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**THE IMPACTS OF COVID-19 ON MINERAL SUPPLY
CHAINS, THE ROLE OF THOSE SUPPLY CHAINS
IN ECONOMIC AND NATIONAL SECURITY, AND
CHALLENGES AND OPPORTUNITIES TO REBUILD
AMERICA'S SUPPLY CHAINS**

HEARING
BEFORE THE
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ONE HUNDRED SIXTEENTH CONGRESS
SECOND SESSION

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PLY CHAINS IN ECONOMIC AND NATIONAL
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TUNITIES TO REBUILD AMERICA'S SUPPLY
CHAINS**

WEDNESDAY, JUNE 24, 2020

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The Committee met, pursuant to notice, at 9:37 a.m. in Room SD-366, Dirksen Senate Office Building, Hon. Lisa Murkowski, Chairman of the Committee, presiding.

**OPENING STATEMENT OF HON. LISA MURKOWSKI,
U.S. SENATOR FROM ALASKA**

The CHAIRMAN. Good morning, everyone. The Committee will come to order. We are here this morning to discuss the impacts of the COVID-19 pandemic on supply chains and the role that those supply chains play in our economic and national security, and the challenges that we face in rebuilding them here at home, especially if we refuse to start at the beginning with the minerals that actually make them possible.

The fundamental importance of minerals to supply chains is certainly not a new topic for us. In fact, it is the ninth hearing that we have had in this Committee. That is a lot of hearings on this issue. I have been Chairman and Ranking Member now for a period of years, but to have nine, nine hearings on this, I think, is significant. This is obviously our first time on the subject since the start of the global pandemic, but it is as timely as ever as more Americans recognize the need for strong, domestic supply chains. The pandemic has brought home that we don't produce many goods important to our country. Over the past several months, that has become clear for a range of crucial medical items, including personal protective equipment (PPE) for doctors and nurses as well as individual Americans. But it also extends to a much wider range of healthcare, electronic, industrial, defense, and energy technologies.

The mining industry has not faced the same level of disruption as we have seen in oil and gas and renewables, but there have been some noteworthy developments. Border closures in Africa have impacted the export of cobalt from the Democratic Republic

of Congo and platinum from South Africa. Mines in Argentina, Peru, and Brazil have temporarily shut down, restricting supplies of lithium, copper, and iron. We are fortunate that those supply impacts have not been more acute or widespread. We certainly hope that remains the case as nations around the world continue to fight the virus, and we certainly thank our American miners who have stayed on the job as truly essential workers. But it is also hard not to conclude that we have just been lucky here and luck usually is not a very good strategy. Despite our significant dependence on imported minerals, we have not yet come up against a severe shortage that causes dramatic harm.

It is worth thinking about what would happen if that did occur because minerals are the building blocks of our modern society. We would not have electricity or phone lines without copper wiring. Portable heart monitors wouldn't function without lithium, nickel, and zinc. The magnets in many electronic and defense technologies rely on rare earth elements. There are a host of minerals that almost no one can name that are critical to our economy, our security, our competitiveness and our health, and many come from places that we would be hard pressed to find on a map and the rest seem to come from the one place that we have no difficulty finding—and that is China.

The U.S. Geological Survey (USGS) tells us that we imported at least 50 percent of our supply of at least 46 different minerals, including 100 percent of 17 of them, in 2019. Beyond the numbers that means we are placing our fate on other's ability and willingness to sell to us, and we are forcing American manufacturers to develop complex global supply chains that sometimes prompt them to realize that it would be cheaper and easier to locate somewhere else. I think it is time that we actually address this. I have been pleased to hear greater discussion of reshoring to bring companies and industries back home. I certainly don't have any pretensions that that is going to be a quick process, but it will be harder still if we refuse to address the front end of supply chains, and that is minerals.

There is no denying that our nation has and will continue to have significant mineral needs including, and especially for, clean energy technologies. The International Energy Agency (IEA) recently released a report acknowledging that clean energy progress after the COVID crisis will need reliable supplies of critical minerals. The World Bank released a report last month estimating that demand for lithium, graphite, and cobalt will increase 500 percent by 2050 to meet clean energy demand. And back in December before the pandemic took hold, the Institute for Defense Analysis pointed out the supply chain vulnerabilities the Department of Defense is exposed to by relying on China and South America for the refining and processing of the minerals in lithium-ion batteries. The Trump Administration has been a strong partner in our efforts to make meaningful progress. The Department of Defense (DoD), State Department, Department of the Interior (DOI), the Forest Service, and the Department of Energy (DOE) all have important initiatives underway. But despite that good work, we will still hear today from witnesses who are concerned about losing multi-billion-dollar industries, such as the manufacturing of semiconductors, to

Asia. We will also hear about the security implications of relying on China and other adversarial countries to obtain minerals.

So we need to do more. And of course, we have an answer here in this Committee. We can start by passing my American Minerals Security Act which provides the framework for a sustainable, domestic mineral supply chain. It recognizes the expertise at agencies like USGS for surveying and forecasting. It directs DOE to conduct research and development into alternatives and recycling while facilitating modest permitting reforms and helping to ensure a skilled workforce. The COVID-19 pandemic has shown how delicate our supply chains are, and that should be a wake-up call for all of us. Our job is not simply to impose a royalty on mineral production on federal lands and then call it a day. It is to rebuild our supply chains and to recognize that no realistic level of subsidies and incentives can compete with having raw materials available here at home.

I thank our witnesses for appearing today. I will introduce you, but first let's turn to my friend and Ranking Member, Senator Manchin, for his opening comments.

**STATEMENT OF HON. JOE MANCHIN III,
U.S. SENATOR FROM WEST VIRGINIA**

Senator MANCHIN. Thank you, Chairman Murkowski, for convening the hearing and thank you to the witnesses for joining us today. The hearing gives us an opportunity to discuss the impact of the COVID-19 pandemic on our mineral supply chains.

Before we dive into the timely and important topic, let us take a moment to acknowledge that we are still in the midst of an ongoing pandemic that has taken the lives of 123,000 of our fellow Americans, including 92 West Virginians, and our heart goes out to the grieving families across the country.

Last week we discussed the impacts of the COVID-19 pandemic on the energy sector, broadly. The mining industry as a whole has weathered the pandemic relatively well and, in many ways, better than other sectors. In April, PriceWaterhouseCoopers forecasted the top 40 largest mining companies would see a six percent hit to their earnings before interest, taxes and amortization due to COVID. However, the revenue for 2020 is still estimated to exceed \$690 billion and dividends will likely be paid up to \$55 billion. So they are still doing pretty well. Even though many mines have continued operating, the raw materials are of little use until they are transformed into the multitude of products that all of us rely on every day. Supply chains across the globe that feed raw materials into manufactured products have been disrupted and borders closed and factory workers told to stay at home.

Over the course of the pandemic we have seen serious breakdowns in supply chains as evidenced by empty shelves at department stores and long backorders of popular products. Critical minerals lie at the heart of many of these supply chain shortages. Our Committee has held several hearings on critical minerals this Congress and China's tight grip on many of the minerals we need for both everyday items and security needs has been a recurring theme in our discussions. According to the United States Geological Survey, China supplied the largest number of nonfuel mineral com-

modities to the United States in 2019. The risk involved in remaining beholden to foreign suppliers should give all of us concern.

We should be focusing on investing in innovative mining and mineral processing practices, developing viable substitutes for critical materials that can be found in our backyard and implementing smart policies for recycling critical materials. All these things can reduce our reliance on foreign imports while creating jobs right here in the United States. We must also work with our allies and trading partners to increase diversity in supply chains where downstream processing is geographically concentrated. I see a great deal of similarity to the challenges currently facing the mineral sectors to the challenges the oil and gas industry faced during the oil price shocks of the '70s—those of us who are old enough to remember the large lines. I know that my dear friend on the right, Angus King, does. I am not sure about my dear friend—I think you were too young to and no lines in Alaska. When that happened America met the challenge head-on with robust policies in investments and research and development. To this day, we continue to enjoy the benefits of these investments such as increased national energy security and contributions to the economy in ways we never thought were possible back then. Like what happened last week when we passed the Great American Outdoors Act where conservation is made possible by energy revenues.

I think we have a real opportunity before us to make some much-needed changes to improve our national security, make America businesses competitive on a global stage and create markets that will support good paying jobs right here in the United States. And I believe that the mineral security title that the Chairman and I agreed to as part of the American Energy Innovation Act is a most fair and reasonable step in the right direction. But we need to be thinking more broadly about ways to incentivize domestic production and manufacturing and utilizing the tools the Federal Government has to do that. I think our panel of witnesses can help us today on that, and I look forward to hearing from you.

The CHAIRMAN. Senator King, you wanted to pop in before you move to another committee.

**STATEMENT OF HON. ANGUS S. KING, JR.,
U.S. SENATOR FROM MAINE**

Senator KING. Please, thank you, I am committed at another hearing.

First, I worked here in the Senate during the oil embargo and one of the most wonderful bill titles came out during that period. It seems that during—there were long lines at gas stations and Senators were sending their staff members to wait in the line to fill their cars. William Proxmire, from Wisconsin, introduced a resolution called, “It shall be the sense of the Senate that Senators have to wait in line, too.”

[Laughter.]

I have always remembered that.

Madam Chair, I want to thank you for calling this hearing and focusing on this issue, because I think it is so important and it is so underappreciated. The Latin phrase is “Vox Clamantis in Deserto,” a voice of one crying in the wilderness, and that is what

you have been doing. But it is incredibly important because, as you have pointed out, these are the building blocks of our modern society.

Two concerns. One is I think we need to talk about upgrading the mining laws that go back to the 1800s without a great deal of change. But secondly, I think we need to think about perhaps paying additional costs for these minerals if they are domestically produced as nothing more than an insurance policy. It is an insurance premium against a catastrophic breakdown in the supply chain of some of our most important products. I think we have to look at it that way and not always go with the low bidder who might be in China or who might be somewhere else in the world that we then become dependent on.

So I commend you for focusing on this issue, and I think it is incredibly important. If we don't do something about it, people are going to look back in 10, 15 or maybe even 5 years from now and say, what were they thinking? How did they miss this? You have not missed it, and I want to thank you for that.

The CHAIRMAN. Well Senator King, thank you. Not only do I appreciate your engagement on this issue, you remind me that I am not a lone voice because I have been joined with many of my colleagues, my Ranking Member here. The awareness is building. It has just been painfully slow. It sometimes reminds me of our effort when it comes to increasing awareness and knowledge of the Arctic. It is just taking some time but we are making great headway and the consequences, as you point out, are considerable. So making sure that we do not let up on this is part of the vigilance of the job. So thank you, thank you for that.

Let us now turn to our witnesses. As we have done in these past few weeks, we have somewhat of a hybrid hearing. We will have members participating by way of our video conference, and we have half of our panelists that are also participating virtually.

We have with us here in the hearing room today, Dr. Nedal Nassar. He is the Chief for the Materials Flow Analysis Section at the National Minerals Information Center with the USGS at the Department of the Interior. We welcome you before the Committee here this morning.

We are also joined this morning by Mr. Joe Bryan. Mr. Bryan is a Senior Fellow at the Atlantic Council's Global Energy Center. We welcome you.

Online we have Mr. Mark Caffarey, who is the President of Umicore USA Incorporated. Welcome.

Dr. Thomas Duesterberg is also with us. He is a Senior Fellow at the Hudson Institute. Welcome.

And we have another gentleman who has appeared before this Committee before, Mr. Simon Moores, who is the Managing Director for Benchmark Mineral Intelligence and has been a leader on so many of these mineral security issues. We welcome you back before the Committee as well.

With that, we will go in the order in which I have introduced you. I would ask you to try to keep your comments to about five minutes. Your full statements will be incorporated as part of the record and after all the panelists have concluded, we will move to a series of questions and answers with our witnesses. Thank you

for being here this morning, whether in person or virtually, and Dr. Nassar, if you would like to proceed, please.

**STATEMENT OF DR. NEDAL T. NASSAR, SECTION CHIEF,
NATIONAL MINERALS INFORMATION CENTER, U.S. GEOLOGICAL
SURVEY, U.S. DEPARTMENT OF THE INTERIOR**

Dr. NASSAR. Good morning, Chairman Murkowski, Ranking Member Manchin and distinguished members of the Committee, and thank you for the opportunity to discuss the U.S. Geological Survey's efforts related to mineral supply chains.

The U.S. Geological Survey's Minerals Resources Program conducts scientific research on how the mineral occurrence is formed geologically, provides assessments on the geological potential for mineral resources and investigates the life cycle of those resources from their origin through their ultimate disposal. Within the Mineral Resources Program, the National Minerals Information Center collects the nation's data on domestic and international extraction, processing, trade, use and recycling of over 90 mineral commodities essential to the economy and national security.

Mineral commodities are the foundation of modern society. Smartphones would have more dropped calls and shorter battery lives without tantalum capacitors and cathode-based, cobalt-based cathodes and their lithium-ion batteries. Bridges, buildings and pipelines would not be as strong without vanadium and other alloying elements in their steels. Medical MRI machines would use more energy and produce lower quality images without helium-cooled, niobium-based superconducting magnets. While the drive toward smaller, faster, lighter and smarter technologies will increase demand for these and other commodities whose properties are uniquely suited for the task, the stability of their supply is not necessarily assured. Among other things, the COVID-19 pandemic highlights the fragility of global supply chains and underscores the risks of supply disruptions during a crisis. This is only the most recent reminder of such risks. China's threats to cut off rare earth supplies in 2010 epitomizes these risks for importing countries who had limited alternatives due to China's near monopoly of rare earth supply chains.

The concentration of production is not, however, limited to rare earths. The mining and mineral processing of many raw materials that underpin manufacturing supply chains have become increasingly concentrated—a decades-long trend. The tantalum in cobalt and smartphones, for example, are now predominately mined in the Democratic Republic of the Congo and refined in China. Having such concentrated production increases the potential for supply disruptions. Concurrently, developed countries such as the United States, have become increasingly import reliant for their mineral commodity needs, thereby increasing their exposure to foreign supply disruptions.

In our latest research, we examined the risk of mineral commodity supply disruptions to the U.S. manufacturing sector by assessing the likelihood of and exposure and vulnerability to foreign supply disruptions. The study assessed over 50 commodities and identifies a subset including cobalt, graphite, niobium, tantalum and the rare earths as having the greatest supply risk. Predictably,

China is the largest producer of most high-supply risk commodities. Additionally, many high-supply risk commodities are recovered as by-products. The supply of by-products has the additional challenge of potentially being unresponsive to demand signals given their relatively minimal contribution to producers' revenues. This research is thus an enhancement to the original methodology used to develop the U.S. Critical Minerals List and forms the basis for updating that list through the interagency process established under the U.S. National Science and Technology Council's Critical Minerals Subcommittee.

Once a mineral supply chain is identified as high-risk, the next step is to determine the best way to reduce that risk. Various strategies can be pursued including diversification of supply, identification and potential expansion of domestic mineral resources, increasing recycling, developing substitutes, maintaining strategic inventories and bolstering trade relations. In response to Executive Order 13817, a federal strategy has been released in which these and other actions are explicitly outlined. Importantly, many of these strategies are core to missions of several federal agencies including the U.S. Defense Logistics Agency, the U.S. Department of Energy and, of course, the U.S. Geological Survey. In coordination with the Association of American State Geologists, the USGS launched the Earth Mapping Resources Initiative to improve the geological, geophysical, and topographic mapping of the United States and thus advance our understanding of the potential geological resources of our country.

At USGS, we continue to improve our capability to analyze mineral supply chains and assess the associated supply risk through advanced modeling techniques that will soon allow us to quantify how different supply disruptions may ripple through and impact the economy. We are also expanding our capability to develop forward-looking supply and demand scenarios that will help anticipate how certain trends and disruptive technologies may impact the minerals industry. Each commodity supply chain is unique. Moreover, bottlenecks may occur at different stages of the supply chains. Mineral supply chains must therefore be examined individually to determine the most effective strategy needed at each stage with the ultimate goal of minimizing the overall risk to the U.S. economy and national security so that we, as a nation, are better prepared for when another devastating event like the COVID-19 pandemic strikes.

Thank you for the opportunity to testify today, and I look forward to any questions you may have.

[The prepared statement of Dr. Nassar follows:]

**Statement of Dr. Nedal T. Nassar
Section Chief, National Minerals Information Center
U.S. Geological Survey
before the
U.S. Senate Committee on Energy and Natural Resources
on
June 24, 2020**

Good morning Chairman Murkowski, Ranking Member Manchin, and Members of the Committee, and thank you for the opportunity to discuss the U.S. Geological Survey's efforts related to mineral supply chains.

Background

The Department of the Interior manages one-fifth of the Nation's lands, as well as the Nation's offshore energy. These responsibilities include leasing and permitting activities for both onshore and offshore access to and development of the Nation's mineral resources, through the Bureau of Land Management (BLM) and the Bureau of Ocean Energy Management (BOEM). The U.S. Geological Survey (USGS) Mineral Resources Program (MRP) conducts scientific research on how mineral resources form geologically, provides earth-science based assessments on the geologic potential for mineral commodity occurrences across the Nation and globe, and studies the life cycle of those resources with a focus on their origin and characteristics; supply, demand, and trade; and characteristics of mineral wastes.

Within MRP, the National Minerals Information Center collects the Nation's data on domestic and international supply and demand for over 90 minerals and mineral materials essential to the economy and national security. These data support analyses on the flow of resources through the global economy as both commodity and waste. These data also provide the essential foundation for understanding and quantifying mineral supply risk and support the development of the U.S. Critical Minerals List and the Federal Critical Minerals Strategy.

Statement

Mineral commodities are the foundation of modern society. Smartphones would have more dropped calls and shorter battery lives without tantalum capacitors and cobalt-based cathodes in lithium-ion batteries. Bridges, buildings, and pipelines would not be as strong without vanadium and other alloying elements in steels. Medical MRI machines would use more energy and produce lower-quality images without helium-cooled niobium-based superconducting magnets. Jet engines would operate at lower temperatures and be less efficient without rhenium in their turbine blades.

While the drive towards smaller, faster, lighter, and smarter technologies will increase demand for these and other commodities whose properties are uniquely suited for the task,¹ the stability of their supply is not necessarily assured.

Among other things, the COVID-19 pandemic highlights the fragility of global supply chains and underscores the risks of supply disruptions during a crisis. This is only the most recent reminder of such risks to economies that are heavily reliant on imported goods and materials, with global supply chains having recently endured disruptions stemming from trade wars, labor strikes,² natural disasters,^{3,4} and previous disease outbreak.⁵ China's threats to cut-off rare earth supplies in 2010 epitomized these risks for importing countries who had limited alternatives due to China's near-monopoly of the rare earth supply chain.

The concentration of production is not, however, limited to rare earths. The mining and mineral processing of many raw materials that underpin manufacturing supply chains have become increasingly concentrated—a decades-long trend. The tantalum and cobalt in smartphones, for example, are now predominately mined in the Democratic Republic of the Congo and refined in China. Having such concentrated production increases the potential for supply disruptions.

Concurrently, developed countries such as the United States have become increasingly import reliant for their mineral commodity needs,^{6,7} thereby increasing their exposure to foreign supply disruptions.

In our latest research, we examined the risk of mineral commodity supply disruptions to the U.S. manufacturing sector by assessing the likelihood of and exposure and vulnerability to foreign supply disruptions.⁸ The study assessed over 50 commodities and identifies a subset including cobalt, graphite, niobium, tantalum, and the rare earths as having the greatest supply risk.

Predictably, China is the largest producer of most high-supply risk commodities. For commodities which China does not have sufficient domestic resources, such as cobalt and niobium,⁹ Chinese firms have sought to secure supplies through foreign investments in mineral assets worldwide.¹⁰

Notably, many high-supply risk commodities are recovered as byproducts, such as cobalt. The supply of byproducts has the additional challenge of potentially being unresponsive to demand signals given their relatively minimal contribution to producers' revenues.¹¹

This research is thus an enhancement to the original methodology¹² used to develop the U.S. Critical Minerals List and forms the basis for updating the List through the interagency process established under the U.S. National Science and Technology Council's Critical Minerals Subcommittee.

Once a mineral supply chain is identified as high-risk, the next step is to determine the best way to reduce the risk. Various strategies can be pursued including diversification of supply, identification and potential expansion of domestic mineral resources, increasing recycling, developing substitutes, maintaining strategic inventories, and bolstering trade relationships. In response to Executive Order 13817 and through the interagency process, the U.S. Department of Commerce released a Federal strategy entitled, "*A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*", on behalf of the U.S. National Science and Technology Council, in which these and other actions are explicitly outlined.¹³

Importantly, many of these strategies are core to missions of many federal agencies. The U.S. Defense Logistics Agency, for example, is responsible for maintaining strategic and critical materials in the U.S. National Defense Stockpile thereby providing a measure of resilience in the event of a disruption. Over the past seven years, the U.S. Department of Energy's Critical Materials Institute has been researching and developing alternative materials and enhanced recycling techniques. In coordination with the Association of American State Geologists, the USGS launched the Earth Mapping Resources Initiative to improve the geological, geophysical, and topographic mapping of the United States and thus advance our understanding of the potential geological resources of our country.¹⁴ The strategy released by the U.S. Department of Commerce also recognizes the potential to reprocess mine wastes for resources, an issue spanning multiple agencies.

At USGS, we continue to improve our capability to analyze mineral supply chains and assess the associated supply risk through advanced modeling techniques that will soon allow us to quantify how different supply disruptions may ripple through and impact the economy. We are also expanding our capability to develop forward-looking supply and demand scenarios that will help anticipate how certain trends and disruptive technologies, such as vehicle electrification, may impact the minerals industry.

Each commodity supply chain is unique. Moreover, bottlenecks may occur at different stages of the supply chain. For example, while there is now substantial rare earth mine production outside of China, bottlenecks in downstream processing and magnet manufacturing remain. Each mineral supply chain must therefore be examined individually to determine the most effective strategy needed at each stage with the ultimate goal of minimizing the overall risk to the U.S. economy and national security so that we, as a Nation, are better prepared for when another devastating event like the COVID-19 pandemic strikes.

Thank you for the opportunity to testify and I look forward to any questions you may have.

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The CHAIRMAN. Thank you, Dr. Nassar.
Mr. Bryan, welcome to the Committee.

**STATEMENT OF JOE BRYAN, SENIOR FELLOW,
ATLANTIC COUNCIL GLOBAL ENERGY CENTER**

Mr. BRYAN. Thank you, Madam Chairman.

Senator Murkowski, Senator Manchin, members of the Committee, thank you for the opportunity to testify today. My name is Joe Bryan, and I am a Senior Fellow with the Atlantic Council's Global Energy Center. I was previously the Deputy Assistant Secretary of the Navy for Energy and, prior to that, spent about 14 years working in the Senate, most of that time on the Armed Services and Intelligence Committees. So I've spent a lot more time in the seats behind you than the one I'm in now.

We are in the midst of a historic shift in global energy. From the electrification of transportation to the integration of renewable energy into the grid, lithium-ion batteries are at the center of that transformation. The massive global investment we see in the lithium-ion supply chain, mostly driven by expected demand for electric vehicles, speaks to the pace and scale of that shift. Other witnesses will detail the U.S. competitive position in the race for supply chain investment. Suffice it for me to say, the United States is getting lapped. And while China is the dominant player, we are also quickly losing ground to our European allies as well. This is a problem.

Our supply chain weakness has obvious economic implications but it also creates risk for our military and, more broadly, U.S. national security. From communications gear that keeps our troops connected on the battlefield; to unmanned aerial and subsurface platforms; to tactical ground vehicles transitioning away from lead acid, lithium-ion batteries are everywhere. That is not surprising. Energy storage cannot only increase capability but, by reducing fuel use, can also help take convoys off the road and our troops out of harm's way.

Lithium-ion is also key to future capabilities. Army Futures Command is imagining what an All-Electric Brigade Combat Team might look like. The Navy has an Electric Ships Office, and the deployment of next generation weapon systems like rail gun and lasers will depend, to one extent or another, on energy storage. The future is electric, and lithium-ion batteries are essential to that future. That is why the current state of our supply chain is so concerning.

Over the past few months, COVID-19 has exposed the vulnerability of our supply chains for critical materials and not just personal protective equipment. For example, COVID-19 severely impacted the supply of cobalt, a key mineral in the production of lithium-ion batteries.

The cause of the disruption this time was a pandemic, but it could have been a material shortage, a trade dispute or, in the worst case, military conflict, that cut off access to key materials. The bottom line is that weak battery supply chains carry significant risk.

But the lithium-ion market also represents an opportunity. Tesla's Nevada Gigafactory is one example. The State of Ohio re-

cently landed a \$2.3 billion investment from General Motors and Korea's LG Chem to build a battery plant in Lordstown, Ohio. That facility will bring more than 1,000 jobs to the Mahoning Valley. Now we can't change geology and create resources where they don't exist, but we can change direction and compete for supply chain jobs in minerals extraction, processing, anode and cathode production, and cell production. That cannot happen soon enough.

The scale of global investment in the lithium-ion supply chain is massive and investment patterns will have geopolitical impacts. Right now, commercial relationships are being forged and trade alliances hammered out. Decisions made over the next few years will define the global transportation industry for decades to come and plant the seeds of future political alliances. Maintaining our global influence and diplomatic leverage depends on us not just getting in the race but setting the pace.

From establishing priorities for research and development; to setting conditions for attracting investment; to, most importantly, hitting the accelerator on transportation electrification, there are things we can do. But to date, our actions have matched neither the scale of the opportunity, the efforts of our competitors, nor the risk we accept should we remain on the sidelines.

Thank you for this Committee's leadership on this issue, and I look forward to your questions.

[The prepared statement of Mr. Bryan follows:]

**Statement of Joe Bryan, Senior Fellow, Atlantic Council Global Energy Center
US Senate Committee on Energy and Natural Resources
Hearing on the Impact of COVID-19 on Mineral Supply Chains
June 24, 2020**

Senator Murkowski and Senator Manchin, members of the committee, thank you for the opportunity to testify today. My name is Joe Bryan and I am a senior fellow with the Atlantic Council's Global Energy Center. I was previously the Deputy Assistant Secretary of the Navy for Energy and prior to that, spent 14 years working in the Senate. I spent most of that time on the Armed Services and Intelligence Committee staffs.

We are in the midst of an historic shift in global energy. From the electrification of transportation to the integration of renewable energy into the grid, Li-ion batteries are at the center of that transformation. The massive global investment we see in the Li-ion supply chain, mostly driven by expected demand for electric vehicles, speaks to the pace and scale of that shift.

Other witnesses will detail the US competitive position in the race for supply chain investment. Suffice it for me to say, the United States is getting lapped. And while China is the dominant player, we are quickly losing ground to our European allies as well. This is a problem. Our supply chain weakness has obvious economic implications. But it also creates risk for our military and, more broadly, US national security.

From communications gear that keeps our troops connected on the battlefield; to unmanned aerial and subsurface platforms; to tactical ground vehicles transitioning from lead acid, Li-ion batteries are everywhere. That is not surprising. Energy storage can not only increase capability but, by reducing fuel use, can also help take convoys off the road and our troops out of harm's way.

Li-ion is also key to future capabilities. Army Futures Command is imagining what an all-electric Brigade Combat Team might look like. The Navy's has an electric ships office. And the deployment of next generation weapons systems like lasers and rail gun will depend, to one extent or another, on energy storage. The future is electric, and Li-ion batteries are essential to that future. That is why the current state of our supply chain is so concerning.

Over the past few months, COVID-19 has exposed our vulnerability to supply chains for critical materials, and not just personal protective equipment. For example, COVID-19 impacted global shipments of cobalt, a key mineral in the production of Li-ion batteries.

The cause of the disruption this time was a pandemic. But it could have been a material shortage; a trade dispute; or, in the worst case, a military conflict that cut off access to key materials. The bottom line is that a weak battery supply chain carries significant risk.

But the Li-ion market also represents an opportunity. The State of Ohio recently landed a \$2.3B investment from General Motors and South Korea's LG Chem to build a battery plant in Lordstown, Ohio. That facility will bring more than 1000 jobs to the Mahoning Valley. We can't change geology and create resources where they don't exist. But we can change direction and compete for supply chain jobs in minerals processing, anode, cathode and cell production. That cannot happen soon enough.

The scale of global investment in the Li-ion supply chain is massive and investment patterns will have geopolitical impacts. Right now, commercial relationships are being forged and trade alliances

hammered out. Decisions made over the next few years will define the global transportation industry for decades to come and plant the seeds of future political alliances. Maintaining our global influence and diplomatic leverage depends on us not just getting in the race but setting the pace.

From establishing priorities for research and development; to setting conditions for attracting investment; to, most importantly, hitting the accelerator on transportation electrification, there are things we can do. To date, our actions have matched neither the scale of the opportunity, the efforts of our competitors, nor the risk we accept should we remain on the sidelines.

Thank you and I look forward to your questions.

The CHAIRMAN. Thank you, Mr. Bryan. We appreciate you pointing out the importance of mineral security for our military. Some of us think that our American Mineral Security Act would be a good fit within the NDAA that will be coming before us for Floor action in these next few days, so thank you for that reminder.

We will next go to Mr. Mark Caffarey. Welcome Mr. Caffarey.

**STATEMENT OF MARK CAFFAREY, PRESIDENT,
UMICORE USA INC.**

Mr. CAFFAREY. Thank you, Chairman Murkowski, Ranking Member Manchin and members of the Committee. My name is Mark Caffarey, and I'm President of Umicore USA. Thank you for holding this hearing and providing the opportunity to testify.

Umicore is a global energy materials and recycling company, with nearly \$4 billion in revenue, 70 percent of which is from clean mobility and recycling. Of our 11,000 employees worldwide, approximately 500 are in the U.S. with facilities in ten states including our regional headquarters in Raleigh, North Carolina. Due to the economic impacts of COVID-19 on the automotive supply chain, Umicore was forced to close its automotive catalyst manufacturing facility in Tulsa, Oklahoma, unfortunately impacting approximately 100 employees.

Umicore recycles end-of-life electronics, spent automotive catalysts, industrial catalysts and other materials that contain precious metals like gold and silver and also copper in a nearly half million metric ton yearly processing facility in Belgium. At the same time, we are able to recycle—at the same site, we are able to recycle critical elements such as cobalt, nickel and lithium from battery manufacturing scrap, portable and electric vehicle batteries once they reach their end of life. Currently Umicore has the capacity to recycle 7,000 metric tons per year of lithium-ion battery materials with plans to grow in both scale and geographic scope by the end of this decade. Umicore would like to expand that capacity globally. The number of end-of-life energy battery packs in the U.S. is predicted to grow to over one million by 2030. These batteries will contain quantities of valuable critical minerals that need to be recycled by recyclers. It is important that a policy and economic framework be put in place now while the volume of these battery packs is relatively low so the industry and nation will be prepared to handle the increased volume we expect in the next five to ten years.

Umicore supports the recycling components in the American Mineral Security Act which seeks to ensure that the U.S. has a secure, ready and domestic access to critical materials required for defense and civilian high-technology products. Our nation's industrial scrap, lithium-ion batteries from cars and energy storage, electronics and electronic applications could provide nearly boundless valuable resources that could be recycled and put back into the economy and complement the materials coming from the mines.

First, recycling critical materials will avoid the purchase of materials mined in unreliable areas. Over 50 percent of the primary global cobalt supplies are derived from the Democratic Republic of Congo where small mines have a history of human and environmental health and safety concerns. Umicore introduced a Sustainability Procurement Framework for cobalt in 2004 and is the first

to obtain external validation through its ethical procurement approach in this area. However, if more lithium-ion batteries with cobalt concentrations were recycled, the supply chain could rely more on sustainable cobalt from recycled sources rather than from poorly-managed mines.

Second, recovering metals from end-of-life products yields more materials per ton than mining from primary resources. Other witnesses have testified that electrification technologies are growing, so there will be a greater need for battery materials. The COVID-19 situation has made the sale of electrical vehicles in 2020 less robust, but it is clear that in the longer-term the need for materials is only increasing.

Finally, the economic growth benefits of the U.S. commitment to recycling of critical materials could be enormous creating a high number of jobs with varying skill levels throughout the recycling supply chain in: the collection of discarded end-of-life products and scrap; the dismantling, sorting of products and separation of components; and the pre-treatment of the separated components. Those steps must be robust to enable economies of scale and the possibility of jobs in what Umicore does: the refining of the pre-treated materials into final, critical minerals.

We think the Federal Government has an important role to play in both leadership as well as in research and development. Stakeholder collaboration, public-private partnerships, standards, and a systems approach will be crucial in determining how we want to map out our domestic recycling supply chain. Umicore is excited the Department of Energy launched the Lithium-Ion Battery Recycling Prize competition which will highlight best practices for the collection and the initial processing of these critical materials. We are optimistic that, because of this hearing and discussion, we can implement policies that open up new markets to recycling, create—

[Mr. Caffarey's video froze.]

The CHAIRMAN. I do think you were getting close. If you come back, Mr. Caffarey—are you now back online?

Mr. CAFFAREY. Hello.

The CHAIRMAN. Yes, Mr. Caffarey, you cut off right there at the end. I believe you were concluding your remarks, but I want to make sure that you were, in fact, finished with your comments. You froze right at the end.

Mr. CAFFAREY. Yes, but that was the end of it. Thank you.

[The prepared statement of Mr. Caffarey follows:]

Testimony of Mark Caffarey

President, Umicore USA

before the

United States Senate

Committee on Energy & Natural Resources

June 24, 2020

Chairman Murkowski, Ranking Member Manchin, and Members of the Committee, my name is Mark Caffarey, and I am President of Umicore USA Inc. Thank you for holding this hearing and for providing the opportunity to testify on the critical topic of critical materials and the impact of COVID-19 on supply chain security.

Umicore is a global energy materials and recycling company, with nearly \$4 billion in revenue,¹ 70% of which is from clean mobility (such as electric and fuel cell vehicles) and recycling. Of our 11,000 employees world-wide, approximately 500 are in the United States with facilities in ten U.S. states: Alabama, Massachusetts, Michigan, New Jersey, New York, Ohio, Oklahoma, Tennessee, Texas, and the U.S. headquarters in Raleigh, North Carolina.

Umicore is a leader in what is called the Circular Economy—the principle of keeping the value of products, materials and resources in the economy as long as possible without having to

¹ Financial figures can be found in Umicore's annual report here:
<https://annualreport.umicore.com/performance/key-figures>

extract new resources. For many of the products we manufacture, we also prefer to collect them upon end of life in order to recycle the materials and use them again. While we understand that mining is still an important component to extracting materials, we believe that recycling will become increasingly crucial, as more and more technological innovation is deployed that requires these materials. Metals are infinitely recyclable, including those found in lithium ion batteries such as cobalt, nickel, lithium. Given the exponential deployment of lithium ion batteries alone, and the 10-50 times increase in the number of operating cells we predict by 2025 for rechargeable batteries, recycling will become important from an environmental and humanitarian point of view, and to the global integrated supply chain.

Umicore today is recycling end of life electronics, spent automotive catalysts, end of life industrial catalysts and other precious metals containing materials to recover and provide a new life to Au (Gold), Ag (Silver), Cu (Copper), In (Indium), Pb (Lead), Sn (Tin), Sb (Antimony), Pd (Palladium), Pt (Platinum), Rh (Rhodium), and other metals in a nearly half million metric ton yearly processing facility in Hoboken, Belgium. At the same site, Umicore introduced its environmentally friendly battery recycling technology in 2011 and is prepared to recycle critical elements such as Cobalt (Co) Nickel (Ni) and Lithium (Li) from portable lithium ion batteries, manufacturing scrap, and electric vehicle batteries once they reach their end of life. Currently, Umicore is recycling 7,000 metric tons per year of end of life lithium ion battery materials of various chemistries at this facility but plans to grow this recycling step in both scale and geographic scope. Umicore would like to expand its battery recycling capacities globally over the next ten years based on the needs of local markets. The current fraction of end of life batteries that is recycled in the United States is very low; the Department of Energy estimates it

to be approximately 5%.² Globally, every year the equivalent output of two large cobalt mines is “lost” because these batteries do not find their way to efficient and certified recyclers.

While Umicore’s current recycling operations are primarily in Belgium, it is still possible for the originating country, such as the United States, to retain ownership of the critical and precious metals that Umicore processes. In this scenario, Umicore can act as a service provider and refine materials that another company owns for a fee. This allows companies to have access to our superior refining technology while not losing ownership of their materials. Presently, there are no companies in the U.S. or globally that can recover over 20 different metals from over 200 complex feeds.

According to a study by Kelleher Environmental,³ approximately 350,000 electric vehicle batteries will reach their end of life by the end of 2020; that number is expected to grow to over one million by 2030. These batteries will contain large quantities of valuable critical minerals that should be recycled by certified recyclers. It is important that a policy and economic framework is put in place now while the volume of end of life portable and vehicle lithium ion batteries are relatively low so the industry and country can handle the massive number of these batteries in the next five to ten years. These policies are also necessary before Umicore and companies like ours are in a position to build recycling facilities that require economies of scale. While recycling cannot completely replace mining, it can complement it and be a sustainable supply of energy materials as the battery industry grows.

In addition to recycling end of life lithium ion batteries, Umicore is a leading supplier of

² <https://www.energy.gov/articles/energy-department-announces-battery-recycling-prize-and-battery-recycling-rd-center>

³ <https://bit.ly/3a8PcYj>

cathode materials for rechargeable batteries used in electrified transportation, energy storage, and portable electronics. One out of five batteries manufactured globally contains Umicore rechargeable battery materials technology. This allows Umicore to be in a unique place in the supply chain as we are able to interact with both the beginning and end battery lifecycle. Our lithium ion battery operations are another example of our closed loop approach where we are able to manufacture and recycle the same materials. In the critical materials industry, it is common for refining, manufacturing, and recycling to cluster together geographically. This is true for Umicore as well as other companies.

Umicore manufactures countless other products. Specifically, Umicore is one of three global leaders in emission control catalysts for light and heavy-duty vehicles with our materials in approximately 1/3 of all catalysts in the global vehicle fleet. Umicore has a testing and development facility in Auburn Hills, MI in order to work closely with the Big Three auto companies on emissions control technology. Due to the economic impacts of COVID-19 on the automotive supply chain, Umicore was forced to close its automotive catalyst manufacturing facility in Tulsa, Oklahoma, unfortunately impacting approximately one hundred employees.

Finally, Umicore's electro-optic business unit manufactures germanium materials in Quapaw, OK. Germanium is an essential element to communications technology, high speed internet, and satellites. Umicore's germanium wafers were on the Mars Opportunity Rover and allowed it to have a lifespan far longer than experts predicted. Other wafers are installed on Low Earth Orbit satellites which is the foundation of an expanded internet and Space 2.0. We also provide the U.S. Department of Defense with germanium materials used in optics and infrared technologies.

Umicore supports the recycling components in the American Mineral Security Act, which seeks to ensure that the U.S. has a secure, ready, domestic access to critical materials required for defense and civilian high-technology products. Our nation's industrial scrap, end-of-life lithium ion batteries from cars and energy storage, electronics, and electronic appliances could provide nearly boundless valuable resources that could be recycled and put back into the economy. Recycling critical materials found in these products will avoid having to purchase materials mined in unreliable parts of the world and will provide a home-grown resource stream for those materials. For example, China and Russia provide nearly 70% of the world's refinery and production reserves for germanium while the United States is one of the largest consumers.⁴ The recycling of germanium which Umicore does in Quapaw, Oklahoma helps offset the lack of natural sources for critical applications using germanium like 5G fiber networks and Low Earth Orbit satellites. In fact, Umicore recycles Germanium for the US Department of Defense. Furthermore, over 50% of the primary global cobalt supply is derived from the Democratic Republic of Congo (DRC). Local artisanal small mines have a history of human and environmental health and safety concerns. Umicore is the first company in the world to have introduced a Sustainable Procurement Framework for cobalt and is the first to obtain external validation for its ethical procurement approach in this area. However, if more lithium ion batteries with cobalt concentrations were recycled, the supply chain could rely more on sustainable cobalt from recycled sources as opposed to primary sources from the DRC.

Second, recovering metals from end-of-life products yields more material per ton than mining from primary resources. For example, for every ton of gold-containing ore taken from the

⁴ See the USGS Mineral Commodity Summaries 2019 (pages 68-69) here: https://prd-wrct.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs2019_all.pdf

ground through mining, on average less than five grams of gold can be recovered. By comparison, for every ton of mobile phones recycled, we can harvest up to 250 grams of gold, or approximately 50 times the yield from mining. For automotive catalysts, we can recover 400 times the yield in recycling for Platinum Group Metals (PGMs) than we harvest in mining. New electrification technologies—like electric vehicles and energy storage—provide markets for the increased need for battery materials. Electric vehicle sales increased over 80% from 2017 to 2018 in the U.S.⁵ The number of vehicles sold in the U.S., however, was dwarfed by China which has 60% of the total electric vehicle market.⁶ Bloomberg New Energy Finance increased its prediction of the adjacent energy storage market to \$1.7 Trillion by 2040.⁷ Granted, with reduced movement due to COVID-19, sales will potentially be less robust in 2020, but it is clear that over the longer term, the need for materials is only increasing.

Finally, the economic growth benefits of a domestic commitment to the recycling of critical materials could be enormous. The employment potential of a robust U.S. critical materials recycling industry is significant, involving not only a high number of jobs but also employment of varying skill levels at the first three stages of the recycling process: (1) the collection of discarded end-of-life products and scrap; (2) the dismantling and sorting of products and the separation of components; and (3) the pre-treatment of the separated components. Employment possibilities at the fourth stage, the refining (Umicore's business) of the pre-treated materials into the final critical material products, is limited due to the economies of scale needed to economically recycle these materials. In addition to primary jobs, indirect jobs

⁵ See analysis here: <https://www.greentechmedia.com/articles/read/us-electric-vehicle-sales-increase-by-81-in-2018#gs.bmvvm7v>

⁶ See article in Detroit Free Press here: <https://www.freep.com/story/money/cars/mark-phelan/2019/03/27/china-electric-vehicles-production/3217195002/>

⁷ Article from Utility Dive here: <https://www.utilitydive.com/news/bnef-raises-forecast-for-global-battery-deployment-to-12t-by-2040/541541/>

could include supporting services in IT, engineering, transportation, sales, administration, as well as research at universities and research centers.

Umicore believes the federal government has an important role to play in leadership as well as in research and development. Stakeholder collaboration, public-private partnerships, standards, and a systems approach, will be important to sharing information about these processes and what it will take to move toward more sustainable practices. Umicore is excited that the Department of Energy has taken a greater interest in these issues this year by launching the Battery Materials Recycling Hub at Argonne National Laboratory and supporting a lithium ion battery recycling prize competition, which will promote best practices for the collection and the initial processing of these critical materials. We are also optimistic that, because of this hearing and discussion, we can implement policies that open up new markets to recycling, create highly skilled jobs, and secure our critical resources for a clean, safe, and economically positive future for all.

The CHAIRMAN. Thank you. Thank you very much. Sorry for that technical glitch there.

Let's go to you, Dr. Duesterberg. Welcome to the Committee.

**STATEMENT OF DR. THOMAS J. DUESTERBERG,
SENIOR FELLOW, HUDSON INSTITUTE**

Dr. DUESTERBERG. Chairman, Ranking Member Manchin, members of the Committee, it's a pleasure for me to be with you today on this incredibly important topic. I spent the last 25 years or so working on various issues related to the strength of the manufacturing sector, including—[Dr. Duesterberg's video froze]—Manufacturers Alliance for Productivity and Innovation. So today I'm going to focus my remarks on the importance of mineral resources to the U.S. manufacturing sector which itself is so important to defense, innovation, capital investment and both low- and high-skilled jobs.

The U.S. manufacturing sector has seen something of a decline in the last two to three, four decades in the number of factories and of jobs. Part of that deterioration is due to the often unfair competition of our Chinese competitors. I would note that the pandemic we're now facing has accelerated pre-existing trends toward finding ways to rebuild and bring supply chains closer to home. A major stimulus with this trend is not only the interruption of supply chains during the pandemic but also the increasing control of our major economic and political competitor, China, over both upstream raw resource supplies and downstream processing and manufacturing of finished products.

I'm going to start my remarks by noting the importance in a major success story of one of the United States' only, most important sectors, that is chemicals and plastics. Our superior natural endowments of natural gas and an incredibly productive new extraction technology has created a boom in gas production and the domestic industry of chemicals and related products. The United States' chemicals industry relies for about two-thirds of its feedstock from natural gas compared to our competitors in, for instance, Europe and Japan and China which rely on petroleum products. This gives us a cost advantage of major proportions. So in the last decade or so, we've seen over \$200 billion in new capital investment and over 400,000 new jobs due to the shale gas revolution alone. Much of the domestic investment is coming from competitors in Europe and East Asia who prefer to take advantage of the abundant resources and fair prices here in the United States.

Let me now turn to the auto industry. Other witnesses have noted the importance of lithium-ion batteries and the control of China over the major mineral resources that go into those batteries. This is incredibly important to the future of the auto industry. China has clearly targeted this industry. It has control of the resources as a goal of producing for its own domestic market, which is the largest market in the world—80 percent of electric vehicles, domestically, by 2025. I would also note that China is a major producer of manganese and magnesium minerals which are associated. It controls over 80 percent of those magnesium resources which is incredibly important to the future of light vehicles. Substituting alloys with magnesium products is one key to reducing the weight of all kinds of transportation vehicles and construction equipment, I

would also mention. So this is incredibly important to eventually meeting our goals for reduction of CO₂.

So I'll pass over any details on lithium-ion batteries, other than to note that they are important to other major manufacturing industries, self—[Dr. Duesterberg's video froze]—airliners in the new all electric internal control of 787 Boeing aircraft and also to large-scale solar electric facilities for storage. Other witnesses have also mentioned rare earths and other important minerals for which we are dependent on China such as tantalum, and to a certain extent, cadmium. These are all important to the \$500 billion semiconductor industry where the United States holds the technology lead and produces over 45 percent of the chips that it produces here in the United States. I would also note that gallium arsenide is crucial to the high-performance chips used in national defense and telecommunication applications. Rare earths are also key to fiber optic cables and lasers that power them. We do not manufacture most of our chips domestically. We would like to manufacture more.

Recently, within the last few months, the largest semiconductor fabricator in the world, TSMC, has announced they're going to put a new fabrication facility, a \$12 billion facility, in Arizona. So China is behind the United States in all of these technologies but catching up fast. The danger of a cutoff of rare earths where China is dominant is especially crucial to commercial products and defense needs.

I will finally note that the solar power industry also depends on rare earths like cadmium and tellurium and the leading producer in the United States, First Solar, has a thin film technology that depends greatly on these minerals and gives it a cost advantage over the old related products that are being subsidized heavily by China.

So what to do about these issues? Just briefly. I support codifying the recent Executive Branch, Executive Order for action and support the American Mineral Security Act, S. 1317, as the Chairman outlined here today.

The CHAIRMAN. Thank you, Dr. Duesterberg.

Dr. DUESTERBERG. I'm sorry?

The CHAIRMAN. I thought you had concluded. You are over your time, but go ahead and finish.

Dr. DUESTERBERG. I'll be very quick.

I'm especially interested in the national—in processing technology, recycling and workforce training as part of S. 1317. Second, we do need to pay attention to rare earths, as has been mentioned. I support coordination with our closest allies in the Five Eyes group which have good supplies of rare earths and other needed minerals. We absolutely need to reduce regulatory barriers and permitting times if we are to incentivize domestic production. Expansion of R&D by tax credits and expensing of capital investments is helpful to U.S. investment and also, finally, the use of trade policy to caution and fight back against Chinese subsidization and theft of technology and acquisition of mineral resources around the world, especially in places that have lower environmental and human rights standards than our miners do.

So let me conclude there, and I look forward to your questions.

[The prepared statement of Dr. Duesterberg follows:]

Testimony of Dr. Thomas J. Duesterberg
Senior Fellow, Hudson Institute
U. S. Senate Committee on Energy and Natural Resources
June 24, 2020
On
“The Impact of COVID-19 on Mineral Supply Chains, the Role
of those Supply Chains in Economic
and National Security, and Challenges and Opportunities to
Rebuild America’s Supply Chains”

Chairman Murkowski, Ranking Member Manchin and Distinguished Members of the Committee,

My Name is Thomas J. Duesterberg and I am a Senior Fellow at the Hudson Institute in Washington, DC. I have served in various positions in the Congress and in the George H. W. Bush administration. I have also served as President and CEO of the Manufacturers Alliance for Productivity and Innovation, as a Senior Fellow at the Aspen Institute, and on the Board of Advisors of the Manufacturing Policy Institute at the O’Neill School of Public and Environmental Affairs at Indiana University. I would like to acknowledge the research assistance of Suri Xia, a master’s degree student at the O’Neill School. The views expressed in this testimony are mine alone and do not represent any position of the Hudson Institute.

Overview

The COVID-19 pandemic has accelerated some important preexisting trends toward bringing industrial supply chains, including medical products, back to the United States. First, the cut-off of medical supplies, not just from China but from Europe and other allies to some extent, brought the vulnerabilities of relying on outside sourcing into clearer and more immediate focus. 90 countries blocked the exports of medical products during the early months of the pandemic. Second, border closures around the world, even within the European Union,

added to the worries about interruptions in supply chains, including for workers and logistics. 70% of the world's points of entry restricted foreign travelers at some point as the pandemic grew.ⁱ Third, border closures and supply chain interruptions increased tension between nations, especially between the United States and China, which suffered severe reputational damage for its suppression of information at the start of the pandemic. Cooperation between the United States and allies also suffered. Fourth, the economic collapse due to the pandemic response again focused attention on the need to create more domestic jobs, including those in the hard-hit industrial sector. Finally, all of these developments led allies such as the United Kingdom, Japan and the European Union (EU) to reinvigorate thinking, and concrete policy proposals meant to bring production back to home territories. Clearly, these trends support policies to increase the resiliency of domestic production even beyond the parameters of defense and medical security.

I will focus my contribution on the importance of mineral and related metal resources to the manufacturing sector in the United States. Throughout our history, the vast mineral wealth of the United States has been a strong pillar of economic growth and of a high standard of living. Mineral resources have undergirded the strength of the manufacturing sector for over 200 years. Abundant energy resources have facilitated the flourishing of metals industries as well as more modern technology sectors. In recent decades however, this leadership position has been challenged by competitors ranging from Europe and East Asia to developing economic powers like China, Mexico and Brazil.

Moreover, the sources of growth in the globalized economy have evolved to more technologically sophisticated industries such as telecommunications, semiconductors, advanced computing, robotics, medical products and aerospace. Many of these new industries require different types of natural resources, combined with advanced scientific expertise, to foster new products for the global economy. The United States is not always well-endowed with the needed mineral resources, or the ability to procure them in an economically and environmentally efficient manner to compete with competitors, especially those with substantial state subsidies behind their extraction and manufacturing sectors. While the United States remains a leader in many of these industries of the future, and the related digital services and technologies enabled by them, such as artificial intelligence, autonomous vehicles and the Internet of Things, its leadership is increasingly challenged by capable and sometimes adversarial competitors such as China and Russia.

Part and parcel of the challenge, especially from the world's second largest economy, China, is exploiting a country's own natural resources, or gaining control of resources in other countries, needed for advanced industries. China's tactics, encapsulated in its Made in China 2025 and Belt and Road (BRI) programs, include purchasing mining assets from Central Asia to Africa, South America and even Australia.ⁱⁱ In the first decade of aggressive Chinese state investments to acquire natural resources outside its borders, nearly 50% of its purchases were in energy and 20% in mineral resources.ⁱⁱⁱ

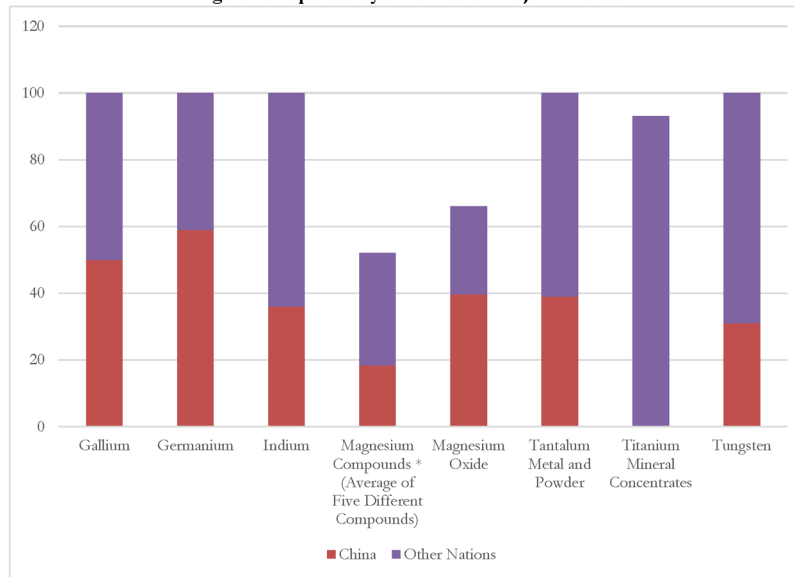
In the rest of this report, I will concentrate on selected examples of growing US vulnerability to global competitors due to shortages of key mineral resources in our domestic supply base. Dependence on China for raw materials and competition with its manufacturing firms is also a key focus. Shortages do not always indicate a problem because our close allies in mineral-rich countries like Australia and Canada can mitigate gaps in domestic supply. However, China's growing control over many basic materials, and its history of using that control as leverage for its own economic and political goals makes this a cause of concern for the continued strength of the US manufacturing economy. In the remainder of my testimony, I will describe a few of the major concerns, and provide a few ideas of how to mitigate the problems.

Impacts of Mineral Shortages on US Manufacturing;

-Traditional Industries

It is worthwhile to begin by noting the most recent example of US strength in natural resources, and the technologies of extraction, and their importance for manufacturing. The US chemicals industry, a nearly \$800 billion per year giant, has greatly benefitted from new drilling and mining techniques to become the world's leading producer of natural gas, and ample production has kept the price of this commodity very low in the United States. The US chemicals sector primarily employs natural gas and associated liquids as a feedstock, in contrast to European and Asian competitors which depend on petroleum-based liquids for a substantial majority of their primary feedstock.^{iv} Large and well-priced supplies of natural gas give the US producers an initial cost advantage compared to most global competitors.^v According to the American Chemistry Council, the recent boom in domestic supplies of natural gas has led to over \$200 billion in new capital investment in chemicals production in the United States, much of it by large European and Asian firms.^{vi} The related plastics industry in turn benefits from increased supplies at competitive prices of basic chemical feedstocks such as ethane. Over 400,000 jobs have been created in the United States by increased production and investment in the chemicals and related industries. The United States is now a large exporter of both natural gas and chemicals.

The US automobile industry remains one of the backbones of the manufacturing sector, but faces tough competition for the products of the future. Among the many challenges are competitively producing lighter weight and electric vehicles. Meeting carbon emission goals for this sector will require progress in replacing steel parts with lighter materials. A key component of lighter weight vehicles is magnesium. The metal is 70% lighter and stronger than steel. Its use of course is not limited to autos. It is important to all transportation equipment, construction materials, cases for laptop computers and cell phones, and batteries. Unfortunately, the United States produces virtually no raw manganese ore or finished magnesium (see Table 1).^{vii}

Figure 1: Dependency on China for Major Minerals

Source: U.S. Geological Survey (USGS), *Mineral Commodity Summaries*, National Minerals Information Center, January 2020.

China is now the world's largest producer and exporter of raw manganese and refined magnesium. Much of its access to raw materials results from ownership of mines in Africa. For the important magnesium metal market China produces over 80% of global production. The United States is highly dependent on foreign sources for manganese and magnesium metal, which is used in both steel and aluminum alloys. It has blocked imports of most finished magnesium from China much of this century, but because of its dominance of global production much of this originates in China and is reexported to the United States. The United States does import significant amounts of specialty compounds from Chinese sources. There are many other sources for magnesium compounds and metals, such as Canada, Australia, Brazil, Israel and Mexico. The Chinese auto industry, spurred by the Made in China 2025 program, prioritizes production of lighter vehicles and plans to increase the content of magnesium parts by over 500% in the next decade.^{viii}

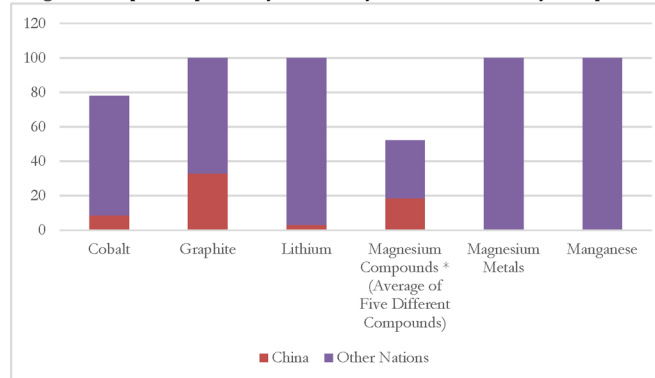
China is also determined to dominate the production of electric vehicles and their key component, advanced lithium-ion batteries. It has systematically acquired mining resources throughout the world for the metals that are used in these batteries (see Figure 2). China has a goal of reaching 80% domestic production of electric vehicles for the Chinese internal market,

the world's largest, by 2025.^{ix} Lithium-ion batteries are also crucial to electronic products such as computers and cell phones. China has acquired substantial cobalt, lithium, magnesium oxide and graphite resources in major producing countries. The largest cobalt producer in the world is the Republic of the Congo, where China has bought 8 of the 14 largest mines. It also owns mines in Chile and Australia. The United States is totally dependent on imports, including from China, for these materials. 60% of imported magnesium oxide originates in China. A report from the *Wall Street Journal* bluntly concludes that "...there is a global race to control batteries and China is winning."^x

Chinese battery manufacturers are not yet as agile and sophisticated as Japanese, Korean, and American firms. China does account for 37% of global battery production and 51% of US supply, as of 2019, but its dominance in raw materials and refining, along with its status as the world's largest producer and consumer of autos, cell phones and computers, will likely result in superior economies of scale and a larger market share for advanced batteries in the future.^{xi} The Middle Kingdom has plans to increase battery production from its current level of 110 Gigawatt hours (GWh) to 260 GWh in the next few years, often with massive government subsidies. By comparison, Tesla's "Gigafactory" in Nevada hopes to achieve annual production of 35GWh this year.^{xii} China has also captured 69% of the global market for recycling lithium-ion batteries.^{xiii}

China's capture of fundamental raw materials for autos and battery production is a major threat to auto manufacturers in the United States, Europe and East Asia. The challenge is especially important because it has proven to be an unreliable supplier to foreign firms. China's control of battery production, if it continues to expand, will also make any return of advanced electronics production to the United States problematic. But there are other challenges for high technology industries, in which the United States is now the world leader.

Figure 2: Import Dependency on Primary Lithium-ion Battery Components



Source: U.S. Geological Survey (USGS), *Mineral Commodity Summaries*,
National Minerals Information Center, January 2020.

-Advanced Technology Industries

It is well known that China has been the major force in production of so-called rare earths, and metals derived from them, partly because of its lesser standards for environmental protection than in the United States and other advanced countries. The US government, led by the Department of Defense, is supporting efforts to reenter the rare earths business, in large part because of the importance of these materials to high technology products like cruise missile guidance systems, night vision devices, and various defense-related electronics. I will focus on the importance of these and some other metals important to the vast commercial applications of semiconductors and for which the United States must depend on foreign suppliers. It is worth noting too that modern transportation vehicles are increasingly reliant on advanced electronics. Semiconductors also are the heart of computing and communications products that facilitate leading edge manufactured products such as autonomous vehicles and electric (rather than hydraulic) internal control systems for commercial airliners.

Gallium is not a rare earth but is a fundamental component of high-performance Gallium-Arsenide semiconductors, which are used in defense and mobile phone applications, among many others. Again, the United States has virtually no domestic sources for Gallium and relies on China for some 50% of its supplies (see Figure 1). China accounts for around 80% of global capacity for Gallium, according to U. S. Geological Survey data. The metal is also important to Light Emitting Devices (LEDs) and to fiber optic systems. Worldwide consumption of Gallium-Arsenide chips is expected to grow from \$4 billion in 2018 to \$22 billion in 2026.^{xiv}

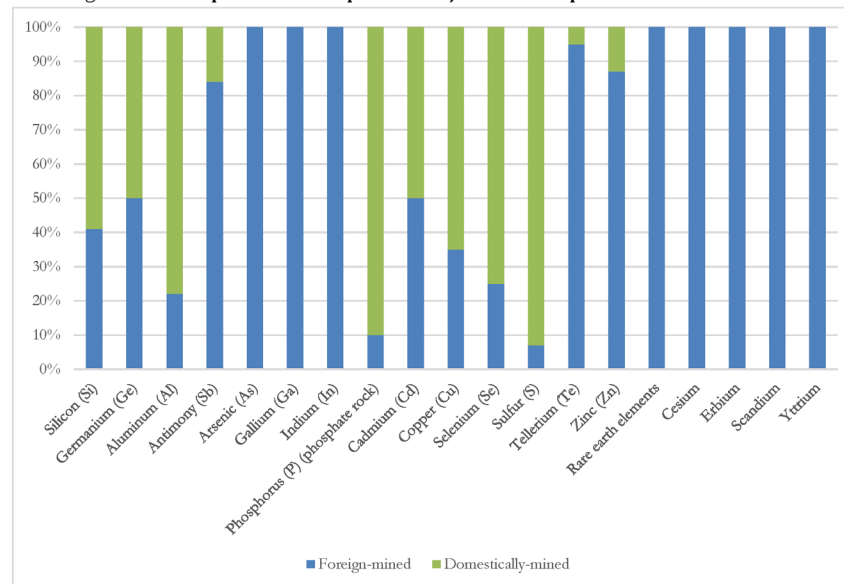
Other metals important to semiconductor production and for which the United States possess little or no domestic supply and depends on China for much of its imports include Tantalum (39% of imports from China), Tungsten (31% from China), and Indium (36% from China). China currently accounts for about 85% of global production of rare earths and around 80% (more in some recent years) of US imports of these metals.^{xv} Other important elements of semiconductor production include Selenium and Tellurium (see Table 3). It is worth noting that the estimated size of the global advanced semiconductor market is around \$500 billion.^{xvi}

It is hard to exaggerate the importance of semiconductors to the US economy.^{xvii} Although 55% of the actual physical production of US-designed semiconductors is done outside of the country, most leading-edge designs originate in domestic firms such as Intel, NVIDIA, Texas Instruments, Micron Technology, and AMD. Some US firms such as Qualcomm, a leading designer of advanced chips used in cell phones and other communication equipment, contract

most of their designs to fabricators such as Taiwan Semiconductor Manufacturing Corporation (TSMC). US firms represent 47% of world production of semiconductors and maintain a large trade surplus in these products, despite producing many of them abroad. They exported more than \$45 billion of product in 2019 and maintain a large trade surplus. The US industry devotes around 20% of revenues to research and development to maintain its technological lead over competitors in China, Japan, Taiwan, Korea and Europe. This spring TSMC, the world's largest fabricator, announced it will build a \$12 billion new facility in Arizona.^{xviii}

If the United States wants to build on its lead in semiconductors and expand the domestic production footprint, it would benefit from having a greater capacity to produce the rare earths and other somewhat obscure minerals listed in Figure 3 that form the basis of advanced electronic circuits. The large and growing computer and telecommunications sectors as noted earlier depend on advanced semiconductors. The entire US electronics industry requires a more reliable resource base to maintain, and preferably expand, its manufacturing footprint.

Figure 3: U.S. Dependence on Imports for Major Metal Components of Semiconductors



Source: Christiana Honsberg & Stuart Bowden, "Semiconductor Materials," PVeducation, 2019;

U.S. Geological Survey (USGS), *Mineral Commodity Summaries*, National Minerals Information Center, January 2020.

It is also worth noting that two other high technology sectors also require many of the same materials as the semiconductor industry. Although severely challenged by subsidized Chinese competitors, US solar photovoltaic (PV) manufacturers are leaders in this growing field so important to meeting commitments for reduction of greenhouse gases. First Solar, the largest US player in the market, uses a “thin film” technology with an electronic core of Cadmium and Tellurium compounds.^{xxix} US suppliers do produce about 50% of the Cadmium required for its products, but must import almost all of the Tellurium. China supplies over 90% of annual US consumption of this rare earth. First Solar’s products are much less bulky and thick than silicon crystal solar cells, thus requiring less labor to install. Its systems are less costly than competing silicon crystal products. In the face of intense competition from Chinese and European producers, First Solar is concentrating its business on large electric generating facilities, a growing part of the US market.

The fiber optic cable and laser industries also depend on important rare earths: Erbium, Ytterbium, Neodymium, Thulium and Holmium. The first three are the most widely used.^{xxx} Tungsten, Titanium and Zirconium are also integral components of fiber optic systems, the backbone of the digital transmission network.^{xxxi} Lasers are obviously a key part of these systems, ensuring the generation and amplification for long-distance transmission of light impulses carrying data, and they utilize many scarce materials. China is the major source of the most important rare earth metals for fiber optic systems, and a significant source of Tungsten and Titanium. The United States does not produce any raw Tungsten and relies on China for 31% of supply. (This metal is also important for metalworking and oil and gas drilling equipment). It also has minimal amounts of domestic Titanium, producing only about 9% of consumption, although most supplies originate in Japan.

Chinese telecommunication giant Huawei is a major competitor in fiber optic cable systems.^{xxxi} Given the importance of these systems as the backbone of modern digital communications, it is essential for US fiber optic and laser industries to maintain leadership and market share in these technologies. Access to scarce raw materials is crucial. Lasers are also extremely important, and becoming more important, to national defense applications.

Some Ideas for US Strategy for Key Minerals for Advanced Manufacturing

The Trump administration has already begun to address the underlying problem of import dependence for critical minerals. A 2017 presidential executive order on “critical materials” charged the executive branch with developing a comprehensive strategy to reduce dependencies. In May of 2018, the Department of the Interior issued a list of 35 critical minerals, which includes all the major minerals highlighted in this report. DoD has also for many years been active in defining mineral resources needed for national defense and has built

stockpiles of many of the most important of these. These efforts are a starting point and deserve support by the Congress. This is especially important in terms of budgetary support and clear legislative authorization for minerals used in commercial applications not covered by DoD priorities. The bipartisan bill authored by the Chairman and Ranking Member of this Committee, the “American Mineral Security Act,” S. 1317, is an excellent start to accomplishing this national priority.^{xxiii} I would emphasize the importance of the attention in the bill to promoting research in processing technology, recycling and development of the appropriate workforce for the mining and processing industries.

In view of the importance of the critical materials to the highly productive and innovative manufacturing sector, and of the goal to consolidate production and supply chains in the United States (or at least away from unreliable and subsidized Chinese sources) other ideas ought to be considered by the Congress. Senator Cruz has a proposal for tax incentives for onshore investment in rare earth mines, and for a 200% deduction for purchases of domestically produced rare earth metals.^{xxiv} It also requires DoD to source all purchases of rare earths from US suppliers. I would urge the committee also to review the more general ideas of Professor Willi Shih of the Harvard Business School, who outlines a policy of broad “demand side” stimulus from Federal purchasing power for critical industries, as well as methods to allow “pre-competitive research consortia” to promote public-private collaboration in developing new technologies.^{xxv} These ideas could be applied to the mineral resources and processing industries.

DoD recently awarded, then shortly thereafter suspended, two contracts for seed funding for rare earth processing in the United States.^{xxvi} Opposition in the Congress to the Australian awardee, Lynas, was based on debate about whether to use US government funding for minerals from a foreign source.^{xxvii} Questions about a minor Chinese stake in the California-based awardee, MP Materials, was behind the freezing of the second contract. These questions are appropriate for Congress to debate, but don’t seem insurmountable to clear up. Overall, the underlying idea of supporting new process-manufacturing technology is a sound one, as is the overall idea of using Federal resources for incentivizing demand for domestic production. Using Federal purchasing power to stimulate the demand side is appropriate for other critical materials.

I also believe that US strategy on the larger question of reliable supplies of critical materials ought to include coordination with the “Five Eyes” group.^{xxviii} These are historically our most consistent allies, and ones who share a common economic philosophy as well as a willingness to push back on growing Chinese influence. They can be trusted to be part of critical supply chains, as suggested by London’s Henry Jackson Society. Fortunately, members of this group—Canada, Australia, United Kingdom and New Zealand—are significant producers of minerals and metals, and manufactured goods, needed for defense and advanced technology leadership. Some analysts, including the Henry Jackson Society, have also supported the idea of eventually bringing Japan into the Five Eyes.

If the United States is to reinvigorate mining, recovery and processing of critical minerals, it undoubtedly requires a new look at how these industries are regulated. To compete with China and its growing natural resources network in developing countries means either incentivizing production by lowering well-known regulatory barriers or simply deciding to pay more for the critical resources, either through use of public funds or by imposing more costs on the users of these materials. Some rethinking of regulatory barriers is warranted in my view.^{xxxix}

I and many others have argued that trade policy represents another basket of tools to reduce import dependency due to unfair trade practices or to meet national security requirements.^{xxx} US trade actions to increase tariffs on China and reduce its ability to buy strategic assets have already reduced the ability of China to use its economies of scale and advance its ascent of the technology ladder in manufacturing. Other related tools, but ones not widely recognized, are the antidumping (AD) and countervailing duty (CVD) laws. These are the most widely used trade actions in the US arsenal in the last decades, and are partially effective in blocking subsidized products. Magnesium metal imports are just one target among the hundreds of actions directed against China.^{xxxi} I also would argue that US trade policy should be coordinated—difficult as that is—with close allies, not only the Five Eyes group but with Europe, Japan, Korea, Taiwan and, hopefully, India.^{xxxii} China is simply too large an economy, with growing political reach, for the United States acting alone to influence decisively. The World Trade Organization could be helpful in curbing China’s mercantilist policies of subsidization and theft of intellectual property, but it requires significant reform before it can be effective in doing so.^{xxxiii}

In closing, I commend the Committee for its leadership in addressing one of the most important economic and political challenges in the difficult domestic and global political economy now facing the United States. These challenges were not caused by the COVID-19 pandemic but were certainly deepened by it. I hope the analysis and suggestions in this testimony are helpful to the deliberations of the Committee.

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ⁱⁱ See John Lee, “China’s Economic Slowdown: Root Causes, Beijing’s Response and Strategic Implications for the US and Allies,” Hudson Institute, December 16, 2019. <https://www.hudson.org/research/15551-china-s-economic-slowdown-root-causes-beijing-s-response-and-strategic-implications-for-the-us-and-allies>

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- ^v American Chemistry Council, “Shale Gas, Competitiveness, and New US Chemical Industry Investment: An Analysis Based on Announced Projects.” May, 2013. March 4, 2020. https://www.americanchemistry.com/News_and_Resources/?topic=&srchtext=&ref=VGv4dCxlYnR0YXhvb9teW/NhdGVnb3J5LGVidHRheG9ub215Y2F0ZWdvcnkIM2ElMjIjY250ZW50K3R5cGUraW5mb2dyYXB0aWZK2FuZCtmYW/NOK3NoZWV0cyUyMg==
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- ^{xii} Patterson and Gold, *op cit.*
- ^{xiii} See Tanaka Precious Metals, “How China is cornering the Lithium-ion Cell Recycling Market.” November 28, 2019. <https://tanaka-preciousmetals.com/us/elements/news-cred-20191128-04/#:~:text=It's%20just%20that%20China%20has,U.K.%20Dbased%20Circular%20Energy%20Storage.>
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- ^{xv} In addition to USGS sources, see: “U. S. dependence on China’s rare earth: Trade war vulnerability;” *Reuters*, June 27, 2019. <https://www.reuters.com/article/us-usa-trade-china-rareearth-explainer-idUSKCN1TS3AQ>
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- ^{xxix} See Oren Cass, "On Regulatory Reform: Outdated environmental regulation poses an irrational barrier to reshoring efforts," *American Compass*, June 10, 2020. <https://americancompass.org/essays/on-regulatory-reform/>
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- ^{xxxiii} Thomas J. Duesterberg, "Now is a Good Time to Modernize the WTO." *The Wall Street Journal*, December 1, 2019. <https://www.wsj.com/articles/now-is-a-good-time-to-modernize-the-wto-11575229069>

The CHAIRMAN. Thank you, sir.

Let's now finally go to Mr. Simon Moores, of the Benchmark Mineral Intelligence.

**STATEMENT OF SIMON MOORES, MANAGING DIRECTOR,
BENCHMARK MINERAL INTELLIGENCE**

Mr. MOORES. Senator Murkowski, Senator Manchin and members of the Committee, I thank you for inviting me to this hearing today.

China has been the equivalent of one battery megafactory a week; the United States, one every four months. This is my third time presenting to the Senate on behalf of Benchmark Mineral Intelligence in two and a half years. In that time, we have witnessed a global battery arms race and watched the world's number of supersized battery plants, known as battery megafactories or gigafactories, go from 17 to 142. Since 2017, China's battery megafactory pipeline has increased from 9 to 107, of which 53 are now active and in production. Meanwhile, the United States has gone from 3 to 9 battery plants of which still only 3 are active, the same number as just under three years ago.

Lithium-ion batteries are a core platform technology for the 21st century. They allow our energy to be stored on a widespread basis in electric vehicles and energy storage systems, and they spark the demand for the critical raw materials and chemicals.

A new global lithium-ion economy is being created, yet any ambitions for the United States to be a leader in this lithium-ion economy continues to only creep forward and be outstripped by China and Europe. So I'll repeat this fact: China is building the equivalent of one battery megafactory a week; the USA, one every four months. The rise of these battery megafactories will require demand for raw materials to increase significantly. By 2029, so ten years from now, demand for nickel will double, cobalt will grow three times, flake graphite and manganese by four times, lithium by more than six times. The tectonic plates of this industry have shifted. Layered on top of this are new, emerging demands of supply chain security, transparency, and accountability.

Not only has the COVID-19 crisis exposed the weaknesses of truly global supply chains and the need to build domestically, it has continued to shine a spotlight on how these raw materials are extracted around the world. In the United States, progress is far too slow on building out a domestic lithium-ion economy but the opportunities that remain are vast and pioneers have emerged. Tesla has continued to lead the industry and build on its Nevada gigafactory by announcing supersized battery plants in Germany and China and expected to announce a fourth in Texas which would give the United States its first ever 100 percent-owned and made lithium-ion battery cells. Ohio has recognized the scale of this opportunity and attracted the \$2.3 billion General Motors/LG Chem joint venture. You could also turn to Alabama, Georgia and Tennessee for electric vehicle and battery cell investment success. Yet these developments are more of a stand-alone achievement than a coherent U.S. plan and all rely on imported raw materials and chemicals for the two main components that make a lithium-ion battery: the cathodes and the anodes. America has some of the best

cathode knowhow in the business yet only three cathode plants producing under one percent of global output, while China produces over two-thirds of global supply from over 100 cathode facilities. It's reassuring to see Mark Caffarey here from Umicore here today and actually have one of the true leaders in the industry step forward to talk about these issues. That's really important.

For graphite anode, the United States has zero manufacturing plants while China has 48 plants and controls 84 percent of the total global anode supply. Developing this mid-stream of the supply chain will create a domestic ecosystem, an engine for more battery plants to be built, more electric vehicles to be made, more energy storage systems to be installed and will spark the development of domestic mining and chemical processing. However, be under no illusions, the United States needs to build this 21st century industry from scratch. FDR's New Deal, for example, built the core infrastructure the United States still relies on today. Nearly 100 years later in similar economic and industrial circumstances, your country has to do this all over again. Yet instead of dams, you need to build battery megafactories in their tens. Instead of highways and bridges and tunnels, you need to build the supply chains to enable these megafactories to operate securely and consistently. These include cathode and anode plants and the lithium, cobalt, graphite, nickel and manganese sources to feed them. And this has to be done at a speed, scale, and quality that will make most U.S. corporations feel uncomfortable. Even more, these supply chains need to be underpinned by giga-sized factory recycling facilities to match the scale of these new operations and close the loop.

One can also look to the creation of a—back to the creation of a widespread U.S. semiconductor industry back in the 1980s. The lead that the United States built in semiconductors and computing power has sustained your country's dominance in this space for over five decades. Those who invest in battery capacity and supply chains today will hold the sway of industrial power for generations to come. I would like to thank Senator Murkowski, whose leadership on the subject over the years has been crucial and relentless. The industry is listening.

Thank you.

[The prepared statement of Mr. Moores follows:]



Wednesday 24 June 2020

Written Testimony of Simon Moores, Managing Director, Benchmark Mineral Intelligence

For: US Senate Committee on Energy and Natural Resources Committee

Hearing: Wednesday, June 24, 2020, at 9:30 a.m. EDT in Room 366 of the Dirksen Senate Office Building in Washington, DC and online.

Subject: Full Committee Hearing on the Impact of COVID-19 on Mineral Supply Chains

When was the last time the USA built a heavy industry from scratch?

This is my third time presenting to the Senate in two and a half years on the criticality of securing supply chains for the electric vehicle and energy storage revolution.

In that time, we have witnessed a global battery arms race and watched the world's number of supersized battery plants – known as battery megafactories or gigafactories – go from 17 to 142.

China has increased its number of battery megafactories from 9 to 107, of which 53 are now active and in production

The USA has gone from 3 to 9 battery megafactories in the pipeline of which still only 3 are active, the same number as back in 2017.

Lithium ion batteries are a core platform technology for the 21st century.

They allow our energy to be stored on a widespread basis in electric vehicles and energy storage systems, and they spark the demand for the critical raw materials to be mined, chemically refined and made into engineered, functional materials.

A new global lithium ion economy is being created.

Yet, any US ambitions to be a leader in this lithium ion economy continue to only creep forward and be outstripped by China and Europe.

In more stark terms: China is building the equivalent of one battery megafactory a week, the USA one every four months.

This rise of the battery megafactories will require demand for battery raw materials to increase significantly: by 2029, demand for nickel will double, cobalt to grow by 3 times, flake graphite but four times, and lithium by more than six times.

The tectonic plates of the industry have shifted.

Layered on top of this are new, emerging demands of supply chain security, transparency and accountability.

Not only has the COVID-19 pandemic showed the weakness of truly global supply chains and the need to build domestically, it has continued to shine a spotlight on how these raw materials are extracted around the world.

In the USA, progress is far too slow on building out a domestic lithium ion economy, but the opportunities that remain are vast and pioneers have emerged.

Tesla has continued to lead the industry and build on its Nevada gigafactory by announcing super-sized battery plants in Germany and China and is widely expected to announce a fourth plant in Texas.

Ohio, with bipartisan support and of organizations like JobsOhio, has recognized the scale of this opportunity and successfully attracted the \$2.3B General Motors /LG Chem joint venture.

The state now has the potential to become a second major regional hub for batteries in the USA.

You can also turn to Alabama, Georgia and Tennessee for inspiration and knowhow in their successful attempts to court automotive and battery cell investment.

Yet most of these developments are more stand-alone achievements than a coherent US plan, and all rely on imported raw materials and chemicals for the two main components that make a lithium ion battery: the cathodes and anodes.

America has some of the best cathode knowhow in the business, yet only three cathode plants producing under 1% of global output. While China produces over two third of global supply from over 100 cathode facilities.

It's a pleasure to see Umicore on this panel here today - one of the true leading lights and a company that should be leading major capacity expansions in the US as it has done elsewhere in the world.

For graphite anode, the USA has zero manufacturing plants that can supply automotive-grade anode at scale. China has 48 plants and controls 84% of total global supply.

Developing this mid-stream of the supply chain will create a domestic ecosystem, an engine for more battery plants to be built, more electric vehicles to be made, and will spark the development of domestic mining and chemical processing.

I return to my original question: When was the last time the USA built a heavy industry from scratch?

FDR's New Deal built the core infrastructure that the USA still relies on today.

Nearly 100 years on eerily similar economic and industrial circumstances, your country has to do this all over again for the 21st century.

Yet instead of dams, you need to build battery megafactories in their multiples.

Instead of highways, bridges and tunnels, you need to build the supply chains to enable these megafactories: the cathode and anode plants and the lithium, cobalt, graphite, nickel and manganese sources to feed them securely and consistently.

And this has to be done at a speed, at scale and quality that will make most of corporate America uncomfortable.

Even more, these supply chains need to be underpinned by Giga sized battery recycling facilities to match the scale of these new operations and close the loop.

One can also look to the creation of a widespread semiconductor industry in the 1980s.

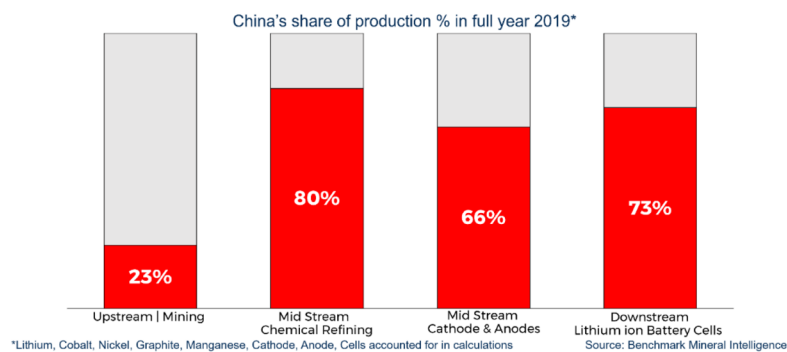
The lead that the USA built in semiconductors and computing power due to companies like Fairchild Semiconductor and Intel Corporation has sustained the USA's dominance in global computing for over 5 decades.

Likewise, those who invest in battery capacity and supply chains today are likely to dominate this industry for generations to come.

It is not too late for the US but action is needed now.

I would like to thank Senator Murkowski who's leadership on this subject over the years has been crucial and relentless. The industry is listening.

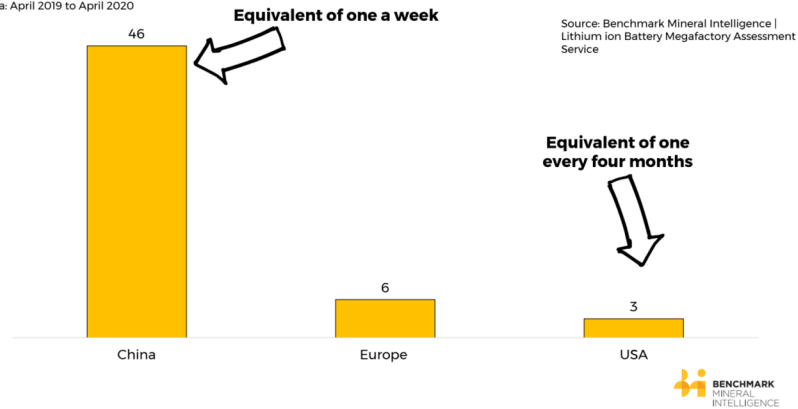
Where does China's dominance lie in the lithium ion battery to EV supply chain?



China's supply chain dominance lies in the midstream of the lithium ion battery to electric vehicle supply chain. While many long term contracts and asset ownership secure raw materials located in foreign countries, China's domestic chemical conversion, cathode and anode capacity creates an ecosystem for lithium ion battery and electric vehicle production to flourish.

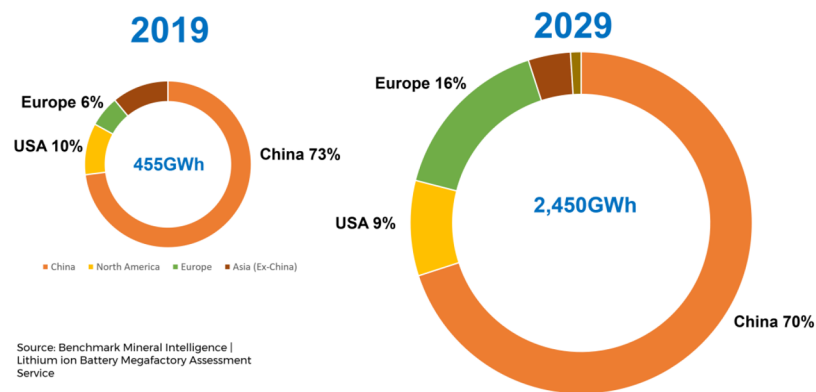
The number of new battery megafactories in last 12 months

Data: April 2019 to April 2020



Between April 2019 and April 2020, China planned 46 new lithium ion battery megafactories for its electric vehicle and energy storage industries versus 3 plants in the USA.

China surges ahead in the lithium-ion battery arms race



Benchmark forecasts China to account for 70% of lithium ion battery capacity in 2029 versus 16% within Europe and 9% in the USA. Europe's capacity investments over the last 18 months have allowed it to increase its share of the global capacity pie from 6% to 16%.

A handwritten signature in black ink, appearing to read 'Simon Moores', with a stylized flourish at the end.

Simon Moores
Managing Director
Benchmark Mineral Intelligence

The CHAIRMAN. Thank you, Mr. Moores. You always remind us of the urgency of where we are, and I think you have laid out a good roadmap with some specificity there. We so appreciate that.

Senator Manchin has a conflicting engagement here in a few minutes, so I am going to defer to him for his first round of questions.

Senator MANCHIN. Thank you, Madam Chairman. I appreciate it very much.

This is for, I think, Dr. Nassar and maybe Mr. Moores also, but earlier this year Saudi Arabia announced it was changing its mining investment laws and last week Papua New Guinea announced it was amending its mining laws. Other countries are considering changes to encourage investment from the mining sector and/or re-evaluate its production and revenue sharing regimes. Yet here in the United States we have the General Mining Law of 1872, which frankly is nothing short of an embarrassment to our country. In 1872, Ulysses S. Grant was elected President and Susan B. Anthony was served an arrest warrant and fined for voting. That tells you how antiquated our laws are for the hardrock mining.

If we are serious about reducing our import reliance for critical minerals, our mining laws need to be updated. We need to improve the regulatory scheme for mines in low-risk, yet high-grade areas, end the claim patent system and help the mining industry put themselves in a better light in public by establishing a royalty to share the profits with the American people. So with that, can you please speak to how mining laws impact a country's ability to attract investment and to reduce mineral dependence?

Dr. Nassar.

Dr. NASSAR. As USGS is a scientific organization of the Department of the Interior, that's not something that I can really comment about, and I would defer to other federal agencies that would be able to better address that question.

Senator MANCHIN. Is there somebody else who wants to speak to that? Nobody.

Mr. MOORES. I can. Basically—Simon Moores here on the screen now.

The problem with mining laws and regulation in the U.S., I can't speak of specific mining laws here but the point is to attract investment, people look to countries like Canada and Australia as mining-friendly jurisdictions and with the U.S. it's not known as a mining jurisdiction, especially if you're trying to develop lithium and cobalt and graphite mines. And this is not on the radar, I think a wholesale look at mining laws specific to critical minerals and specific to these raw materials needed in industries that are in the automotive space or energy storage space should be actually separated out in some way, if that's possible, to help investment in this industry. And I think at the moment everything is treated as one, and it's not just stifling U.S. mining but it's actually detracting a lot of investment.

Senator MANCHIN. Thank you.

Dr. Nassar, I think you can answer this one. Last month you and a handful of other United States Geological Survey scientists published an article in Mining Engineering magazine discussing the USGS' critical minerals review. You wrote, in part, "Simply estab-

lishing domestic mining and concentrate production does nothing to mitigate the risk of downstream processing. It's highly concentrated geographically, imported and unreliable."

Well, I could not agree more with you, and we need to make sure we are addressing these gaps. What portion of the supply chain, either upstream or downstream, needs the most attention in terms of our national security?

Dr. NASSAR. Thank you, Ranking Member Manchin.

So it really, the answer depends on the commodity. So different commodities will have different bottlenecks in their supply chains. In some cases, there's a highly concentrated production on the mining stage. In other cases, it might be further downstream. So, for example, for niobium, an element that's produced in only a handful of mines worldwide. And so, there are very few mines that are producing it and a single mine might be producing somewhere on the order of two-thirds of the world supply. On the other hand, there might be commodities where it's really not about mining and it's the, there's enough concentrate being produced but we're simply not recovering it further downstream such as many of the by-products. So, earlier, one of the other witnesses mentioned tellurium. There's a lot of tellurium in some of the concentrate that we're mining with copper. Once it gets to our copper electrolytic refineries, it's simply not recovered for economic reasons. And so, there are different stages for different commodities, and that's why I mentioned in my testimony that we do need to look at these supply chains individually to figure out what really is the bottleneck and what strategy would be most effective at reducing that bottleneck.

Senator MANCHIN. Well, the U.S. is an erratic supporter for a handful of minerals. Are there any minerals on that list that we could lose if we do not remain vigilant on that? What we are exporting now, the few that we do, are we in jeopardy of losing those?

Dr. NASSAR. I can't think of, off the top of my head, what that would look like, but it's something that we can get back to you on.

Senator MANCHIN. Please do.

Dr. NASSAR. Thank you.

Senator MANCHIN. Thank you.

Thank you, Madam Chairman.

The CHAIRMAN. Thank you, Senator Manchin.

We have long talked about the vulnerability of our mineral supply and the supply chain, and the testimony from each of you today just, kind of, reinforced that. This Committee, as I mentioned, has looked at this issue repeatedly over the years and instead of that reliance being offset, we just become more reliant, more vulnerable and, again, whether it is from a defense perspective or just our ability to be competitive, we are at greater risk, higher vulnerability. And as I mentioned in my opening comments, we have seen, within these past few months as we are dealing with COVID-19, people in this country are starting to understand what it means to have vulnerable supply chains because they are seeing it with lack of PPE and understanding that while we might not have the masks that we need and we need to wait on China and we don't like that. So what are we doing? How are we going to return that business to the United States?

It is a little bit different to manufacture masks than it is to get a mine up to speed and actually producing the resources that we need. We understand that, that the ability to move quickly is very, very different when it comes to critical minerals because of the infrastructure, the permitting and, in some cases, the processing, the manufacturing. The question that I would have for each of you is, what would it look like? For instance, it has been noted that we turn to China for so much of the need for these critical minerals. What would the situation look like if China were to decide that they were going to cut off supplies of critical minerals to this country, not just rare earths like they did to Japan in 2010, but the critical minerals?

It was the discussion between Senator King and Senator Manchin that reminded us, okay, we knew what it looked like when we were talking about oil vulnerability and we saw in the early '70s the impact when those oil supplies were cut off. The American public could visualize that, and they are still talking about that 50 years later. What does it look like? What would it look like? I know that that requires you to do a little bit of a hypothesizing or prognosticating, and we don't like to do that around here, but just help me out because I think that this is a struggle for most Americans to really understand the nexus between this thing and what we are talking about here in this Committee about the value of critical minerals.

So if you can each briefly speak to that. Mr. Bryan, I hope you will be able to speak to it from the perspective of defense, but Dr. Nassar, why don't we start with you and just go down the line?

Dr. NASSAR. Sure, thank you, Chairman Murkowski.

So, obviously, it's very difficult to anticipate how supply chains might react to such an action. But we can generally assume that prices are going to rise for a lot of the commodities that we need, that our manufacturers need to use as their input for their manufacturing processes. So if, for example, tungsten is cut off, it's used in cutting tools that are used throughout our manufacturing sector, including manufacturing of cars. So you can imagine the impact that would have throughout the manufacturing sector and then, ultimately, to the U.S. consumer. So—

The CHAIRMAN. That is going to increase prices, consumer prices.

Dr. NASSAR. That would be the expectation.

The CHAIRMAN. Sure.

Mr. Bryan.

Mr. BRYAN. So, Senator, a couple things. One, I think the Navy alone has about 2,000 different systems that rely on lithium-ion batteries. So I can't speak to the stockpile of those systems and the batteries that support them but I think, suffice it to say that if you don't have access to the raw materials, the processed materials, the cathode and anode as Mr. Moores talked about and the rest of the supply chain, you are effectively limiting the number of those devices that you can field. Similarly, for future systems like I mentioned—lasers, directed energy weapons, electrification of systems—that the military knows they have to do to keep pace with our competitors.

So I can't speak to the very, very short-term interruption, but that's problematic. But the long-term impact on military's ability to

field existing capabilities and to deploy new capabilities to remain competitive with our international adversaries, is, would be challenged. I would also say that, you know, the indirect national security implications of cutting off a key input to key industry, like the auto industry, I think, we are—transportation is electrifying globally and the scale of that and the scale and pace of that move is large and fast. And if we don't keep up or are precluded from keeping up because we don't have access to the things our industry needs, that could dislocate a significant industry that's really important to the United States' economy and, by extension, important to our national security and our position in the world.

We think about things like innovation in the auto industry moving east and out of the United States. So there's short-term implications in terms of fielded systems and our ability to move quickly. There's also long-term implications about, like, how do we remain competitive from a military standpoint and from an economic standpoint? Are we at the table? And if we're not, who is?

The CHAIRMAN. I am over my time but I want to give the opportunity, very briefly, if any of the three of you online would care to respond.

Mr. Caffarey?

Mr. CAFFAREY. Yes, I'd be delighted to but I won't step on my recycling soapbox because there are lots of materials already in the U.S. that could serve as a source for these critical minerals. And I do believe that if we can organize, if the U.S. can organize the collection and preparation of the different materials that are already here, that would alleviate some of the issues. It might not be the whole solution, but it can be a great contribution to providing a more stable supply of materials.

I'll give another example—China did shut off supply of scrap copper a couple of years ago and the U.S. industry, sort of, adjusted and we now have the announcement of a secondary copper smelt for the first time in many years being established in Southern Ohio that will take secondary scrap copper and make copper metal. So that's an example of something that the U.S. can do going forward to reduce the reliance on foreign countries.

The CHAIRMAN. Thank you, Mr. Caffarey. I recall a hearing here in the Energy Committee and one of our witnesses made the comment when it came to recycling that the first place we should look to mine is within our own economy, not in the earth, but what we have already produced and basically, remine, repurpose, reuse that. So thank you for that comment.

Very, very quickly, either Dr. Duesterberg or Mr. Moores?

Dr. DUESTERBERG. Yes, I'd like to weigh in just a little bit, if I may.

I think the consequences of a long-term cutoff of some of the critical materials that we've discussed today would just be disastrous for the U.S. economy in the first place. And I mentioned the size of the semiconductor in the auto industry, but it's not just those industries. It underlies computers, commercial aviation and so on and so forth. We simply can't stand up, Madam Chairman, as you know, new mining operations overnight. There are all kinds of horror stories about how long it takes to get just the permits in place. So that's one reason, I think, we need to think about both stock-

piling and working with allies to—[Dr. Duesterberg's video froze]—Five Eyes group to assure secondary sources of supply.

In the longer run, as Senator Manchin alluded to, we need to revise our mining laws to speed up the permitting process and perhaps put some time limit on the environmental reviews and the mining permitting for critical materials, let alone widely-used materials like magnesium or some that go into the solar cell production industry and the battery industry. So that's a long-term project and we need a national commitment to do that and perhaps the threat of China, which is becoming more and more evident every day, even during this pandemic, maybe that will stimulate a lot more attention to the longer-term problems.

The CHAIRMAN. Thank you.

Mr. Moores, I am going to come back to you for your response on this, because I have another question for you, but I am going to defer now to my colleague from Nevada, Senator Cortez Masto.

Senator CORTEZ MASTO. Thank you, Chairman, thank you to the Ranking Member and to all of you participating today. I so appreciate it.

Let me jump to an issue that has been brought to our attention by previous panelists, and it is the issue of the technical workforce that is necessary to really address what we are talking about today. As you all know, Lithium America is pursuing the largest number of lithium resources in the United States. According to the company, Thacker Pass in Northern Nevada has the potential to produce enough lithium to fulfill 25 percent of the world's demand. However, when the President and CEO of Lithium America sat before this Committee in May 2019, he shared concerns about the limited pool of technical professionals available to fill the roughly 300 permanent positions a mine the size of Thacker Pass would require. Moreover, the U.S. Department of Commerce released a report on critical minerals in June 2019 and it warned, and I quote, "The entire U.S. critical mineral supply chain faces workforce challenges, including aging and retiring personnel and faculty," and what we are talking about today, foreign competition for U.S. talent. Unless these challenges are addressed, there may not be enough qualified U.S. workers to meet domestic production needs across the entire critical mineral supply chain.

So my question is to everyone on the panel. Do you believe the U.S. is currently doing enough to foster a strong workforce of technical professionals and specialists to support what we are talking about here in the hope of the projected growth of domestic critical mineral extraction production and, if not, what should we be doing?

Let me just start with the panelists, and I will start with Dr. Nassar.

Dr. NASSAR. Thank you, Senator, for that question.

It is an issue that I think other agencies are quick to, better equipped to answer. I will say, however, that in the federal strategy that's been put out by the Department of Commerce, there's a specific call to action about growing America's workforce on critical minerals that's being led by the Department of Education and the National Science Foundation.

Senator CORTEZ MASTO. Thank you.

Anyone else? Yes, please, Mr. Caffarey. We will go to Mr. Caffarey first. Thank you. Oh, I think you are on mute. Perfect.

Mr. CAFFAREY. Thank you. Thank you for that question.

Yes, I do believe that more needs to be done in the U.S. for educating technical people, and definitely we need to reinforce the workforce. There are several universities that are active in forming young, technical people but there are not enough of the requirements that are out there. And there is a lot of, how do I say, distraction. One example was a recent graduate from the Colorado School of Mines found a job as an investment banker in Boston. So there are people that then disappear from that potential workforce.

Umicore tries to provide local training for that purpose. We bring in some experts from Europe, from other areas within Umicore and then we have those people locally train U.S. citizens in the technical aspects needed for our companies. So I think allowing foreigners from established companies to come in and educate the local force for specific jobs is one, but definitely try and encourage universities to bring out more technical degree personnel.

Thank you.

Senator CORTEZ MASTO. Thank you.

Dr. Duesterberg?

Dr. DUESTERBERG. Yes, thank you, Senator.

I've elsewhere called for spending as much as \$80 billion more per year through the, mostly through the National Science Foundation, for education of a technical workforce but mostly higher education. But I think we also need to keep in mind that a lot of the jobs in manufacturing, including the processing of materials, require skilled jobs that can perhaps be accomplished through the training of community colleges.

And finally, we need to do something, I think, to motivate women in the technical workforce. Perhaps this is a longstanding problem that is a well-known issue, the representation of women in physical sciences and engineering and mathematics is not as robust as it should be. There must be some way to make these sorts of jobs a little bit more attractive not only to women but to men as well and perhaps linking them up somehow with these because we spent this hearing talking in large part about semiconductors, lasers, gallium-arsenide chips and that sort of thing. So it's a long-term project, but there's a cultural element to it as well that national leaders like yourself, I think, could play a big role in just starting to talk about it and urging, you know, diversification of the technical workforce.

Senator CORTEZ MASTO. Thank you.

I couldn't agree more, and you highlighted Tesla earlier. Tesla is in Nevada. I will tell you, I have toured Tesla, I can't tell you how many times, but they have a program and they call it, Engineer Like a Girl. They invite all of these young women in to talk about opportunities and explore the STEM really, kind of, professional background that is necessary in this field. So I agree with you. I think more needs to be done, and that is my focus here in the Senate. So thank you.

I notice my time is up. Chairman, thank you so much. Thank you, gentlemen.

The CHAIRMAN. Thank you, Senator Cortez Masto.

Senator Barrasso.

Senator BARRASSO. Thank you, Madam Chairman, for holding this important, timely hearing. The coronavirus pandemic has challenged each of us in unprecedented ways. The pandemic, the economic response, has had a profound effect on all of us and it has been, it has helped demonstrate our strengths but also exposed a number of our weaknesses and that is the purpose of this hearing today.

Our domestic mineral supply chain is one area that we can actively strengthen through sound proactive policies we should take the opportunity, I believe, to strengthen, to facilitate and to rebuild our domestic supply chains. China has ramped up production of certain critical minerals, like rare earth elements, and now it undercuts the rest of the world on price. We use rare earth elements in everything from smartphones to defense applications. This practice has allowed China to dominate both production and processing of these minerals. This is as much a geopolitical move as it is an economic move. The Department of Defense has issued certain funding opportunities under the Defense Production Act for the domestic production of key minerals and products in recent months.

So Mr. Bryan and Mr. Duesterberg, what policy tools do we have today at our disposal to break China's grip on these minerals?

Mr. BRYAN. Thank you, Senator.

I think there are things that the Department of Defense can do. I think there's an opportunity to one, identify critical shortages, figure out sources of supply. We can use the Defense Production Act to put in place some economic incentives to encourage investment. At the same time, I think we have to recognize that the global move here toward electrification dwarfs any ability of the Department of Defense to control that market.

DoD is a big customer, don't get me wrong. I think since about the mid-1980s, we've, for example, we've bought like, something like 300,000 Humvees. That's a big order. But the United States auto market is 17 million cars a year. The Department of Defense can't control that market. And I think until we get our EV policy right and until we determine that with the rest of the world to determine that that's the direction we're going and we put in place the structures, incentives, programs we need to attract supply chain investment across that, I think, the Department of Defense is going to be at a disadvantage and where there are opportunities they're going to pay a lot.

So I worry about, there are things DoD can do—don't get me wrong—a lot, but they are ultimately going to be, I believe, going to be victim, to a certain extent, to the larger global transition.

Senator BARRASSO. Dr. Duesterberg?

Dr. DUESTERBERG. Thank you, Senator.

I'd focus on two or three different approaches. The most important is to develop our own ability to produce needed resources and I think, again, we need to work with our close allies in places like Canada and Australia which have abundant supplies, and it includes not only the raw minerals but the processing capacity, for instance, for rare earths.

Second, I would focus on trade policy. China clearly subsidizes its mineral industries through its Belt and Road programs. It's using

zero cost financing in many cases to acquire the rights to mines. This is contrary to the spirit, at least, and in some instances, the law of the world—[Dr. Duesterberg's video froze]—sanction their unfair acquisition of and exploitation of mineral resources just as we can for manufactured products.

Senator BARRASSO. Thank you.

Dr. DUESTERBERG. If you want I can, I have a few other ideas, but—

Senator BARRASSO. Maybe in writing because I am running out of time, and I do have a question for Dr. Nassar.

Dr. DUESTERBERG. Okay.

Senator BARRASSO. Thank you.

Dr. Nassar, the Energy Information Administration recently released its annual report on uranium production. The report shows that 2009 production of American uranium was down 89 percent from the previous year. Wyoming has led the United States in uranium production, and the outlook for our nation's uranium production, I believe, is dire. We need to reverse this alarming trend. That is why I support immediately establishing the Department of Energy's Uranium Reserve. You know, absent immediate action from Washington, can you talk a little bit about, do you expect American uranium production to recover unless we do something dramatically to increase uranium demand here at home?

Dr. NASSAR. Thank you, Senator, for that question.

As you mentioned, this is information that the Energy Information Administration covers and it's really not covered by our Center, at the National Minerals Information Center at U.S. Geological Survey. So I wouldn't be able to comment about that specific question.

Senator BARRASSO. We asked them last week, and I also felt they hedged on the answer. When you think of something that drops that dramatically and your knowledge on the issue, anything else you would want to offer?

Dr. NASSAR. I'm afraid I don't have anything to offer on that.

Senator BARRASSO. Thank you, Madam Chairman.

The CHAIRMAN. Thank you, Senator Barrasso.

Senator Lee.

Senator LEE. Thank you, Madam Chair, and thanks to both of you for being here.

Mr. Nassar, I would like to start with you, if that is all right.

You mentioned in your written testimony that, "Once a mineral supply chain is identified as high risk, the next step is to determine the best ways to reduce the risk. Various strategies can be pursued including diversification of supply, identification and potential expansion of domestic mineral resources, increasing recycling, developing substitutes, maintaining strategic inventories and bolstering trade relationships."

Can you tell me how often essential minerals are found on federal land and while being found on federal land are rendered more or less inaccessible as a result of administrative withdrawals and other restrictive designations?

Dr. NASSAR. Thank you, Senator, for that question.

The question on federal lands is something the BLM, the Bureau of Land Management, can address, probably more accurately. It's

important to note, however, that simply more exploration companies look for deposits for commodities that are either base metals or precious metals. A lot of the commodities that we're talking about that we would define as critical minerals, are typically not explored for and so we would not know that information because they're typically recovered as by-products further downstream. And so, it's difficult, I think, in a lot of cases, even on, in any deposit to figure out what the potential is to recover some of these critical metals.

Senator LEE. So you are saying you often don't know what is in there?

Dr. NASSAR. That's right.

Senator LEE. And you can't know until——

Dr. NASSAR. Well, they're typically——

Senator LEE. ——somebody else develops it as part of a supply chain for something else?

Dr. NASSAR. Exactly.

So, a lot of cases, they're going after maybe the copper or the gold and they're typically not looking in the assays for some of these by-products. And so, we don't actually know if it's going to happen or not or if it's going to be recovered. And sometimes it's not really the mining companies that do the recovery, it's a separate company that's further downstream that does it.

Senator LEE. Okay.

One of the reasons why I ask is that one such deposit of uranium exists near a Utah southern border, but it remains inaccessible because of an administrative withdrawal. I was just going to ask you, do you think that in a time of crisis and if the administrative withdrawal could somehow be lifted in this hypothetical, do you think mineral development in that kind of circumstance could be implemented quickly enough to avoid disruption?

Dr. NASSAR. It's difficult to know. We know that mining, going from exploration to mining development to actually full-scale production can often take decades. And that might be due to permitting, it might be due to technical reasons. It takes a lot of effort to get a mine up and running. So often in cases that if it's a short-term issue, going from exploration to full production is typically not feasible in a short timeframe.

Senator LEE. But it is certainly possible that if you could lift the administrative withdrawal, you might be able to gain access to it faster or at all, whereas you could not without lifting the withdrawal?

Dr. NASSAR. Yeah, that's something that I really can't comment about.

Senator LEE. Okay.

Mr. Bryan, let's turn to you. You also mentioned in your testimony that the State of Ohio recently landed a \$2.3 billion investment from General Motors and South Korea's LG Chem to build a battery plant in Lordstown, Ohio, and that that facility would bring more than 1,000 jobs to the Mahoning Valley. Is that right?

Mr. BRYAN. That's correct, sir.

Senator LEE. It is a very significant investment by a private entity. Do you think there is enough market demand to establish secure supply chain through private investment?

Mr. BRYAN. So I would defer to, first of all, I think it's a massive investment. It's a big deal for Ohio. I think Mr. Moores is probably best positioned to talk about the broader market, the private sector market or investment in supply chain infrastructure. What I would say is that I think in the, especially in the wake of COVID, you're seeing a lot of auto manufacturers even look to see how they can remove risk from their supply chains, and battery and supply chain facilities are best close to where they produce their vehicles. But again, I think Mr. Moores is probably really well-positioned to speak to that question as well.

Senator LEE. But do you believe that there is enough market demand to establish a secure supply chain through private investment?

Mr. BRYAN. So, sir, I can't, I can't speak to that.

Senator LEE. Okay, thank you. Thank you, Madam Chair.

The CHAIRMAN. Thank you, Senator.

We have Senator Hoeven who is with us virtually. Welcome, Senator Hoeven.

Senator HOEVEN. Chairman Murkowski, can you hear me?

I would like to address my first question to Dr. Nassar. To what extent has USGS collaborated with Department of Energy on the protection of the commercialized rare earth minerals from domestic coal and coal by-products?

Dr. NASSAR. Thank you, Senator, for that question. I believe there is a partnership there. I don't, I can't speak to the exact terms because I'm not entirely knowledgeable of it, but it is something that both DOE and USGS are investigating.

Senator HOEVEN. All right. Has the USGS performed any assessments of other potential domestic sources for rare earth minerals such as rail cuttings from unconventional shale production or other sources?

Dr. NASSAR. There are other potential sources for rare earths, as you mentioned. I can get back to you on the specifics the USGS is investigating.

[Information regarding potential domestic rare earth sources from USGS follows.]

Question from Senator John Hoeven:

Question: “Has the USGS performed any assessments of other potential domestic sources for rare earth minerals such as rail cuttings from unconventional shale production or you know, other sources?”

Answer: In 2010 the U.S. Geological Survey (USGS) independently completed a summary of domestic deposits and a global perspective of rare earth elements (REEs, <https://pubs.usgs.gov/sir/2010/5220/>). This included a nontechnical overview of domestic reserves and resources of REEs as well as a deposit-by-deposit review of the most significant domestic REE deposits. Subsequent planning studies for the Earth Mapping Resources Initiative (Earth MRI), a nationwide effort of geologic mapping, airborne geophysics and high resolution topographic mapping via lidar that is directed at better informing our Nation about its critical mineral resources, have produced a series of reports, digital map databases, and associated mineral resource information outlining where domestic rare earth element deposits are most likely to occur. The first two years (2019 and 2020) of Earth MRI data acquisition have largely focused on identifying potential REE deposits still in the ground. Earth MRI and the National Cooperative Geologic Mapping Program's STATEMAP programs support the state geological surveys for geologic mapping of areas permissive for hosting critical mineral resources.

The USGS also conducts research on other potential sources such as energy production and mining wastes. The USGS and the Department of Energy's National Energy Technology Laboratory (NETL) have had a Memorandum of Agreement (MOA) for the last four years to cooperate on REEs from coal sources, and the USGS and NETL are in the process of approving a new MOA for this cooperation that will extend it for the next five years. Apart from the USGS-NETL MOA, the USGS and DOE are in the process of discussing expanded roles for each which could potentially include resource assessments.

Other USGS research has previously shown that phosphate formations, particularly ones of Devonian-age, may contain potentially economic REE levels. Because phosphates are mined and processed on large scales worldwide, the recovery of REEs as a by-product could be a significant contributor to world REE supply.

Dr. NASSAR. But I think it's important to recognize—including recycling of, for example, waste electronics. But I think it's important to recognize that at this stage there's significant supply outside of China of rare earth mining. What is really still missing, however, is further downstream in the separation and then into magnum manufacturing. And that's something that really, it needs to be addressed and is partially being addressed by what's going on with Department of Defense and the Presidential determinations have been put out.

Senator HOEVEN. Thank you.

Mr. Bryan, what policies should we prioritize to strengthen our supply chain and manufacturing capabilities, for example, for things like unmanned aviation and that kind of thing?

Mr. BRYAN. So, sir, thanks for that question.

As I look at the defense demand for lithium-ion batteries which has been the focus of my testimony, I think the Department of Defense, writ large, their demand for lithium-ion is around 300 megawatt-hours a year in demand or thereabouts. That's about the same amount of batteries that go into about 3,500 Teslas, and Tesla made about 100 times more cars than that last year. I think the policies that we have to really think about, I mean, look, there are things, again, the Department of Defense can do. I think there's Defense Production Act incentives that can be put in place. I think we need to really understand what our supply chain vulnerabilities are, what our material shortages are, what materials are actually critical, whether or not we have them and how long the supply chain, how long the lead time we have in the supply chain for that. We can do battery standardization things within the Department to increase demand for particular types of batteries.

But ultimately, the Department of Defense's demand, I do not believe, is big enough to define the industry. And so, I think that, I think that we really have to look broadly to the supply chain and look and see what kind of policies we need to put in place to attract manufacturing here and what kind of programs we need to put in place. And that's going to extend far beyond the Department of Defense to a more—and I think this Committee has talked about it quite a lot over the past couple years, that this is a whole government approach and we need a whole government approach to that.

I think at the same time, from a national security perspective, we may not have minerals in some segments of the supply chain, but we do have allies and people we can work with and we need to really reach out to those folks, like Australia is a perfect example. What do we—how are we working with Australia to diversify our supply chain to support our own needs and also, perhaps, to hedge against China? So I think there are things we can do, but I do believe that in the defense sector we are going to be subject, to a certain extent, to the broader industry.

Senator HOEVEN. What about military and economic ramifications that fall behind on advanced energy storage technology?

Mr. BRYAN. Two things I would raise. One is, of course, we have specific platforms that rely on lithium-ion batteries. We have, I mentioned earlier, we have, I think, the Navy alone has about 2,000 systems that rely on lithium-ion batteries. Our future capabilities from electric ships to an electric brigade combat team, to di-

rected energy weapons, all, to one extent or another, incorporate capabilities that are enabled by lithium-ion batteries. So the implications tactically for us are significant. An interruption, you know, I can't speak to how well we'd manage a short-term interruption, but certainly a long-term reduction in the availability of supplies would affect our ability to remain competitive, I think.

I also think that our, if we are not at the table as this massive industry transitions, if we are not at the table in the middle of these trade discussions, in the middle of these negotiations that are happening, we give up some of our ability to influence world events and use diplomatic leverage to hedge against some of our competitors.

Senator HOEVEN. Thank you. Thank you, Madam Chairman.

The CHAIRMAN. Thank you, Senator Hoeven.

Let's go to Senator McSally. You have been patiently holding.

Senator MCSALLY. Thank you, Madam Chair. Thanks for holding this really important hearing as we focus on this issue that is important for our national security. It is important for all of us in each of our states, and you have been sounding the alarm for a long time and we have been with you about our critical minerals and the challenges in our supply chain. I think the coronavirus has certainly awakened many people to our reliance on our adversary, China, for supply chains for many things.

I flew the A-10 Warthog and we wouldn't be able to build a Warthog, we are not building them today, without relying on an adversary, China, for the pieces and parts of the A-10 and also other parts of our national security and our military. So this is a very critical conversation that we are having and we have to get our legislation passed. I support including it in the NDAA, and I appreciate everybody's testimony on this today.

I want to talk about, it is not just, obviously, the extraction of these critical minerals. Arizona is a mining state. We have 18,000 jobs and over, I want to say, \$13 billion of economic impact that comes from mining in Arizona. But there is also the issue of processing of these elements and, as we have talked about, green energy and lithium-ion batteries, roughly 22 percent of the battery for an electric vehicle has purified or processed graphite in it.

I just want to share a story from last week. I had a virtual meeting with a company in Arizona that started with technology that was researched out of the University of Arizona, and it was focused on this graphite processing. So it is not just the extraction of these critical elements, but it is the processing. In this case, we are totally reliant on China for processing of graphite. They have created a technology that is cheaper and greener than what is available out there, and now they are located in Arizona trying to ensure that we have these jobs in America. We bring the supply chain home and, again, I was just so proud to hear that these types of efforts were happening because this is critical for energy storage, as you all have been talking about already. It is also an element of our nuclear energy and coming from there is purified graphite that is important for our nuclear energy.

So it is initiatives like this that are allowing us to be more reliant on ourselves with American jobs, American reliance for key elements. And it needs to happen in so many parts, but as I talked

to these guys at Urbix Resources last week, we had a conversation about what else needs to be done in order to incentivize investment, for investment to come home. We discussed things like opportunity zones to encourage investment in distressed communities. Are there things that we can do, this question is to any of the panelists, to incentivize investment in innovation that is bringing the supply chain home? And what more needs to be done for us to continue to invest in the research and development for us to have those best technologies out there so we can be a leader again in the processing of these critical minerals for our national security and for other elements of our energy security? This was, again, a great example right in Arizona with Arizona jobs, Arizona research. What else can we do in order to encourage that kind of investment, that kind of research, to address this issue?

Dr. DUESTERBERG. This is Tom Dueterberg. I'll take a stab at that.

First, I think it's important to continue to do research on alternative sources of materials. There are companies out there, I know that Toyota is working on, for instance, an alternative to the lithium-ion battery. I don't know how far along that is, but that's one thing.

We can incentivize research through building basic knowledge through our national labs. We do need to devote a bigger proportion of our federal budget to basic research, including in things like processing technology.

Finally, I would just note, Senator, on rare earths, as you probably know, which offers tax incentives both to the producers and to the consumers of rare earth products that would probably, you know, be somewhat costly although the numbers are not huge because rare earths are, they're vital, but they're not huge in quantity. But that sort of approach might be worth taking a look at as well.

Senator MCSALLY. Great, thank you.

Mr. MOORES. I have comments.

Senator MCSALLY. Yes?

Mr. MOORES. Thanks, Senator.

I think there's twofold from my experience and my perspective. One is actually encouraging the industry—supersized battery plants, more of them to be located within the U.S. So actually the business already exists for companies like Urbix to actually sell to customers within the domestic U.S. because at the moment all the customers are in Asia.

Senator MCSALLY. Yes.

Mr. MOORES. And so that's, kind of, the base level. But then you look at what the European Union does, it's quite interesting. They have founded the European Institute of Innovation and Technology which allows, it's kind of focused on identifying early stage companies like this and giving them access to, basically, debt capital, easy money. They call it "no recourse" capital, but it allows them to better their technologies to a stage that attracts capital from the private markets. And I think those two combined helps start creating this ecosystem, this lithium-ion economy for the USA where things like graphite and what Urbix are doing are crucially impor-

tant because 84 percent of that material is produced in China and none is produced in the U.S. So yeah, that's my comments.

Senator MCSALLY. Great, thank you.

Thank you, Madam Chair.

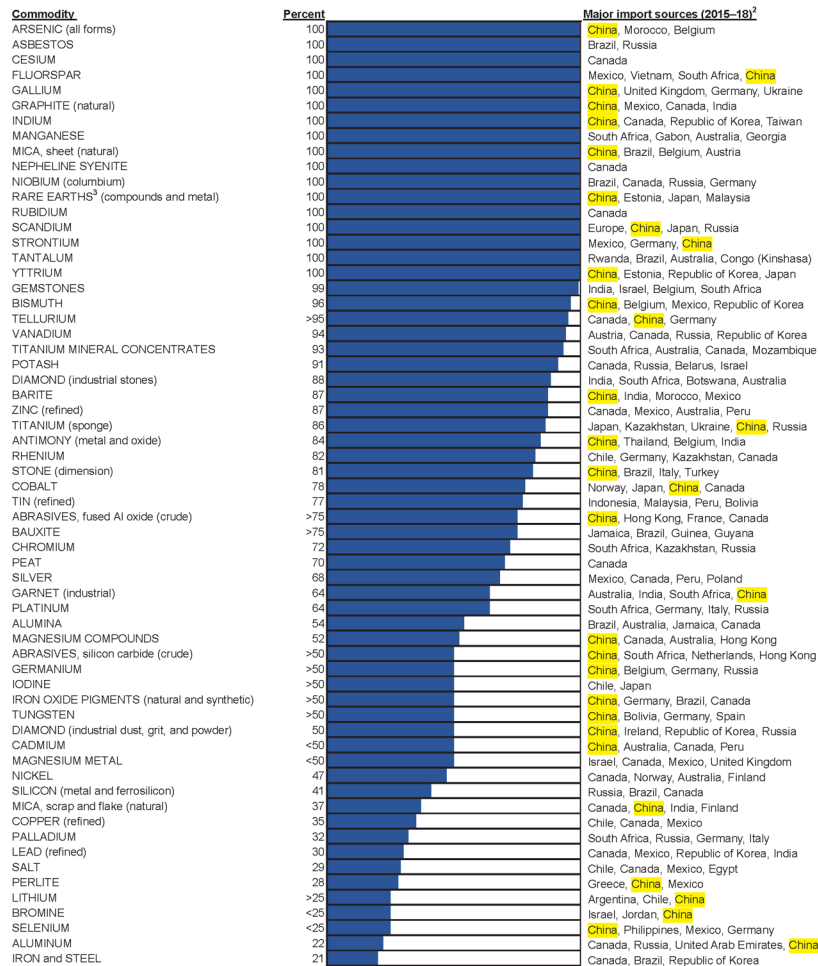
The CHAIRMAN. Thank you, Senator McSally.

Let's go to Senator Daines.

Senator DAINES. Thank you, Chair Murkowski.

Behind me is the USGS' 2019 list of mineral companies and commodities that the United States is relying on for foreign countries for imports.

[USGS Charts Displayed—2019 U.S. Net Import Reliance chart follows:]

2019 U.S. NET IMPORT RELIANCE¹

¹Not all mineral commodities covered in this publication are listed here. Those not shown include mineral commodities for which the United States is a net exporter (abrasives, metallic, boron, clays, diatomite, gold, helium, iron and steel scrap, iron ore, kyanite, molybdenum concentrates, sand and gravel, industrial, soda ash, titanium dioxide pigment, wollastonite, zeolites, and zirconium mineral concentrates) or less than 21% import reliant (beryllium, cement, feldspar, gypsum, iron and steel slag, lime, nitrogen (fixed)-ammonia, phosphate rock, pumice, sand and gravel, construction stone, crushed, sulfur, talc and pyrophyllite, and vermiculite). For some mineral commodities (hafnium, mercury, quartz crystal, industrial, thallium, and thorium), not enough information is available to calculate the exact percentage of import reliance.

²In descending order of import share.

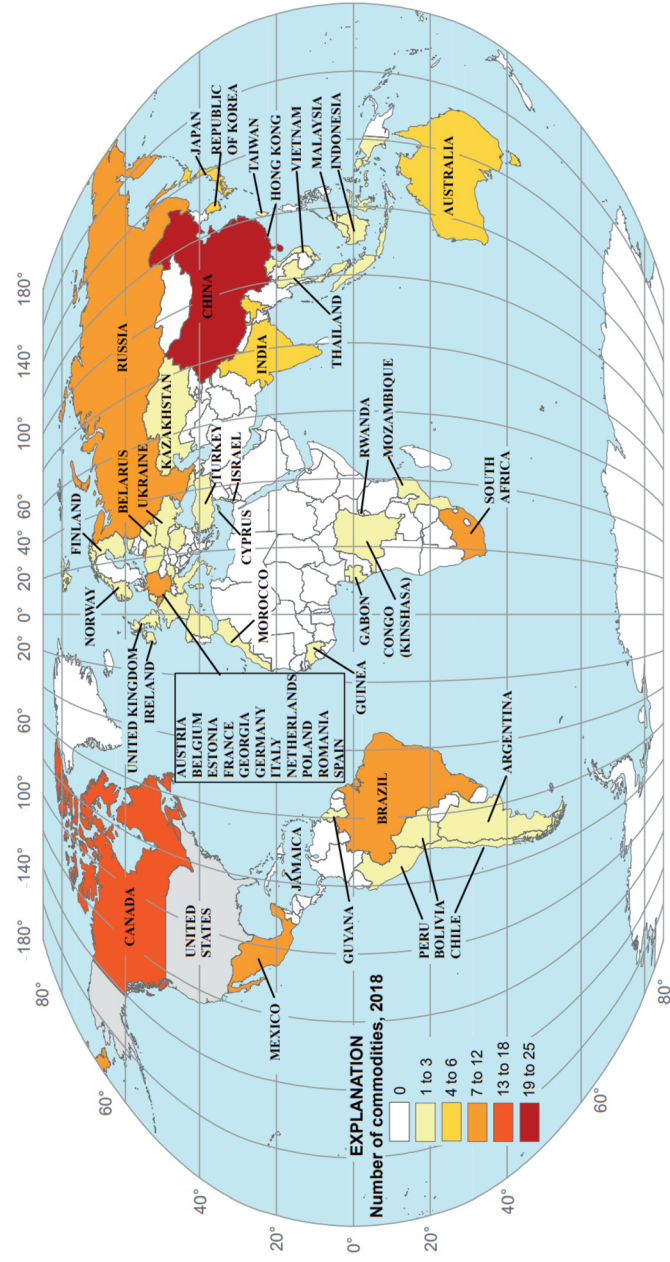
³Data include lanthanides.

Senator DAINES. I want to highlight a few things. You can see in the chart we are dependent on China for over half of the 62 minerals on the list. It is highlighted there in yellow. Other countries we are dependent on for critical minerals on this list include Russia, Argentina, Vietnam, Rwanda and many more. But being 100 percent reliant on imports for a product or a commodity import is never good for supply chain reliability. However, being 100 percent import reliant on China or Russia for materials for our healthcare system, for energy industry and technology sectors is a national security nightmare.

This next map shows the different countries that we are more than 50 percent reliant on for mineral commodities.

[Major Import Sources of Nonfuel Mineral Commodities chart follows:]

**MAJOR IMPORT SOURCES OF NONFUEL MINERAL COMMODITIES
FOR WHICH THE UNITED STATES WAS GREATER THAN 50% NET IMPORT RELIANT IN 2018**



Source: U.S. Geological Survey

Senator DAINES. You will notice that China is the darkest color on the map. It is scary that the United States has gotten to this point, especially since we have many of these resources in our very own backyard in the United States. We don't need to be so dependent on foreign countries for these critical minerals. However, when it takes over two decades to permit a mine in the United States, like it has for the Rock Creek Mine in Montana, it is no wonder we are being forced to rely on foreign countries. We need to bring these high-paying mining jobs back to the United States and back to Montana. In fact, in Montana the average mining job paid an annual wage of nearly \$90,000. That is double the average wage for Montana which is about \$45,000 a year.

Increasing our domestic production of critical minerals will create jobs, high-paying jobs, twice the state average wage, generate revenue for our rural communities and bolster our national security. Bringing the production back to the United States will help ensure that we have a steady and a reliable system and stream of the critical minerals that are used in our healthcare system and modern technology every day. COVID-19 has shown us that we need to bring back manufacturing jobs in the United States and increase our domestic mining capacity. The U.S. should never, never be in a position where we are beholden to China or to Russia for supplies to keep our country safe and healthy, especially when we have many of these minerals in the United States. I need to be focused. We need to focus more on the issue. I am excited to talk about it more today.

I want to start with Dr. Duesterberg. You said in your written testimony that in order to compete with China we need to lower regulatory barriers. We have mines in Montana that have taken decades, decades to federally permit. Even when the Federal Government is minimally involved, it can take a decade of testing before a mine is permitted in Montana alone. How do these lengthy delays increase our dependence on China and increase national security risks and how do we lower these regulatory barriers?

Dr. DUESTERBERG. Well Senator, thank you for the question. I think it's obvious that these lengthy delays are disastrous for trying to—[Dr. Duesterberg's video froze]—China, but also dominance in Russia and things like uranium production. But I think we ought to consider for critical materials some time limit on the permitting process. There will have to be coordination between state and federal permitting authorities but I think it's, if we're going to be serious about this, we have to find a way to put some limits on, temporal limits on the permitting.

We also need to think through what critical regulations really are, how critical they are and try to roll back some that are not cost-effective, especially, again, for critical materials.

Senator DAINES. Thank you.

I want to ask a question of Mr. Nassar. Many of the minerals on your critical minerals list are used in the healthcare system, including medications, medical equipment and more. Many of those we also are heavily import reliant upon. Did you take into consideration the medical supply chain and import sources when creating the critical minerals list?

Dr. NASSAR. Thank you, Senator, for that question. It's always great to see USGS data up there.

So you're absolutely right. Minerals are used throughout the healthcare industry, whether it's pharmaceuticals, diagnostic imaging, surgical equipment, even dental, right? So even a single commodity like platinum is used in over 50 percent of anti-cancer drugs. It's used in biomedical devices, et cetera. The list goes on and on.

In terms of our critical minerals list—and it is a Federal Government approach through the interagency, not just a USGS list—we took into account both production concentration and import reliance and in our latest attempt we looked into economic vulnerability. And so by definition we looked at whether or not that commodity is used in industries that are important to the U.S. economy.

Senator DAINES. So the problem also is not just where something is mined, I might note, but also where it is processed. Montana mines a lot of copper and because of that we are less import reliant. However, the number of copper smelters in the United States is dwindling while China is building new ones. How would processing dependence affect the critical mineral list?

Dr. NASSAR. In developing the critical minerals list we look at multiple supply chain stages, wherever we are able to obtain data. So we would look at the mining production concentration as well as the smelting and refining stages. And so, if the bottleneck occurs further downstream, we're able to capture that and use that information to highlight that in terms of which commodities are most critical.

Senator DAINES. Thank you, Mr. Nassar.

Thanks, Chairman Murkowski.

The CHAIRMAN. Thank you, Senator Daines.

I want to go back to you, Mr. Moores. It was both you and, I believe it was Mr. Bryan, I think it was you, Mr. Bryan, that said the U.S. is getting lapped by China which we know. We talk about a lot but you also say and Europe. And Mr. Moores, you have said the same. Again, we often talk about mineral and battery manufacturing in China and other Asian countries, but Mr. Moores, you mentioned that more European countries are now making it a priority to onshore additional components of the battery supply chain.

I would ask you first, Mr. Moores, and then we will go to you, Mr. Bryan, a little bit on what is happening in Europe and if Europe can do this, if they can get into the game, what is wrong with us over here? So Mr. Moores, you first on the European investment.

Mr. MOORES. Thank you, Senator Murkowski.

Within Europe they are building battery plants much quicker than the U.S. and we've got 16 of these battery megafactories in the pipeline at the moment and that's a reaction from the automotive industry, speaking with the government level and identifying a need for the independent, European independent, battery production. And the way they've done this, really, considering there was hardly any lithium-ion battery production within Europe before, as it's been the European Union, they firstly discussed the subject, discussed again and treated it like we do in these hearings,

like we do at our conferences at Benchmark. Then they identified the problems and companies that can come to the solution and then they gave access to the capital.

So the way they did this first was they created this EU Battery Alliance to discuss these issues and bring industry together with government and together with financiers. Then they created the second phase which was this European Institute of Innovation and Technology and the commercial arm of that called Commercial Partnership for Inner Energy. They then identified companies that could be, smaller companies that are going to be part of the supply chain going forward. And the third part, the European Investment Bank came on board as well and helped with access to debt capital. And those three components actually sparked one of the highest—one of the most successful cases is the development of Northvolt. Northvolt, a European-based, lithium-ion battery producer. They're not in production yet, but they are already planning their second plant in Germany. And so, the way they've been described by Henry Sanderson at Financial Times was "the airbus of the battery industry." And that's exactly what the U.S. needs to be doing. They've created a champion. It's encouraging more industry and more people to get involved in the supply chain, and it's starting to go out toward the upstream, toward the cathode manufacturing as well.

The next step up to cathode is, of course, the raw materials and that's now, as a result, getting more attention. So that's, kind of, how they did it.

The CHAIRMAN. So very coordinated or, certainly, collaborative strategy.

Mr. Bryan, do you want to speak to that?

Mr. BRYAN. So Mr. Moores knows this far better than probably anybody in the industry, but I'd only point, as a point of reference, note the scale of the European's investment. Just one of the tranches of funding that came out of this, came out of the EU, last December they put \$3.5 billion into supply chain investments. Three and a half billion dollars, that's one tranche. I think the European Investment Bank has said that something like \$100 billion has been channeled to the battery supply chain. So the scale of their effort is, we sort of pale in comparison to that, notwithstanding your efforts, Madam Chairman.

The other thing I would say is post-COVID, it's interesting, I think Europeans have seen support for electrification and the supply chain in their stimulus packages. I know Germany and France have both targeted those industries as part of their stimulus. And I think the reason for that is we, obviously—countries are going to want to recover what they have lost, but they also are seeing this as an inflection point for them to decide where they want to be in the future. And so, I think they've taken advantage of that opportunity and have, sort of, doubled down on it. And I think we're in the same position as we assess where we are and where we're going, but the scale of their commitment has been, I'll say, impressive.

The CHAIRMAN. Well, I would agree, and I think it is something that we need to pay attention to.

You mentioned this inflection point. Bloomberg recently ran an article entitled, "Supply Chains of 2020 Needing Repair Now are the Banks of 2008." That article references a Michigan State University, or a white paper from Michigan State. They assert that companies need to take action immediately in order to shore up supply chains and that low cost should no longer be the only consideration. Dr. Duesterberg, I will ask you, what do you think about that? Do you think U.S. companies should do this once in a generation overhaul of their supply chains?

You have your mute button on, Dr. Duesterberg. There you go. Dr. DUESTERBERG. Sorry about that.

I do think we need quite a bit more attention on vulnerabilities of supply chains. We've talked about that all morning. And I would note that U.S. industry is already aware of that and they're slowly making moves to achieve more resilience, move supply chains out of China where possible. But again, partly like mining, you can't do this overnight. So there does need to be a national commitment. We can think of ways where we can incentivize companies to take these steps.

If I may just make a quick comment about Europe and two things. Number one, the support of national champions including battery makers in Europe is going to lead to some questions about their subsidization of industry. We're in danger of having a subsidy war with our European friends the way things are moving now. And second, they can't build batteries without getting access to the same raw materials that we do and that those raw materials are controlled more by China than anyplace else for batteries. China is well known for exercising leverage, political leverage, over countries that are dependent on them. Europe is already dependent on China for sales of autos. If they're going to be dependent on China for a new major thrust in industry like lithium-ion batteries, they become more vulnerable to political pressure from China and that will—[Dr. Duesterberg's video froze]—which, I think, dangerous in the long run.

The CHAIRMAN. Thank you, Dr. Duesterberg.

Mr. Moores, I want to go back to you and, kind of, key into a question that I think Senator King might have asked were he here. He suggested that given the vulnerability, the reliance that we have on foreign nations, many of them are adversaries, that it might, might, be something to consider to pay effectively a premium for domestic production. So to you, Mr. Moores, are you seeing any signs that U.S. companies and manufacturers view supply chains as a vulnerability and are therefore willing to invest or to pay a bit more for the raw materials to improve a level of resiliency?

Mr. MOORES. That is a good question. We are seeing automotive companies that are aware they need the battery cell capacity and when you get to that stage it's very clear lithium-ion batteries are all about the raw materials. And so I would say, not yet, that the investment is not coming from the downstream fully to build these new resources domestically within the U.S. and the question actually is whether it's, whether the supply chain is more integrated, that's the key thing I think. You know, it's not just having the cobalt mined and then you're selling it to make precursor. It's actu-

ally having the people that make the precursor own the cobalt mine. Or the lithium—lithium is quite integrated because it comes from brine in South America, but the people that own the resorts actually own the chemical processing facility that makes battery-grade lithium to go into a lithium-ion battery. So that's the model.

Mining companies have to become chemical companies and integrate it and that way, actually, the costs, generally, the cost sensitivity within the supply chains is reduced. And actually you can, the business cases are already there with junior mining companies, development companies in the U.S. They can actually build these things economically if there was a domestic industry, if there was cathode and anode manufacturers within the U.S. they could sell to, if there was battery manufacturing and the demand there. And so I would say you can get around paying a premium for the raw materials if the supply chain is more integrated, and that's where the industry is going. So it all comes back to encouraging supersized battery plants to be built within the U.S. Cathode manufacturing is so critical. The U.S. needs a giga-cathode manufacturing facility. Tesla would be able to take the majority of it with its new plants. LG Chem is going to need cathode as well as they build out their domestic U.S. facilities. So I would say supply chain integration is the way forward rather than just paying a premium for raw materials.

The CHAIRMAN. Now I appreciate that and it speaks to what we are seeing with this clustering, the multiple steps of supply chains coming together, clustering in one region. We see them in Nevada, certainly, as we heard from Senator Cortez Masto.

I have one final question and this is probably directed to both of you, Dr. Nassar and Mr. Bryan, and this is related to stockpiling. It has been referenced briefly this morning. It is certainly one solution to increase mineral security, particularly in the defense space within the NDAA that we will again have before us here in the next few days. There is focus on critical minerals, mineral stockpiles, but can you speak just to the concept, the notion, of stockpiling raw materials as a viable solution to protect against supply disruption, particularly over the long-term?

We will go to you first, Dr. Nassar, and then Mr. Bryan.

Dr. NASSAR. Thank you, Senator.

I think stockpiling can play a very important role. It definitely is there to provide a buffer for when there is an unexpected supply disruption. The U.S. Defense Logistics Agency obviously manages the national defense stockpile, and they provide a report to Congress on a biannual basis. I think this is really useful information. They do their own shortfall analysis to try to understand what might happen under different scenarios and are able to then request purchases for the stockpile to be able to hedge against those events. It is not, by itself, a solution to supply risk, but it is an important, one of the important levers that can be pulled.

The CHAIRMAN. Mr. Bryan.

Mr. BRYAN. So, you know, I kind of agree with Mr. Nassar. I'm not an expert, certainly on stockpiling or on, even on minerals markets necessarily. My observation would be that stockpiling wouldn't be my first instinct. I'm not, it's not clear to me on the volume and the feasibility of creating a stockpile for all the volume of materials

we're going to need, not just for defense applications but certainly for the auto industry. I don't know whether it's realistic to think we're going to stockpile enough lithium to fuel our auto industry, but I'm sure it has some place.

I would also note that, you know, as Mr. Moores has made really clear, that our weaknesses throughout the supply chain, so if we have a stockpile of minerals but they're not processed and useable then I'm not sure how much good it does us. If we have to ship the stockpiled minerals to China for processing, that's probably not the most ideal scenario. So I think we have to look again holistically at the supply chain, look at what we need and figure out how we position ourselves to attract the kind of massive, massive economy changing, transforming, levels of investment that are happening globally to the United States.

The CHAIRMAN. Well, I couldn't agree more. It has to be the whole supply chain and, again, when we talk about the level of investment, we are seeing the investment in these mining activities but we are not seeing that investment here in this country. The investment, again, whether it is in extracting the raw material first off or the processing or along the chain. As you have used the term, the United States is being lapped here and it is how we, kind of, pick up our game that I think is going to be very, very important moving forward and that is why we continue to press this issue whether it is in this Committee or attempting to advance legislation like our Mineral Security Act. So we will continue with that.

I want to thank all those who have participated in the panel today, not only for your comments, your responses, but to what you are doing to lead in this very, very important area. It really is a matter of education and awareness, and I think we just need to keep that up regardless of how many times we have said what we have said and the importance and the urgency we just need to keep saying it. So thank you for that.

I want to conclude today's hearing with just a comment. It has been noted, not only in this hearing but in others, as we have talked about critical minerals, the subject of mining law reform comes up and the push for a royalty for hardrock mining on federal lands. I have said before and I will repeat, I am happy to engage on a discreet set of updates to the mining law but my minimum standard here is that we can't harm our mineral security. That, to me, is very clear and, again, it becomes more clear with every hearing that we have. But to this point, the proposals that I have seen appear to be designed to discourage mineral development on federal land and frankly that makes it hard to even begin a conversation about something viable. We often hear proponents of mining law reform make it sound like federal lands are a free for all, but that is not a reality. Approvals of operations, reclamation, bonding, these are all required. You have to have compliance with NEPA, the Clean Water Act, the Endangered Species Act, just to name a few.

Again, we hear today and we have heard in previous hearings, we are ceding a host of industries to other countries. I become concerned when I think that we might be chasing miners off of public lands and sending, really, a wrong signal here in terms of U.S. support for mining activity. So if members are interested in reasonable

legislation that acknowledges the unique challenges and the disadvantages of mining on public lands and that protects our prospectors and our miners who put tremendous time and certainly tremendous resources at risk to find, explore, prove up and develop our mineral deposits, I am ready. In the meantime, I think we are where we need to be which is focused on the greater challenges which include rebuilding our supply chains and ensuring that our nation is strong and competitive.

Again, we will continue these good and important and timely discussions here in this Committee, and we thank you all for contributing to the debate today.

With that, the Committee stands adjourned.

[Whereupon, at 11:31 a.m. the hearing was adjourned.]

APPENDIX MATERIAL SUBMITTED

Question for the Record Submitted to Dr. Nedal T. Nassar
 Senate Committee on Energy and Natural Resources
 Oversight Hearing on *The Impacts of COVID-19 on Mineral Supply Chains*
 June 24, 2020

Question from Ranking Member Joe Manchin III

Question: The U.S. is a net exporter for a handful of minerals. Of the minerals for which the U.S. is a net exporter, have there been any trends involving a decrease in the commodities export percentage, and what is the reason for the decrease?

Response: In 2019, the United States was a net exporter¹ of 18 nonfuel mineral commodities: abrasives (metallic), boron, clays, diatomite, gold, helium, iron and steel scrap, iron ore, kyanite and related minerals, molybdenum concentrates, rare earth mineral concentrates, sand and gravel (industrial), soda ash, titanium dioxide pigment, wollastonite, zeolites (natural), zinc ores and concentrates, and zirconium ores and concentrates. Additionally, the United States was previously a net exporter of alumina (recently in years 2011, 2014, 2015, and 2016), cadmium (for certain forms), and selenium (2007-2017).

Over the past 5 years (2015-2019), U.S. exports have either increased (e.g., for iron ore) or not declined in a significant and progressive manner for any of the above-mentioned commodities except alumina.² U.S. alumina³ exports have declined from 2,210 thousand metric tons (\$912 million in value) in 2015 to 200 thousand metric tons (\$391 million in value) in 2019. Over the past five years, U.S. alumina exports have been shipped to more than 100 countries, with Canada being the largest export partner. The decline in U.S. exports of alumina can be attributed to decreased production resulting from the closure of two alumina refineries in 2016.⁴ Importantly, U.S alumina production is derived exclusively from imported metallurgical-grade bauxite.

¹ As reported in the 2020 Mineral Commodity Summaries (USGS, 2020) on the basis of quantity.

² U.S. exports of a few of the above-mentioned commodities (e.g., certain forms of cadmium, gold, selenium, and titanium dioxide pigments) have declined in recent years but none have had both their export quantities and export values decline in such a significant manner as they have for alumina.

³ Specifically, aluminum oxide (HTS code 2818.20.0000) and aluminum hydroxide (HTS code 2818.30.0000), combined using calcined weight equivalence.

⁴ In September 2016, Sherwin Alumina Co. LLC (a subsidiary of Glencore International AG) permanently shut down its 1.65-Mt/yr. refinery in Gregory, TX. Sherwin filed for bankruptcy protection in January 2016 citing a price dispute with its bauxite supplier, Noranda Aluminum Holding Corp. (Franklin, TN), and low prices for alumina. Alcoa Corp.'s 2.3-Mt/yr. alumina refinery in Point Comfort, TX, was temporarily shut down in March 2016. In December 2019, Alcoa Corp. announced that this refinery was now permanently closed.

**U.S. Senate Committee on Energy and Natural Resources
June 24, 2020 Hearing: *The Impacts of COVID-19 on Mineral Supply Chains,
the Role of those Supply Chains in Economic and National Security,
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Questions for the Record Submitted to Mr. Mark Caffarey**

Questions from Ranking Member Joe Manchin III

Question 1: While the United States has some supply of minerals, we don't have every mineral our economy demands. Recycling offers a viable way to reduce our import reliance on critical minerals.

a. What policies are needed from Congress to take you to the next level?

The prospect of significantly increased manufacturing and deployment of electric vehicles and stationary storage both of which require batteries (lithium ion as the predominant chemistry at the moment)—necessitates that our nation consider the resources needed for these batteries. This mobility transformation needs a broad portfolio of material technologies and circular economy services to reach the next level of sustainability. Umicore is an important stakeholder in this technology challenge. While recycling technology for these batteries exists today, no end refiners of these materials are located in the United States. This is in large part because of the lack of policy that could increase collection of end of life batteries and electronic waste or the lack of battery or electronics manufacturing in the US. Our comments lay out policy recommendations to establish that market, thereby retaining or recouping much of the value from batteries deployed here in the U.S.

Collection.

Collection policies occur at the state and local level. These policies are inconsistent, not uniform, nor do they conform to any set of best practices.¹

Policy Recommendation #1: The federal government should develop, in coordination with state and local leaders as well as private sector participants, best practices for collection that can be shared and cost-effectively and easily implemented by state and local governments. This could include best practices for banning landfill of collected portable batteries and all industrial and automotive batteries.

Policy Recommendation #2: Create a cash prize program for local and state governments that demonstrate excellence in collection processes for end of life electronics and batteries.

Policy Recommendation #3: Create incentive for retailers to become collection points for end of life portable electronics and portable lithium ion batteries.

Policy Recommendation #4: Create appropriate monitoring procedures to ensure that collected electronics and lithium ion batteries are properly channeled into high quality certified recycling streams to prevent mismanagement. Promote certification bodies such as R2, E-Stewards, and CENELEC. The Department of Energy has made some strides in this area by creating the Lithium Ion Battery Recycling Prize. Umicore is a participant, and with our partners we are creating a nationwide collection network for end of life electric vehicle batteries that end up in automotive scrapyards. For more information, please visit <https://www.herox.com/BatteryRecyclingPrize>.

¹ <https://www.call2recycle.org/recycling-laws-by-state/>

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Federal Government Leading by Example.

The federal government should be the steward of its own resources and implement policies throughout federal agencies for recycling.

Policy Recommendation #5: Develop guidelines for federal recycling of electronics and batteries with which agencies would be required to comply.

Policy Recommendation #6: Require that the federal government report annually on amount of recycling achieved through their own collection program.

Manufacturing Partners.

Manufacturers of vehicles, batteries and e-waste could bear some responsibility for reusing or recycling critical materials from batteries they produce, use and sell.

Policy Recommendation #7: Create voluntary program modeled on, the US developed, Energy Star for manufacturers to clearly label their products such that consumers understand that they are able to return them to a specific place.

Policy Recommendation #8: Similar to a bottle bill, require that manufacturers build in pricing (like an Environmental Handling Fee) such that there is incentive for purchasers to return electronics and batteries for recycling and reuse.

Policy Recommendation #9: Require that manufacturers label their products with recycling metrics so that consumers are able to clearly understand what portion of the materials are recycled.

Policy Recommendation #10: Incentivize manufacturers to design products to make the recycling process easier. Similar to the recent EU proposal.²

Consumers.

Consumers should have knowledge of and incentives to return electronics and batteries to appropriate collection points.

Policy Recommendation #11: Ensure consumer education through Ad Council campaign (similar to anti-litter campaigns) with national website pointing to local collection points. Potentially work with Call2Recycle.

Policy Recommendation #12: Create incentives for state & local governments to educate their constituents on local options for battery and e-waste recycling.

Recyclers.

Participants throughout the recycling supply chain—especially pre-processors, dismantlers, and refiners--should be incentivized to build facilities in the U.S. and hire staff for those facilities.

Policy Recommendation #13: Continue DOE Battery Recycling Prize Program, with additional funding for pilot programs.

² The European Union recently proposed this model:
https://resource-recycling.com/e-scrap/2019/08/15/eu-seeks-to-incentivize-design-for-recycling/?utm_medium=email&utm_source=internal&utm_campaign=Aug+15+ESN

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Policy Recommendation #14: Incentive recyclers to become certified through one of the major certification bodies to ensure their practices are safe for human and environmental health.

Incentivize all members of the recycling chain to work with certified recyclers globally.

Policy Recommendation #15: Provide tax credits, loans, and other incentives for certified recyclers along the full recycling chain to build processing plants in the U.S. in order to join the global supply chain.

Policy Recommendation #16: Require that the Department of Labor deliver an annual report on jobs created in the electronic and battery recycling industry.

b. What do you view as the biggest gap in federal laws when it comes to metal recycling?

The biggest issue with federal law when it comes to critical minerals recycling is lack of legislation regarding collection. Recycling is a chain; therefore, each step is highly dependent on the one that comes before. Collection is the first step in that chain and where most of the opportunities lie for policymaking and job creation. Implementing any of the policies listed above could significantly increase the materials in the recycling supply chain which, in turn, would decrease the need for new raw materials.

Question 2: Over the last several months, we have seen projects held up, in part, because of supply chain disruptions due to restrictions on imports from the coronavirus. We need to make American businesses competitive on the global stage in clean energy manufacturing, and I have been examining several existing frameworks, like the clean energy manufacturing tax credit, as ways to do that.

a. Do you believe we need to be shoring up our domestic supply chains in this way?

As I discussed in my testimony, the level of U.S. dependence on certain materials could be cause for concern depending the location of those materials. For example, the U.S. is the biggest customer of germanium, 70% of which is produced and refined in China and Russia. Umicore's plant in Quapaw, OK, recycles germanium. Lessening dependence on these resources and focusing more on recycling could increase the security of germanium supplies. Over half of the global supply of cobalt is sourced from the Democratic Republic of Congo which has a history of poor worker treatment, including child labor. In this case, Umicore has introduced a first of its kind Sustainable Procurement Framework for cobalt and is the first to obtain external validation for its ethical procurement approach in this area.

In March 2018, Umicore submitted comments on the Department of Interior draft list of critical materials; those [comments](#) indicate Umicore's expert view on the criticality of these materials. Umicore would urge that Congress take into consideration the global nature of natural resources and put into place measures that will secure these minerals—whether within or outside of the U.S. borders. This could include certification of recyclers and creating programs such as the [Battery Passport](#), a digital record that tracks information about

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the battery along the entire life cycle, starting with raw material extraction to the stage of end-of-life where batteries are recycled. In each step of the battery's life, essential information would be registered on the passport. Verification mechanisms need to be developed to ensure that the information added to the passport is reliable. Umicore believes that third-party validation is required for crucial information along the supply chain, including data about the raw material origin and the carbon footprint of production steps. The Global Battery Alliance (through the World Economic Forum) developed a battery passport proposal; the U.S. government could recognize the battery passport to increase the potential for global recycling that can lead to economic benefits and mineral security for the U.S.

Thus, rather than focusing solely on ensuring minerals are sourced in the U.S., we recommend taking a holistic approach that includes recycling, certification, and policy strategies developed by international allies to shore up supply chains.

- b. Are you familiar with the clean energy manufacturing tax credit, and do you believe it or some other federal tools would be helpful in strengthening our domestic supply chains?

Umicore supports incentives, including tax credits, to encourage the siting of manufacturing facilities in the U.S. As Umicore considers development of a facility in the U.S., we look to state and federal support to ensure full and fair competition based, not only on price, but also on quality of output, experience in the industry, and efficiency of material production. Umicore foresees a bright future for critical material recycling in the U.S., provided that incentives and collection policies, as discussed in the previous question, are put into place.

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Questions from Ranking Member Joe Manchin III

Questions: Alternatives to critical minerals, such as synthetic graphite, can help to reduce our reliance on foreign supplies.

- a. How can we incentivize the expansion of these substitute materials in U.S. manufacturing?
- b. What do you believe is the proper role for the federal government in this process?

Responses:

- a. Mining and processing of raw metals are both capital intensive industries. It would be helpful to have 100% expensing of capital expenditures for mining and building needed processing facilities. If a blanket extension of full expensing is not feasible, it would at least be helpful to designate critical materials as defined by the Departments of the Interior, Defense and Energy to be eligible for such treatment. A second set of incentives would be in substantially reducing regulatory barriers to opening new mines or reopening older ones. Processing plants are also crucial to rebuilding domestic industry and regulatory barriers need to be reduced. Strict time limits for completing all environmental and land use reviews, perhaps designating a three year window, are needed especially but not exclusively for critical materials and associated processing facilities. Building robust stockpiles of critical materials at the Federal level could also help incentivize domestic production, especially a strict application of buy American rules for Federally funded stockpiles, to the extent feasible. Finally, in my written testimony I suggested that the Committee at least evaluate Senator Cruz's legislation to grant tax credits for purchase of domestically produced rare earths.
- b. As noted above, Federal tax, procurement and regulatory policy are key to improving the economic attractiveness of producing domestically. Designation of a robust list of critical materials should not be limited to defense related materials and end products reliant upon them. My testimony noted important high technology sectors, such as semiconductors, lasers, fiber optic cables, and telecommunications equipment which are important both economically and to national security. The Federal government has an important role to play in analyzing the need for the basic metals needed for national defense but also for economic resilience in the face of unfair competition from major actors such as China. While trade policy can help to combat Chinese mercantilism, it is crucial that interagency teams understand the need for economic viability of industries that produce essential dual-use products such as semiconductors. The Department of Defense has undertaken just such an exercise for semiconductors, but other such studies on foundational technologies are needed and

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the Departments of Energy and Commerce especially have key roles to play. The basic research function of the Federal government, largely through the National Science Foundation, is important to further the materials science needed not only to support existing mining and processing technologies, but to find new ways to meet national needs for resilience and self-sufficiency. If substitute technologies can be found for industries at risk, such as lithium ion batteries, it would clearly reduce dependency on foreign suppliers. Finally, ensuring a skilled workforce, both at the research and specialized production worker levels is an essential role for the Federal government working in conjunction with state and local education providers.

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Questions from Ranking Member Joe Manchin III

Questions: Electric vehicles can play a key role in curbing greenhouse gas emissions in the transportation sector, and prior to the pandemic, it was projected that electric vehicle prices would drop to be comparable to combustion engine vehicles in the next two years.

a. Has the pandemic impacted the costs of EVs?

The pandemic has not directly and immediately impacted the cost of EVs today but the disruption will delay the build out of the supply chain – the building of more battery capacity worldwide – and will add to raw material price volatility in the longer term.

Lithium ion battery cells are 30-35% average cost of an EV.

b. When do you think EVs will become more affordable?

EVs will become more affordable when the industry can reach a lithium ion battery cell purchase price of under \$100/kWh consistently. Right now, the average for large contract, automotive battery cells is \$125/kWh. For smaller autos this can go up to \$170/kWh.

(Note: for context in 2016 this was ~\$300/kWh so much progress has been made).

The big EV makers need to be able to manage their costs under \$100/kWh for the long term and as 80% of the costs of a battery cell are raw materials – minerals, metals, chemicals – this is only achieved through secure, predictable supply of these materials.

Secure, predictable supply means investing in new capacity in the USA to help increase scale, reduce links in the supply chain, reduce logistics distance and therefore reduce overall cost of these raw materials.

At Benchmark, we expected 2024/2025 to now be the year when the consumer can walk into a showroom and choose from a good selection (>5) EVs under \$30,000.



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June 23, 2020

The Honorable Lisa Murkowski
Chairman
Committee on Energy & Natural Resources
U.S. Senate
304 Dirksen Senate Building
Washington, D.C. 20510

The Honorable Joe Manchin
Ranking Member
Committee on Energy & Natural Resources
U.S. Senate
304 Dirksen Senate Building
Washington, D.C. 20510

Re: AEMA Statement for the Record for the June 24, 2020 Committee on Energy & Natural Resources Hearing on the Impact of COVID-19 on Mineral Supply Chains

Dear Chairman Murkowski and Ranking Member Manchin,

I write today on behalf of the American Exploration & Mining Association (AEMA) in support of your important efforts to rebuild America's mineral supply chains.

The recent coronavirus pandemic and resulting global supply chain issues highlight the importance of an abundant and affordable supply of domestic minerals for America's future. Mining is the beginning of the supply chain for virtually every sector of our economy, including infrastructure, healthcare, renewable energy, and all types of manufacturing. Just as this pandemic has highlighted the need to bring pharmaceutical manufacturing back to the U.S., as our economy starts opening up it is critical that we revitalize our nation's manufacturing sector. To accomplish that objective, we must responsibly mine domestic sources of the raw materials required to drive that economic engine.

Unfortunately, a lack of access to economically viable mineral deposits and a lengthy, inefficient federal permitting system has resulted in the U.S. being increasingly dependent on foreign sources of strategic and critical minerals. It's time that we as a Nation recognize this vulnerability and the vital importance of minerals to our national security, our economy and our everyday lives. We have heard a lot over the years about the importance of energy independence, but it is equally as important, if not more so, that we are minerals independent.

The most recent USGS *Mineral Commodity Summaries* published in 2020 indicates that the U.S. is now import-dependent for 46 different metals and minerals – and 100 percent import-dependent for 17 of those. That's half of the naturally-occurring elements on the Periodic Table, most of which can be mined in the U.S. Our mineral dependency is at a record-high, now double what it was 20 years ago. Today, less than half of the mineral needs of U.S. manufacturing are met from domestically mined resources.

Mining makes every aspect of our lives possible. Most people never think about the pivotal role mining plays in their lifestyle and standard of living, but mined products are key to the advanced,

technological, comfortable and more healthful existence we enjoy. Like food and water, energy and minerals are essential. We are fortunate that America is blessed with a rich mineral endowment, and it is more important than ever to responsibly utilize our own mineral resources. In fact, it is a national imperative.

Congress has acknowledged repeatedly the importance of a strong domestic mining industry. The *Federal Land Policy and Management Act* of 1976 (FLPMA) 43 U.S.C. 17.01 *et seq* lists twelve policies with respect to the public lands of the United States. Section 102(a)(12) states that it is the policy of the United States that:

the public lands be managed in a manner which recognizes the Nation's need for domestic sources of minerals, food, timber and fiber from the public lands including implementation of the *Mining and Minerals Policy Act* of 1970 (30 U.S.C. 21a) as it pertains to the public lands;

The *Mining and Minerals Policy Act* of 1970 declares, in part:

[t]hat it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries,

We are grateful for your efforts to highlight the current supply chain problems and implement solutions. It is important that legislation such as S. 1317, the American Mineral Security Act, advances to help address these issues. It is equally important that Congress reject legislation currently being considered that would thwart development of our nation's mineral resources, such as H.R. 2579, S. 1386, and H.R. 5598.

The Mining Law, as amended, invites U.S. citizens to make substantial investments of time, knowledge, and money to explore for minerals on federal lands with the hope of discovering a mineral deposit that can be developed into a mine. This process, known as "self-initiation," greatly benefits our Nation because it effectively leverages private investments that transform undeveloped federal land into mining operations that create jobs, pay taxes, and provide the minerals the country needs – at no expense whatsoever to U.S. taxpayers.

Because mineral deposits are rare and unique geologic phenomena, they are very difficult to find. In a 1999 report, the National Research Council of the National Academy of Sciences recognized just how rare economically viable mineral deposits are: "Only a very small portion of Earth's continental crust (less than 0.01%) contains economically viable mineral deposits. Thus, mines can only be located in those few places where economically viable deposits were formed and discovered." *Hardrock Mining on Federal Lands*, National Research Council, National Academy Press, 1999, p. 2-3.

Keeping lands open to exploration and development improves the odds of finding "the needle in the haystack" mineral deposit that can be developed into a mine. Conversely, withdrawing land from operation of the Mining Law and restricting the amount of land that can be explored diminishes the odds of discovery, interferes with the Mining Law's self-initiation process, and severely compromises the Nation's ability to capitalize on private-sector investments to discover and develop domestic mineral deposits. The Department of the Interior estimates that over 50 percent of federal land is *already* off limits to mining.

The U.S. minerals industry operates in a highly competitive global environment. The search for new mineral deposits occurs around the globe. Major mining companies operate internationally and weigh many factors in determining whether the potential return on mineral investment is worth the geologic, economic and political risk.

There can be no question that mining creates new wealth and provides high paying jobs with an indirect job multiplier more than twice the national average. As mining companies weigh the geology/mineral potential, economic and political risk, they will invest in mineral development where they can obtain access to the land; access to regulatory approvals; access to capital; and access to the resources necessary to build and operate the mine such as people, water and energy.

We also are in a period of resource nationalism where many countries, led by China, are asserting control over natural resources located within their country. Unlike the Arab oil embargo of the early 70's, countries like China are using resource nationalism not to control the market or the market price for a given commodity, but to attract long term manufacturing jobs. Manufacturing requires a stable and affordable supply of metals and minerals. In a nutshell, resource nationalism says, "if you want our minerals, locate your manufacturing facility in our country."

If the U.S. is going to compete in this global mineral environment fueled by resource nationalism, it must adopt policies that guarantee access to lands with mineral deposits, must provide a competitive tax regime, and must reduce permitting delays.

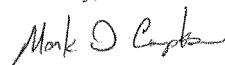
It is important to note that the streamlining of the mine permitting process does not equate to reducing environmental protections. Environmental safeguards, an efficient regulatory system, and environmental stewardship are vital components of any mining project. However, just as the Covid-19 experience exposed vulnerabilities in PPE and pharmaceutical supply chains in the U.S., we now understand that we must take action before a crisis or a conflict hits. Now is the time to address our regulatory regime and ways to foster a more robust mineral supply chain.

Thank you again for your leadership and attention to this important matter. We appreciate your efforts to keep the American economy strong and your consideration of the needs and concerns of the men and women in the mining industry. The mining industry is well-positioned to create thousands of jobs that typically pay well above the median for the communities in which they are or would be located. In fact, mining jobs typically pay more than twice the average wage in many states. Many potential projects are already in the permitting pipeline and are "shovel ready" or could be within a relatively short time.

The economic impact of mining ripples out far and wide: to employees, mine suppliers, local economies and the downstream domestic industries we supply with our products. That's not to mention the tax revenues we generate for local, state and federal governments as a result of this economic activity. Few industries pack such an economic punch.

We look forward to continuing to work with you to ensure America has a secure and affordable supply of the minerals and metals needed for our modern society.

Sincerely,



Mark Compton
Executive Director

EVOLUTIONMETALS



To: U.S. Senate Committee on Energy and Natural Resources

Attn: Sen. Lisa Murkowski, Chairwoman
Sen. Joe Manchin, Ranking Member

From: Mr. David Wilcox, President and CEO

Date: June 23, 2020

Re: *The Impacts of COVID-19 on Mineral Supply Chains, the Role of those Supply Chains in Economic and National Security, and Challenges and Opportunities to Rebuild America's Supply Chains*

Evolution Metals Corp. (EMC) wishes to commend the United States Senate and the Committee on Energy and Natural Resources for acknowledging the value of the Mineral Supply Chain, including Critical Minerals, and for holding a hearing on the matter on Wednesday, June 24th, 2020.

Additionally, we at EMC wish, for the record, to point out a few relevant points on this matter:

What Are Critical Minerals?

Critical minerals are materials, the majority of which are minor metals, that are vital to the US and Global economy: they are essential components of renewable energy, electronics and aerospace & defense.

The list of rare earth elements has evolved over the years but typically includes the lanthanides, plus yttrium and scandium. The list of critical minerals includes the rare earths plus other metals such as tantalum, niobium, copper and nickel.

The list of "critical minerals" we refer is defined by the United States Government. In 2017, Executive Order 13817 directed the United States Government to evaluate the critical minerals supply chain.

As a result, the United States Department of the Interior conducted a study and issued a white paper that designated 35 materials as critical.

The complete list of critical minerals was recorded in the Federal

Register in May 2018. What Are the Applications for Critical Minerals?

These materials are critical components of in the manufacture of electronics, renewable energy, anything that requires permanent magnets as well as aerospace & defense.

- One of the key components in electric vehicles is the battery, which requires materials such as high-grade processed lithium, nickel, cobalt and graphite.
- Electronics are highly dependent on many of these materials. Smart phones and microelectronics cannot be manufactured without them.

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- Many products we use every day rely on magnets, which are made with materials such as neodymium. Many wind turbines rely heavily on magnets. Many automobile components rely on magnets.
- Advanced alloys required to manufacture automobiles, airframes, energy transmission cables and many other products we require for the modern economy to function rely on these materials.
- In aerospace & defense these materials are required to make night-vision goggles, operate guidance & navigation systems and countless other applications. The United States has over 100 weapons systems that require materials for which a reliable supply chain does not exist. High performance systems such as the F-35 Lightning II fighter aircraft require these materials.

Without access to a reliable source of these materials we cannot operate modern industries and provide for our military defense.

Where Do Critical Minerals Come From?

For much of the 20th century, the United States was the largest producer of rare earths in the world: the California Mountain Pass mine being one of the largest producers. However, over the past decades the US has ceded leadership which resulted in China becoming the largest producer with over 80% of the market currently based in China.

What Are the Risks to The Supply Chain?

Demand for many rare earth and critical minerals has skyrocketed in recent years with the spread of high-tech devices that use a wide variety of materials and is expected to rise dramatically.

If the United States and its allies are to create high-tech jobs, transition to a greener economy and maintain modern defense capabilities they will require a secure and reliable supply of these materials.

In June 2019, the Department of Commerce issued a study entitled “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals”. This study states “The United States imports most critical mineral commodities. Specifically, the United States is import-reliant (imports are greater than 50 percent of annual consumption) for 31 of the 35 minerals designated as critical by the Department of the Interior. The United States does not have any domestic production and relies completely on imports to supply its demand for 14 critical minerals.”

The United States supply of critical minerals is heavily dependent on foreign resources which leaves the US vulnerable to supply chain disruptions related to political and natural events.

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What is Being Done About this Crisis?

There are ongoing efforts to create supply chains that are not dependent on China. Private industry is pursuing solutions. The Government and Military of the United States have issued calls for private industry to engage with them to solve the crisis. And United States has entered into agreements with allies including Canada and Australia to tackle the problem.

How Is Evolution Metals Corp. providing a Leading Solution?

Evolution Metals Corp.'s mission is to secure a reliable and sustainable supply chain of critical minerals for the US and its allies through the acquisition of development of mine assets and domestic production facilities.

EMC is establishing a vertically integrated supply chain. This effort includes investment in ore sources and processing facilities in friendly locations as well as engaging directly with the Executive Branch, Senate, and House of the United States Government to create alliances between companies and countries and develop solutions to the crisis.

EMC seeks out higher grade ore sources and technologies, which result in less environmental impact in the mining process. Often the rare earth elements can be simply extracted from the tailings sites where host materials such as nickel and cobalt have been mined in the past, such as coal fly ash.

EMC is focused on becoming the pre-eminent supplier of critical minerals produced in the Western Hemisphere and supporting our modern economy and security.

EMC is developing a supply chain for these materials that will support the growth of cleaner power generation. For example, electric vehicle technology has reached the point where electric vehicle demand will dramatically increase and there will be a requirement for millions of batteries that rely on various chemistries and materials such as lithium and various forms of nickel, cobalt and graphite. Larger scale storage of electric power, typically to capture the power generated by solar and wind, will demand the same materials.

As we face a never before seen coronavirus crisis, EMC is focused on establishing a secure, robust and reliable supply chain for the United States and our allies. Our focus is on bringing back jobs and manufacturing capabilities, while supporting a transition to a green economy.

David Wilcox

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EVOLUTION—
METALS

<https://evolution-metals.com/>



Industrial Minerals Association — North America

Statement of the
 Industrial Minerals Association – North America
 Washington, DC
 U.S. Senate Committee on Energy and Natural Resources
 “Impacts of COVID-19 on Mineral Supply Chains, the Role of those Supply Chains in Economic
 and National Security, and Challenges and Opportunities to Rebuild America’s Supply Chains”
 June 24, 2020

Introduction

Chairman Murkowski, Ranking Member Manchin and members of the Committee, thank you for holding this hearing today and for allowing comments to be submitted for the record.

The Industrial Minerals Association – North America (IMA-NA) represents the industrial minerals industry in North America.¹ Industrial minerals are the raw material feedstock for the manufacturing sector. Without industrial minerals, production of homes, cars, glass, electronics, ceramics, and virtually any other manufactured product would not be possible. Industrial minerals are found throughout the United States. According to the United States Geological Survey (USGS), in 2019 the industrial minerals sector of the mining industry had over 150,000 direct jobs and a total value of \$58.2 billion.² The data from the USGS also shows that we are relying on foreign sources for an increasing amount of these minerals. The United States is now net-reliant on countries like China and Russia for 50 mineral commodities and likely can expect reliance for dozens of other minerals to continue to rise. Industrial minerals are low margin products that require significant financial commitments to long-term projects. As this public health crisis has shown us over the last several months, being reliant on other countries for our mineral production is far from ideal. However, if proper policies are not implemented to make production of these minerals in the United States more viable, we risk seeing even more of this crucial initial link in our manufacturing supply chain relocate overseas.

Industrial Minerals Industry During COVID-19

¹ IMA-NA represents ball clay, barite, bentonite, borates, calcium carbonate, diatomaceous earth, feldspar, kaolin, mica, perlite, salt, soda ash, talc and wollastonite among other minerals.

² See the 2020 Mineral Commodity Summaries 2020 p. 5
<https://pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf>

Recognizing steps needed to be taken to ensure critical parts of the U.S. economy were permitted to continue operating during this global health pandemic, the Department of Homeland Security's Cybersecurity & Infrastructure Security Agency (CISA) developed guidance on Essential Critical Infrastructure Workers on March 19th and has continually revised this document to provide needed clarity. CISA recognized early on the essential nature of the industrial minerals industry to the critical manufacturing sector, and specifically named the industrial minerals workforce as critical and essential. With this designation in place, our member companies and their employees have been hard at work, continuing to produce the minerals that are vital to the Nation's supply chain.

Even with this designation in place, and our sector permitted to maintain operations, to do its part to help supply the manufacturing industry, we have seen unprecedented declines in production levels due to this public health crisis. A number of our customers have not been declared essential industries. Use of our minerals has declined in other parts of the world as the COVID-19 virus continues to strike. This has led to significant reductions in production, plant closures, furloughs, and, unfortunately, job losses. Despite these significant challenges, our industry remains committed to providing these essential minerals and helping to support the economic and overall recovery of the United States and the entire global market.

Policy Needs

As a nation, we have long faced a combination of trends and various other issues that have led to the Committee and Administration to examine how reliable the supply of mineral commodities is, with a specific focus on national security. We have seen attempts to address the critical minerals issue fail to gain the traction necessary for movement in the last several sessions of Congress. The failure by others in Congress to support the Committee's efforts to address these concerns has led to the problem being exacerbated by the recent COVID-19 crisis.

We encourage others in Congress to support the efforts by the Committee to enact legislation recognizing that minerals are critical to our supply chains. Thankfully, CISA recognized early on in this crisis that the industrial minerals industry is essential to the manufacturing supply chain. We encourage Congress to likewise recognize this fact in its legislative efforts. Unfortunately, we are seeing continued growth in our reliance of key minerals from foreign sources. This is unfortunate, and in many cases, unnecessary.

As we look toward legislative solutions following the COVID-19 epidemic to strengthen our domestic supply chains and bring more manufacturing back to the United States and away from China, we encourage Congress and the Committee to help develop policies that will strengthen and promote the entire domestic minerals industry. Industrial minerals are a low-margin industry that requires significant financial resources to bring mines and processing facilities on line. There needs to be long-term surety in place for companies to be able to make these investments. Any disruption or negative changes to tax codes, regulations, etc.... that add new costs to the industry will make production of these minerals, which are the initial link in the manufacturing supply chain, uneconomical, and thus we will see production continue to move overseas to China and other nations where they do not have unnecessary regulatory burdens hampering mineral development.

We must have a strong federal strategy in place to ensure a secure and reliable supply of industrial minerals in the United States. Companies that mine on federal lands that are subject to federal royalties should be paying the minimum amount required by law for the foreseeable future to allow for the companies to regain their footing. We have seen production levels fall by 35-40% in the domestic natural soda ash and uintaite industries for example. Meanwhile, these companies are faced with royalties of anywhere between 6-12.5% on their production while their competitors in China and Iran are being heavily subsidized by their governments. This type of short-sighted policy promotes the growth of the industries in China and Iran, not the United States. If Congress moves forward with a Phase IV COVID-19 legislative response, we strongly encourage Congress to include language that would reduce the federal royalty rates paid by minerals under the Minerals Leasing Act to 2%.

We need swift reviews of mining claims to allow the companies to know if they are able to mine located mineral deposits. For example, several of our bentonite companies have seen extraordinarily lengthy delays in reviews under Section 106 of the National Historic Preservation Act on mining claims in Wyoming. One such delay is approaching twenty years and many others are approaching ten years. That sort of delay is unacceptable. We need Congress and the Administration to work together to fix these problems. We strongly encourage Congress to move forward with a Phase IV COVID-19 legislative response that includes language requiring reviews be completed within one year from the date of their submission. Delays in reviews are preventing companies from moving forward with projects. Delays in reviews are costing jobs and economic growth. Delays are impacting the U.S. manufacturing supply chain. Bentonite is a clay of 1,000 uses . . . from filtration to kitty litter. It is a prime example of the role industrial minerals play in our supply chain. The industry needs these reforms to help business get back on track swiftly. There is no acceptable reason a review should last longer than one year.

If Congress moves forward with a Phase IV COVID-19 legislative response, we strongly encourage Congress to include the Committee's legislative proposal for Critical Minerals in that package. This is an essential initial step in the process of ensuring we have an adequate supply of minerals actively being developed domestically. We simply cannot allow China, Iran, Russia, and other hostile nations to hold the U.S. mineral supply chain hostage. Inaction is not a viable alternative. We have seen firsthand with the COVID-19 pandemic the crippling impact a global crisis has had on our domestic supply chains. Enacting this legislation is a necessary step in ensuring we have a stable domestic supply of minerals.

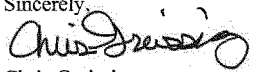
These are three simple legislative responses Congress can enact that will help to ensure our domestic supply chains can be effectively rebuilt by relying on the production of minerals in the United States: 1) Lowering the federal royalty rate for minerals operating under the Minerals Leasing Act to 2%; 2) Capping reviews of mineral claims at 1 year to allow for more rapid development; 3) Passing the critical minerals legislation that has been championed by this Committee.

The domestic industrial minerals industry is an essential critical infrastructure component of the U.S. economy that can become more reliable if Congress implements strong policy encouraging domestic production. The industrial minerals industry can be a source of new, high-paying jobs

throughout the country if given the opportunity to succeed. If Congress and the Administration agree to move forward with a Phase IV COVID-19 response package, they must focus in on the minerals industry and promoting its growth as a necessary first step in developing a more reliable domestic supply chain. We cannot allow our Nation to continue to be unnecessarily reliant on foreign-sourced materials. We have a unique opportunity to correct decades of bad policy by rebuilding our supply chains so they begin in the United States, which will in turn bring more manufacturing and the millions of associated jobs with it back to the United States as well.

We thank you for holding this vital hearing today and for the opportunity to provide this statement for the record. We applaud this Committee for recognizing that we need to rebuild our domestic supply chains, and that task begins with promoting and rebuilding the domestic minerals industry. We stand ready to assist you in this endeavor.

Sincerely,



Chris Greissing
Executive Vice President
Industrial Minerals Association – North America



June 23, 2020

The Honorable Lisa Murkowski
Chairman
Committee on Energy & Natural Resources
U.S. Senate
304 Dirksen Senate Building
Washington, D.C. 20510

The Honorable Joseph Manchin
Ranking Member
Committee on Energy & Natural Resources
U.S. Senate
304 Dirksen Senate Building
Washington, D.C. 20510

Dear Chair Murkowski and Ranking Member Manchin,

On behalf of Mining Minnesota, I write today to thank you for your ongoing efforts to secure the mineral supply chains critical to our economy and to examine ways of reducing the United States' dependence on foreign minerals.

We greatly appreciate your leadership to advance S. 1317, the American Mineral Security Act, and we commend the Committee on Energy & Natural Resources for holding an important hearing this week to examine the impact of the COVID-19 pandemic on our industry.

The metals and mining industry has been one of the hardest hit by COVID-19, and volatile global commodity markets continue to hinder its recovery. Many mining operations have been forced to temporarily halt operations or shutdown altogether, negatively impacting U.S. jobs and manufacturing. The pandemic has also highlighted how reliance on non-allied countries for critical materials exacerbates supply chain vulnerabilities and poses a serious threat to the future of our economy and national security.

Minerals and metals serve as the front end of our nation's supply chains, particularly for maintaining a strong defense industrial base and to meeting the increasing demand for renewable energy. Given these facts, it is concerning that the U.S. is currently more than 50% import-reliant on 31 of the 35 designated minerals identified on the U.S. Department of the Interior's Critical Minerals List. Further, we are 100% reliant on foreign countries, including Russia and China, for 18 important minerals.

It is for these reasons that we are deeply concerned that Congress continues to evaluate several ill-conceived bills that would thwart future development of our nation's mineral resources: 1) H.R. 2579; 2) S. 1386; and 3) H.R. 5598. In addition to increasing our reliance on China, which already controls a large percentage of the critical minerals needed for essential U.S. military and battery technologies, these bills

would eliminate high-paying U.S. jobs, damage the broader economy, and place further strain on the mining industry already struggling under the weight of the COVID-19 pandemic.

Fortunately, the U.S. is endowed with an abundance of highly valuable and important mineral resources that can be used to address these issues. In Minnesota alone, the Duluth Complex contains significant reserves of strategic minerals including copper, cobalt, nickel, platinum, and palladium. More specifically, as shown in the attached Minnesota Minerals Resources chart, the Duluth Complex hosts approximately 95% of known nickel reserves in the United States, as well as 88% of the known domestic cobalt and over half of its platinum and palladium – all of which will be required to meet the needs of our national defense and for renewable energy and low-carbon technologies.

Accordingly, we urge the Committee to continue its efforts to secure our domestic mineral supply chains, and strongly oppose legislation that would reduce domestic mining and exacerbate supply chain vulnerabilities. Please see the Women’s Mining Coalition white paper, also attached, which more fully outlines how mining can aid in the industry’s economic recovery following the pandemic. I would be happy to meet with you or your staff to discuss the findings of the white paper and/or specifics of Minnesota’s minerals resources opportunities at your convenience.

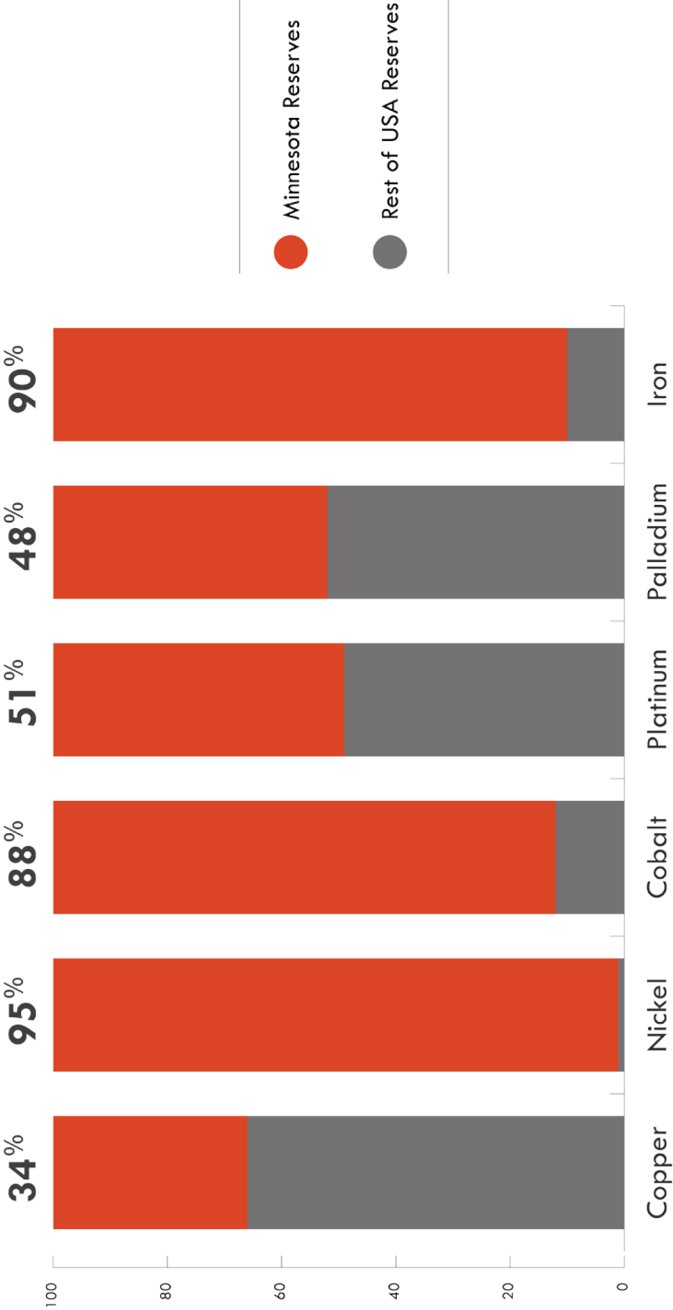
Thank you again for your ongoing support and steadfast leadership on this important issue.

Sincerely,



Frank Ongaro
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Minnesota is Ready to Supply America's Strategic Minerals



Source: Dr. Dean Petersen, University of Minnesota, National Resources Research Institute (NRRRI), 2010



MINING'S ROLE IN OUR ECONOMIC RECOVERY

The Covid Pandemic and Economic Crisis Make This the Worst Possible Time for Legislation That Would Reduce Domestic Mining and Exacerbate Supply Chain Vulnerabilities

CONGRESS IS CONSIDERING THREE PROBLEMATIC MINING BILLS

The U.S. Geological Survey's 2020 Mineral Commodity Summaries shows the U.S. produced \$86.3 billion of non-fuel mineral resources in 2019 that industries like steel, electronics, and aerospace used to make \$3.13 billion in value-added products. Despite this important contribution to our economy, Congress is evaluating three ill-conceived bills that would thwart future development of the nation's mineral resources: 1) **H.R. 2579** (Grijalva); 2) **S. 1386** (Udall/Heinrich); and 3) **H.R. 5598** (McCollum).

These bills would put important mineral resources completely off-limits to development. H.R. 2579 and S. 1386 propose draconian amendments to the U.S. Mining Law that governs locatable mineral exploration and development on public lands in the western U.S. Both H.R. 2579 and S. 1386 would eliminate the security of land tenure needed to attract investment in domestic mineral exploration and development; create numerous obstacles to make mine permitting more costly, time-consuming, and difficult; and impose unworkable royalty and taxation schemes. H.R. 5598 prohibits future development of the world-class copper-nickel-platinum-cobalt deposits in Minnesota's Superior National Forest.

If any of these bills are passed, they will increase our already excessive reliance on mineral imports and eliminate jobs for our citizens. Even worse, by reducing domestic mineral production, these bills would enhance China's and Russia's leverage as producers of many essential minerals used throughout our economy in infrastructure, technology, manufacturing, conventional and renewable energy, and national defense. These bills would also forfeit much-needed, well-paying U.S. mining jobs. According to the National Mining Association, the average metal mining salary in 2016 was \$88,800.

MINING IS A CRITICAL INFRASTRUCTURE INDUSTRY

In its March 28, 2020 *Guidance on the Essential Critical Infrastructure Workforce*, the Department of Homeland Security, Cybersecurity and Infrastructure Security Agency classified the mining sector as part of the critical manufacturing infrastructure workforce necessary for the country's response to the coronavirus. The guidance document states: "workers necessary for mining and production of critical minerals, materials and associated essential supply chains" are part of the critical workforce that should maintain their work schedules to aid in the United States' response to the coronavirus outbreak."

MINERAL IMPORTS CREATE SUPPLY CHAIN VULNERABILITIES

Relying on non-allied foreign countries for essential minerals makes us vulnerable to supply-chain disruptions. As the Covid-19 crisis clearly illustrates, depending on China for critical supply-chain materials like copper, which has important antimicrobial and anti-viral properties, poses a serious threat. Despite

our abundant domestic copper resources, the U.S. imported 35% of the copper we used in 2019, and relied on China and other countries to smelt and refine much of the copper that we do mine. According to the International Copper Study Group, China accounted for over 40% of world copper smelter production in 2018. There are only three copper smelters in the U.S. – one in Utah and two in Arizona.

Although the U.S. is blessed with a rich mineral endowment, the U.S. Geological Survey's 2019 Mineral Commodity Summary shows we import many minerals besides copper:

- We are 100 % reliant on foreign countries, including Russia and China, for 18 important minerals including the rare earth minerals that are needed to manufacture the magnets in wind turbines.
- 68% of the silver we use, including antimicrobial silver in medical applications, is imported.
- We import at least 50% of 30 other minerals from foreign countries.
- Our reliance on foreign minerals has increased at an alarming rate since 1995.

The dramatic decline in the production of domestic minerals is due in large part to unfavorable policies that have substantially chilled investment in domestic mineral exploration and development and have put public lands off limits to mining. Additionally, our time-consuming and costly permitting process does not compare favorably to other mineral-rich countries like Canada and Australia that have stringent environmental protection requirements but much more practical mineral development and investment policies.

H.R. 2579 IS DESIGNED TO REDUCE MINING ON WESTERN PUBLIC LANDS

- Eliminates mining claims and substitutes an impractical minerals leasing system.
- Puts more land off-limits to mineral exploration and development, completely disregarding the fact that mines can only be developed where minerals have been discovered.
- Authorizes federal land managers to deny a permit or revoke a lease at any time.
- Changes current life-of-mine permits to a 20-year lease with no assurance that leases may be renewed beyond the 20-year primary term.
- Creates onerous and impractical environmental standards that make mining difficult if not impossible.
- Ignores existing comprehensive environmental protection regulations that prohibit unnecessary impacts, safeguard all aspects of the environment, and effectively mitigate mining impacts.
- Disregards current financial assurance requirements that guarantee mines will be reclaimed. In Nevada alone, state regulators and federal agencies hold over \$3.15 billion in reclamation bonds.
- Imposes a retroactive royalty on pre-existing claims that will result in takings litigation.
- Establishes a confiscatory prospective royalty and a displaced materials fee that will render most deposits uneconomic to develop.
- Will substantially chill private-sector investment in mineral exploration and development.
- Will exacerbate our reliance on foreign minerals and increase our mineral supply chain vulnerabilities.

H.R. 5598 WOULD ELIMINATE MINING IN THE SUPERIOR NATIONAL FOREST

- Eliminates access to one of the largest undeveloped copper-nickel-platinum-cobalt deposits in the world in Minnesota's Superior National Forest.
- Limits U.S. access to domestic minerals that are critical to manufacturing, economic security, renewable and conventional energy, and national defense.
- Locks our country out of the nickel industry. Roughly 95% of known domestic nickel resources are in Minnesota.

- Permanently places important copper, nickel, platinum group metals, and cobalt deposits off-limits to development. These metals are key elements needed in the green economy for electric batteries, wind turbines, solar panels, and electric and hybrid vehicles.
- Minnesota's vast iron-ore resources makes Minnesota the 4th largest non-fuel producing state according to the U.S. Geological Survey. Development of the copper-nickel-platinum-cobalt projects in the Superior National Forest would enhance Minnesota's standing as one of the most important mining states in the country. These mines would operate under comprehensive and stringent state and federal environmental protection regulations.

NEW WORLD BANK GROUP STUDY IDENTIFIES ESSENTIAL MINERALS

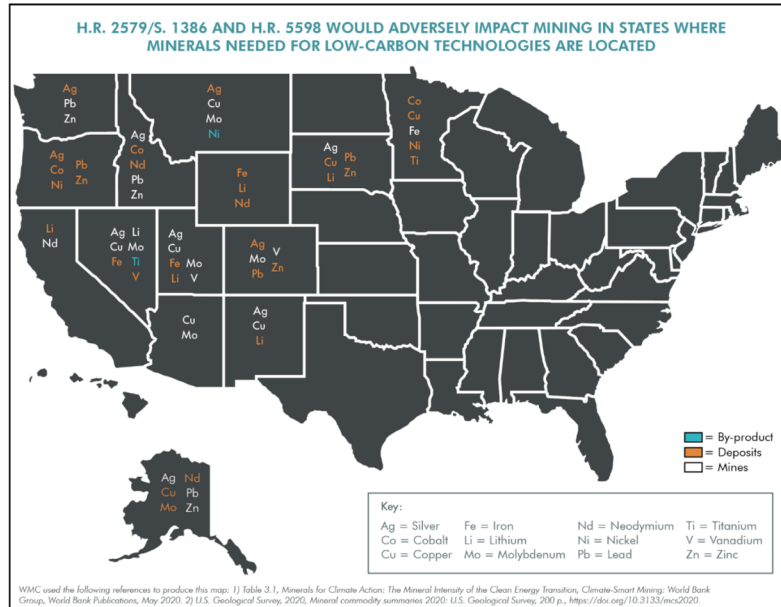
The May 2020 World Bank Group report, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," identifies the 17 minerals shown below that are essential to low-carbon energy technologies. According to the U.S. Geological Survey, in 2019, the U.S. relied on imports for all of these minerals.

	Wind	Solar photovoltaic	Concentrated solar power	Hydro	Geothermal	Energy Storage	Nuclear	Coal	Gas	Carbon capture and storage	Import Reliance	Exporting Countries
Aluminum*											> 75%	Jamaica, Brazil, Guinea, Guyana
Chromium											72%	Norway, Japan, China, Canada
Cobalt											78%	South Africa, Kazakhstan, Russia
Copper											35%	Chile, Canada, Mexico
Graphite											100%	China, Mexico, Canada, India
Indium											100%	China, Canada, Republic of Korea, Taiwan
Iron Ore											21%	Canada, Brazil, Republic of Korea
Lead											30%	Canada, Mexico, Republic of Korea, India
Lithium											>25%	Argentina, Chile, China
Manganese											100%	South Africa, Gabon, Australia, Georgia
Molybdenum											<20%	Peru, Chile, Canada, Mexico
Rare Earths**											100%	China, Estonia, Japan, Malaysia
Nickel											47%	Canada, Norway, Australia, Finland
Silver											68%	Mexico, Canada, Peru, Poland
Titanium											86%	Japan, Kazakhstan, Ukraine, China, Russia
Vanadium											94%	Austria, Canada, Russia, Republic of Korea
Zinc											87%	Canada, Mexico, Australia, Peru
Total	10	8	2	8	6	11	11	9	8	6		
* Bauxite, ** Neodymium												

Sources for table: <https://doi.org/10.3133/mcs202> and <http://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf>

BILLS WOULD IMPACT MINERALS USED IN LOW-CARBON TECHNOLOGIES

The U.S. is fortunate to have significant mines and deposits of many of the 17 minerals identified by the World Bank Group. Unfortunately, proposed legislation would curtail mining and mineral exploration on public lands in the western U.S. and in Minnesota's Superior National Forest where important mines and deposits of these minerals are located.



Now more than ever, the national agenda demands domestic minerals for our country's security, global economic competition, technology, energy, and infrastructure.

Congress should not enact H.R. 2579/S.1386 or H.R. 5598, which would put more lands off-limits to mining and make mine permitting more costly and difficult.

About WMC

WMC is a grassroots organization with over 200 members nationwide. Our members work in all sectors of the mining industry including hardrock and industrial minerals, coal, energy generation, manufacturing, transportation, and service industries. We hold annual Washington, D.C. Fly-Ins to meet with members of Congress and their staff and federal land management and regulatory agencies to discuss issues of importance to both the hardrock and coal mining sectors. For more information about WMC, please contact Emily Arthun at Emily.Arthun@gmail.com or visit our website at: www.wmc-usa.org

