POSITION STATEMENT

Using **extended producer responsibility** to manage end-of-life EV batteries

March 2020

propulsion Québec

Cluster for Electric and Smart Transportation

About Propulsion Québec

Propulsion Québec rallies the entire sector around joint projects aimed at positioning Quebec as a global leader in developing and implementing smart and electric modes of ground transportation.

By 2026, the cluster's aim is for Quebec to :

- **Be recognized as a global leader in the business segments tied to electric and smart transportation;**
- **Have a solid core of worldclass businesses that span the entire electric and smart transportation value chain;**
- **Become a hub for electric and smart vehicle trials and use.**

Background

According to data from MELCC, transportation accounted for 43% of Quebec's GHG emissions in 2016. In order to meet its emission reduction targets by 2030, Quebec is electrifying transportation and investing in electric mobility, among other things. According to Propulsion Québec's recent study on the lithium-ion battery industry, sales of EVs in Quebec will grow dramatically over the next decade. This will create challenges and opportunities with regard to end-of-life EV battery management. Innovative strategies must be developed to leverage the batteries' significant potential for reuse (second life) and recover the valuable materials they contain to offset recycling costs. These costs are substantial—batteries have to be dismantled prior to chemical recycling and transportation is expensive because the batteries are heavy. The environmental impact of EVs is closely tied to the environmental and carbon footprints of extracting the metals used in EV batteries and the risk of end-of-life battery mismanagement, which could harm water and natural environments.

In order to harness their potential economic value and limit risks to the environment, it is necessary to control and manage end-of-life batteries.

That is why more and more countries are using extended producer responsibility (EPR) as a tool to maximize recovery and recycling rates. EPR is already used in Quebec and Canada for similar materials like household batteries and e-waste.

Propulsion Québec hired consulting firm EY to assess the suitability of EPR for managing end-of-life EV batteries in Quebec. EY conducted research, analysis, interviews, and a workshop with industry stakeholders[1] to identify the challenges and opportunities involved in implementing EPR for end-of-life EV batteries in Quebec. This document presents a summary of EY's report in the form of frequently asked questions. The last section addresses the big question: Given the key success factors for EPR as presented in EY's report, what actions should be prioritized to make EPR acceptable to all (government, the public, and industry), particularly in light of hopes to develop a green battery industry in Quebec?

1 The EY's Report is based on research and consultations with key market players. EY conducted some 20 individual interviews along with a stakeholder consultation workshop to gain insight into the state of the industry and the issues it's facing. To facilitate the process, Propulsion Québec struck a steering committee that reviewed preliminary results and approved subsequent steps and the contents of the final report.

Reference: EY, 2020. "Study of Extended Producer Responsibility for Electric Vehicle Lithium-Ion Batteries in Quebec," final report, March 23, 2020.

What economic and environmental challenges do end-of-life batteries pose?

- As mentioned above, the economic value of end-of-life EV batteries is twofold. They can be reused in a second life for energy storage or other applications and are made of valuable materials that are in demand in the growing EV market. The metals in end-of-life batteries can be extracted and reused in the production of new batteries. Several Quebec players are active in this sector, including Lithion Recycling. Businesses in the battery value chain already understand the importance of end-of-life management, with or without EPR.

  Growing EV sales suggest that end-of-life management of millions of batteries could be a heavy environmental burden. Under certain conditions it could even exceed the benefits of EVs, given the sizeable environmental footprint associated with extracting and processing the metals used to manufacture batteries and the risks involved in end-of-life battery handling and storage, not to mention the fact that end-of-life batteries contain substances that can be harmful if abandoned. The expected growth in EV sales could also trigger a shortage of strategic materials and lead to less environmentally responsible procurement practices. That is why end-of-life EV battery management must follow circular economy principles. EPR would address these issues in part by introducing a mechanism to ensure all end-of-life EV batteries, regardless of their economic value, are handled responsibly, to minimize environmental impacts, and to foster the development of a green EV battery industry.

What is EPR?

- It is a mechanism established in Quebec through the *Regulation respecting the recovery and reclamation of products by enterprises*. It puts responsibility for end-of-life management of certain products into the hands of the companies that make them. EPR regulation is used in Quebec for a number of products, including small lithium-ion batteries. Requirements include setting up recovery and recycling programs available for free for targeted products, performing R&D, reporting back on program results, and conducting public education campaigns. A new EV battery program must be non-exclusive. It must require producers to recover all batteries free of charge, including those made by competitors. Companies may decide to create their own recovery and recycling programs, or join a recognized management organization (RMO) that would be responsible for deploying such a program. The RMO could be entrusted with managing a reserve fund—a sum of money earmarked for EPR's financial and future costs. Therefore, the RMO can require contributions from its members.

- In EPR mechanisms, the recovery and recycling system costs are factored into the purchase prices of products subject to recovery and recycling and will be paid in the most cases by the customer.

  EPR has yet to be adopted for EV batteries in North America. As mentioned above, EPR is currently in place for lithium-ion batteries, other than those used in an electric vehicle or used exclusively for industrial purposes. Lead-acid batteries are not included under EPR in North America either, but a deposit-based recycling industry has developed organically to harness the economic value of end-of-life batteries. Canada has provincial regulations and standards for end-of-life vehicles, thereby benefiting the recycling industry. For example, according to Quebec's Association of Auto Parts Recyclers, its members recycle 83.3% of a vehicle's weight. The Quebec government published the Guide to Best Practices for ELV Management in 2001 to improve the environmental performance of ELV recycling activities.

  EV batteries are considered hazardous goods and hazardous waste and are regulated at the provincial and federal levels. There is also a bilateral agreement between the United States and Canada that regulates the shipping of hazardous waste and hazardous recyclable materials between the two countries. Current standards and regulations do not impede the movement of batteries between provinces or between Canada and the U.S. The main hindrance to the transportation of end-of-life EV batteries is their weight, which makes them expensive to transport.

Which companies in the electric transportation sector would be subject to EPR?

- In Quebec, the first brand owners and/or suppliers of affected products are subject to EPR.

  For EV batteries, this would include:

  - Automakers
  - The first importers and/or suppliers of targeted products (e.g. batteries and cells) and of products made of a targeted products (e.g. EV)
  - EV battery brand owners and first suppliers to the Quebec EV market (e.g.cars, buses, trucks and trains)
  - Niche EV manufacturers other than those for recreational uses (e.g. bikes, scooters, snowmobiles, etc.)
  - Dealers that import EVs of any kind from makers who do not have places of business in Quebec.

Why is EPR a suitable regulatory mechanism for managing end-of-life lithium-ion batteries?

- **EPR is flexible and allows** companies to choose how to develop the required program to manage end-of-life batteries. They are free to implement their own recovery and recycling programs or call on a recognized management organization. In other words, EPR would not prevent companies from managing and recycling their own end-of-life batteries if they wished to do so.
- **EPR could make the social cost of vehicles more transparent.** The costs of recovering and recycling batteries can be included in EV purchase prices. If so, the brand owners have the possibility to make them visible.
- **EPR clarifies responsibilities all along the value chain.** Producers' financial and operational responsibilities are set out in a legal framework. The framework ensures that all eligible end-of-life products are reused, recovered, and recycled, not only the valuable ones.
- **EPR pays for itself.** It creates a structured collection system that internalizes costs within the industry, thereby leveling the playing field. It can also include a reserve fund to absorb unforeseen costs, such as managing batteries made by a manufacturer that has since gone out of business.
- **EPR facilitates risk management.** Ongoing awareness campaigns and training promote safety and minimize environmental risk of battery mismanagement.
- **EPR ensures materials remain available.** It provides a measure of assurance that resources will be available for recyclers. Given the size of the Quebec market, it is not possible to predict from the study whether the supply of end-of-life batteries will be sufficient to sustain a local recycling industry. To this end, EPR could also be implemented jointly with other provinces or states to provide Quebec recyclers with access to a larger pool of end-of-life EV batteries in North America.

Are there any issues with Quebec being the first jurisdiction in North America to implement EPR for end-of-life EV batteries? What impact would that have?

- The North American market and its legal framework do not pose any problems for the implementation of EPR for EV batteries in Quebec. Research shows that the province is ready to take the lead on this issue. However, EPR may be viewed as a financial and administrative burden by foreign producers. They are calling for a voluntary management system, mainly because they fear that a range of disparate regulatory mechanisms will be adopted across North America for end-of-life EV batteries. This issue has not been raised by Quebec EV producers, so there is an opportunity for Quebec to take the lead rather than having to play catchup with legislation adopted in other provinces and/or states, which may not fit the needs of our manufacturers and recyclers. Quebec's position at the vanguard of transportation electrification could help it assume a leadership role in North America.

Why not manage end-of-life lithium-ion batteries using a voluntary system, like for lead-acid automobile batteries?

- As the chemical composition of electric vehicle (EV) batteries varies according to models and uses, notwithstanding their second-life value, their ultimate end-of-life market value is also variable since it depends largely on which metals it is composed of. On the opposite, lead batteries always have a high end-of-life economic value since their chemical composition does not vary. Even tough they are not subject to EPR in Quebec, the value of lead batteries is an incentive for the industry to constantly manage them through multiple ways at their end-of-life, but this does not apply to EV lithium-ion batteries. Indeed, in a voluntary management scenario for lithium-ion batteries, it is reasonable to say that the variable market value of EV batteries would negatively impact the willingness of the industry to properly manage batteries for which the chemical composition does not represent high value.

  When lead batteries end up in dismantling sites of members of the Association of Auto Parts Recyclers (ARPAC), they are resold to individuals or to recyclers. When sent to used vehicles recyclers which are not members of ARPAC, it is difficult to track them. In some cases, an informal deposit system – i.e. a voluntary, non-governmental and non-regulated system – is used in some regions of Quebec for lead batteries. Garage owners pay a deposit to the manufacturers who sell them the battery; when the garage owner have accumulated enough end-of-life batteries, he contacts the producers which collect the batteries and reimburse the deposit. Discussion with stakeholders confirms that such mechanism would be difficult to apply to EV batteries because of their size, which would require much larger storage capacities than what is required for lead-acid batteries, and because of issues associated with intellectual property for the various technologies used in lithium-ion batteries. Moreover, in such case, EV producers would only be selling the EV battery to garage owners for replacement.

What costs are involved in implementing EPR and what impacts would it have on the development of the fledgling electric transportation industry?

- As part of its report, EY carried out a preliminary quantitative analysis to simulate the impact of EPR for end-of-life EV batteries. Given that the EV market is underdeveloped, there is uncertainty about some of the parameters and assumptions employed in the analysis. As a result, only passenger EV batteries were included in the model due to a lack of data on other battery types. Due to a lack of data in Quebec, the analysis uses assumptions based on the European market. The data should be interpreted with caution. It should be fine-tuned for more rigorous analysis that more accurately models the impacts on the electrification of transportation.

  According to the assumptions used, the unit cost for battery management under an EPR system is affected by factors such as average battery weight, collection and transport costs, and recycling and reuse costs. The estimated unit cost for battery management is $932.

  EPR costs depend on the number of end-of-life batteries, the aforementioned unit management cost, the reserve fund, and the number of new EVs sold. In principle, EPR costs would be assumed by EV producers, who could integrate them into the prices of new vehicles.

  EPR costs are based on the following formula:

$$\textit{EPR cost} = \frac{\textit{(number of end-of-life batteries} \times \textit{unit management cost)} + \textit{reserve fund}}{\textit{number of new EVs sold}}$$

  Initially, end-of-life battery volumes will be lower than the volumes of batteries on the market (in new EVs) due to the time lag between them. Recycling cost and EPR cost are respectively attributable to end-of-life battery volumes and battery volumes in new EVs. Considering the EPR cost per EV sold formula[2], the EPR cost per EV sold will initially be less than the recycling cost per battery (unit cost). This is because the EPR costs will be shared with a large volume of new vehicles.

  However, the time lag does not reduce the EPR costs, but defers it. The number of end-of-life batteries on the market will increase, which will reduce their recycling cost. The number of new EVs will continue to grow, but to a lesser extent, which will increase the cost of EPR per new EV to just over $400 in the next decade, or about 1% of the value of a new EV. This growth in EV sales (new EVs) being progressively slower as EV market shares stabilizes, the cost of EPR will gradually catch up with the unit cost of recycling (currently estimated at $900). It should be noted that recycling cost could significantly be reduced through economies of scale and new recycling technologies.

2 The EPR cost formula demonstrates that the number of new EVs sold is in the denominator and the number of end-of-life batteries is in the numerator.

TABLE 1: Sensitivity analysis for EPR (base year: 2030; source: EY, 2020)

PARAMETER	Impact on the 2030 EPR cost ($ per new EV) if a parameter changes by 50% (+)	(-)	Average	Impact
Volume of new EVs sold in 2030	271	812	542	Significant
Volume of end-of-life batteries (metric tons)	914	102	508	Significant
Unit cost of collection and recycling	564	248	406	Moderate
Unit cost of collection and reuse	451	361	406	Limited
Portion of end-of-life batteries suitable for reuse	384	429	407	Limited

If the EPR cost were to drop to $400, the impact on EV sales and the industry would be minimal. It would represent only 1% of the cost of a new EV.[3] The price elasticity for EVs suggests that a 1% increase in price would reduce sales by 1%. There is an impact, but it is limited. Potential EV purchasers are deeply concerned about the environmental impacts of their choices. EV prices are expected to fall (due in part to lower battery and battery component costs), so the impact of EPR cost could eventually be absorbed by this overall drop in price.

3 Based on an average cost of $40,000.

Given the key success factors for EPR as presented in the EY report, what actions should be prioritized to make EPR acceptable to all, particularly in light of hopes to develop a green battery industry in Quebec?

- Propulsion Québec is in favor of EPR for EV batteries, mainly because it addresses most of the issues raised by stakeholders, including safe and environmentally friendly management of end-of-life batteries. Without EPR, the market could become quite a patchwork, leading to a lack of direction and increased risk of batteries going to landfill instead of being recycled.

  Preliminary financial estimates by EY show that the cost of EPR would not impede the EV market. Contrary to general perceptions, the administrative cost of EPR is not a significant part of recycling costs. End-of-life costs are inherent in the battery life cycle. EPR just can make these costs more visible from the outset. Its contribution is actually relatively small when compared with other products. The effect of EPR on EV growth would therefore be marginal, especially given that EV prices are expected to fall dramatically in the coming years. Quebec has also adopted the Act to increase the number of zero-emission motor vehicles in Québec in order to reduce greenhouse gas and other pollutant emissions (the "ZEV act"), which is designed to get more EVs into the Quebec marketplace.

  If, as we hope, the Quebec government decides to regulate end-of-life EV batteries, it should take the issues listed below into account.

- **Quebec, Canada, and North America on the same page**

  Based on past and current experience with EPR in Quebec and elsewhere, companies are forced to comply with a range of regulatory requirements and administrative controls. EPR creates significant administrative and operational burdens for businesses, especially if different provinces and/or states decide to implement EPR, in which case companies could have multiple audits to juggle. The Quebec government must therefore strive to harmonize management mechanisms for end-of-life batteries with the rest of Canada and, ideally, the eastern North America. If EPR is not harmonized, companies that sell into multiple jurisdictions could find themselves all tied up in red tape. Aligning EPR regulations across jurisdictions, provinces, and states in North America would make it easier for everyone and give Quebec recyclers access to a larger pool of EV batteries. This would not only make it simpler for companies to comply with EPR, it would also make companies involved in EV battery reuse and recycling more financially viable. Indeed, EPR would provide a pipeline of materials and make sure that recyclers have access to at least part of the resources they need. However, given the size of the Quebec market, it is doubtful that materials from Quebec alone could sustain a local recycling industry. As mentioned above, Quebec could join with other provinces or states to introduce EPR, which would provide its recyclers with a more reliable source of end-of-life EV batteries.

- **Timing**

  The government needs to consider when would be the best time to launch EPR in Quebec. If it is too early, the supply of end-of-life batteries may be too small and could jeopardize financial viability. If it is too late, a significant number of batteries could be mismanaged, or market share could be lost to recyclers outside Quebec. EPR should be phased in gradually and flexibly to give industry players enough time to set up a suitable collection system. This is doable because we already know how many batteries are out there and how soon we can expect to attain the critical mass needed to make the project technically and financially viable. EV sales are an excellent indicator of the volume of batteries that will need to be recycled in eight to ten years, or beyond if they are given a second life. Quebec is already one of the top EV markets in North America, so it is well positioned to take a leadership role in developing a circular economy for EV batteries.

- **A second life for EV batteries**

  Although there appears to be a lot of potential for reusing EV batteries in other ways at end-of-life (e.g. energy storage in stationary units), this poses certain challenges in terms of EPR. But there is no denying that giving EV batteries a second life shows real promise and many companies are already working on it. EPR must therefore have a clear scope of application because the definition of battery life can vary depending on how it is interpreted and what a battery's intended post-EV use is. It is very important that provision for battery reuse be made in any future EPR regulations.

- **Protection of intellectual property**

  By its very nature, EPR could affect product confidentiality. EPR programs oblige producers to recover all batteries free of charge, including those made by their competition. As a result, it could compromise the intellectual property of producers who invest heavily in R&D programs to develop cutting-edge batteries. Under EPR, these end-of-life batteries could end up at any recycler, scrap dealer, or dealer, who would then have access to the technology. It is important that any proposed EPR mechanism in Quebec allow producers to manage end-of-life vehicles and batteries as they see fit and have the option to manage EPR for their products independently, as long as they meet the target objectives (battery recovery and recycling, R&D, reporting, awareness and education).

  In terms of intellectual property, EPR must also take into account the specific features of batteries and the different types on the market. End-of-life passenger EV batteries are not managed the same ways as end-of-life electric truck batteries. Two main battery streams with different characteristics will coexist: passenger EV batteries, and medium- and heavy-duty vehicle batteries (buses and heavy-duty trucks). The types will encompass a range of chemical compositions. Each stream has specific features that will require different management systems. An operational issue may arise since EV producers' recycling technologies are not designed to process other battery models. It will be important to take a good look at this issue when EPR regulations are implemented. One of the solutions would be to educate the public about where to drop off different types of batteries depending on what kind they are.

- **Consultation and strategic planning**

  Consultations are key to tailoring EPR regulations to today's industry landscape. Recovery objectives need to be discussed with the industry and modified as required. Although everyone is aware of the environmental challenges posed by end-of-life battery management, each industry operates within a specific framework (e.g., varying availability of end-of-life batteries, different markets, technological and financial viability, intellectual property protection issues, balanced reserve fund, etc.). EPR is a shared concern, and it is vital for the system to recognize and respond to these issues appropriately.

  Although EY's report shows that EPR's impact on EV sales should be small or negligible, a rigorous, in-depth quantitative analysis is needed to better estimate EPR costs and their impact on the electrification of transportation. The analysis discussed here should be interpreted cautiously given the lack of reliable data for Quebec and the use of assumptions that are based on the European market. Mobility electrification is important for the economy and the environment, and it is important to remember that the financial and technical viability of the EV battery recycling industry and its very existence depend on a ready supply of end-of-life batteries and thus on the presence of EVs on our roads.

  It should be noted that EPR is one component of a broader strategy to develop circularity and eco-responsibility in Quebec's EV battery industry, a sector the Quebec government is seeking to strategically develop. This vision, which is shared by Propulsion Québec, cannot become a reality unless government and industry work hand in hand to develop a strategic approach and an actionable plan. The industry cooperation generated by Propulsion Québec's arrival on the scene is irrefutable proof that working together produces the best results. Propulsion Québec will continue to foster collaboration, equipping the industry to inform and educate the public, carry out collaborative R&D on recovery and recycling techniques for recovered products and materials, and engage in market development.

In brief

Where does Propulsion Québec stand on using EPR to manage end-of-life EV batteries in the transportation industry?

Propulsion Québec is in favor of EPR, but recommends that the government of Quebec consider the following factors should it decide to regulate end-of-life EV batteries:

- **Consult** relevant stakeholders to establish the main parameters for EPR, including realistic targets, the dynamics in different markets, and intellectual property protection issues.
- **Distinguish** between the various types and chemical compositions of end-of-life batteries as these may affect EPR parameters and collection and processing logistics.
- **Gradually** implement EPR within a realistic timeframe and harmonize it as much as possible with other jurisdictions in North America that are considering similar mechanisms. Quebec is well positioned to be a leader in North America and has the potential to exert a positive influence on legislation in other jurisdictions.
- **Establish** a flexible regulatory framework that can be reviewed periodically to ensure it is in step with the availability of end-of-life EV batteries and the technical and financial viability of automakers and recyclers.
- **Carry out** a rigorous, in-depth quantitative analysis to better estimate EPR costs and their effects on transportation electrification, since the quantitative analysis carried out by EY must be interpreted with caution as a result of a lack of reliable data for Quebec and the use of assumptions based on the European market.

6666 Saint-Urbain Street,
Suite 360
Montreal, Quebec
H2S 3H1
Canada

1150 de Claire-Fontaine Street,
Suite 740
Quebec City, Quebec
G1R 5G4
Canada

propulsionquebec.com

propulsion Québec

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