Li-Cycle's Written Testimony Before the U.S. Senate Committee on Environment and Public Works

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Introduction

On the behalf of all of us at Li-Cycle, I would like to extend our gratitude and thanks to Chairman Tom Carper, Ranking Member Shelley Moore Capito, and the other members of the committee for this opportunity. It is a privilege and a honor to share with you our perspective on the topic of e-waste, or electronic waste.

Background on Li-Cycle

For background, Li-Cycle was founded in 2016 to address a missing link in the future of global electrification – the lack of an economically and environmentally sustainable lithium-ion battery recycling solution. Lithium-ion batteries are increasingly powering our world in automobiles, energy storage projects and consumer electronics. Back in 2016, Tim Johnston and I co-founded Li-Cycle after realizing that the world needed improved technology and supply chain innovations to better manage end-of-life batteries and manufacturing waste to meet the rapidly growing demand for battery-grade materials, such as lithium, nickel, and cobalt. We created Li-Cycle to directly address this global challenge by developing innovative technology to sustainably recover valuable resources from batteries and drive a cleaner transition to electrification.

Fast forward to today, Li-Cycle's safe, sustainable, and scalable Spoke & Hub Technologies™ return lithium-ion batteries and battery manufacturing scrap to the supply chain with up to an overall 95% recycling efficiency rate. As we scale our industry-leading technologies, our commitment to sustainability continues to be of paramount focus, as our processes have minimal solid waste streams, minimal wastewater discharge, and low impact air emissions.

Spoke & Hub Technologies™ - two-step sustainable process to recycle and recover critical battery materials

Our highly scalable two-stage Spoke & Hub business model enables us to safely receive and recycle all lithium-ion batteries regardless of condition, form factor, and state-of-charge. At our Spokes, the first stage of our vertically-integrated business model, we safely recycle battery materials through a proprietary submerged shredding process to produce 'black mass,' an intermediate product which contains highly valuable metals such as lithium, nickel, and cobalt.

Last year, we operationalized our 'Generation 3' Spoke technology at our facilities in Gilbert, Arizona and Tuscaloosa, Alabama. Our Generation 3 Spoke technology has the capability to directly process full electric vehicle (EV) and energy storage battery packs without any manual dismantling or discharging, which enhances safety and efficiency and is a significant value differentiator for Li-Cycle. Our Spoke technology is also one of the most energy efficient solutions commercially available.

Across our operational Spokes in North America, we have a total processing capacity of up to 51,000 metric tons of lithium-ion battery material per year. While we have predominantly been expanding and bolstering our presence in North America, with the majority of our recycling capacity within the U.S., we are also actively expanding in Europe. Our first European Spoke is expected to commence operations later this year in Germany, and will become our largest Spoke to date. We have other European Spokes planned in France and Norway, which will bring Li-Cycle's future planned capacity across our global Spoke network to more than 100,000 metric tons of lithium-ion battery material per year.

At our Hub facilities, the second stage of our vertically integrated process, we process black mass to produce the battery-grade materials that are the fundamental building blocks of new lithium-ion batteries, such as lithium carbonate, nickel sulphate, cobalt sulphate, manganese carbonate, and more. Our first commercial Hub is under construction in Rochester, New York and is on track to commence commissioning in late 2023, with ramp up of operations in 2024. The facility is expected to be the first source of recycled battery-grade lithium carbonate in North America. It is a flagship asset for our company, and we strongly believe that this first-of-its-kind clean-tech refining facility will play a key role in solving many challenges associated with e-waste in the U.S., and North America more broadly.

North America Hub: Rochester Hub On Track to Commence Commissioning in Late 2023

Once fully operational, the Rochester Hub is expected to deliver annual production of up to 7,500-8,500 metric tons of battery-grade lithium carbonate, 42,000-48,000 metric tons of battery-grade nickel sulphate, and 6,500-7,500 metric tons of battery-grade cobalt sulphate, in addition to other valuable materials. The Rochester Hub is expected to be one of the largest sources of lithium supply in North America and will be able to process up to 35,000 metric tons of black mass per year, the equivalent of

lithium-ion battery material to power up to approximately 300,000 EVs . The Rochester Hub is also creating approximately 1,000 American jobs during construction and 270 permanent jobs once the facility is operational.

The environmental benefits of Li-Cycle's recycling process

As demonstrated through a Life Cycle Assessment, compared to traditional mining and refining processes, our overall process provides emission reduction benefits of up to 67% for carbon dioxide or CO_2, 86% for sulfur oxides or SO_x, 89% for nitrogen oxides or NO_x, and reduces water usage by up to 97% per metric ton of battery input[1]. To complement our environmentally friendly process, we continue to maintain our dedication to being a customer led organization and we have amassed a growing global network of more than 200 customers, which includes a range of the world's largest automakers.

Growing global presence

What started out as a visionary idea discussed by two engineers over a cup of coffee has now transformed into a leading global lithium-ion battery resource recovery company and North America's largest pure-play lithium-ion battery recycler, with a rapidly growing presence across Europe. To support our global growth, we now have more than 450 employees worldwide and have opened regional offices in Switzerland and Singapore. We believe we are just getting started.

As we continue to lead in innovation and recycling in North America, we also believe there are many key learnings from our experience that we can take to the European market. Working together, we can help reduce reliance on foreign battery ecosystems and help build a long-lasting, localized infrastructure in both North America and Europe. Of note, we recently expanded upon our strategic partnership with Glencore, a global leader in primary sources of battery metals and one of our key investors, with a view to developing our first Hub in Europe. Li-Cycle and Glencore are now studying the possible development of a new Hub in Portovesme, Italy, through a planned 50-50 joint venture. The Portovesme Hub would be a landmark project for Europe's battery recycling industry and would be the largest source of recycled battery-grade lithium, as well as recycled nickel and cobalt, on the European continent. To align with our recycling expertise, we plan to repurpose an existing Glencore metallurgical facility to enable a cost-efficient and expedited development plan. Once operational, the Portovesme Hub would be expected to have a processing capacity of 50,000-70,000 metric tons of black mass per year, or the equivalent of lithium-ion battery material to power up to approximately 600,000 EVs.

Lithium-ion Batteries and E-Waste

Lithium-ion batteries are now ubiquitous in today's world. There are many benefits to lithium-ion batteries as evident by their proliferation, but the bottom line is that if these batteries are not properly handled and recycled, they will lead to a mountain of potentially harmful e-waste. I would like to

[1] *Based on independent Life-Cycle Assessments (LCA) completed on behalf of Li-Cycle in 2022. Environmental benefits are shown as emission offsets comparison for one metric ton of Battery Input. Mining & Refining baseline calculated by a third party, including external sources (GREET, Argonne National Laboratory). Li-Cycle's LCA results are fully loaded, i.e., inclusive of indirect emissions not directly associated with the Spoke & Hub process, including transportation of material. Li-Cycle's process offsets 40-67% of the CO_2 Profile of an EV Battery. The battery pack often accounts for over ~ 40-50% of an electric vehicle's total CO_2 emissions profile (Source: Volkswagen AG).*

provide a quick overview of what Li-Cycle sees as the opportunities and the challenges of lithium-ion batteries.

The Opportunities

Lithium-ion batteries are an essential source of power to support the transition to clean energy, as many next-generation, cleaner applications depend on them – namely EVs. Lithium-ion batteries also create an "urban mine" with a wealth of highly valuable and finite materials, most notably nickel, cobalt, and – of course – lithium. For perspective of their value, an EV battery can contain 50 kgs of lithium carbonate (the chemical compound of lithium used in EV batteries), 40 kgs of nickel, and up to 15 kgs of cobalt[2]. In December 2024, the estimated prices, per metric tonne, of lithium carbonate is expected to be $47,699, $19,319 for nickel and $36,764 for cobalt[3]. This means that per average EV battery, there is upwards of $3,700 of contained value in each EV battery, in lithium, nickel and cobalt alone. With more than 900,000 battery EVs projected to be sold within the US during 2023[4], this is equivalent to more than $3 billion of contained recoverable value within EV batteries – from this year's projected sales alone and is growing continuously.

With a large amount of lithium-ion battery material in North America, there is extraordinary potential to turn e-waste into a key commodity given the valuable raw materials contained within the batteries. Importantly, the raw materials in lithium-ion batteries can be recycled infinitely without degrading. Their properties are as valuable and useful today in a battery as they would be if we recycled the materials 100 times or more.

Another clear opportunity is that all these materials are already here in the U.S., and North America more broadly. There is no single mine that contains these materials. We can recycle these batteries to recover and keep these valuable materials in the U.S. and put them back in the supply chain and close the loop to create a circular economy. The urban mine available in our backyards can be a driver in building a domestic supply chain that helps diminish our dependence on foreign countries, with the added benefits of being more environmentally friendly, and more cost effective, compared with mineral extraction.

The Challenges

Despite their value and importance to enabling our clean energy future, lithium-ion batteries create their own set of environmental challenges. Unsafe mining practices for these materials can be harmful, as certain methods of extraction can be associated with negative environmental and social impacts. At the end of their useful life, if not handled properly, batteries can also have negative environmental impacts. Furthermore, lithium-ion batteries can be dangerous if not handled properly, which can lead to thermal events or fires.

These batteries don't last forever and if we don't have recycling infrastructure established, they will create a tsunami of e-waste in the 2030s to 2040s. However, even before that happens, we have to deal with the significant increase in battery manufacturing scrap in the marketplace.

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[2] *Reuters, February 3, 2022* -- "*Explainer: Costs of nickel and cobalt used in electric vehicle batteries*".

[3] *Projected prices for lithium carbonate, nickel and cobalt are forecasted period-end prices by Benchmark Mineral Intelligence as of March 2023.*

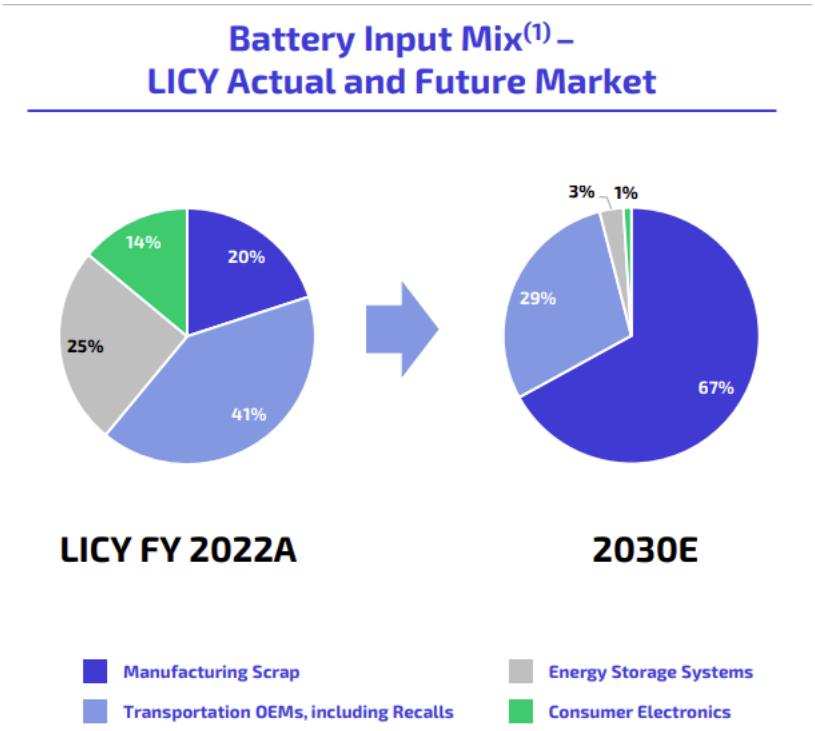
[4] *Statista – https://www.statista.com/outlook/mmo/electric-vehicles/united-states#unit-sales*

The Overlooked Burgeoning Battery Manufacturing Scrap Segment

Despite all the benefits that lithium-ion battery power brings in today's clean industrial revolution era, one urgent and often overlooked near term challenge for lithium-ion battery manufacturing is the potential e-waste created by battery manufacturing scrap.

On average, Li-Cycle estimates at least 10% of battery production ends up as manufacturing scrap (e.g., quality rejects, off-cuts, etc.), and this proportion is typically much higher when a manufacturing facility first starts operations. As the industry continues to grow, and more battery manufacturing facilities come online, there is a significant amount of manufacturing scrap material that can create e-waste, if not recycled. In addition to battery manufacturing scrap – in the near-term – EV recalls happen from time to time, and it is important that valuable material from those batteries is returned into the supply chain in a safe and sustainable manner.

For reference, in 2022, approximately 20% of Li-Cycle's battery feedstock was from battery manufacturing scrap. By 2030, we expect more than two-thirds of available battery recycling feedstock in the market will be made of battery manufacturing scrap, which is in line with the substantial ramp up of proposed battery manufacturing in the U.S.



(1) Measured by weight of input battery materials.

For those closely following the industry, the true amount of battery manufacturing scrap might be underestimated, as all types of scrap might not be accounted for. Estimates can sometimes fail to incorporate the various aspects of cell scrap. There are both off-cuts (e.g., off-cuts of cathode foils) and rejects, depending on the stage of cell making, and not accounting for both can potentially under-

estimate the amount of mass created through the cell manufacturing process. Typically, manufacturing plants also have much higher scrap rates during the ramp-up years as processes are tuned and the plants drive to a steadier state of production. Estimates should take this dynamic into account, especially with the proliferation of new manufacturing plants in North America that are expected to come on-line that will take time to ramp up. Finally, some forecasts can exclude other types of manufacturing rejects – e.g., module scrap and pack scrap – which can further under-estimate the true level of the manufacturing scrap that needs to be addressed.

As a collective industry, it is desirable for manufacturing processes to be as efficient as possible for all participants, including Li-Cycle, in order to drive down battery costs and to proliferate more EVs and battery powered applications. However, the reality is that some processes have physical limitations. The end result is a growing amount of material that must be recycled in the near term.

In order to support the proliferation and growth of electrification in the U.S., there is no question that – at least in the short term – mining for these battery materials will play a key role. However, the accelerating demand for lithium-ion batteries requires a substantial number of mines to come online quickly. In order to help support the continued growth of electrification, we need alternative sources of supply, such as recycled material, and we need these sources to quickly come online.

Lithium-ion Battery Recycling Explained: Not All Recycling Processes Are Equal

A possible solution to these core challenges associated with the electrification of North America is lithium-ion battery recycling. Safe, efficient, and sustainable lithium-ion battery recycling can provide a secondary source of material on a shorter time frame to support the growth of industry while providing an environmentally friendly and long-term solution to deal with the mountains of e-waste that lithium-ion battery material can create. However, not all recycling processes are created equal.

One general misconception of the recycling industry is that all parts of the recycling process are considered one umbrella group of 'recycling.' This is important because public reporting often inaccurately groups recycling into a single activity without differentiating between each stage. Generally, there are two stages within the broader lithium-ion battery recycling value chain, 'pre-processing' (which would be analogous to our Spokes) and 'post-processing' (which would be analogous to our Hubs).

Pre-processing involves the processing of lithium-ion batteries into intermediate products (i.e., black mass). In North America, for pre-processing, most recyclers use mechanical techniques or pyrometallurgy which involves the burning of lithium-ion batteries. A great example of pre-processing is shredding of batteries, or, in Li-Cycle's case, submerged shredding in a proprietary liquid solution. By leveraging submerged shredding, we enable a safer process by mitigating the risk of fires. It is also more environmentally friendly since there is zero combustion and no direct greenhouse gas emissions.

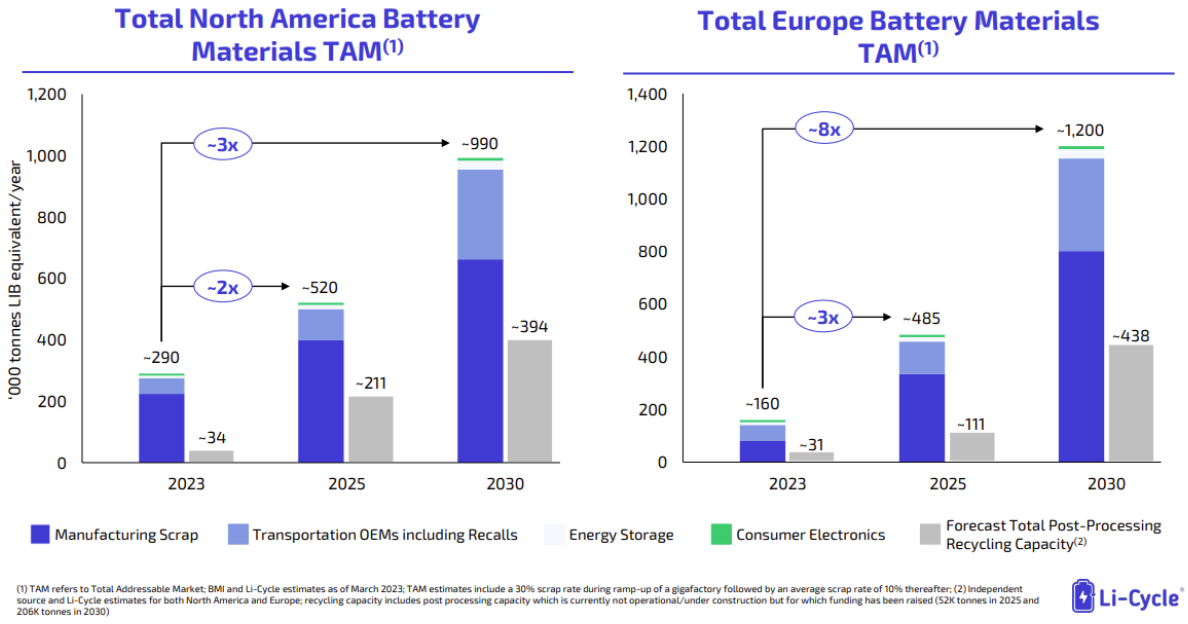
Post-processing involves the processing of intermediate products (i.e., black mass) into refined end-products. Li-Cycle's Hub technology (our flagship Rochester Hub will leverage this technology) uses hydrometallurgy and is a great example of post-processing recycling. This process produces battery-grade materials with minimal wastewater and air emissions.

Li-Cycle sees the amount of material available for recycling occurring in the two 'phases' of growth. With respect to the 'first phase' of growth, manufacturing scrap is a predominate driver. As mentioned

earlier, on average, approximately 10% of battery production ends up as manufacturing scrap. In addition to battery manufacturing scrap, EV recalls occasionally happen and we have also seen an increased volume of large energy storage projects that require recycling.

The 'second phase' of growth will be predominantly driven by end-of-life batteries. Global EV sales were 10% of new cars in 2022 and currently, there are about 20 million passenger EVs on the road with the potential for 10 times that amount by the end of the decade[5]. Eventually, the vast amount of material (or 20 million EVs worth of batteries each year) that actually ends up in the EVs will need to be recycled. That is just the lithium-ion batteries dedicated to the EV industry and doesn't consider all battery-powered applications. There will be an eventual tsunami of end-of-life batteries – it's just a question of when.

The bottom line is that demand for post-processing recycling will continue to outstrip capacity in North America for quite some time. In 2023, Li-Cycle expects that approximately 290,000 metric tonnes of battery material will be available for recycling compared to only 34,000 metric tonnes of post-processing capacity in North America. By 2030, Li-Cycle expects that that there will be approximately 1 million metric tonnes of material available for recycling, or a three-fold increase, compared to less than 400,000 metric tonnes of post-processing recycling capacity. This growth will predominantly be driven by manufacturing scrap.



(1) TAM refers to Total Addressable Market; BMI and Li-Cycle estimates as of March 2023; TAM estimates include a 30% scrap rate during ramp-up of a gigafactory followed by an average scrap rate of 10% thereafter; (2) Independent source and Li-Cycle estimates for both North America and Europe; recycling capacity includes post processing capacity which is currently not operational/under construction but for which funding has been raised (52K tonnes in 2025 and 206K tonnes in 2030)

How Recycling Can Lead to an Enhanced Domestic Battery Supply Chain

In Li-Cycle's view, sustainable lithium-ion battery recycling is essential for the future of North America's transition to clean energy, and its importance goes well beyond the inherent environmental benefits. Sustainable, safe, and efficient lithium-ion battery recycling can also:

Create a more sustainable and diverse energy system for the country

[5] *The Wall Street Journal, January 16, 2023* – "EVs Made Up 10% of All New Cars Sold Last Year".

Recycling can provide a long term, sustainable supply of materials that will continue to grow as the industry grows. This growth will continue to add to the diversity of clean energy sources and material sources needed to support many industries connected to the battery supply chain.

Reduce dependence on foreign supply chains

Recycling can help create a closed-loop domestic supply chain for critical battery materials, or in other words – old batteries can be used to make new batteries. This ability to support a completely localized, circular supply chain in North America further reduces the reliance on foreign supply chains for these key materials. We can have "Made in America" batteries through recycling. This also helps increase energy and economic independence in North America. Being less dependent on foreign supplies of critical materials will also have inherent benefits for national security concerns.

Enhance safety

Improper handling of lithium-ion batteries can present thermal event risk, which has led to an increase in news stories about fires associated with lithium batteries, especially given the wider use of lithium-ion batteries in today's society. Recycling experts like Li-Cycle can help with the proper handling of end-of-life or damaged lithium-ion batteries. Furthermore, by having these batteries recycled, they no longer present a fire hazard by just lying dormant.

A Step in the Right Direction – the IRA was an Accelerator for the Industry

In Li-Cycle's view, significant progress has been made to support domestic battery recycling in North America. In particular, awareness of the importance of a sustainable EV supply chain has changed 180 degrees with major players at the table looking to be part of the solution compared to a few years ago when this issue was not at the forefront.

Since our inception in 2016, building localized supply chains of battery-grade materials to support the production of lithium-ion batteries has been a key part of our vision. To that end, the Inflation Reduction Act (IRA) has provided benefits to Li-Cycle and the battery recycling industry both directly and indirectly. Some of these industry benefits include up to $60 billion in five-year production tax credits, which provides for 10% of the cost of producing critical materials, including lithium, nickel and cobalt. The IRA also includes up to $10 billion in advanced energy project tax credits, which allocates up to a 30% investment tax credit for developing clean energy facilities in the U.S. including recycling facilities. Additionally, the IRA is pushing for building EV batteries using material sourced in the U.S. or free trade agreement countries, as 40% of battery critical minerals are required to come domestically, or from free trade agreement countries. This threshold increases to 80% by 2027 in order to qualify for the clean vehicle tax credits.

Li-Cycle believes this push for domestically sourced battery-grade materials will incentivize automakers to incorporate a higher percentage of recycled material, which is generating further demand for our sustainable recycled material.

We believe the IRA helped recognize recycling as an accelerator for the domestic supply of battery materials to support the increasing demand for EVs and energy storage. The IRA initiatives will reduce the cost of building new facilities to produce domestic critical materials and help bring down manufacturing costs for batteries. Key policy initiatives such as the IRA help support battery manufacturers and automakers to source their recycling material domestically.

Key Initiatives to Support Battery-Recycling

While the IRA has provided benefits to the industry, there are some key policy initiatives that Li-Cycle believes are important to further support sustainable recyclers' efforts to address and manage e-waste problems:

Defined responsibility for end-of-life battery management

End-of-life lithium-ion battery management serves as an important part of ensuring that all batteries are collected and properly reused, repurposed, or recycled to create a sustainable and circular economy to meet global goals for carbon footprint reduction. Further definition of how we can best manage end-of-life batteries safely and efficiently to ensure they do not end up in landfills or lie dormant in homes around the country is paramount.

Incentivizing battery recycling centers

A frequently asked question Li-Cycle gets is – "how can I get my batteries to you?" Creating incentives for building and operating battery collection centers for consumers, automakers, dealerships, and more will further streamline the recycling process. Policy ideas, such as financial incentives to battery recyclers that establish and develop a system for the collection of batteries, or to communities to help create centers that can serve as battery aggregation points of collection, could further incentivize the collection of these batteries and prevent them from being discarded in landfills.

Landfilling of lithium-ion batteries should be strongly discouraged

Batteries no longer need to end up in landfills where critical materials are lost and surrounding environments are negatively impacted. Today, all types of lithium-ion batteries can and should be recycled. Li-Cycle is a great example of a commercial lithium-ion battery recycler with operations at scale. Encouraging industry-led or consumer-based programs to discourage landfilling of batteries should be prioritized.

Incentivize recycling that meets the highest environmental standards

It is essential that increased battery recycling in the U.S. does not lead to adverse environmental impacts created by the processes of battery recyclers. It is important to incentivize environmentally friendly and efficient lithium-ion battery recyclers, including those that have high recovery rates and processes that have minimal environmental footprints.

Requiring minimum recycled content in new batteries

Li-Cycle believes that to further incentivize recycling, there should be further exploration of regulatory requirements for a minimum amount of recycled content in every battery produced domestically. The new rules being proposed in the European Union, such as their requirements for new batteries to have certain minimum amounts of recycled material — 16% for cobalt, 6% for lithium and 6% for nickel in 2030 – are a positive step in the right direction. They accelerate efforts by automakers and battery manufacturers to incorporate recycling into their production processes. Li-Cycle believes that a similar policy or initiative should be explored in the U.S. By including recycled content, automakers can not only

ensure that batteries are made with sustainably sourced materials, but can also help further counter the narrative that EVs are less sustainable than internal combustion engines.

Clear and consistent regulations on the movement of batteries and black mass

Li-Cycle is also supportive of clear and consistent regulations to govern the safe and efficient movement of batteries to our Spokes, and black mass to our Hub, in order to provide a closed loop solution for lithium-ion batteries. Black mass is a critical ingredient into our industrial process for making the raw materials necessary for new battery production, and regulatory certainty that enables safe and efficient movement of batteries and black mass is vital to the industry's ability to address the growing amount of e-waste we face in the U.S. and globally.

Conclusion

Li-Cycle was founded to create domestic, closed-loop supply chains for key battery materials to support the sustainable growth of global electrification. As part of our vision to sustainably recycle batteries, we are part of the solution to the growing 'mountain' of e-waste that both end-of-life batteries and battery manufacturers are expected to produce. We will continue to scale to grow in lock step with our customers to solve these key challenges. We believe that establishing policies and incentives to support environmentally friendly recycling solutions and encouraging automakers and battery manufacturers to use recycled material are vitally important to support the clean energy transition. These actions will be critical to accelerating the successful future of this emerging industry, an industry which is essential to the future of our planet.