**STATEMENT OF JAMES J. GREENBERGER**

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**before the**

**COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS**

**UNITED STATES SENATE**

**concerning**

# "RECYCLING LITHIUM-ION BATTERIES TO PROMOTE U.S. BATTERY MANUFACTURING AND GREENHOUSE GAS REDUCTION"

**July 17, 2019**

# Testimony

Good morning Chairman Barrasso, Ranking Member Carper, and members of the Committee. Thank you for the opportunity to speak with you today. My name is James Greenberger. I am the Executive Director of NAATBatt International, a trade association of approximately 120 corporations and research institutions working to promote advanced battery technology and the industries it will power in North America.

The subject of my testimony this morning is the important role that recycling of lithium-ion batteries can play in developing new industry that can provide high paying jobs to American workers and supporting reduction of greenhouse gas emissions.

## The Importance of Lithium-Ion Battery Technology

Advanced battery technology, or more precisely the technology that enables deliver of electric power to devices not connected to the grid, will be one of the most important technologies of the 21st Century. Lithium-ion battery chemistry, which was invented in the United States and first brought to market in 1991, represents the most powerful new battery technology widely used in commerce today. Lithium-ion batteries not only power but enable electric vehicles, wearable and implantable medical devices, mobile robotics, consumer electronic devices, drones, the Internet of Things, high energy weapons, such as railguns and lasers, and a variety of other power applications.

Several new technologies will shape human society and the wealth of nations in the 21st Century. Advanced battery technology will be one of them. But advanced battery technology is unique in that it will enable and provide added value to the large majority of those other technologies. Nations wanting to gain or maintain leadership in those other technologies need to have a vibrant advanced battery industry within their borders and, if possible, hold a leadership position in advanced battery technology worldwide.

The competition for leadership in lithium battery technology is well underway. Japan and South Korea grabbed an early lead in the last decade, spending billions of dollars to support their companies working in the industry as part of a planned industrial strategy. Today in South Korea industrial technical personnel working in battery factories are exempt from otherwise compulsory active military service. Just this year France and Germany announced and funded a €1.7 billion consortium to manufacture lithium-ion battery cells of the latest generation, with a view to ensuring that 30% of all lithium-ion batteries are made in the EU by 2030.

But to date China has bested them all. Starting from virtually nothing 10 years ago, China today manufactures about 75% of all lithium-ion batteries made worldwide. Two Chinese companies, CATL and BYD, are now the largest companies in the industry. The number of scientists and engineers working to develop new battery technology in China today probably substantially exceeds the number of scientists and engineers working on the same technology in Europe and North America combined.

By comparison, in the United States where lithium-ion battery technology was invented, U.S. companies manufacture only about 3% of lithium-ion batteries made worldwide. The shift in manufacturing capacity and technology development from the United States to Asia, and perhaps soon to Europe, has been dramatic. It is impossible to tell what long term impact this shift will have, not just on the battery industry, but also on the auto industry, the medical device industry, robotics, drones, high-energy weapons, consumer electronics, electric aircraft and the Internet of Things. But the Chinese, Japanese, Koreans and Europeans have all considered that question and come to the same conclusion. It is only America that still needs convincing.

Energy Materials and the Lithium-Ion Battery Supply Chain

If the United States decides to get serious about advanced battery manufacturing and lithium battery technology, one of the principal barriers we will face is limited access to the materials needed to make lithium-ion batteries. Although many different materials go into making lithium-ion batteries, supply chain concerns tend to center on three elements: cobalt, Class I nickel and lithium.

It is important to start any discussion of potential supply chain disruption by distinguishing between the physical scarcity of certain elements in nature and the institutional inefficiencies that are more commonly the cause of supply chain problems and price spikes. Cobalt, nickel and lithium once extracted from the ground must go through a series of processing and refinement, often done in different parts of the world, to be put into the state that they can be used in the cathode of a lithium-ion battery cell. Each step of the process is necessary and each step of the process holds the potential for disruption and supply-demand imbalance.

The fact that about half of the world's reserves of cobalt are located in the Democratic Republic of the Congo is an act of God. The fact that more than 80% of the cobalt sulfate used in batteries is processed in China is an act of government policy.

While North America enjoys modest natural reserves of lithium and nickel, almost none of the processing of energy materials into the cathode and anode compounds used in lithium-ion batteries takes place in the United States. This fact poses a supply risk for any manufacturer wanting to produce lithium-ion battery cells in the United States. The effect is circular: Without robust demand for battery materials by cell manufacturers in North America, there is little incentive to process energy materials here. Without robust demand for lithium-ion batteries in North America (relative to the rest of the world), there is little incentive to make battery cells here, and so on.

The Potential Role of Recycling in the Lithium-Ion Battery Supply Chain

What drives much of the interest in lithium-ion battery recycling in the United States today is that it offers a potential way out of the otherwise self-reinforcing lithium-ion battery supply chain problem. That is because the lithium-ion batteries that we import today into the United States contain the very energy materials and battery compounds that we do not and might be challenged to manufacture domestically.

Recycling those batteries at the end of their original lives can provide a reliable source of energy materials supplies for battery manufacturers that might wish to establish operations in the

United States. More interestingly, certain innovative direct recycling technologies, such as those being developed at the Department of Energy's new ReCell Center, may be able to preserve and reuse higher level cathode and anode compounds from batteries being recycled than has been the case with more traditional pyro- and hydro-processing recycling technologies. The impact of this new recycling-driven supply chain could be significant. A recent NREL report suggests that by 2040 a full 65% of the cobalt needed to supply electric vehicle demand in the United States could be provided by recycling.

The Barriers to Lithium-Ion Battery Recycling Today

Today, however, only a small fraction of lithium-ion batteries are recycled in the United States. The reason is economics. It simply costs more to recycle a lithium-ion battery than the market value of the energy materials a recycler can recover. The economics of lithium-ion battery recycling today stand in stark contrast to the economics of lead acid battery recycling, where recyclers can recover their costs and make a profit from the sale of recovered lead. Today about 98% of automotive lead-acid batteries are recycled. It is estimated that less than 5% of lithium-ion automotive batteries are recycled.

The high cost of recycling lithium-ion batteries is a threat to vehicle electrification and to storing renewable energy on the grid. According to the EPA the transportation sector is the largest emitter of greenhouse gases, accounting for about 29% of all greenhouse gas emissions in the United States. Vehicle electrification is one of the most powerful tools we have for reducing greenhouse gas emissions. Any program that mandates the recycling lithium-ion batteries, however structured, will end up burdening consumers with the cost of that recycling. That cost will diminish demand for electric vehicles and, in turn, diminish greenhouse gas mitigation efforts.

It is critical that any program which mandates the recycling of lithium-ion batteries do so in a way that minimizes the cost of recycling to consumers and, perhaps one day through use of next generation recycling technologies, eliminates that cost altogether.

Recycling Lithium-Ion Batteries is Important

There are two other reasons why recycling lithium-ion batteries is important, in addition to the need to recover strategic energy materials. The first is good environmental stewardship. Much of what drives consumer and government interest in electric vehicles is their positive environmental attributes. Those perceived positive attributes will be fundamentally undermined if one of the consequences of vehicle electrification is that millions of tons of used lithium-ion batteries end up in landfills or by the side of the road.

Also, there are significant environmental benefits to replacing the mining and processing of virgin energy materials with recycled energy materials. A recent report produced by the ReCell Center suggests that direct recycling of lithium-ion battery cathode materials will use only 18% as much energy, 23% as much water, and produce only 9% as much Sulphur oxide emissions as producing those compounds from virgin materials.

The other reason why lithium-ion batteries need to be recycled is because of the environmental threat that they pose. To be clear, used lithium-ion batteries are, in the traditional sense, relatively environmentally benign when compared to older batteries based on lead-acid or

nickel-cadmium chemistries. The principal environmental danger that lithium-ion batteries pose relates to the high voltage electricity that they can potentially contain. A used lithium-ion automotive battery laying in a junkyard or by the side of a road poses a direct threat to human health and safety from high voltage electric current. We call this the "stranded energy" problem. First responders, second responders, junk yard operators, hobbyists, and curious adults and children are all at risk from the stranded energy that used lithium-ion batteries may contain.

If we do not properly dispose of high voltage lithium-ion batteries, it is not a question of if a child wandering through a field or junk yard will be electrocuted, but how many--and how long will it be before we decide to do something about it.

The good news is that we have a little time to decide what to do about it. The electric vehicle and stationary energy storage markets are still in their infancy. It will be several years before used high voltage lithium-ion batteries start reaching the end their useful lives in significant quantities.

Proposed Approaches to the Lithium-Ion Battery Recycling Challenge

But it is not too early to start thinking about the problem and to start putting in place a program that will ensure U.S. manufacturer's access to a stable supply of energy materials, protect public safety, and keep the cost of lithium-ion battery recycling to consumers as low as possible. I would respectfully suggest that any such program should include the following elements:

1. A Single, Consistent Nationwide Program. Any mandatory program to recycle lithium-ion batteries should be managed on a national basis, and probably try to include Canada. Nothing will increase the cost of recycling to consumers more than to have individual states enact unique and potentially inconsistent requirements for batteries sold or recycled within their jurisdictions. Keeping the cost of electric vehicles as low as possible is critical to the national goal of greenhouse gas reduction. Congress should immediately pre-empt the field of lithium-ion battery recycling to federal jurisdiction.

2. Differentiate Between High Voltage and Consumer Batteries. There is a significant difference in strategic materials content, manufacturing quality and safety hazards between the high voltage lithium-ion batteries used in automotive, stationary energy storage and many industrial applications, on the one hand, and the lower voltage batteries used in consumer electronic devices, on the other. Defining the difference between these two types of batteries and regulating them differently, for purposes of recycling, transport and storage, would better protect public safety and lower the cost of electric vehicles and renewably generated electricity to consumers.

3. Prohibit the Export of Used Lithium-Ion Batteries. Energy materials and compounds contained in used lithium-ion batteries are strategic commodities. Foreign manufacturers should be prohibited from requiring their U.S. customers to return used batteries and battery materials to the foreign manufacturer at the end of the original battery life. The general export of used lithium-ion batteries and used battery materials and compounds should also be restricted or prohibited.

4. Support for New Battery Recycling Technology. Congress should continue to support scientific research into new recycling technologies that have the potential to reduce or eliminate the negative cost of lithium-ion battery recycling. Programs such as the U.S. Department of Energy's ReCell Center can indirectly do much to help lower greenhouse gas emissions and help U.S. industry regain its leadership in lithium-ion battery technology.

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