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The Electric Vehicle Battery and Circular Economy Observations

Recycling, Jobs, R&D & Scope 3 Carbon Emissions

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About the Authors

The Center for Automotive Research (CAR) is a non-profit 501(c)3 organization based in Ann Arbor, Michigan. CAR's mission is to inform and advise, through independent research, education, and dialogue, enabling a more viable and sustainable automotive ecosystem. CAR has been an independent entity since 2003 and has a reputation for providing leading, thought-provoking, impactful research. CAR focuses on the future of automotive business, economic, manufacturing, and technology trends and helps critical stakeholders understand how the automotive industry is changing. CAR researchers are widely recognized as experts.

CAR has a decades-long history of evaluating automotive workforce, education, and training trends. CAR's work in these areas has spanned a variety of funders, including the State of Michigan, other state governments, as well as the Canadian federal government, and the province of Ontario. CAR is also performing cutting edge research on the implications of electrification on all facets of the automotive industry. This work has provided CAR with a precise understanding of the technologies and subject matter areas that will be impacted, making CAR an ideal partner to evaluate the future of battery recycling or how best to report Scope 3 emissions.

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Abstract

The concept of a circular economy for Lithium-Ion batteries (LiBs), along with its drivers, barriers and enablers has been studied recently (NREL 2021) with a view to inform public policy at the federal, state, and local levels and associated government initiatives and related goal setting. More recently, estimates on the monetary value generated per ton of battery recycling material have begun to appear [McKinsey 2023], as private investors and public sector agencies look for strategic and operational guidance. At Center for Automotive Research (CAR) we have observed an accelerated investment in electric-vehicle (EV) assembly plants, EV LiB manufacturing and related research & development (R&D) in the North America – primarily in the United States (U.S.), followed by Canada and Mexico.

With the intention of looking ahead and informing automotive policy makers, investors, manufacturers and suppliers, and communities, including the state and local economic developers, CAR has summarized our initial observations in this whitepaper. We begin with an overview of the U.S. battery recycling plant locations and capacities, as they stand in mid-2023. This is followed by our observation of the U.S. market demand for battery recycling jobs, skills, and roles. Next, we outline the U.S. battery R&D outlay and then conclude with an early observation of the growing urgency to help the auto investors and communities with Scope 3 Reporting.
Keywords: Circularity, batteries, Lithium-ion, recycling, emissions, Scope 3, electric vehicles, EVs, inflation reduction act, IRA.

Introduction

As general understanding of sustainability grows and the full life cycle analysis of products and processes gain scrutiny, Scope 3 emissions and identifying pathways towards a viable circular economy for EV batteries are growing in importance. In the automotive industry, the broad topic of circularity can be narrowed into recycling of vehicle parts, which now includes EV batteries as companies race to produce electric vehicles. Battery recycling investments are growing fast in the U.S., especially now that the IRA qualifies any material “recycled” in the U.S. as being “sourced” in the U.S. Few minerals needed for batteries can be mined in North America, so recycling within the U.S. is crucial for companies to meet the sourcing requirements for credits in the IRA. However, these new companies must be able and ready to operate sustainably, as reporting standards for Scope 3 emissions loom in the EU, with the likelihood of the U.S. following shortly. Reducing transportation related emissions represents one method to limit Scope 3 emissions. This has implications for the choice of locations of battery recycling plants and is of great interest to economic developers and private investors alike.

Battery Recycling Plant Locations and Capacities

Battery recycling plant locations are spread across the U.S., with just one plant north of the U.S. -Canadian border, as shown in Figure 1. As of August 2023, there are 11 operational battery recycling facilities in North America, with 8 more planned to begin production by 2030. These are either currently operational or planned non-demonstration plants from Nth Cycle, Jaewon International, Green Li-ion, Ascend Elements, Redwood Materials, Li-Cycle, American Battery Technology, Cirba Solutions, Aleon Renewable Metals, and EcoBat. There are a variety of other start-up companies, some of which have demonstration plants, showing a rapid rate of growth in the recycling industry. Figure 1 shows the distribution of battery recycling plants alongside BEV assembly plants and battery manufacturing plants. Also noted are the three cities that contain a battery manufacturing plant and a battery recycling plant, and one city with a BEV assembly plant and a battery recycling plant. Proximity of production and recycling reduces transportation costs for battery materials between the two plants and allows for increased circularity and partnership.

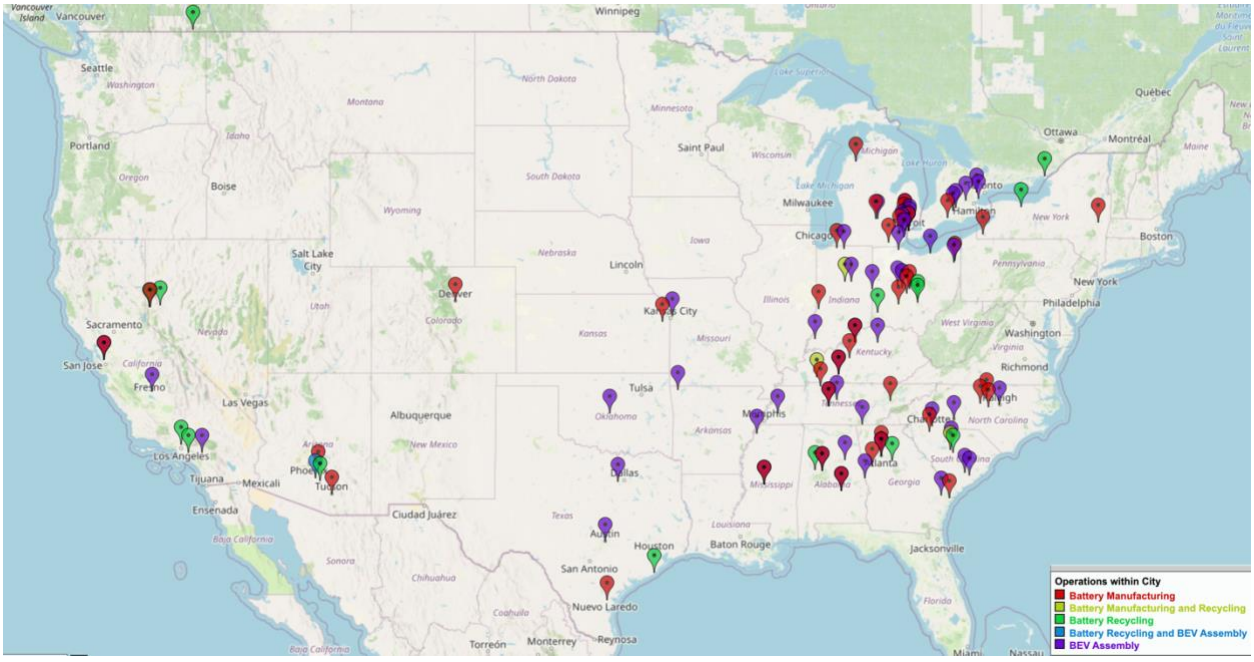

Figure 1: Map identifying plants for battery recycling (green), battery manufacturing (red), BEV assembly (purple), cities with battery manufacturing and recycling (yellow), and battery recycling and BEV assembly (blue).

It is noteworthy that Michigan, a traditional hub for the automotive industry, is not home to any large-scale battery recycling plants. Cirba Solutions is headquartered in Michigan, and Ascend Elements has a demonstration plant in the state, but there

are currently no large-scale operations in the state. What might be necessary to entice battery recyclers to invest in a hub of automotive assembly and battery manufacturing plants? There is a relatively short window of opportunities for the selection of sites for battery recycling plants as most of the projected EV assembly and battery manufacturing plant investments will be in place in the 2025 timeframe, with only one set of major investments planned for 2030. Planning and executing on battery recycling now (c. 2024) will allow for time to test and refine the business sustainability plans. This will help ensure the creation of a viable pathway to absorb the predicted supply of used batteries and use this as "feedstock" for the extraction of critical minerals needed for new battery manufacturing. However, understanding the nature of the expected used-battery surplus will create space for new investments and associated opportunities for state and local economic developers.

Battery Recycling: Jobs, Skills, and Roles

In an automotive battery recycling facility, a variety of roles and positions are essential for ensuring the efficient and safe recycling of used automotive batteries. These types of plants have the standard practice of managers and organizers overseeing operations but require more specialized skills for other niche roles. These types of plants require Environmental Health and Safety (EHS) Managers to maintain workplace safety and adherence to environmental regulations. Another niche role is that of the chemists and lab technicians who analyze battery components and waste materials. These are highly specialized roles that require previous experience. Lastly, innovation and research experts need to stay updated on recycling technologies and methods, making adaptability and innovation critical to the success of these facilities. These roles are highly skilled and require experience in related fields, including the lifecycle of a battery — whether it be its manufacturing or disposal. Beyond these specific roles, others can generally be filled by less skilled labor.

It is important to note that 50% or more of the cost of recycling any LiB comes from transportation costs. This is largely due to two factors. The first is that vehicle batteries are exceedingly difficult to transport given their bulky size; batteries rarely take advantage of a truck's full capacity, leading to an increase in the shipping cost per pound. The second reason is that since the pandemic, shortages of both drivers and containers have put increasing strain on transportation networks. This is further exacerbated by the small number of recycling locations, making transportation costs even higher. For more recycling facilities to be viable, there needs to be a way to lower shipping costs, and any prospective recycling plant needs to establish a strong labor force of drivers. The truck drivers that transport batteries to the plant are arguably the most important role in the process.

Looking at the overall workforce sizes for battery recycling facilities across the United States and Canada (Fig. 2), we see a large variation in the number of employees required for facilities. Although the median number of employees for the U.S. and Canada at battery recycling facilities is 30, there is a large rightward skew, with firms like Ascend Elements and Cirba Solutions having more than 200 employees. In general, larger workforce sizes are correlated with higher capacity. For example, Ascend Elements has 200 employees and a capacity of 30,000 million tons of waste per year, while Blue Star Recyclers has 46 employees and a capacity of 10,500 million tons of waste per year. This is not axiomatic, but rather dependent on the plant specialization and the technology employed. Observing the workforce specialization helps determine the total number of employees needed.

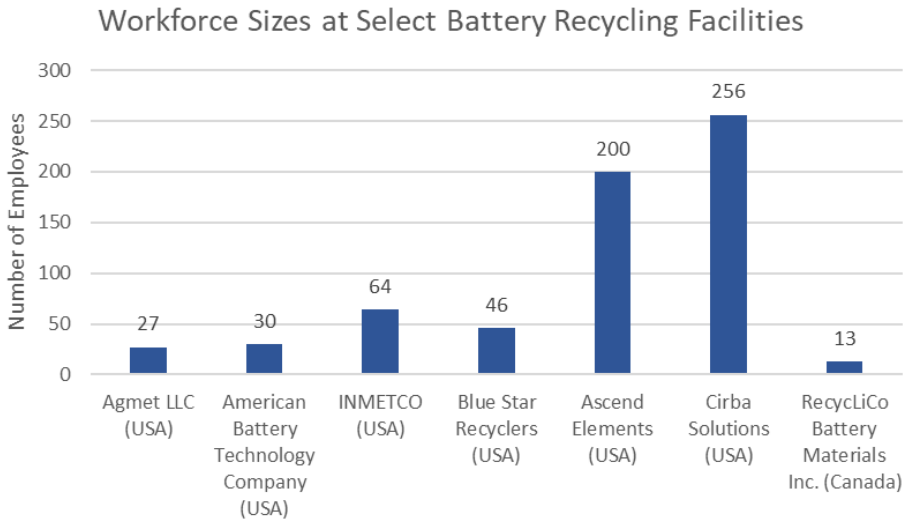

Figure 2: Graph identifying workforce size at selected battery recycling facilities in North America.

Battery Research and Development

As the battery recycling industry grows, it becomes more likely that companies will work to improve battery recyclability. Batteries that are not easily recyclable will experience decreased demand. The increase in production capacity that is forecast will see a proportional increase in demand for easier to recycle batteries from manufacturers, whether suppliers or OEMs. In looking at the tracked investments from CAR's Book of Deals for both automotive manufacturers and suppliers since 2022, North Carolina led the United States in R&D investment. Full investments are shown in Figure 3, with most investments happening in North Carolina and Michigan.

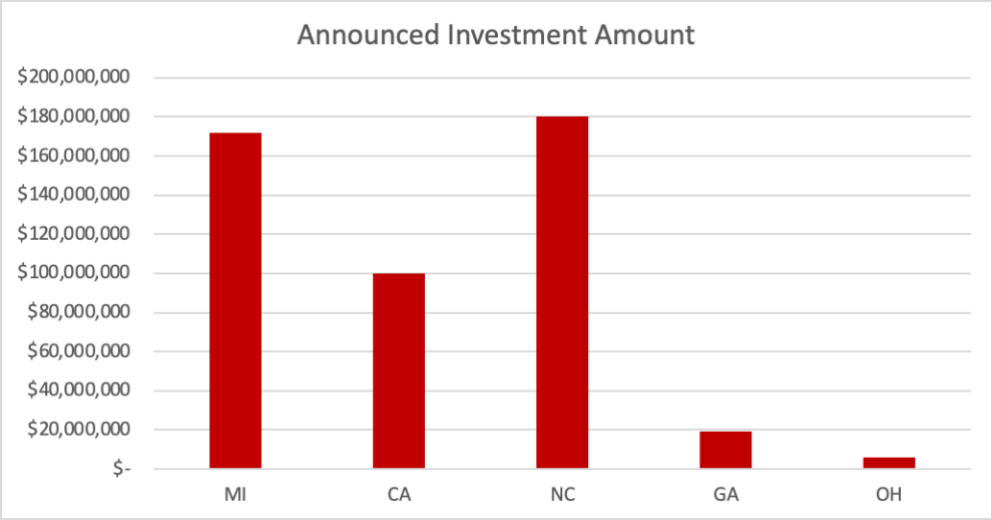

Figure 3: Graph identifying announced investment amounts in the United States by state.

Shown below in Figure 4 is the geographic distribution of investments across the United States (one investment in Tennessee is not shown in Figure 3 as the amount of investment has not yet been disclosed). Looking at the investments by location shows a southernly movement in production, but not a guarantee of southern motion in battery R&D. This is bolstered by Michigan's three investment locations, which total the second-most of any state, but these investments are largely based in safety and reliability of battery production rather than changing battery makeup or chemistries. This would be the assumption that R&D investment should aid battery recycling. However, this is not the case for Michigan. Moving forward, there could be further investment in battery chemistry R&D aimed at improving recyclability. At present, Michigan shows multiple investment locations, and while they do not lead in investment now, this could change over the coming years.

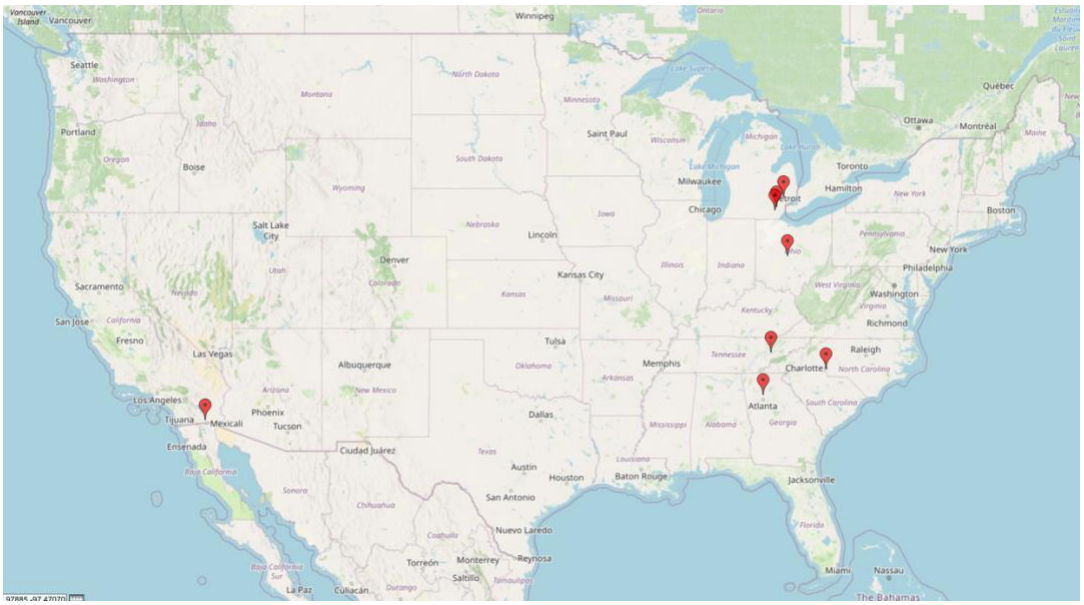

Figure 4: Map identifying announced locations for investment in battery R&D in the United States. Michigan locations are Superior Township, York Township, and Auburn Hills.

Scope 3 Reporting

Currently in the U.S., there is no requirement to report on Scope 3 emissions. It has been proposed by the Securities and Exchange Commission (SEC), but not fully required yet. However, due to a European Union regulation that requires Scope 3 reporting, many U.S. companies will likely be impacted and may pre-emptively begin reporting or at least documenting Scope 3 emission internally and requiring reports from their suppliers. Reporting is largely done through the lens of the Greenhouse Gas (GHG) Protocol, which has a framework of different categories through which companies may report emissions. This provides a lens for categorizing the origin of emission, including both upstream and downstream transportation. As Scope 3 is a part of carbon neutrality targets being established globally, reporting will likely be needed by 2030. Key to public economic development and private investment considerations will be minimizing transportation emissions and costs, as this is a relatively near-term way to ensure efficiency and lessen emissions in the value chain.

Conclusion

In looking at the geographic distribution of battery recycling operations in the U.S., recycling operations largely focus on battery manufacturing and BEV assembly. Yet there are two regions lacking battery recycling operations; Michigan and the metropolitan Kansas City area. In Michigan, there are few battery recycling operations despite the large concentration of BEV assembly and battery manufacturing plants. A similar situation exists around Kansas City where there are battery manufacturing plants but a dearth of recycling operations. Both areas would benefit from a battery recycling plant, enabling the recycled material to remain in region, lowering transportation costs, reducing emissions, and aiding in achieving sourcing thresholds required by the IRA. With these benefits, attracting a new or existing battery recycling company utilizing on-site recycling technology, such as that offered by Nth Cycle, would be of great economic and environmental benefit to these regions.

References

NREL. (2023, June 30). Lithium-Ion Battery Supply Chain Database. *National Renewable Energy Laboratory*. Retrieved October 9, 2023, from https://www.nrel.gov/transportation/li-ion-battery-supply-chain-database-download.html

NREL. (2021, August). A Circular Economy for Lithium-Ion Batteries Used in Mobile and Stationary Energy Storage: Drivers, Barriers, Enablers, and U.S. Policy Considerations. Retrieved October 9, 2023, from https://www.nrel.gov/docs/fy21osti/77035

McKinsey & Company. (2023, March). Advanced Industries Practice: Battery recycling takes the driver's seat. Retrieved October 9, 2023, from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/battery-recycling-takes-the-drivers-seat

Additional Readings

Aleon Metals. (2022, June 16). Aleon Renewable Metals announces closing of $75,000,000 financing. *Aleon Metals*. Retrieved August 24, 2023, from https://aleonmetals.com/2022-06-16/.

Ascend Elements. (2023, March 30). Ascend Elements Opens One of North America's Largest Electric Vehicle Battery Recycling Facilities in Georgia. *Ascend Elements*. Retrieved August 24, 2023, from https://ascendelements.com/ascend-elements-base-1-grand-opening/.

Ascend Elements. (2022, October 20). Ascend Elements Begins Construction of Apex 1 in Kentucky. *Ascend Elements*. Retrieved August 24, 2023, from https://ascendelements.com/ascend-elements-begins-construction-of-apex-1-in-southwestern-kentucky/.

Cirba Solutions. (2023, March 22). World-Class EV Battery Materials Facility in South Carolina. *Cirba Solutions*. Retrieved August 24, 2023, from https://www.cirbasolutions.com/world-class-ev-battery-materials-facility-in-south-carolina/.

EcoBat. (2023, February). Casa Grande Q&A. *EcoBat*. Retrieved August 24, 2023, from https://ecobat.com/wp-content/uploads/2023/03/Casa-Grande-QA.pdf.

Li-Cycle Corp. (2023, August). *Operations*. Li-Cycle Operations. https://li-cycle.com/operations/

Research, C. (2023, July 11). *American battery technology: Soon to be public leader in Battery Recycling. Seeking Alpha*. https://seekingalpha.com/article/4616403-american-battery-technology-company-soon-to-be-public-leader-in-battery-recycling

Schneider, A. (2019). *GPS Visualizer: Do-it-yourself mapping*. GPS Visualizar. https://www.gpsvisualizer.com/

Team Kentucky: Cabinet for Economic Development. (2022, August 1). Ascend Elements to Locate Largest U.S. Facility in Hopkinsville, Create 250 Full-Time Jobs with $310 Million Phase 1 Investment. News Room. Retrieved August 24, 2023, from https:2030//ced.ky.gov/Newsroom/NewsPage/20220801_Ascend.

WRI/WBCSD GHG Protocol. GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard, 2010, provided at www.ghgprotocol.org.