background Study on the Content of Shredder Residue", January, 2014

[66] Ciacci, L., et. al. (2010), *A Comparison Among Different Automotive Shredder Residue Treatment Processes*, published in the International Journal of Life Cycle Assessment.

[67] Cheminfo, "Background Study on the Content of Shredder Residue", January, 2014

On the basis of the information in the previous Cheminfo studies, Table 2 shows that plastic in ASR in Canada ranges from 125,000 to 175,000 tonnes/year depending on the total ASR generated.

Table 2: Estimated Range of Plastic in ASR in Canada

Plastic	Proportion in ASR	Potential Plastic in ASR	
		@320,000 tonnes/year ASR	@448,000 tonnes/year ASR
Polyester, polypropylene, polyvinyl chloride, styrene, polyethylene, acrylic	30%	96,000	134,400
Polyurethane Foam (PUR)	9%	28,800	40,320
Total	39%	124,800	174,720

Should ASR become a focus for recovery of auto plastic from ELVs, these estimates as well as the composition studies need to be updated to reflect today's ASR composition as well as the quantities produced annually.

C6.2 Federal Research to Date on ASR

On 12thFebruary, 2020 The National Research Council of Canada (NRC) and Environment and Climate Change Canada (ECCC)announced funding through the Federal Government's *Plastics Innovation Challenge*[68] to support ASR research. The funding process involved two phases: In Phase 1, small companies were invited to propose solutions and after an evaluation process was conducted, selected companies received up to $150,000 to develop a proof of concept. In Phase 2, the proofs of concept were evaluated and successful companies received up to an additional $1 million to develop a prototype.

Two companies were successful at securing Phase 1 funding for ASR research. Universal Matter in Burlington, ON received $150,00 and Pyrogenesis Canada Inc. in Montreal, QC received $145,412. Neither company's proof of concept was selected for Phase 2 funding. Information about their proposals was not made available.

[68] https://www.ic.gc.ca/eic/site/101.nsf/eng/00001.html

C6.3 Technologies that Sort Plastics from ASR

While the focus of secondary processing of ASR has traditionally been to recover additional metals, some technologies are emerging which are attempting to recover plastics from ASR. These are described below.

Ad Rem NV (JV Galloo and Valtech)

Ad Rem NV, based in Belgium, is a joint venture between the Galloo Group and the Valtech Group, owner of Hamos GmbH. Ad Rem uses Hamos technology to sort out plastics and metals from ASR, shredded appliances and shredded waste electrical and electronic equipment (WEEE). The patented sorting process involves multiple stages of float/sink technology using a liquid suspension (or medium) made of water and an additive to increase the suspension density. In the first float/sink tank, a suspension with a density of 1.4 kg/L (40% heavier than water) is used to separate metals from plastics. The metals, which sink to the bottom of the tank, are then conveyed to a tank with a suspension density of 3.2 kg/L that separates lighter aluminum and magnesium from heavier metals.[69]

The mixed plastics from the first tank are then conveyed through a series of three float/sink tanks. The first tank, with a suspension density of 1.2 kg/L, separates non-toxic plastics from chlorinated and brominated plastics which sink to the bottom of the tank and are disposed of safely. The non-toxic plastics go to a second tank with a suspension density of 1.09 kg/L in which recyclable plastics (PE, PP, PS and ABS) float to the top and non-recyclable plastic sinks. The non-recyclable plastic is converted to a refuse derived fuel (RDF). The recyclable plastics go to a third tank with a suspension density of 1 kg/L where the PE and PP floats and the PS and ABS sinks.[70]

. The plastics mixes are then further purified and separated into PP, PS, ABS and HDPE regrind, which, after fine regrinding and cleaning are compounded into plastic compounds.[71] Figure 1 shows an example of the material output.

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[69] https://vimeo.com/432521952
[70] https://vimeo.com/432523953

Figure 1: Plastic Output from Ad Rem ASR Sorting Technology[72]

The compounding takes place at one of the five extruders. The final polypropylene compounds can be filled with talcum to allow for higher stiffness or with EPDM to allow for higher shock resistance, or remain unfilled.

During the compounding process, several additives can be used to enhance specific properties such as temperature stability, UV-stability, scratch resistance etc. to the final product.

The whole process is under continuous quality control. Every final batch of products gets its proper product certificate, indicating the most important specifications.

The recovered HDPE is used for extrusion parts, due to its low melt flow index.

The ABS and PS granules are mainly used for the production of technical parts for the electro and automotive industry, but also for the building, horticulture, agriculture and other sectors.

Most of the PP granules are being reused in the injection moulding for car parts, such as wheel arch liners, engine bottom protection plates, bumper parts, under the bonnet parts and for other technical parts.

On January 4, 2022, Ad Rem NV announced it is providing technology to a heavy media separation plant in Polykastro, Greece, designed to help separate more than 10 metric tons per hour of mixed plastics and metals from shredded end-of-life vehicles (ELVs). The plant is expected to be operational in early 2022.[73]

Ad Rem is currently constructing a second facility in Omaezaki City, Japan using the same patented float/sink technology. The facility will be operated as a joint venture between Toyota Tsusho, Veolia Japan and Kojima Sangyo and operate under the name PLANIC. The facility will process about 40,000 metric tonnes per year of plastic material coming from various sources including automobiles (ASR), home appliances, pallets and containers, and packaging materials from distribution centers and shopping centers. The PLANIC facility is expected to be operational in 2022.[74]

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[72] autorecyclingworld.com/galloo-plastics-from-elv-to-valuable-plastic-compounds
[73] Ad Rem system to separate ASR in Greece, Brian Taylor, Recycling Today, January 2022
[74] https://www.adrecyclingmachines.com/en/cases/ad-rem-to-build-largest-facility-for-plastic-recycling-in-japan

ARN, Holland Post Shredder Technology

The Netherlands have had a producer responsibility system for ELVs in place since 2002, as part of their requirement to adopt the ELV Directive at the national level. Until 2020, the producer responsibility organization ARN owned a 'Post Shredder Technology' (PST) plant which has since been sold off to private interests. [75]

The unique post shredder technology helps auto recycling to achieve a 98.4% rate. ARN is constantly refining the techniques and processes at the PST plant in Tiel to achieve higher recovery rates for different plastic resins and find new end markets.

Almost 200 different machines work in the plant on separating all plastic resins.

> "It is very time consuming to find the right configurations for all the machines so that the entire production process runs smoothly", says Hans van de Greef, Director of ARN Recycling. "This is complicated by the fact that eleven material flows delivered to us by shredder companies all have a different composition. We figure out these flows, in a manner of speaking, using the latest technologies."

Recovered auto plastics are used as a raw material for the car industry, as well as for sheet piling and dam walls.

ARN works with the research organisation Brightlands van Chemelot (DSM) on various projects. The development of sound barriers for use along railway lines is currently being explored as well as potentially making railway sleepers from recovered raw materials from the PST plant. Railway sleepers must be rigid and dimensionally stable which is a particular challenge. The use of X-rays is being explored on one nylon by-product, but cost data is not available at this time.

Steinert Global GmbH

Steinert Global GmbH, based in Germany, has developed a unique ASR sorting technology (called UniSort BlackEye) that, after ferrous and non-ferrous metals are extracted from ASR, sorts out specific plastic resins such as PP, PE, PVC and PS/ABS from the mixed plastic fraction**.**[76]

Toyota Metal Co.,

Toyota Metal Co., a subsidiary of Toyota Motor Co., has an ASR recycling plant in Japan (constructed in 1998) with a capacity to process ASR from 15,000 ELVs per month. In addition to extracting ferrous and non-ferrous metals, the plant extracts PUR and fibre which is processed into Recycled Sound-Proofing Products (RSPP) used in various vehicle parts, including dashboard and floor pan silencers.[77]

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[75] https://arn.nl/en/car-recycling/.
[76] Steinertglobal.com, The solutions for automotive shredder residue (ASR) recycling
[77] Toyota Boosts Use of Recycled Materials, global.toyota/en/detail/8131400, November 1999

C6.4 Chemical Recycling of ASR

Eastman and Padnos (through USAMP)

Eastman Chemical Company (Eastman) in July 2021 announced a collaboration with the United States Automotive Materials Partnership LLC (USAMP) and automotive recycler PADNOS for a concept feasibility study to demonstrate a closed-loop project to recycle automotive-industry mixed plastic waste in the automotive supply chain. USAMP is a subsidiary of the United States Council for Automotive Research LLC (USCAR).

The study will assess how well Eastman's carbon renewal technology (CRT), one of Eastman's two molecular recycling technologies, breaks down the plastic-rich fraction of ASR into molecular building blocks. By recycling these complex plastics in CRT, Eastman would replace fossil-based feedstock and create polymers without compromising performance for use in new automotive applications.[78]

C6.5 Creating Syngas From ASR

SIMS Ltd Rocklea ASR Pyrolysis Pilot Project

Sims Ltd., the Australia-based parent company of Sims Metal and other scrap recycling firms operating in Australia, North America and the United Kingdom, is researching technology to convert the non-metallic portion of ASR into a synthesis gas (syngas) product.

A pilot facility, called Resource Renewal Rocklea, will be located in Rocklea (a local community within Brisbane, Australia) and is expected to be operational in 2022. The facility will test the technical and commercial viability of using plasma gasification technology to transform ASR into a syngas and an inert "glass-like" by-product suitable for use as a paving material aggregate.[79] A schematic of the pilot plant is presented in Figure 2.

[78] Eastman announces project with USAMP and PADNOS for fully circular recycling study in automotive market, Eastman.com, July 2021
[79] Sims takes long-term view with ASR project, Brian Taylor, Recycling Today, July 2021

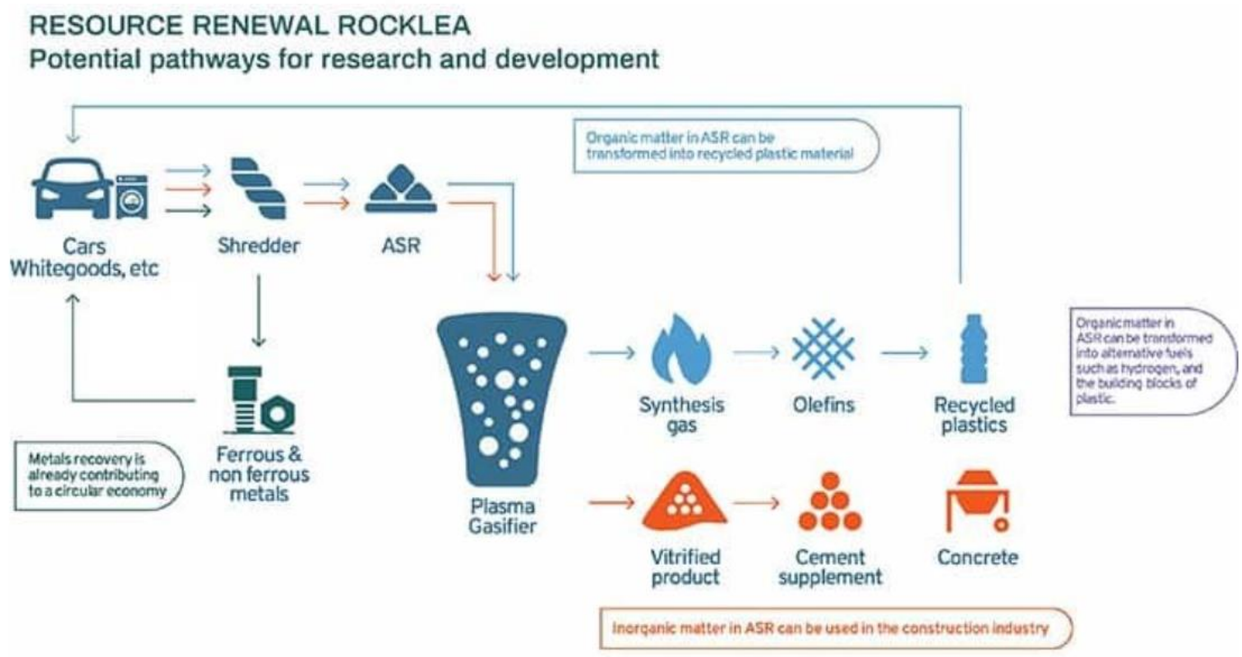

Figure 2: Schematic of SIMS Rocklea ASR Plasma Gasifier Pilot Plant[80]

Enerkem

Enerkem's Waste to Biofuels and Chemicals Facility in Edmonton, AB is the world's first commercial-scale waste-to-biofuels facility of its kind and is designed to turn household garbage into biofuels and renewable chemicals

The facility was built, and is owned and operated by, Enerkem Alberta Biofuels, a subsidiary of Enerkem. Using Enerkem's proprietary technology, the facility has a potential capacity to convert up to 100,000 tonnes of municipal solid waste into 38 million litres of biofuel annually.

When interviewed for this project, Enerkem staff indicated that the company can potentially take ASR but does not take any at the present time.

In 2014/2015, ArcelorMittal sent them some ASR to Enerkem for testing and analysis. The limitation for Enerkem at the time was that it is an inert material. ArcelorMittal would have had to make significant investments in order to purify the feedstock and make it more attractive to Enerkem

Enerkem have tested ASR from other sources (aside from ArcelorMittal) in the past and the key issue was the metal content. The metal needs to be removed before the material comes to them

[80] https://www.recyclingtoday.com/article/sims-auto-shredder-residue-recycling-australia-syngas/

C6.6 Summary of ASR Technologies and Options

While recovery of plastic resins from ASR for recycling is technically feasible there are two barriers to widespread implementation in Canada:

1) the cost of sophisticated sorting technology to sort out plastics from ASR and

2) the low value for most plastic resins.

It is unlikely that this situation will change unless significant incentives are provided to recover plastics from ASR.

Should any further research on ASR be carried out, the baseline needs to be established through:

- More accurate quantification of the amount of ASR produced annually in Canada – the current range of 320,000 to 448,000 tonnes is a number of years old; and
- A comprehensive ASR composition study would need to be carried out at shredders across Canada to establish the actual amount of plastic in ASR. While most of the plastic comes from vehicles, some – a small amount - comes from appliances.