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Prepared for the U.S. Senate Committee on Energy and Natural Resources
Hearing on Transportation Technologies
March 16, 2021

Introduction

Chairman Manchin, Ranking Member Barrasso, and distinguished members of the Committee:

Thank you for the invitation to provide testimony to the Energy & Natural Resources Committee as part of your examination of ways to strengthen research and development on innovative transportation technologies. I appreciate the opportunity to share solutions that leading companies in the private sector are embracing to decrease emissions, reduce our reliance on foreign supply chains, and increase manufacturing in the United States.

I am Edmund Adam Muellerweiss, President of the Responsible Battery Coalition and Chief Sustainability Officer for Clarios.

> The Responsible Battery Coalition (RBC) is a leading coalition of companies, academics and organizations dedicated to the responsible management and environmental sustainability of the batteries of today and tomorrow. The RBC mission is to advance the responsible production, transport, sale, use, reuse, recycling, and resource recovery of batteries primarily used for transportation and stationary storage applications.
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> As part of our nation's critical infrastructure, my company, Clarios, supplies batteries that ensure that the majority of cars, trucks and emergency services vehicles on our country's roads stay on the move and that the country's agricultural equipment and military transport vehicles remain operational in the field. Clarios is the world's largest producer of low-voltage batteries that are essential for vehicles to start, perform efficiently, and keep people safe. Every vehicle requires the type of batteries we make – no matter if they are internal combustion, hybrid, or fully electric.

Securing the future transportation and energy systems of the United States requires addressing the following three priorities:

1. We need more batteries – but there is no silver bullet.
2. A different approach is required – one that takes into account every stage of a battery's life.
3. Embracing a lifecycle approach creates opportunities for domestic job creation, material efficiency, and system-wide carbon reductions.

A Battery-Driven Society Needs More Batteries

Every aspect of our daily lives is tied to batteries. If this morning you have used your cell phone, made coffee, used the internet, or turned on a computer, you have already engaged with multiple batteries.

The combined demand for transportation and stationary batteries is expected to increase fourfold by 2030 to more than 2,500 GWh, from a 2018 baseline.[1]

Recent analysis from the International Energy Agency predicts that 125 million electric vehicles will be on the road around the world by 2030, and other projections suggest that a total of 2 billion combustion engine and electric vehicles will be on the road globally by 2040, each requiring batteries.[2]

No one-size-fits-all or silver bullet

Yet, there is no single battery type, design, or chemistry that meets all these needs. Commonly used consumer batteries differ greatly from those used to provide back-up power to the grid. The batteries used in electric vehicles or to store wind and solar energy bear little resemblance to the ones NASA used in the rover now on Mars.

Despite these differences, all batteries are a contained chemical reaction. This means every stage of the battery's life – from mining and manufacturing to end-of-life and recycling – must be considered to decrease greenhouse gas emissions and reduce risk to human health and the environment.

This becomes a national imperative as the demand for batteries accelerates exponentially.

A Different Approach is Required

The batteries needed to secure our future transportation and clean energy systems must be developed, designed, and deployed differently. Every aspect of a battery's life, especially its end-of-life must be considered from the very beginning.

Each battery chemistry has specific characteristics and tradeoffs that make it suitable for some applications and not others. Some chemistries have higher energy density while others have higher life expectancy. Some use abundant, readily available and recyclable materials, and others use rare materials with limited supply.

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[1] Energy Storage Grand Challenge - Energy Storage Market Report, December 2020, https://www.energy.gov/sites/prod/files/2020/12/f81/Energy%20Storage%20Market%20Report%202020_0.pdf

[2] https://www.responsiblebatterycoalition.org/rbc-u-of-m-publish-first-green-principles-for-ev-battery-management/

Factors such as resource availability, geopolitical implications, supply-chain risk, human and environmental impacts, domestic manufacturing capacity, and recyclability should be as important in the choices we make today as performance and cost.

Typically batteries have been designed, made, and used following a linear process. The selection of materials was tied primarily to performance and price instead of the sustainability of its supply. End-of-life was rarely considered upfront, leaving environmental managers to address the impacts later in the process.

Critical Role of End-of Life Recovery and Recycling

Recycling is too often viewed as something to do out of altruism or moral obligation. In fact, battery recycling is an economic driver, a risk reducer, and is about protecting our supply chain. Using recycled materials can dramatically reduce energy consumption, greenhouse gas emissions, and potentially harmful pollutants.

Effective and responsible recycling can reduce conversion costs, increase domestic supply chain resilience, decrease dependence on foreign material sources, ensure better cost predictability, improve operational efficiency, and reduce the chance of production disruption.

A study on battery recycling by Argonne National Laboratory indicates that using recycled lithium, aluminum, and copper could theoretically reduce the embodied energy in these batteries by approximately 40 to 50 percent.[3]

Dr. Ramon Sanchez of the T.H. Chan School of Public Health at Harvard University and chair of the Responsible Battery Coalition's Science Advisory Board said, "The recycling of lead-acid vehicle batteries is one of the great achievements in protecting public and environmental health. With 99 percent of the vehicle batteries in North America currently being recycled, we are reducing pollution, including the greenhouse emissions caused from sourcing new battery materials."[4]

I was honored to be with Dr. Sanchez in 2018 when the RBC launched the "2 Million Battery Challenge" with the U.S. Senate Auto Caucus at our nation's capitol. The 2 Million Battery Challenge raises awareness with consumers on the importance of returning lead-acid batteries, and includes specific efforts for recovering used batteries from rural Alaska and Canada.

Developing similar recycling systems is critical for next generation battery chemistries, which rely on metals that are in limited supply or produced in unstable regions. Over the next 20 years, the projected global used battery volume from electric vehicles alone will increase to

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[3] Material and Energy Flows in the Materials Production, Assembly, and End-of-Life Stages of Automotive Lithium-ion Battery Life Cycle; Argonne National Laboratory, 2012; https://greet.es.anl.gov/publication-lib-lca.

[4] https://www.responsiblebatterycoalition.org/rbc-launches-2-million-battery-challenge-at-u-s-senate-auto-caucus-briefing-on-sustainability/

more than seven million metric tons annually, with more than two million metric tons of used battery waste produced in the United States alone.[5]

Current Initiatives Supporting a Complete Lifecycle Approach

As an affiliate member of the Department of Energy's Joint Center for Energy Storage Research led by Argonne National Laboratory, the Responsible Battery Coalition is engaged to help identify opportunities to accelerate the development of recycling and circular supply chains for future battery chemistries.

Recognizing the significant energy, environmental, and economic benefits of battery recycling, our coalition has entered into a joint research project to further advance battery innovation and ensure that the batteries of tomorrow are designed for maximum recyclability. The project goal is to generate detailed information to help battery manufacturers design batteries with re-use and recycling in mind.

The project provides a platform for the battery industry to assess the full lifecycle attributes of various battery technologies before they go into production. By modeling the complete lifecycle in advance, a manufacturer has the opportunity to compare and contrast different battery chemistries "in the lab."

This helps proactively identify risks, reduce production costs, and enable environmentally-responsible battery design from materials selection through end-of-life recycling. This work will lead to tangible, real-world solutions, benefiting industry and consumers alike.

At my own company, Clarios, we have had the privileged to work alongside the Department of Energy's Joint Center for Energy Storage Research as the only battery company in the first phase helping shape this public-private partnership to accelerate advance battery research and development.

Through the Department of Energy's Lithium-Ion Battery Recycling Prize, we have assembled a private sector team working with national labs to apply the lessons learned though our decades of experience in battery recycling to the challenge of recycling lithium ion batteries at scale.

Clarios collects and converts used batteries into materials to build new batteries. We convert 8,000 used lead-acid batteries every hour of every day across our network to help feed our plants that build new batteries with up to 90 percent recycled content. This innovative circular supply chain starts and ends when a consumer replaces a used vehicle battery with a new one at a dealer, repair shop, or auto parts store. By considering end-of-life in the design of our batteries, up to 99 percent of the materials in our batteries can be recovered and reused.

[5] https://www.responsiblebatterycoalition.org/rbc-argonne-national-laboratory-partner-on-advanced-design-recycling-programs-for-new-battery-technologies/

Green Battery Principles

The Responsible Battery Coalition is working with battery manufacturers, recyclers, the automotive industry, fleet owners, and academia to advance responsible lifecycle management of all batteries.

Foundational to this work is translating science and making it usable in the real world, informing battery technology through sharing best practices and principles.

A team led by Dr. Gregory A. Keoleian, director of the University of Michigan's Center for Sustainable Systems and a member of the Responsible Battery Coalition's Scientific Advisory Board, developed new "Green Principles for Vehicle Energy Storage." These principles define best practices applicable for both current and emerging battery technologies – from initial raw materials extraction, battery-in-use, through to end-of-life.[6]

These green principles establish a comprehensive set of recommendations to guide mobile battery technology development and deployment minimizing the environmental impact of electric vehicle (EV) batteries – most notably lifecycle energy consumption and greenhouse gas impact.

As batteries play an ever-larger role in meeting our energy needs, applying these principles supports the creation of a sustainable domestic battery economy.

Conclusion

If I could leave you with one take away – Every stage of the battery lifecycle presents opportunities for domestic job creation, material efficiency, and system-wide carbon reductions.

While much attention has rightly focused on ensuring supplies of critical minerals in the United States, to complement these efforts we need to adopt a whole lifecycle approach to battery design that includes end-of-life recovery and recycling.

In closing, advancing a comprehensive lifecycle approach to battery innovation is critical for this Committee to consider as it strives to create a sustainable, domestic battery economy to decrease emissions, reduce our reliance on foreign supply chains, and increase manufacturing in the United States.

Senators, I thank you again for this opportunity to appear before you today. I look forward to taking your questions.

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[6] https://www.sciencedirect.com/science/article/abs/pii/S2352152X19302956?dgcid=coauthore