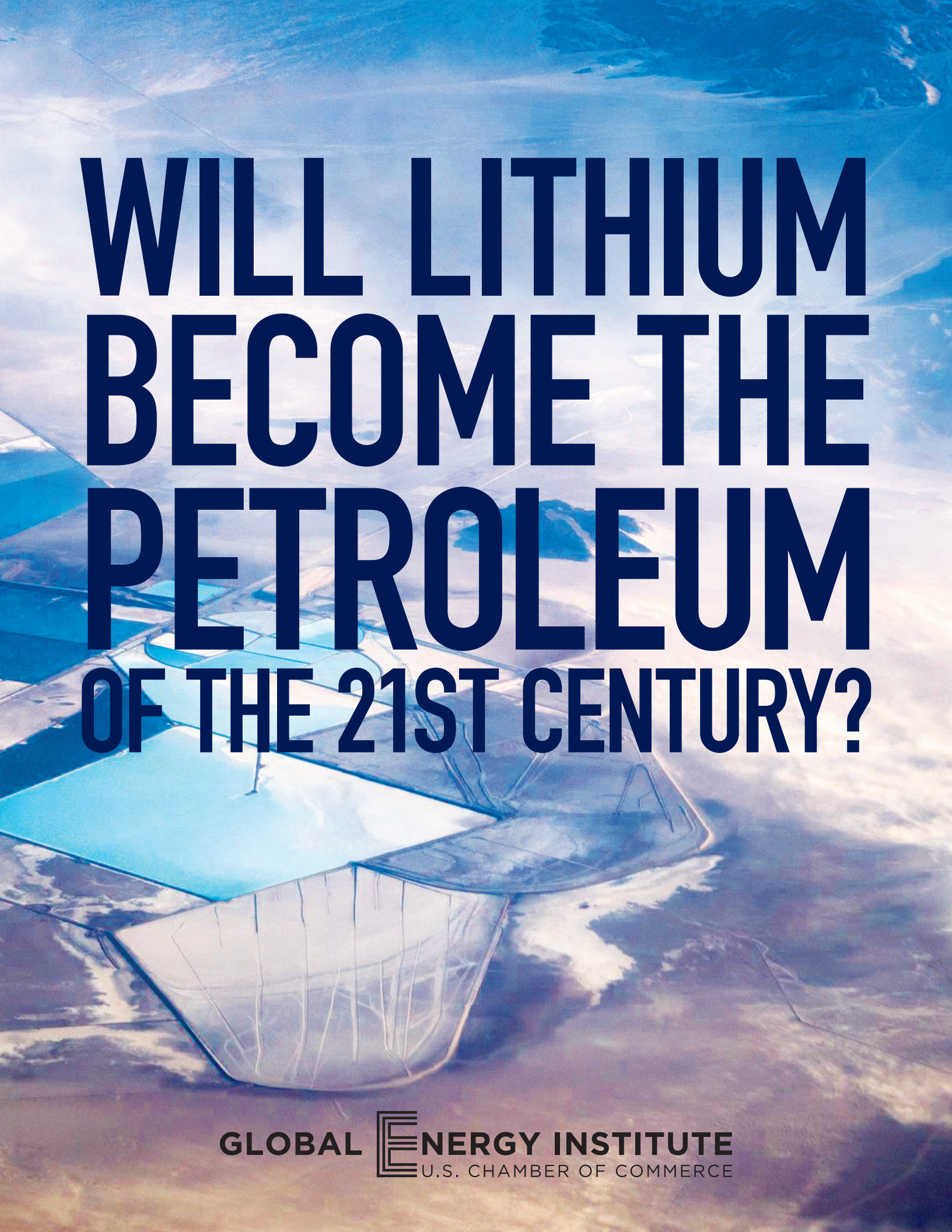


WILL LITHIUM BECOME THE PETROLEUM OF THE 21ST CENTURY?

GLOBAL ENERGY INSTITUTE
U.S. CHAMBER OF COMMERCE

Will Lithium Become the Petroleum of the 21st Century?

For decades, the availability, price, and security of petroleum supplies has cast a large shadow over U.S. economic policy and international relations. Now, as the clean energy transition gains momentum and our reliance on batteries grows, new energy supply threats are emerging.

Experts such as Daniel Yergin ("The Prize") tell the story of oil's growing importance through the 20th century as not just an energy resource, but as a keystone supporting broader economic, political, societal, and geo-strategic objectives. For the U.S.—long the world's largest consumer of oil and its largest importer—oil policy and foreign policy were deeply entwined.

With the advent of shale and tight sands technologies early in the 21st century, foreign oil's grip on the U.S. economic lifeblood began to loosen. As U.S. production of oil and natural gas reversed its long-term decline and began to increase sharply, imports correspondingly decreased. Today, according to EIA data, the U.S. is the global leader in production and a net exporter of both petroleum and natural gas. Our long-sought pursuit of "energy independence" has effectively been realized.

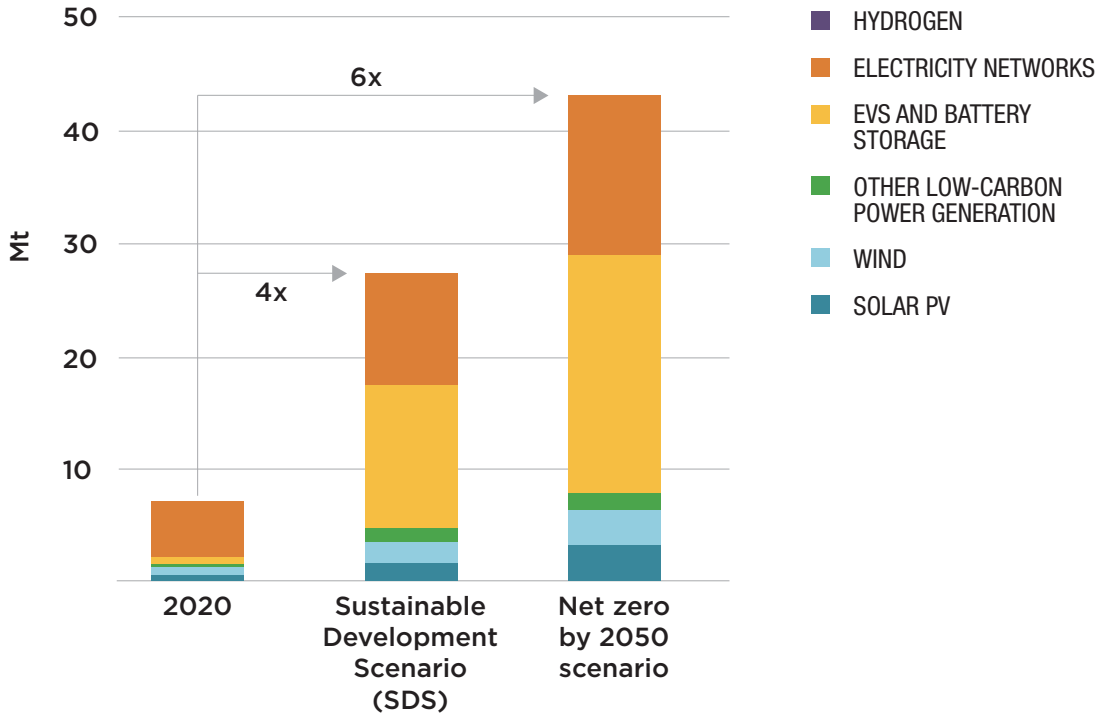
As a result, U.S. energy security risk has also shown steady improvement over the past decade. The Global Energy Institute's *Index of Energy Security Risk* periodically assesses the current and future state of U.S. energy security risk, using over three dozen measures of energy security. As America's long-running energy scarcity has shifted toward abundance, the overall U.S. energy security risk has improved from a dire state just ten years ago to dramatically better now and likely into the future.

With efforts underway in the U.S. and other countries to reduce emissions in the electricity and transportation sectors, global energy security concerns long associated with petroleum may give way to "clean energy dependence" risks.

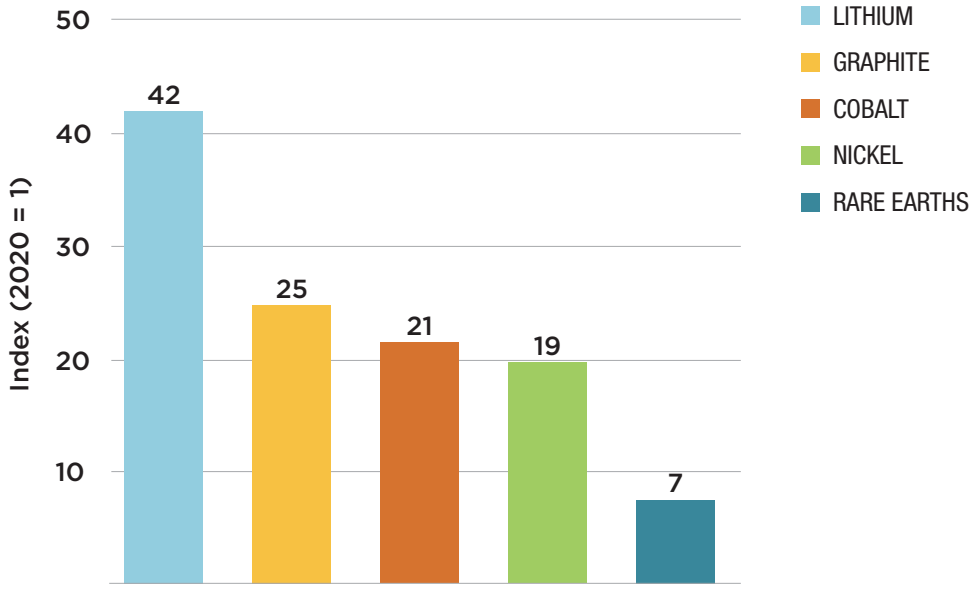
But as these risks wane, new ones are emerging. With efforts underway in the U.S. and other countries to reduce emissions in the electricity and transportation sectors, global energy security concerns long associated with petroleum may give way to "clean energy dependence" risks. Specifically, many of the key technologies for decarbonization—such as solar panels, wind turbines and batteries—require large quantities of certain critical minerals. Presently, these critical minerals are largely imported, potentially posing economic and geopolitical risks not unlike petroleum did for much of the 20th century.

MINERAL DEMAND FOR CLEAN ENERGY TECHNOLOGIES BY SCENARIO

Growth to 2040 by sector



Growth of selected minerals in the Sustainable Development Scenario (SDS), 2040 relative to 2020



Based on concerns regarding the ability to expand mining, refining, processing and manufacturing on the scale and timeline necessary to meet the expected demand for clean energy end-products, IEA issued the following warning:

"...supply and investment plans for many critical minerals fall well short of what is needed to support an accelerated deployment of solar panels, wind turbines and electric vehicles. Many minerals come from a small number of producers. For example, in the cases of lithium, cobalt and rare earth elements, the world's top three producers control well over three-quarters of global output. This high geographical concentration, the long lead times to bring new mineral production on stream, the declining resource quality in some areas, and various environmental and social impacts all raise concerns around reliable and sustainable supplies of minerals to support the energy transition."

In May, the International Energy Agency (IEA) warned that these circumstances also present major risks to global climate objectives, in a special report on the *Role of Critical Mineral in Clean Energy Transitions*. The report examined demand trajectories involving a number of critical minerals and clean energy applications, including renewables, electricity transmission, hydrogen, and electric vehicles. As the graph below illustrates, IEA projects dramatic demand growth for minerals such as lithium, graphite, cobalt, nickel, and rare earths.

Because batteries are metal-rich products that comprise approximately 30% or more of the cost of an electric vehicle, the cost and availability of those metal inputs are key to accelerating the manufacture and sale of EVs in the years ahead. As it stands today, however, the U.S. is highly dependent on China and other foreign countries for manufacture and delivery of key electric vehicle battery components.

The Chamber is actively working with its diverse membership to ensure reliable supplies of each of these critical minerals, not only for energy security but broader economic and national security as well. For example, we recently filed comments with the Department of Energy on critical mineral supply chain concerns related to high capacity batteries, as well as with the Department of Defense as it examines broader national security implications of this issue. In this piece, however, we'll hone in on just one key component of the larger picture: mining, refining, and manufacturing of lithium needed for electric vehicle batteries (EVs).

The amount of lithium used in an EV depends upon the vehicle's range, the miles/kWh efficiency of the vehicle, and the particular chemistry used in the battery. But, a typical EV today contains roughly 10 kilograms of lithium. So, for every 100 EVs, about one metric ton of lithium would be needed.

So how is the United States currently positioned in terms of lithium and lithium-ion battery supply chain resilience? Not very well.

Currently, global lithium mining production is under 90,000 metric tons annually, with the vast majority of production concentrated in just three countries—Australia, China, and Chile. At present, clean energy technologies comprise around 30% of total demand (up from a minuscule share in 2010). If governments domestic and foreign—as well as automakers themselves—move forward with plans to phase out sales of internal combustion engine vehicles, it's clear that lithium demand will skyrocket.

In the U.S. alone, 17 million light-duty vehicles are sold annually, and more than 250 million are in operation nationwide. In theory, replacing just the U.S. light duty fleet would result in a cumulative demand of more than 2.5 million metric tons of lithium. Of course, the global passenger car market is much larger and poised to grow substantially, with the global market for EV batteries alone expected to reach nearly a trillion dollars by 2030.

That demand, along with similar growth in other market segments (such as electric buses, medium- and heavy-duty trucking, and the power sector) has led Wood Mackenzie to forecast annual growth in energy storage needs to average 31% over the next decade. It is therefore no surprise that IEA's sustainable development scenario forecasts a whopping 42-fold increase in lithium demand by 2040.

While these demand trajectories are subject to considerable technology and policy uncertainties, this data illustrates why lithium and other critical mineral clean energy components are viewed by many as eventually becoming "the petroleum of energy security."

So how is the United States currently positioned in terms of lithium and lithium-ion battery supply chain resilience? Not very well.

Even though the U.S. is estimated to have the world's fifth largest reserves of lithium, only one large-scale lithium mine is currently in operation—a Nevada facility that produces less than 2% of global annual supplies. Fortunately, the private sector sees great opportunity, and additional production sites are at various stages of development in Nevada, California, Oregon, Tennessee, Arkansas, and North Carolina. Importantly, however, they will have to overcome opposition from environmentalists and others seeking to block permitting for the projects—a common obstacle to the clean energy transition that the Chamber is working to address.

For example, in recent weeks, two major lithium mining projects in Nevada have encountered setbacks resulting from legal and regulatory challenges. Thacker Pass, the largest known lithium resource in the country, announced delays to its plans to begin mine excavation in June due to a lawsuit seeking to block the project. If permitted, the mine could produce more than 30,000 tons of lithium annually—enough to supply 475,000 electric vehicle batteries. Meanwhile, just days earlier, the U.S. Fish and Wildlife Service handed a setback to another world-class lithium development project in Nevada, due to concerns that the project is on federal lands home to an endangered species of buckwheat flower.

We are heartened that Secretary of Energy Jennifer Granholm has recognized this opportunity, announcing $30 million in recent grants to increase domestic production of critical minerals such as lithium, and commenting that China "wants to be the go-to place for the guts of the batteries, yet we have these minerals in the United States. We have not taken advantage of them, to mine them."

Signals from the executive branch remain mixed, however, as we detail in a recent *Fuel for Thought* post examining the Biden Administration's comprehensive assessment of broader supply chain vulnerabilities. Culminating in a 250-page White House report that was accompanied by a DOE-led National Blueprint for Lithium Batteries, the administration details a number of specific steps it plans to undertake regarding materials sourcing and manufacturing related to EV batteries. In short, while the Chamber commends the overall comprehensive approach and recommendations set forth in these reports—including encouragement of expanded domestic lithium mining—significant concerns remain regarding the need to reduce permitting obstacles that deter private investment.

In any event, while shoring up domestic mining capacity is necessary for clean energy security, it isn't sufficient. Owning and producing raw materials is just one step in the production of EV batteries; downstream processing and refining is critical as well. Here too, China is dominant—not only with respect to lithium (59% market share), but cobalt (82%), nickel (65%) and graphite (100%), as well as final

Ignoring these potential supply risks, and assuming that supply chain risks will naturally work themselves out, is a dangerous lack of strategy, threatening both energy security and climate goals.

assembly of the battery cells (73%). In fact, when it comes to battery manufacturing, China holds a towering lead over the rest of the world. According to Benchmark Mineral Intelligence, of the more than 200 lithium ion battery "megafactories" planned between now and 2030, 149 will be in China, while only 11 are planned for North America.

Add all of these market dynamics up, and it is not hyperbole to suggest that, if U.S. clean energy dependence grows, adversaries could pursue various forms of critical minerals embargoes as a geopolitical weapon. Ignoring these potential supply risks, and assuming that supply chain risks will naturally work themselves out, is a dangerous lack of strategy, threatening both energy security and climate goals.

Fortunately, while we are behind, there are a number of steps that can be taken. First and foremost, we must encourage development of domestic resources, recognizing the need to streamline permitting and facilitate greater private sector investment in lithium mining operations. We should also accelerate research into technologies that use less or even no critical minerals, including new chemistries that may provide alternatives to lithium-ion batteries. And we can advance programs to recycle and recover components to reduce the demand for virgin materials. The Energy Act of 2020 addresses each of these areas, and the Chamber is working to secure full funding for it.

Grants and tax incentives provide a potentially promising tool to facilitate increased domestic battery manufacturing capacity, and the aforementioned White House supply chain report, as well as President Biden's American Jobs Plan, propose a number of policies in this area that warrant strong consideration. Finally, we should recognize that diversity of transportation choices enhances system resiliency, and alternative options from hydrogen fuel cells to good old-fashioned fuel efficiency improvements can provide additional insurance from EV-related supply chain risks, while also reducing emissions.

There are positive signs that policymakers are committed to addressing the serious vulnerabilities associated with lithium and other clean energy intensive critical minerals on a bipartisan basis, and the Chamber will be working to continue building consensus on the importance of making sure lithium does not replace petroleum as the energy security concern of the 21st century.

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