S. HRG. 118–467

DIGGING DEEPER: BUILDING OUR CRITICAL MINERALS WORKFORCE

HEARING

BEFORE THE

SUBCOMMITTEE ON EMPLOYMENT AND WORKPLACE SAFETY

OF THE

COMMITTEE ON HEALTH, EDUCATION, LABOR, AND PENSIONS

UNITED STATES SENATE

ONE HUNDRED EIGHTEENTH CONGRESS

SECOND SESSION

ON

EXAMINING BUILDING OUR CRITICAL MINERALS WORKFORCE

JUNE 12, 2024

Printed for the use of the Committee on Health, Education, Labor, and Pensions

Available via the World Wide Web: *http://www.govinfo.gov*

U.S. GOVERNMENT PUBLISHING OFFICE

57–243 PDF WASHINGTON : 2025

COMMITTEE ON HEALTH, EDUCATION, LABOR, AND PENSIONS

BERNIE SANDERS (I), Vermont, *Chairman*

PATTY MURRAY, Washington
ROBERT P. CASEY, JR., Pennsylvania
TAMMY BALDWIN, Wisconsin
CHRISTOPHER S. MURPHY, Connecticut
TIM KAINE, Virginia
MAGGIE HASSAN, New Hampshire
TINA SMITH, Minnesota
BEN RAY LUJÁN, New Mexico
JOHN HICKENLOOPER, Colorado
ED MARKEY, Massachusetts

BILL CASSIDY, M.D., Louisiana, *Ranking Member*
RAND PAUL, Kentucky
SUSAN M. COLLINS, Maine
LISA MURKOWSKI, Alaska
MIKE BRAUN, Indiana
ROGER MARSHALL, M.D., Kansas
MITT ROMNEY, Utah
TOMMY TUBERVILLE, Alabama
MARKWAYNE MULLIN, Oklahoma
TED BUDD, North Carolina

WARREN GUNNELS, *Majority Staff Director*
BILL DAUSTER, *Majority Deputy Staff Director*
AMANDA LINCOLN, *Minority Staff Director*
DANIELLE JANOWSKI, *Minority Deputy Staff Director*

SUBCOMMITTEE ON EMPLOYMENT AND WORKPLACE SAFETY

JOHN HICKENLOOPER, Colorado, *Chairman*

ROBERT P. CASEY, JR., Pennsylvania
TAMMY BALDWIN, Wisconsin
TIM KAINE, Virginia
BEN RAY LUJÁN, New Mexico
ED MARKEY, Massachusetts
BERNIE SANDERS (I), Vermont, *(ex officio)*

MIKE BRAUN, Indiana
ROGER MARSHALL, M.D., Kansas
MITT ROMNEY, Utah
TOMMY TUBERVILLE, Alabama
TED BUDD, North Carolina
BILL CASSIDY, M.D., Louisiana, *(ex officio)*

C O N T E N T S

STATEMENTS

WEDNESDAY, JUNE 12, 2024

DIGGING DEEPER: BUILDING OUR CRITICAL MINERALS WORKFORCE

Wednesday, June 12, 2024

U.S. SENATE,
SUBCOMMITTEE ON EMPLOYMENT AND WORKPLACE SAFETY,
COMMITTEE ON HEALTH, EDUCATION, LABOR, AND PENSIONS,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:35 p.m., in room 562, Dirksen Senate Office Building, Hon. John Hickenlooper, presiding.

Present: Senators Hickenlooper [presiding], Casey, Smith, and Braun.

OPENING STATEMENT OF SENATOR HICKENLOOPER

Senator HICKENLOOPER. The Subcommittee on Employment and Workplace Safety will come to order.

Today's hearing is going to explore how we can strategically build our critical minerals workforce. My co-chair, Ranking Member Braun, and I will each give an opening statement. Then, we'll introduce the witnesses and after the witness give their testimony. Senators will have 5 minutes to ask a round of questions.

Last month, the Subcommittee convened a hearing about the importance of health and safety in the overall mining industry. And our witnesses talked about America's mining history and practices we can adopt to enhance the safety of our workers today, and going into the future.

Today, we're going to dig deeper into the future, talk about how to build the critical minerals workforce that our Country's going to depend on for decades to come.

I think it's fair to say right now, America's in the middle of a great transition to a clean economy. But to reach full energy independence, we're going to need to build faster and to build smarter. To power the transition, we're going to need critical minerals just as we do the transition, and we're going to need a lot of them. According to the International Energy Agency, mineral demand could double by 2030 and quadruple by 2040. Those are sobering statistics to say the least.

Globally, we don't have nearly enough of some of these minerals, but even for the minerals we do have, processing facilities are controlled by a relatively small number of countries. Not all of them are allied with our values, and even if they were all our friends,

we end up with bottlenecks in supply and the resulting geopolitical competition.

As mineral demand rises, I think we're going to see that vulnerability increase, as far as actors try to insert themselves into our supply chain, manipulate prices for their own benefit.

I think China's made it clear that they are aggressive in this type of role, especially as in terms of processing minerals that would be crucial for our national and for our energy security.

As a couple of examples, China dominates 70 percent of rare earth element production, 90 percent of the processing. These minerals are crucial for wind turbines, for electric vehicles, missile systems, I could go on. It's a long list, as you all know.

To meet our clean energy goals, reduce our dependence on China, we need to increase domestic production and processing of critical minerals and strengthen our alliances with international partners. Preparing for this new wave of domestic minerals production it's a little bit like a jigsaw puzzle. All the right pieces have to get in the right place at the right time if this is really going to work.

A key piece of the puzzle is recruiting and training and making sure you can retain a robust, talented, diverse, resilient workforce that could address critical minerals.

It's estimated that the critical minerals workforce will need to double over the next 5 years to just meet the needs we now project. But instead of the workforce growing, what we've seen in the last couple years is a decline. And over a longer term, we've seen a decrease of roughly 40 percent over the last 30 years.

Many workers are retiring as that average age, got older and older. Some have moved into other industries. I think even more concerning our talent pipelines are not in shape. They're not fit to be able to deliver the number of skilled workers we need and making sure these workers have the right skills.

While China is graduating literally thousands of students from mining related programs every year, the U.S. has only about 600 students over total enrollment right now.

According to the Bureau of Labor Statistics, we'll need at least 70,000 more craftsmen to build out these work sites. We'll also need surveying, mapping technicians to make sure that we can find the mineral deposits. We're going to need upskilling and reskilling our workforce to meet the diverse demands that this is all going to require, especially for all these workforce slots.

A lot of this has got to happen in rural communities. There are certainly some bright lights in our State of Colorado. The Colorado School of Mines is a leader, in the way in how you go about training engineers and chemical processors and geologists. As a recovering geologist myself, I'm sensitive to the challenge involved in that educating process.

Unions like the United Steelworkers and International Union of Operating Engineers are offering apprenticeship and other training opportunities to train not just engineers, but construction workers and heavy equipment operators, equipment servicers.

This is all a great start, but we need to build and expand these programs, and we need to learn from our international partners

like Australia and Canada, that have maintained their energy in this regard over these last few decades, when we have maybe backed off.

In many ways they are ahead of the game in training this next generation of crucial mineral workforce. So, it's time to get building, today we're going to get to hear from a panel of experts, as we begin to craft a blueprint to expand the critical minerals workforce.

I want to thank my co-chair, Senator Braun, and his staff for working with us to host this hearing. And before I hand it off to Senator Braun for his opening, I want to submit two statements for the record. The first statement is from the United Steel Workers Union. The other is from MP Materials, a Nevada-based company in support of today's hearing.

[The following information can be found on page 37 in Additional Material:]

Senator HICKENLOOPER. With that, I'll recognize Ranking Member Braun for his opening statement, and to also introduce our first witness.

OPENING STATEMENT OF SENATOR BRAUN

Senator BRAUN. Thank you, Mr. Chairman. Critical minerals have been regarded as the building blocks of U.S. economic and national security. The physical and chemical traits of these unique materials allow them to be applied to advanced technologies that can benefit our Nation in many ways.

Strengthening America's critical minerals helps to reduce our reliance on getting these materials from adversarial countries, and it seems to be a lot of that is at play currently. Additionally, our critical minerals supply chain is an important issue for strengthening American manufacturing and keeping jobs here in the U.S. as part of a connected supply chain.

Strength of America's critical minerals largely depend on the strength of the workforce. And in so many different places in our Country, the workforce just has not stayed up with the demand. So, much of that has to do with how we educate kids and advise them when they're in high school.

This should be starting in middle school, and a lot of the programs that would've prepared kids for this have been disbanded. And we don't have the guidance systems. We don't have higher education working together, especially through transparency on what these high demand, high wage jobs are.

To me that is simple and for too long, we've kind of just hid behind a system that's not doing it well in many arenas, not just critical minerals. This leads us into the issue of improving that workforce development.

As with many industries facing shortages, we're trying to still find that right mix. In my own State of Indiana, which is the biggest manufacturing state per capita, we've been talking about it for years. When I was in our state legislature back seven, 8 years ago, we had 15–20 different programs spending a billion dollars a year, not quite getting it right.

On my own, I built a business in my hometown and county. Found out our school systems were stigmatizing against pathways like this. Very simple, high demand, high wage jobs. Put it out there. Know what the career pay is going to be, what starting pay is, and what educational costs are going to be associated with it. It's imperative that young people understand this along with their parents or else we will miss opportunities.

The way to drive home this message is to make sure our kids and their parents have full information and transparency.

We're going to talk about it, particularly today on Critical Minerals. I get the opportunity here to introduce our first witness Dr. Barbara Arnold, who is a professor of Practice and Mining Engineering at the Penn State, which I won't get into our competition with Indiana University and Purdue with Penn State. Let's stay on a pleasant subject here.

Dr. Arnold has over 30 years of experience in the coal and mineral industries, and over 20 years, she represented several coal and mineral processing equipment companies in the U.S. and consulted with coal companies and engineering contractors to develop flow sheets for new coal preparation plants and plant retrofits.

She's a recognized international expert in coal preparation, and we welcome her expertise to this panel. Thank you for being here. I Yield back. I think Dr. Arnold, you're welcome to your opening statement.

STATEMENT OF BARBARA J. ARNOLD, PH.D., P.E., CHAIR OF MINING ENGINEERING, PROFESSOR OF PRACTICE IN MINING ENGINEERING, THE PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA

Dr. ARNOLD. Thank you, Senators, staff, and guests. Good afternoon, and thank you for the opportunity to address you on a matter of utmost urgency, the need to expand our critical minerals workforce.

My name's Barbara Arnold, a professor of Practice and chair of the Mining Engineering Program at the Pennsylvania State University. I teach and conduct research on mining health and safety, focused on respirable dust and critical minerals, assessing the domestic critical mineral resources, especially in Appalachia.

The National Academies hosted a workshop in late January, 2024, supported by the United States Geological Survey titled, Building Capacity for the U.S. Mineral Resources Workforce. The workshop report was recently published.

Let me quote from that report. "The 14 mining engineering programs across the United States collectively graduated only 162 students in 2023. Falling far short of the estimated employment demand for 400 to 600 mining engineering graduates per year in the United States. By contrast, China's 45 mining engineering programs currently enroll about 12,000 students and graduate approximately 3000 annually, about 16 times the number of graduates in the U.S."

One might think that the need for critical minerals in a stable domestic supply would encourage increased enrollment in our min-

ing engineering programs. But let me quote the NASEM report again. "A key concern expressed by several participants is that negative public perceptions of mining can dissuade students from considering a career in minerals extraction.

For many, the minerals industry is linked with the legacy of environmental damage, which has been reinforced by negative depictions of the industry and popular culture. To begin to overcome this perception, several participants suggested focusing on reframing the industry as being part of the solution to environmental issues. Improving awareness of the role of mining in addressing climate change and environmental degradation could help to attract students who are passionate about the environment".

The mining industry itself is moving toward a digital and autonomous future. We incorporate digital twins to optimize mining and mineral processing technology: We fly drones to monitor tailings, do aerial surveys of stockpiles and collect water samples. Autonomous haul trucks and trains move materials with automation and control technologies becoming increasingly sophisticated.

The Society for Mining Metallurgy and Exploration, the lead U.S. based Mining professional society, is focused on workforce development. Their Ph.D., fellowship and career grant program helped address faculty shortages along with research funding for capacity building from the National Institute of Occupational Safety and Health.

Those of us at the U.S. mining schools are revamping our curricula to incorporate this ever-changing landscape. At Penn State, we've added courses on automation and control and sustainability.

Despite these efforts, we still need help attracting more students into our programs. In spring 2023, we graduated only four students with bachelor's degrees in mining engineering at Penn State, they're all employed with an average salary of $75,000. Our program should be attracting more students.

In the QS University rankings, our Penn State Mining Engineering program is ranked second in the U.S. and 13th globally up, from 17th last year. So, we should be attracting talent.

Incoming students just don't know that mining exists. To address this, we're offering our first ever MINING ROCKS! Penn State Summer Mining Camp in August, free of charge to the first 20 students, thanks to support of our alumni and mining industry partners.

During the NASEM workshop, several other actions were suggested. One specific piece of suggestion was, to make sure that the K–12 curriculum incorporates the significance of minerals in our daily lives. For example, there are 62 different elements in a cell phone. All sourced from mining, electric vehicles require much more copper and other critical minerals than conventional cars. Wind turbines and solar panels all require critical minerals.

The 2021 report by the International Energy Agency titled The Role of Critical Minerals in Clean Energy Transitions, says that mineral demand will increase by about four times by 2040 to meet climate goals. Where will the minerals come from? Who will mine

the minerals safely and responsibly? Everyone must understand that if it can't be grown, it has to be mined.

Miners play a crucial role in our society. They provide fertilizers in the metal for farm implements. They provide metals for trucks for catalytic converters in those trucks to reduce pollution, and they provide all the critical minerals in our increasingly high-tech everyday lives.

Let's take a moment to appreciate their hard work and dedication. Thank a miner every day. Thank you for allowing me to discuss the critical mineral workforce with you today.

[The prepared statement of Dr. Arnold follows.]

PREPARED STATEMENT OF BARBARA ARNOLD

Senators, staff, and guests. Good afternoon and thank you for the opportunity to address you regarding the urgent need to expand our critical minerals workforce. My name is Barbara Arnold, a professor of practice and chair of the mining engineering program at The Pennsylvania State University. I teach and conduct research on mine health and safety focused on respirable dust and on critical minerals, assessing the domestic critical mineral resource especially in Appalachia. I obtained my BS in mining engineering and MS and Ph.D., in mineral processing from Penn State, conducted coal beneficiation research at the Electric Power Research Institute's Coal Cleaning Test Facility in Homer City, PA, and then started my own company, selling coal and mineral processing equipment to engineering contractors and coal and mineral companies, developing flowsheets for coal preparation plant retrofits and new construction. In 2020, I joined the faculty at Penn State.

Allow me to start by saying that there are already issues related to the mining and mineral industry workforce, skilled labor as well as scientists and engineers. This will translate to even greater needs for the critical mineral workforce as we will need even more people equipped with mineral exploration, processing, extractive metallurgy, and refining backgrounds. We have 14 mining engineering programs in the U.S. and even fewer economic geology or processing and metallurgy programs.

Related to the current mining and mineral industry workforce issues, the National Academies hosted a workshop in late January 2024 that was supported by the United States Geological Survey titled, *Building Capacity for the U.S. Mineral Resources Workforce*. The workshop report was recently published. Let me quote from that report:

> Kecojevic described a sharp drop-off in mining engineering enrollments, from a collective total of 1,449 U.S. undergraduate students in 2015 to just 590 in 2023, a 60 percent decline over 9 years. The 14 mining engineering programs across the United States collectively graduated only 162 students in 2023, falling far short of the estimated employment demand for 400–600 mining engineering graduates per year in the United States. By contrast, China's 45 mining engineering programs currently enroll about 12,000 students and graduate approximately 3,000 a year—about 16 times the number of graduates in the United States. Keane stated that while enrollment in geosciences undergraduate programs may have rebounded to early 2010's levels following the COVID–19 pandemic, there was a nearly 50 percent drop in enrollment in geoscience graduate programs after 2019. At the same time, demand is rising for geoscience support activities and professional services for mining.

One might think that the need for critical minerals and a domestic supply of these would encourage increased enrollment in our mining engineering programs. But let me quote the NASEM report again:

> A key concern, expressed by several participants, is that negative public perceptions of mining can dissuade students from considering a career in minerals extraction. Climate change and environmental degradation are prominent issues for the current generation, and for many, the minerals industry is linked with a legacy of environmental damage, which has been reinforced by negative depictions of the industry in popular culture. To begin to overcome this perception, several participants suggested focusing on reframing the industry as being part of the solution to environmental issues.

> For example, minerals extraction provides materials necessary for the technologies that play an important role in achieving decarbonization, such as wind turbines, solar panels, and electric vehicles. Improving awareness of the role of mining in addressing climate change and environmental degradation could help to attract students who are passionate about the environment. "Without turning a blind eye to the real environmental damage that's been done in the history of mining, we can still be very proud of mining and what it has done for our planet," Misael Cabrera, University of Arizona, said. "In fact, modern civilization is simply not possible—medicine, computing, data analytics, take your pick—none of it is possible without minerals, and therefore without mining." Cabrera also pointed to mine waste, remining, and reclamation as opportunities for the minerals industry to advance environmental stewardship.

What can those of us in the trenches do? The Society for Mining, Metallurgy, and Exploration (SME), the lead U.S. based mining professional society, is taking this issue very seriously, and one of its strategic committees is focused on workforce development. As early as 2014, SME released a white paper titled, *Workforce Trends in the U.S. Mining Industry*, indicating significant shortages in scientists, engineers, skilled labor. At that time, SME addressed another critical need—the number of faculty available for our mining engineering programs. Their Ph.D., fellowship and career grant program helped address this along with research funding for capacity building from the National Institute of Occupational Safety and Health. SME notably is also promoting a series of videos, Jobs of Tomorrow, available on YouTube. Yes, jobs of tomorrow.

The mining industry itself is moving toward a digital future. We incorporate *digital twins* for optimization of mining and mineral processing technology; we fly drones to monitor tailings impoundments, do areal surveys of stockpiles, and collect water samples. Autonomous haul trucks and trains move materials. Automation and control technologies are becoming more and more sophisticated. Some of this will help to address worker shortages. However, we still need skilled scientists and engineers to ensure that we deliver our mined products in the safest and most responsible way and to develop new technologies to mine and process ores and waste materials. A recent report, called *The Digital Underground*, from Mining Magazine and Mining Monthly, discusses how data analytics will be key in incorporating the large data streams coming from underground mining equipment. Another report could be written on the digital surface mine or the digital processing plant.

Those of us at the U.S. mining schools continue to address our curricula to incorporate this ever-changing landscape. At Penn State, we've added courses on automation and control and sustainability. Despite these efforts, we still struggle to attract more students into our programs. In spring 2023, we graduated only four students with bachelor's degrees in mining engineering at Penn State. One is working for an engineering company in Utah, one in New York and one in Baltimore working in the aggregates industry. The fourth recently left an aggregates company in Virginia to work with a gold company in South Carolina. Their average starting salary with their bachelor's degree was $75,000. This May, we graduated two who are starting their careers with aggregate companies, and a third will graduate in December. Good paying jobs, an increasingly safe and environmentally conscious industry, applications of high technology, addressing a key supply chain component—if it can't be grown, it must be mined. Why do we not have more students? In the QS university rankings, our Penn State mining engineering program is ranked second in the U.S. and thirteenth globally (up from seventeenth last year), so we should be attracting talent. We know that the number of traditional-aged college students is decreasing. We know that other industries are also seeing a shortfall of workers. But if we don't address the critical need for more mining and mineral processing engineers, we will not be able to meet our domestic critical mineral needs.

We have offered seminars to students interested in STEM fields, and we have begun collaborating more closely with our College of Engineering advising staff. We're offering our first-ever MINING ROCKS! Penn State Summer Mining Camp in August that is free-of-charge to the first 20 students that sign up. It's free-of-charge because it's being sponsored by our alumni and mining industry contacts. The students that do enter our program often receive scholarships from our program endowments. We encourage them to apply for the many scholarships that are available for students in the industry. They visit mines, attend industry conferences, and hear from industry speakers. Many companies come to recruit interns and full-time employees each fall. Our students get multiple job offers. Our introductory mining course has about 70 students enrolled in both the Fall and Spring semesters. Most are upper-level students who are taking it as an elective and are well past consid-

ering mining engineering as a major at that point. Incoming students just don't know that mining exists. And it's not just at Penn State. The University of Arizona's program surveyed incoming students and found that many students were not aware of mining engineering as a career. That's in a state that is ranked No. 2 in the value of non-fuel mineral production in the U.S. (Minerals Commodity Summary, USGS, 2024). Arizona produces cement, copper, molybdenum mineral concentrates, sand and gravel for construction, and crushed stone and their principal commodities.

Some actions were suggested during the NASEM workshop. One specific action is to include the importance of minerals in our daily lives in K–12 curriculum. There are 62 different elements in a cell phone—all need to be mined. Electric vehicles require much more copper and other critical minerals than conventional cars. Wind turbines and solar panels all require critical minerals.

According to a 2021 report by the International Energy Agency titled, *The Role of Critical Minerals in Clean Energy Transitions*, mineral demand will increase by about four times by 2040 to meet climate goals. Where will the minerals come from? Who will mine the minerals safely and responsibly? We need everyone to understand that if it can't be grown, it must be mined.

Social media is a great place to see memes thanking farmers or thanking truck drivers. I agree that we should. But we also need to be thanking miners. Miners provide the fertilizers and the metal for farm implements. Miners provide metals for trucks and the catalysts for catalytic converters in those trucks to reduce pollution. And they provide all the critical minerals in our increasingly high-tech everyday lives. Thank a miner every day!

Thank you for allowing me to discuss the critical mineral workforce with you today. I am happy to answer any questions.

Senator HICKENLOOPER. Thank you, Dr. Arnold. I will make sure I thank a miner today, and in future days. Now, I'm happy to introduce our next guest, Dr. Gracelin Baskaran. Dr. Baskaran is the director of the project on Critical Mineral Security at the Center for Strategic and International Studies. Dr. Baskaran has garnered experience studying international and domestic critical minerals production, and regularly offers her expertise at universities and policy forums of all sizes in all shapes.

Dr. BASKARAN.

STATEMENT OF GRACELIN BASKARAN, PH.D., DIRECTOR OF THE PROJECT ON CRITICAL MINERALS SECURITY, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES, WASHINGTON, DC

Dr. BASKARAN. Chairman Hickenlooper, Ranking Member Braun, and distinguished Members, thank you so much for having me.

I'm honored to share my views on this topic today. I'd like to reflect a bit on how workforce has become an impediment to reducing our reliance on China, both domestically and internationally.

By way of introduction, and I think it's a little bit of a background, is I started in the mining industry 11 years ago through a Fulbright Fellowship from the U.S. State Department. And they very kindly dropped me into South Africa's platinum belt, which was a bit of a culture shock at the time. But I really saw the long-term value of the sector, both economically and technologically, acknowledging how, for example, the automotive industry was changing, I grew up in metro Detroit.

My career, which has taken me from the depths of the mines in South Africa through a Ph.D., into the halls of Washington, began with a Fulbright. And that framed some of my recommendations

that I would put forward about how we can actually make existing mechanisms better fit for purpose.

Dr. Arnold did a great job, I don't need to go too far down the numbers again. But we know that the Chinese education system, which has over 38 minerals processing schools and over 44 mine engineering programs, has really enabled them to build this dominant hold they have both on production and processing globally.

Central South University, China's biggest program, graduate about 1,000 undergraduates and 500 graduates alone ready to build that. When China cutoff our rare earth processing technology exports, it really struck us with a shortfall that we have in the knowledge to deploy that technology.

A report published by the U.S. Department of Interior noted that the mining industry is having difficulty attracting young professionals. They always say if there's two industries that are not attractive for the youth, it's at being a farmer and being a miner.

There's two things again, I think Dr. Arnold hit really well. One is understanding its tech base now. We're not in an era of picks and wheelbarrows. We're really in an era of like what essentially resembles a NASA control room, if you've spent a lot of times at new modern mines. And the second is that mining is far more responsible than it was two decades ago. And as such, it doesn't have that negative connotation.

There's three strategies that I would quickly propose. So, the first is to create a dedicated Fulbright program for the mining industry. Right now, we have the Fulbright Arctic Initiative, Fulbright Hays for school age educators and administrators. We have a Fulbright program for people building expertise in Europe.

We have another one for artists, but a Fulbright program that does two things. It takes STEM graduates from the United States and sends them to programs—we have four of the top 12 mining programs in the world in Canada, four in Australia, there's one in Saudi. It opens up potential to send our STEM graduates abroad, but it also gives us potential to bring faculty from abroad to the United States, to help build mining programs in geology programs.

I grew up in a world of geology. My dad is a geology professor, and he said mining has just never been a presence and we need to bring that expertise to our geology and environmental science program.

Second one I'm sure we'll come back to, is increasing NSF, National Science Foundation funding. The National Science Foundation has 15 focus areas. Chemicals and materials is perhaps the closest to mining, but it's still largely absent. And if you look at the active grant opportunities from the NSF, just nine out of 815 of them are for mining, which is about 1.1 percent.

The third mechanism under there is actually expanding the infrastructure Investment Jobs Act. Right now, there's provisions to expand energy jobs, but expanding energy advisory work to mining, to open up those jobs actually lets us ensure that we have the feed stock needed to produce a very renewable energy technology that we set out to build.

The second bucket is saying collaboration between mining companies and universities, there's a lot of scope. We have a lot of expertise in the private sector, but opening up scholarships, which we can come back to as being a best practice elsewhere.

Anglo American, for example, has funded a significant amount of the mining expertise built in South Africa over the years by putting in the bursaries and the graduates go back and work for them afterwards. There are mechanisms that are budget neutral in that way that we can support.

Finally, we need to leverage our U.S. military academies. If we go back and look, many of our academy trained engineers built the railroads and bridges for westward expansion, and they were instrumental in the industrial revolution. It's really time we have a national security challenge on our hand to leverage those institutions.

There are only two American CEOs of mining majors. One is Richard Adkerson at Freeport-McMoRan. The other is Bob Wilt at Ma'aden. And Bob was an Alcoa executive for many years. And then is now, after doing his career with the Army, he's now leading one of the fastest growing mining companies in the world built on that expertise.

At CSIS we're now planning our first National Security and Critical Mineral summit to help fill that gap. So, I think it's a multidimensional challenge. I think we have the solutions at hand as the United States, and I look forward to discussing more how we can do that.

[The prepared statement of Dr. Baskaran follows.]

PREPARED STATEMENT OF GRACELIN BASKARAN

Chairman Hickenlooper, Ranking Member Braun, and distinguished Members of the Subcommittee, I am honored to share my views with you on this important topic. CSIS does not take policy positions, so the views represented in this testimony are my own and not those of my employer. In my testimony, I would like to reflect on how the workforce became a key impediment to reducing our reliance on China for key minerals required for national, economic and energy security. I will then look at potential solutions: how the United States can make existing tools, such as the Fulbright program, National Science Foundation, and the Infrastructure Investment and Jobs Act, better fit for supporting our minerals security needs, how we can support partnerships between mining companies and universities to attract young talent, and how we can leverage our military academies to help meet our workforce needs.

My name is Dr. Gracelin Baskaran. I am the Director of the Project on Critical Minerals Security at the Center for Strategic and International Studies (CSIS). I started in the mining industry 11 years ago, when the U.S. State Department awarded me a Fulbright Fellowship. Through my Fulbright, I spent a year in South Africa's platinum belt, including time in the mines, and saw the long-term value of the sector—both economically and technologically. I went on to do a Ph.D., at the University of Cambridge on the platinum sector and later co-authored a book on leveraging mining, oil and gas for economic transformation amidst decarbonization. My career, which has taken me from the depths of mines in South Africa, such as Twickenham and Mogalakwena, to the halls of Washington DC, began with the Fulbright.

At CSIS, I now work to increase our economic and national security by reducing vulnerability in our supply chains for critical minerals. My work informs the White House National Security Council, State Department, Department of Energy, Development Finance Corporation, U.S. Embassies globally, and bipartisan and bicameral Members of Congress. My work also takes me to resource-rich jurisdictions around the world, where I work with industry players from 8 of the biggest Western mining companies by market capitalization, government officials from the United States,

Middle East, Africa and Latin America, and members of civil society to understand how we can effectively build minerals security. This has given me perspectives that reflect the realities on the ground both domestically and internationally.

Background

Minerals are important for national, economic and energy security. Their strategic value to the United States motivated an active minerals policy in the 20th century. In 1910, the United States Department of Interior created the United States Bureau of Mines with the goal of overseeing domestic mining activities and securing a sufficient mineral supply. The Bureau supported scientific studies and knowledge sharing about mineral resource extraction, processing, utilization, and health and safety standards. In 1996, Congress voted to close the Bureau and decentralize some of its responsibilities amongst several other departments. A Department of Interior report published in 2023 noted that, "At the end of the 20th century, the United States lost its position as the global leader in mining, both in terms of total production and the development of cutting-edge mining technology."[1]

Over the last three decades, China has become a dominant player in the supply chains of minerals key to national and energy security. Even if it is a marginal producer directly, China finances and imports from the rest of the world to control 65 percent to 90 percent of global supply of key metals.[2] This concentration is the result of decades of industrial strategy and foreign policy from Beijing. It is also a strategic challenge for the United States, given the importance of strengthening national security and meeting energy needs while geopolitical tensions between the two countries rise. China has developed a robust workforce that has allowed it to develop an absolute advantage in these supply chains.

Rare earth elements, nickel, lithium, germanium and gallium are critical inputs for defense systems, including precision guided munitions, strategic nuclear applications and several missile classes, lasers that serve as range fingers and target designators, military information communication technology, modern naval missiles, weapon systems, tanks, and radar modules. They are the backbone of national security. Copper, lithium, nickel, manganese, cobalt, graphite, zinc, and rare earth elements are necessary for meeting our global decarbonization goals by manufacturing and deploying offshore and onshore wind, stationary and electric vehicle batteries, solar photovoltaics (PV), nuclear power and natural gas.

The United States, and much of the globe, is most reliant on China for its critical minerals supply.[3] Of the 50 minerals included in the 2022 Final List of Critical Minerals produced by the USGS, the United States had larger than a 50 percent reliance on imports for 31[4,5] and was wholly import reliant for 12. The United States is wholly reliant on China for 9 of them.[6] China has already demonstrated a willingness to use export controls or quotas on critical minerals as a geopolitical tool.

The United States needs a strategy for reducing dependency and strengthening mineral supply. The last two administrations have set out to improve supply through better exploration, production, recycling, and reprocessing of critical minerals. In 2017, President Donald Trump issued Executive order 13817, to facilitate better management of critical minerals to strengthen energy security and executive prosperity. An output of this was an inter-agency report from the Secretaries of Commerce, Defense, Interior and Energy and the U.S. Trade Representative on critical minerals. One of the six calls to action in the report was to, "Enhance International Trade and Cooperation Related to Critical Minerals: [Identify] options for accessing and developing critical minerals through investment and trade with America's allies, discusses areas for international collaboration and cooperation."[7] In

---

[1] U.S. Department of the Interior. Recommendations to Improve Mining on Public Lands. September 2023.

[2] Baskaran, G. What China's Ban on Rare Earths Processing Technology Exports Means. Center for Strategic and International Studies. January 8, 2024.

[3] Stanford University. Assessing the U.S.-China Competition for Minerals Crucial to the Development of Emerging Technologies. October 1, 2023.

[4] National Mining Association. U.S. Reaches Highest Recorded Mineral Import Reliance. January 31, 2023.

[5] This includes 14 lanthanides, which are part of the rare earth elements group.

[6] Department of the Interior. Recommendations to Improve Mining on Public Lands. September 2023.

[7] U.S. Department of Commerce. A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals.

2021, President Biden issued Executive Order 14017 which ordered a review of vulnerability in the U.S. critical mineral and material supply chain. Subsequently, a supply chain assessment was released by the Administration that found over-reliance on foreign sources and adversarial nations for critical minerals and materials posed national and economic security threats. The White House published its "Plan to Revitalize American Manufacturing and Secure Critical Supply Chains" in 2022, where it announced plans to increase domestic processing capacity of rare earth minerals, copper, nickel, lithium, and cobalt.

The Defense Logistics Agency (DLA) has a stockpile of 47 commodities worth more than $1.5 billion. The stockpile was first established after World War 1. In February 2022, Congress authorized $1 billion for the National Defense Stockpile to acquire strategic and critical materials to increase its buffer in the event of crises and disruptions in supply chains. [8]

Over the last few years, Congress also passed the Infrastructure Investment and Jobs Act (IIJA), the CHIPS and Science Act, and the Inflation Reduction Act (IRA), which authorized and provided over $8.5 billion in funding for critical minerals activities. [9] Specifically, the IRA seeks to prioritize domestic production of minerals. The Clean Vehicle Tax Credit and the Advanced Manufacturing Production Tax Credit of 2022 extend tax credits only to vehicles that meet threshold requirements for critical materials sourced domestically and from countries with which the United States has a free trade agreement. These tax credits and spending programs are uncoordinated and mostly focused on domestic mining and processing.

However, the domestic-only approach to critical minerals cannot work. Geologically, a significant share of the minerals we need are not located in the United States or economically recoverable here. The United States has less than 1 percent of the world's nickel, cobalt, and graphite, 1.3 percent of the world's rare earths, and 1.5 percent of the world's manganese, which is a non-substitutable metal required for all steel production.

The United States ability to build both its domestic and international capacity in mining will require a skilled workforce, which we have a significant deficit for. A recent McKinsey survey revealed that 71 percent of mining leaders stated that human capital shortages are preventing them from reaching their production targets and strategic goals. [10] We need mining engineers, geologists and geoscientists, metallurgists, geophysicists, economists, and senior management that we can deploy domestically and internationally. An analysis from CSIS notes:

> "More than half the current domestic mining workforce will need to be retired and replaced by 2029 (roughly 221,000 workers). This number stands in stark contrast to the total of just 327 degrees awarded in 2020 in mining and mineral engineering and a 39 percent net drop in graduations in the United States since 2016. University programs tasked with creating this workforce have also been decreasing, with the number of mining and mineral engineering programs in the United States dropping from 25 in 1982 to 15 in 2023. This is in stark contrast to China, which has over 38 mineral processing schools and upwards of 44 mining engineering programs. Central South University, China's largest mineral processing program, has 1,000 undergraduates and 500 graduate students alone ready to accomplish China's mineral ambitions." [11]

As the graph below shows, without this, we will not be able to meet future minerals demand, which will grow significantly over the next 30 years, largely driven by clean energy technology. In 2020, the world needed approximately 8 million metric tons of minerals for the deployment of clean energy technologies—electric vehicles, electricity networks, solar and wind technology, battery storage, low-carbon power generation and hydrogen. In 2030—just 6 years from now—we will need roughly 50 million metric tons—over a sixfold increase. In 2040, this increases to about 105 million metric tons—a thirteenfold increase from 2020. And by 2050, we will need about 150 million tons—nearly a 19 fold increase. Training a workforce

---

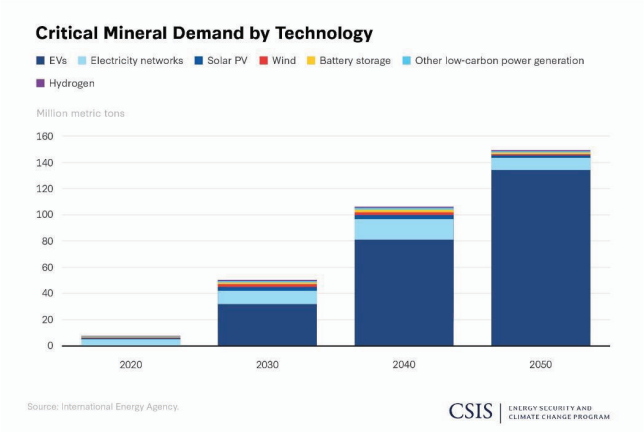
[8] Barna, S., Hastings, A. and Pearce, M. 2023 NDAA Provides New Opportunities for Industry. National Defense Magazine. February 7, 2023.

[9] Broberg, D. and Jacobs, J. Expanding Domestic Critical Mineral Supply Chains. Bipartisan Policy Center. March 15, 2023.

[10] Has mining lost its luster? Why talent is moving elsewhere and how to bring them back. February 14, 2023.

[11] Hale, T. The United States Needs More than Mining Engineers to Solve Its Critical Mineral Challenges. May 8, 2023.

to meet future demand is imperative and it requires efforts that begin as soon as possible.



Addressing the Workforce Shortage

Repurposing Existing Instruments to Build the Mining Workforce

The Department of Interior report published in 2023 noted that, "A lack of educational programs for building expertise in mining and mining oversight and a lack of interest in mining among the cohort of students who will become the managers of tomorrow compound a shortage of properly trained workers." [12]

My dad is the Chair of the Geology Department at Wayne State University in Detroit. As I've built my own career in the mining industry, we have discussed how geology, environmental science and engineering graduates in the United States are not moving to the mining sector. The United States needs to support embedding mining workstreams into geology and engineering programs. The need to build a mining workforce is a more recent priority—so few programs have historical depth here. Catching up in this area will require a significant increase in capacity building and financing. This is for two reasons. First, academic programs largely succeed or fail based on available funding—particularly for research and scholarships. Second, there is often a lack of expertise to build these programs. This will require bringing in both skilled industry experts and faculty from mining programs around the world to cross-pollinate knowledge and build these programs—in particular Australia and Canada have deep academic expertise in the mining sector. The 2024 QS World University Rankings for mineral and mineral engineering show that one out of the top 12 programs in the world are American—Colorado School of Mines. Of the other 11, there are four in Australia and Canada and one in Russia, Chile and Saudi Arabia. [13]

A key solution to achieving these two goals is to make existing mechanisms better fit for mining workforce development. With that in mind, I can make three suggestions:

The first is creating a dedicated Fulbright program for mining, minerals processing, and recycling. There are already a number of Fulbright programs—the Fulbright Arctic Initiative, the Fulbright Hays Program for K–14 teachers and administrators, Fulbright United States Scholar program for United States scholars and artists, Fulbright European Union Scholar-in-Residence (EUSIR) Program to strengthen United States expertise in European Affairs, and Fulbright Specialist Program to send U.S. faculty abroad to serve as expert consults and do faculty development, amongst others. A Fulbright program for mining to bring mining experts and faculty to the United States and send undergraduate and graduate students to

---

[12] U.S. Department of the Interior. Recommendations to Improve Mining on Public Lands. September 2023.

[13] QS World University Rankings by Subject 2024: Mineral & Mining Engineering. *https://www.topuniversities.com/university-subject-rankings/mineral-mining-engineering*.

top mining institutions abroad offers a real opportunity to both establish and expand mining programs in the United States and allow our students, particularly in STEM-related mining fields, to develop the necessary skills and knowledge to enter the modern minerals workforce.

The second is increasing targeted funding to the National Science Foundation (NSF) for mining-related research and capacity building. The NSF is an independent Federal agency that supports science and engineering in all 50 U.S. states and U.S. territories. In 2023, the NSF's enacted budget was $9.9 billion, and they supported over 2,000 organizations in every state and U.S. territory.

- The NSF has 15 focus areas—ranging from the arctic and Antarctic to astronomy and biology. Chemicals and materials are perhaps the closest to the mining sector—but it's still not fit to building mining expertise. The objective of this effort is "breakthroughs in chemistry and materials science that enhance nearly every aspect of daily life, from pharmaceuticals to plastics, environmental cleanup to battling pandemics." Mining is notably absent. [14]
- The NSF also has 11 technology focus areas—ranging from artificial intelligence to biotechnology and cyberinfrastructure. [15]Advanced materials are closest to the mining industry and the institution notes that "NSF invests in the discovery of new materials and processing methods that can unlock innovations across a wide range of sectors—such as medicine, agriculture, electronics, manufacturing, energy and national security." Mining is inadequate in this program.
- Mining remains vastly underfunded by the NSF—just 9 of 815—or 1.1 percent of active grant opportunities are for minerals.

The CHIPS Act of 2022 (Section 10359) authorized funds for the NSF to increase its work on critical minerals mining and development. [16] It includes provisions for institutions of higher education or nonprofits to offer training and research opportunities to undergraduate and graduate students, preparing the next generation of mining engineers and researchers. Funding for these programs has not been appropriated and could be included in the appropriations legislation for fiscal year 2025.

Third, widen the sectoral scope of section 40211 of the IIJA which mandated that the Department of Energy create a 21st Century Energy Workforce Advisory Board to evaluate the requirements of the domestic energy workforce. The Board has also been mandated to develop strategies to provide opportunities for students to qualify to work in the energy sector and identify avenues for the Department of Energy to work with Federal agencies and nongovernmental organizations to drive. [17] It is crucial for this program to go beyond an energy workforce and examine the needs of the mining workforce since the mining sector is essential for the implementation of nearly all new energy technologies. Without upstream support, the downstream renewable energy development will be impossible.

Partnerships Between Mining Companies and Universities

According to the Bureau of Labor Statistics, the median age of a worker in the United States mining industry is 42, which underscores the need to attract younger generations. [18] There needs to be a fundamental rebranding of the mining industry. The report published by the United States Department of the Interior—Recommendations to Improve Mining on Public Lands—in 2023 notes that "The mining industry is having difficulty attracting young professionals and building a workforce.

---

[14] The full list of focus areas include the arctic and Antarctic to astronomy and chemistry and materials, computing, diversity in STEM, earth and environment, education and training, engineering, facilities and infrastructure, mathematics, people and society, physics, research partnerships and interdisciplinary convergence and transformative research.

[15] The full list of the NSF's 11 technology focus areas is advanced manufacturing, advanced materials, artificial intelligence, biotechnology, communications and wireless, cyberinfrastructure and advanced computing, cybersecurity, disaster risk and resilience, energy technology, quantum information science and technology, semiconductors and microcolonies.

[16] H.R. 4346—Chips and Science Act. *https://www.Congress.gov/bill/117th-congress/house-bill/4346*.

[17] Energy and Minerals Provisions in the Infrastructure Investment and Jobs Act (P.L. 117–58). Congressional Research Service. *https://crsreports.Congress.gov/product/pdf/R/R47034*.

[18] Labor Force Statistics from the Current Population Survey. *https://www.bls.gov/cps/cpsaat18b.htm*.

One major obstacle appears to be the negative public perception of the industry." [19] There are two key areas for rebranding.

The first is that the industry is that the industry is tech-based. The modern mining industry is no longer one that uses picks and wheelbarrows—it runs on satellite imaging, artificial intelligence, advanced analytics, automation, robotics, and manufacturing 4.0. I've been to various mines that are entirely run out of what resembles a mission control room—blasting, production, and transportation of minerals.

Second, significant advances have been made in further improving the environmental and social impacts of mining. Responsible mining is a core focus area for nearly all Western companies. The mining industry has a goal of zero fatalities and zero injuries, amongst a range of other Environmental, Social and Governance targets. In the United States, injuries in mines have been reduced by 58 percent over the last 15 years while fatalities have decreased by 55 percent during that same time window. [20] Globally, institutions like the International Council of Minerals and Metals (ICMM), a key industry association for responsible mining, have worked with their members to improve human rights, health and safety, environmental performance, conservation of biodiversity, and social performance. Earlier this year, the ICMM, Mining Association of Canada, World Gold Council and Copper Mark launched a process to create a consolidated global standard for responsible mining.

This means that mining is more technology-based and responsible than ever before. From a financial perspective, there is incentive for young people to go into mining. The average annual salary for a miner in 2023 was $94,848—which is well above the United States average wage of $72,609. This means that the average worker in the mining industry makes 31 percent more than the national average. [21] Furthermore, as the shortage of workforce grows, supply and demand dynamics should drive wages up further.

It is in the interest of mining companies to build their workforce, particularly with young people. Establishing a Federal program to coordinate collaboration between mining companies and universities to strengthen the development of the mining workforce, particularly in STEM fields, enhance research and promote innovation in the industry.

Mining companies can provide curriculum support to reflect the latest industry trends and technological advancements and experts working in the mining sector can deliver guest lectures and conduct workshops to give students field experience and share practical knowledge. Mining firms can also provide internships and co-op programs so students can get paid hands-on experience ahead of graduation, for an easier and more experienced transition to the workforce.

Another key avenue of support for the mining sector is by providing scholarships to students. This has long been used in other mining jurisdictions. For example, in South Africa, where I worked for 7 years, companies like Anglo American have financed many students over the years on the condition that they come back and work for the company after graduation. This is particularly useful to encourage socioeconomically disadvantaged students—who are often underrepresented in the industry—to enter the field, thereby supporting diversity efforts.

Leveraging U.S. Military Academies to Build Tomorrow's Leaders

The primary purpose of U.S. military institutions including the United States Military Academy, United States Naval Academy, United States Air Force Academy, and United States Coast Guard, amongst other institutions is to build future military leaders. Academy-trained engineers built the railroads and bridges for westwards expansion and were instrumental in the Industrial Revolution. It's time to enable them to answer the call for another national security challenge.

I was privileged to speak at West Point on critical minerals in February 2024. Lieutenant General Jonathan Braga—who is serving as the commanding general of the United States Army Special Operations Command—provided the keynote for the event. The interest from cadets afterward was clear. They are our future leaders—they will go on to be political leaders, cabinet members, Ambassadors, and even mining executives that can advance United States mineral interests.

---

[19] United States Department of the Interior. Recommendations to Improve Mining on Public Lands. September 2023.

[20] National Mining Association. Improving Mine Safety and Health. *https://nma.org/category/safety-and-health/*.

[21] National Mining Association. Annual Mining Wages vs. All Industries, 2023. *https://nma.org/wp-content/uploads/2023/06/annual-mining-wages-state-23-1.pdf*.

Mining executives have a key role to play in advancing strategic mining objectives, including talent development and pursuing national security goals. They require an understanding of engineering, diplomacy and strategy. There is a clear need to develop a workforce that is capable of leading mining companies. There are only two American CEOs of large market cap mining companies that I'm aware of—Richard Adkerson at Freeport McMoRan and Bob Wilt, an American West Point graduate and Army veteran from the Gulf War. After a long career at Alcoa, an American company, Bob is now the CEO at Ma'aden, one of the fastest growing mining companies in the world. The experience he gained in engineering, diplomacy and strategy at both West Point and his subsequent military career has been valuable. Scaling up the number of American mining executives is critical if we are to build U.S. leadership in the mining sector—and our military academies are an excellent place to do this.

At CSIS, we are planning the first national security and critical minerals summit, which will be held in October. Our speakers will include many West Point alumni—former U.S. cabinet members, Ambassadors and a mining executive. Our goals are two-fold. The first is to give cadets much needed exposure to the importance of critical minerals and what careers in the mining industry look like. The second is to give faculty more exposure to critical minerals issues, which the United States has disregarded for the last 30 years. Upscaling support to initiatives like this is key.

Conclusion

The future of meeting American minerals security needs will require both domestic and international mining given the distribution of resources. In my conversations with industry, workforce shortages are universally cited as limitation. The United States may have closed its Bureau of Mines in 1996—but investing in workforce development must be a priority to reduce our reliance on China. Without an adequate supply of mining engineers, geologists and geoscientists, metallurgists, geophysicists, economists, and senior management that we can deploy domestically and internationally, China will continue to have the upper hand, leaving our national, economic and energy security highly vulnerable to disruption.

Senator HICKENLOOPER. Great. Thank you for Dr. Baskaran. Next, we'll have Mr. Jon Evans. Mr. Evans is the president, CEO of Lithium Americas, which is building a lithium mine and chemical facility in northern Nevada. John's been with the company since 2017, but he has over 20 years' experience in operating and managing various businesses, including running FMC corporations, lithium division, Mr. Evans.

STATEMENT OF JON EVANS, PRESIDENT, AND CEO, LITHIUM AMERICAS, RENO, AND WINNEMUCCA, NV

Mr. EVANS. Thank you, Senator, Chairman Hickenlooper, Ranking Member Braun, and Members of the Subcommittee. My name is Jon Evans and I am the president, CEO of Lithium America's Corporation. Greatly appreciate your focus on workforce development for critical minerals development. Finding the skilled workforce in my project and industry needs to thrive is a significant challenge, and I commend you for working to address this important issue.

Lithium Americas is building a major lithium mine and processing facility in northern Nevada called the Thacker Pass Project. We've been working on Thacker Pass for more than a decade and are pleased to be fully permitted and funded to move forward with this essential project.

Once in operation in 2027, we'll produce enough refined lithium carbonate for approximately 800,000 electric vehicle batteries per year. That's a market improvement on the U.S.'s ability to provide

materials we need. To start the projects offtake will be sold exclusively to General Motors. This will profoundly assist GM with their transition to electric vehicles.

Workforce development is a challenge that we're trying to meet head on. Lithium Americas will utilize as many as 2000 skilled workers to build Thacker Pass. To ensure we get the workers we need in a remote area of Nevada, we've entered into a Project Labor Agreement with a North American Building Trades Union. NABTU knows how to recruit and train local and regional professionals to build large scale projects like ours and to get the job done right.

Once completed, Lithium Americas will employ roughly 350 full-time professionals at our Thacker Pass facility. These jobs will operate sophisticated processing and chemical manufacturing plants and the workers we need are not readily available. I'll add that the average wage with benefits is $100,000 a year.

To meet this need, we have embarked on aggressive efforts working with the University of Nevada, Great Basin College in Nevada, the State of Nevada, and others to implement the training we need so our future workforce is ready to go once Thacker Pass is complete in 2027.

Lithium Americas is committed to doing this project right. This includes sound environmental stewardship, ensuring the benefits of our project accrue to local communities, including the Fort McDermitt Paiute and Shoshone Tribe, and providing family supporting careers in this exciting and emerging battery industry.

Because of the significance of our project and being an industry leader from the start, Lithium Americas has been committed to engaging with local community and Tribal members. This active dialog has allowed Lithium Americas to be transparent about the project's details and its impacts. Lithium Americas has participated in numerous open houses, community meetings, one-on-one dialogs; provided numerous tours; and emphasized employment opportunities and other ways the project could benefit local and Tribal members.

Over the past several years, many throughout Humboldt County have expressed interest in working onsite and participated in job skills training, coordinated, or provided by our company as well.

Numerous members of the tribe have emphasized that this project allows members to stay home or return home because of the jobs we will provide.

Lithium Americas and the Fort McDermitt Tribe have a formal Community Benefits Agreement founded on years of active engagement. It focuses on ensuring the tribe can benefit from the job creation at Thacker Pass, by committing to additional job training and employment opportunities for tribal members, as well as providing infrastructure development and support for cultural education and preservation.

Lithium Americas has agreed to build a $5 million community center for the tribe that includes a preschool and daycare so parents will be able to take advantage of the jobs we'll create while knowing their kids are safe and secure.

Larina Bell, Fort McDermitt's Tribal Chairwoman commented on the announcement of the Department of Energy loan that will help finance construction of the project, that "Thacker Pass will provide important economic and employment opportunities for members of our Tribe."

In the nearby town of Orovada, Lithium Americas is committed to building a new K–8 public school. A leading motivator for this community investment is to ensure prosperity at Thacker Pass benefits many generations of locals starting in elementary school and potentially continuing through lifetime quality careers in the area.

Lithium Americas is committed to meeting the focus of this Subcommittee by growing a skilled workforce to fill family supporting careers in jobs that benefit the Nation's security, bolster the state and local economies, and fulfill a rapidly growing demand to electrify our economy.

Thank you for the opportunity to be with today, and I look forward to your questions.

[The prepared statement of Mr. Evans follows.]

PREPARED STATEMENT OF JON EVANS

Chairman Hickenlooper, Ranking Member Braun, and Members of the Subcommittee, my name is Jon Evans, and I'm the President and CEO of Lithium Americas Corporation (LAC). I greatly appreciate your focus on workforce development for critical minerals development. Finding the skilled workforce my project and industry needs to thrive is a significant challenge, and I commend you for working to address this important issue.

Lithium Americas is building a major lithium mine and processing facility in Northern Nevada called the Thacker Pass Project. We have been working on Thacker Pass for more than a decade and are pleased to be fully permitted and funded to move forward with this essential project. Once in operation in 2027, we will produce enough lithium carbonate for approximately 800,000 electric vehicle batteries per year. That's a marked improvement on the U.S.'s ability to provide the materials we need. To start, the project's offtake will be sold to General Motors. This will profoundly assist with their transition to EVs.

Workforce development is a challenge we're meeting head-on. Lithium Americas will utilize as many as 2,000 skilled workers to build Thacker Pass. To ensure we get the workers we need in a remote area of Nevada, we entered into a Project Labor Agreement with the North Americas Building Trade Unions. NABTU knows how to recruit local and regional professionals to build large-scale projects like ours and to get the job done right.

Once completed, Lithium Americas will employ roughly 350 full-time professionals at our Thacker Pass facility. These jobs will operate sophisticated processing and chemical manufacturing plants, and the workers we will need are not readily available. To meet this need, we have embarked on aggressive efforts working with the University of Nevada, Great Basin College in Nevada, the State of Nevada and more to implement the training we need so our future workforce is ready to go once Thacker Pass construction is completed in 2027.

Lithium Americas is committed to doing this project right. That includes sound environmental stewardship, ensuring the benefits of our project accrue to local communities including the Fort McDermitt Paiute and Shoshone Tribe, and providing family supporting careers in this exciting and emerging battery industry.

Because of the significance of our project and being an industry leader from the start, Lithium Americas has been committed to engaging with local community and Tribal members. This active dialog has allowed Lithium Americas to be transparent about the Project's details and its impacts. Lithium Americas has participated in numerous open houses, community meetings, one-on-one dialogs; provided numerous tours; and emphasized employment opportunities and other ways the Project could benefit local and Tribal members.

Over the past several years, many throughout Humboldt County have expressed interest in working onsite and participated in job skills training coordinated or pro-

vided by LAC. Numerous members of the Tribe have emphasized that this Project allows members to stay home or return home because of the good jobs we will provide.

Lithium Americas and the Fort McDermitt Tribe have a formal Community Benefits Agreement founded on years of active engagement. It focuses on ensuring the Tribe can benefit from job creation at Thacker Pass by committing to additional job training and employment opportunities for tribal members, as well as providing infrastructure development and support for cultural education and preservation. Lithium Americas has also agreed to build a $5 million community center for the Tribe that includes a preschool and daycare so parents are able to take advantage of the jobs we'll create while knowing their kids are safe and secure.

Larina Bell, Fort McDermitt's Tribal Chairwoman, commented on the announcement of the Department of Energy loan that will help finance construction of the Project that, "Thacker Pass will provide important economic and employment opportunities for members of our Tribe."

In the nearby town of Orovada, Lithium Americas has committed to building a new K–8 public school. A leading motivator for this community investment is to ensure prosperity at Thacker Pass benefits many generations of locals starting in elementary school and potentially continuing through lifetime, quality careers.

Lithium Americas is committed to meeting the focus of this Subcommittee by growing a skilled workforce to fill family supporting careers in jobs that benefit the Nation's security, bolster the state and local economies, and fulfill a rapidly growing demand to electrify our economy.

Thank you for the opportunity to be with you today. I look forward to your questions.

Senator HICKENLOOPER. Thank you, Mr. Evans.

Now, Mr. Zisch. Mr. Zisch serves as the Head of The Mining Engineering Department at the Colorado School of Mines. He also has over 40 years of experience in the mining industry, including international mining, mining plant operation, and numerous corporate assignments with various mining companies.

Mr. ZISCH.

STATEMENT OF BILL ZISCH, J. STEVEN WHISLER HEAD OF MINING ENGINEERING, COLORADO SCHOOL OF MINES, GOLDEN, CO

Mr. ZISCH. Chairman Hickenlooper, Ranking Member Braun, and distinguished Members of the Subcommittee, thank you for the opportunity to testify today on the growing importance of our critical minerals workforce.

With over 40 years of experience in the global mining industry, I have seen firsthand the sector's significant contributions to the economy, local communities and living standards. Critical minerals are essential to produce medicines, semiconductors, defense systems, clean energy and more.

I have also seen examples of the lasting damage mining can have on communities and ecosystems. These conflicting realities complicate perceptions of an industry that is vital to our economy, energy future, and national security.

I know that when it comes to critical minerals in the modern world, the most important critical resource is our people, skilled professionals, and stewards of natural resources, trained to solve complex engineering and social challenges. For this reason, I returned to mining education and now serve as the head of the Mining Engineering Department at Colorado School of Mines, the

world's top ranked mineral and mining engineering school. Our interdisciplinary education and research cover the full mineral life cycle from exploration to reclamation.

As a global demand for critical minerals has surged, there is growing recognition that these goals will require more minerals and more mining. At the same time, it is estimated that half of the U.S. mining workforce, about 220,000 people will retire by the end of the decade and the talent pipeline is not sufficient to meet demand.

Declining enrollments are a result of a combination of factors, including limited knowledge or experience with the industry, the globalization of mining operations and industry image that associates mining with environmental concerns as well as a perception of an unsafe workplace.

In response, the university is promoting a new vision for the future of mining and responds to the scientific, social, and environmental challenges facing the sector and aligns with the student's passion for environmental stewardship. It also integrates innovation, advanced technologies, and sustainable practices to minimize environmental impact, optimize resource utilization, and increase productivity.

We must demonstrate that careers in the minerals industry are rewarding and impactful. There are signs of an enrollment rebound at Colorado School of Mines. In fall 2023, undergraduate mining engineering enrollment increased by 22 percent from the prior year with just over 100 students enrolled in the mining engineering program.

With climate change at the forefront of many students' concerns, we work to inform students of the essential link between mining, minerals, responsible resource management, and sustainable energy, which appeals to their sense of purpose and drive to solve the world's most complex problems.

Today, mines curriculum extends beyond geology and mine operations, and includes classes in waste, water, and tailings management and social and community engagement. Our mining department faculty also includes anthropologists, highlighting the need for technical and social awareness to understand projects in an environmental and societal context.

Mines vision for future of mining also recognizes the transformational role of research and innovation. Advanced technologies, robotics, AI drilling innovations, advanced separations, tailings management, recycling, are all essential for an economically viable interest industry with a net positive impact for stakeholders.

At its core, Mines research is rooted in partnerships with industry, national labs, academia, and government. Research is critical to address the most pressing mineral challenges and to the development and retention of mining and mineral educators that support and sustain mining engineering programs. Mining schools play an important role in growing our Nation's critical mineral workforce through both education and research.

Colorado School of Mines is committed to a new vision for mining in the future and working with industry, academia, communities,

and government, to reestablish our mineral workforce as a critical element of the U.S. economic energy and security future. Thank you.

[The prepared statement of Mr. Zisch follows.]

PREPARED STATEMENT OF BILL ZISCH

Chairman Hickenlooper, Ranking Member Braun and distinguished Members of the Subcommittee, thank you for the opportunity to testify today on the growing importance of our critical minerals workforce.

With over 40 years of experience in the global mining industry, I have seen firsthand the value the minerals industry brings to the economy, local communities and living standards. Critical minerals are the building blocks of medicines, semi-conductors, defense systems, clean energy and more.

I have also seen examples of the damage mining can have on communities and ecosystems in the U.S. and abroad, if not done properly or responsibly. This includes lasting environmental damage, unacceptable labor practices and legacy waste sites which are difficult to repair or remediate. These competing realities complicate perceptions of a mining industry that is vital to our economy, energy future and national security.

My experience has taught me that when it comes to minerals and their role in our modern world, our most critical resource is our people—skilled professionals equipped to responsibly manage our earth's resources and solve complex engineering and social challenges.

It is for this reason that I returned from semi-retirement to mining education—first as a professor of practice. Today, I serve as the Head of the Mining Engineering Department at Colorado School of Mines (Mines), home to the top ranked mineral and mining engineering program in the world.[1] Our world-class faculty support interdisciplinary education and research covering all aspects of the mining and mineral life cycle—from exploration, extraction and processing to recycling, mine closure and reclamation, as well as water management, community engagement, occupational health and safety, mineral economics and supply chains. Our broad scope of study also includes space mining and deep underground mining and construction.

Mining and Minerals Workforce Challenges

As global demand for critical minerals has surged, largely in response to energy goals, there is a growing recognition that achieving these goals will consume more minerals and require more mining.

The International Energy Agency (IEA) estimates that to meet demand for clean energy technologies by 2040, the world will need 42 times as much lithium compared to 2020—25 times more graphite, 21 times more cobalt and 19 times more nickel.[2] According to Benchmark Mineral Intelligence, at least 284 new mines will need to be built globally to meet electric vehicle demand by 2035.[3] The challenge is compounded both by the scarcity of economically viable deposits and the length of time required to characterize, permit and develop a new mine.

It is well documented that for most critical minerals, the U.S. is heavily reliant on foreign sources for its consumption requirements[4]—many of which are mined and processed in adversarial nations with low or unenforced environmental, labor and human rights standards. While the U.S. was once the global leader in mineral development, we have ceded that leadership position. Nonetheless, there are important and impactful new mineral developments being advanced throughout the country, including for lithium, copper, manganese, nickel and cobalt.

At the same time, it is estimated that half of the U.S. Mining workforce, about 220,000 people, will retire by the end of the decade, and the talent pipeline is not sufficient to replace experienced professionals in mining engineering or other related

---

[1] QS Top Universities. (2024). *University subject rankings: Mineral & mining engineering*. *https://www.topuniversities.com/university-subject-rankings/mineral-mining-engineering*.

[2] International Energy Agency. (2021). *The role of critical minerals in clean energy transitions: Executive summary*. *https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary*.

[3] Hodgson, C. (2023, May 1). *More than 300 new mines required to meet battery demand by 2035*. Benchmark Mineral Intelligence. *https://source.benchmarkminerals.com/article/more-than-300-new-mines-required-to-meet-battery-demand-by-2035*.

[4] U.S. Geological Survey. (2023). *Mineral commodity summaries 2023* (Report No. 2023–3000). U.S. Department of the Interior. *https://pubs.usgs.gov/periodicals/mcs2023/mcs2023.pdf*.

disciplines.[5] The minerals and mining workforce includes a broad range of skilled professionals including technicians, engineers and scientists trained in geology, hydrology, metallurgy, chemistry, community engagement and social science, business and economics, data science, health and safety, mine closure and reclamation and more.

Today, there are 14 mining engineering programs in the U.S.—down from 25 in 1982. Last year, these mining schools collectively enrolled 590 undergraduate students, graduating just 162 students for an industry demand of 400–600 new mining engineers each year.[6] In comparison, China's 45 mining engineering programs currently enroll about 12,000 students and graduate approximately 3,000 a year—about 16 times the number of graduates in the United States.[7]

Declining enrollments are the result of a combination of factors, including limited knowledge or experience with the industry, the globalization of mining operations, an industry image that associates mining with adverse environmental impacts, as well as a perception of an unsafe workplace.

It is imperative that we—industry, academia and society—thoughtfully address these concerns and demonstrate that careers in mining engineering are rewarding, technology-driven and impactful. Absent a meaningful shift in perceptions, the best and brightest students and leaders will pursue opportunities in other competitive fields.

A New Vision for the Future of Mining

In response to these challenges, Mines is advancing a compelling new vision for the future of mining that aligns with students' passion for environmental stewardship. This vision also integrates advanced technologies and sustainable mining practices to increase productivity, minimize environmental impact, improve safety and optimize resource utilization.

While undergraduate enrollment in Mining Engineering at Mines, like other mining schools, has experienced a decline in enrollment, there are signs of a rebound. In Fall of 2023, Mines' undergraduate Mining Engineering enrollment increased by 22 percent from the prior year, with just over 100 students enrolled in the Mining Engineering program.

This rebound is attributed, in part, to a focus on first and second-year students who are undecided or not yet strongly committed to their major. With climate change at the forefront of many of our students' concerns, informing students of the world's essential critical mineral applications and the need for innovative leadership appeals to their inherent sense of purpose and desire to solve the most complex challenges. Also, promoting strong stewardship of natural resources to create sustainable development and prosperity for communities, tribes, governments and other stakeholders speaks to students' altruistic desire to positively impact the world. Thus, we teach the essential link between mining, minerals, responsible resource management, sustainable energy, and community and societal benefits.

Informed by regular input and support from industry partners, the Mining Engineering curriculum extends far beyond the basic foundations of geology and mine operations. Students take classes in waste, water and tailings management and social and community engagement. Our Mining Department faculty also includes an anthropologist, highlighting the need for both technical and social awareness to understand projects within the context of the environment, communities and society.

Furthermore, our industry partners consistently share that today's mining operations require talent from various disciplines, including expertise in mechanical, electrical, civil, environmental, chemical, petroleum, and humanitarian engineering—and need to extend to economics, computer science, data science, risk management, statistics and math. We believe promoting a Minor in Mining Engineering to students in these disciplines can also help draw non-mining engineers to the sector.

---

[5] Society for Mining, Metallurgy & Exploration. (n.d.). *Workforce trends in the U.S. mining industry*. *https://www.smenet.org/What-We-Do/Technical-Briefings/Workforce-Trends-in-the-U.S.-Mining-Industry*.

[6] Society of Mining Professors and Society for Mining, Metallurgy and Exploration, 2021; data collected by Vlad Kecojevic. National Academies of Sciences, Engineering, and Medicine. 2024. Building Capacity for the U.S. Mineral Resources Workforce: Proceedings of a Workshop. Washington, DC: The National Academies Press. *https://doi.org/10.17226/27733*.

[7] National Academies of Sciences, Engineering, and Medicine. (2024). *Building Capacity for the U.S. Mineral Resources Workforce: Proceedings of a Workshop*. Washington, DC: The National Academies Press. *https://doi.org/10.17226/27733*.

As a result, Mines graduates are highly sought after by industry, academia and government, serving in roles that range from mine planning, extraction and processing, mine remediation and reclamation, community engagement, business and finance, public policy and regulatory compliance.

Mines is also strengthening diverse pathways into engineering careers by actively working with Colorado's community colleges to expand opportunity and access to all Mines engineering degrees, including Mining Engineering. Mines Academy is a program that puts community college students on a direct pathway to a bachelor's degree from Mines after completing a 2-year Associate of Engineering Science degree at a participating community college, which includes minority-serving institutions. [8]

Beyond aligning students' interests with the world's need for critical minerals, Mines also engages in more traditional outreach programs such as career information workshops, highlighting opportunities that include readily available scholarships and internships and near 100 percent graduate job placements in well compensated positions that offer unique lifestyle opportunities.

Mining and Minerals Innovation

Mines' vision for the future of mining also recognizes the transformational role that research and innovation can and must have on the future of mining. Research—and strong research funding—is critical to inspire the most talented minds to tackle the most pressing mining-related challenges. It is also necessary to recruit and retain the next generation of mining and mineral faculty and educators that support and sustain mining engineering programs.

The mining industry faces significant changes due to evolving social and environmental conditions, technological advancements, development costs, market fluctuations and the need for sustainable mining practices. For example, future mines will likely need to be self-sufficient in power and water to avoid competing with local communities, relying on renewable energy systems to support decarbonization efforts.

Advanced technologies and techniques—robotics and artificial Intelligence (AI), drilling innovations, brines extraction, advanced separations, coproduction processes, digital subsurface applications, tailings management, recycling and more—will be critical to create an economically viable industry that generates net positive impact for stakeholders.

Specific advances expected to evolve from applied technological innovation include mine design algorithms that will incorporate social license considerations. Advanced analytics, machine learning and AI will enhance operations by reducing costs and improving dispatch systems, ore sorting, recycling, ore control, maintenance and downtime. Safety advancements will focus on operator fatigue, collision avoidance and vehicle intervention systems. Autonomous equipment like trucks, drills, loaders and dozers will improve safety and efficiency, while drones and robots will handle tasks traditionally performed by humans.

The research community, including the Colorado School of Mines, is actively engaged in applied research of semiconductors, clean energy, and advanced technologies—all of which require critical materials. These strategic investments, supported by the CHIPS and Science Act, the Bipartisan Infrastructure Law and the Inflation Reduction Act, have focused on downstream processing and battery manufacturing, but have not included investments in next generation mining innovation and research and development.

Since the dissolution of the Bureau of Mines in 1996, largely for budget reduction purposes, there has been no Federal program dedicated to improving mining technology and processes for sourcing critical minerals more efficiently and responsibly at home or abroad. Investments in research not only address the mining industry's most pressing economic, environmental and sustainability challenges, they also support a strong academic community, which is essential for developing a skilled workforce.

Research Centers and Partnerships

Central to Mines' vision for the future of mining is partnerships with industry, national labs, academia, government and communities, and a commitment to listen, innovate and co-create advanced mining technologies and processes.

---

[8] Colorado School of Mines. (n.d.). *Mines Academy*. *https://www.mines.edu/undergraduate-admissions/mines-academy/*.

More broadly, mining innovation is intended to support community engagement and regulatory acceptance, develop a skilled workforce and inform mining and mineral policies that ensure a responsible, sustainable, and economically viable domestic mining industry.

Mines serves as the academic lead of the Department of Energy's Critical Material Innovation Hub (CMI), which carries out scientific and engineering research to facilitate more diverse primary supply chains, more efficient manufacturing, reuse and recycling, as well as the development of new materials. In addition, the Center for Resource, Recovery and Recycling (CR3), affiliated with Mines' Kroll Institute for Extractive Metallurgy both have direct application in the recovery of critical minerals through primary processing or secondary and recycling processes. Mines' Tailings Center is an industry-university consortium focused on applied and basic research in tailings and mine waste management, as is the NSF-supported Center for Advanced Science and Exploration to Remediation of Mining (CASERM), a partnership with our colleagues at Virginia Tech.

Additionally, with the support of the Bipartisan Infrastructure Law, the U.S. Geological Survey (USGS) is constructing the new USGS-Mines Energy and Minerals Research Facility on the Mines campus. The new facility will house the USGS Geology, Geophysics and Geochemistry Science Center, and Central Energy Resources Science Center.[9] More importantly the partnership will strengthen collaboration between USGS scientists and Mines faculty and students to advance research on topics including critical mineral origins, supply chains and markets, as well as educate the next-generation workforce that will support the critical materials sector.

Conclusion

The future of mining vision begins with the workforce—and will require active engagement from industry, academia, communities, and government. This effort will take time, resources, and most importantly a coordinated strategy. In that regard, Mines supports legislative efforts, like the bipartisan *Mining Schools Act* (S. 912), which would establish a grant program for mining schools to recruit students and support programs in relevant mining and mineral fields.

A strong minerals workforce will also require a new social relationship with the earth's resources, supported by industry, academia (P–20), and government—a relationship that draws direct connections between the mineral workforce and the economy, energy future, environmental protection and national security.

Mining schools play a crucial role in growing our Nation's critical mineral capabilities through both education and research. The opportunity before us is to engage and inspire the next generation of mining and mineral leaders with a passion for impactful careers in an industry innovating to support a sustainable environment.

Colorado School of Mines is committed to this vision and working with all stakeholders to reestablish our mineral workforce as a critical element of our economic, energy and security future.

Thank you.

Senator HICKENLOOPER. Thank you so much. Thanks to each of you for being here. It really is much appreciated. I'll ask some questions then I'll turn it over to Senator Braun and ask questions. Then I'll probably ask more questions because I'm just naturally being a geologist, naturally curious.

Let me start with Mr. Evans, let's lay a foundation for today's discussion. This is a big deal, right? Making sure we have the workforce we need is of crucial importance and making sure that we don't have an ongoing reliance on foreign adversaries. What types of jobs that your company needs now, let's say needs now or will need in the future. How do salaries in these jobs compare with other jobs that you're competing with in the State of Nevada?

---

[9] U.S. Geological Survey. "Energy and Minerals Research." U.S. Department of the Interior, *https://www.usgs.gov/special-topics/bipartisan-infrastructure-law-investments/science/energy-and-minerals-research*. Accessed 7 June 2024.

Mr. EVANS. Thank you, Senator. Our company requires skilled trades to operate the plant. So, welders, electricians, instrumentation technicians from an hourly standpoint. From a professional standpoint, it's a myriad. We have everything from metallurgists, chemical engineers, mechanical engineers, mining engineers, so highly technical jobs that come out of the STEM field.

The salaries that we offer in this field are quite competitive. They have to be, we're competing against other industries that are attracting STEM talent away. So, we have to pay well above average to get folks. I guess the converse to that is that we've had a lot of success being able to attract people, and I think you've heard it across sort of the theme here. We need to rebrand.

I'm one of the oldest folks in the company and at 55, if you come to our laboratory and technical center in Reno, Nevada, or even out to Winnemucca, you're going to see some gray-haired folks there, which is great, because they have the experience to help train the younger folks.

But by and large, our workforce is quite youthful and quite young. And they want to come into this field, they don't view it as mining necessarily or minerals extraction, but they see it as a burgeoning career area around the economies changing into a more green economy or green energy.

I think you and I spoke in the past. My daughter's a great example of that. She turned a job down with Goldman Sachs. She works at the National Renewable Energy Laboratory in Golden, Colorado. She wanted to go into a field that's growing, that's new and have a front row seat to where our economy's going over the next 20 or 30 years.

A lot of our employees that come either as interns or that we're working closely with the University of Nevada or Reno, or even more importantly in closer term, Great Basin College, which is in Winnemucca, Nevada, are all thinking the same thing.

Senator Braun, you had mentioned, we actually go and talk to kids in high school. We have a constant open house every week, members of the public, we have school kids coming in and so forth.

That's the same out in Winnemucca, Nevada, where we're actually outreaching kids in high school, bringing them through a Great Basin College. They've actually worked to develop programs that are specialized around instrumentation, around electricians, which are two of the hardest to find. And they've already graduated two or three classes and they're able to do that now in an associate's degree program that's only a year versus 2 years.

It's possible, but it's tough. And the other thing I'll add too is that, rural economy it's very difficult too. It's much easier to get folks in Reno, Humboldt County for the East Coast folks is half the State of Connecticut has 16,000 people in it. So, it's very rural and typically when kids leave and they go to the State University they don't come back. So, it's grabbing kids in high school so they don't leave, but it's also trying to get people to come back to the area as well.

Senator HICKENLOOPER. Right, engaging them in different ways. Taking that thread then, Dr. Arnold, can you talk about partner-

ships that you might have with community colleges or apprenticeships and programs with businesses as well, and what challenges do you expect as you try and scale up those programs or see them being implemented in other places?

Dr. ARNOLD. As far as the different programs that we have dispersed away from, we'll say the flagship at University Park, Penn State has commonwealth campuses around the state. And each of those has 2-year associate degree programs in things like electromechanical engineering and those types of programs.

While our mining engineering program doesn't directly link with those, those are programs that Penn State has. We need to do a better job of actually going out into the community colleges and into some of the trade schools to actually address the need for mining programs, the need for folks to actually become better equipped to serve in mining positions, just to understand the different environment that they're going into.

The second part of your question was interacting with businesses. We have many numbers of folks contacting us in the spring, in the summer, to come onto campus in the fall, and to talk to our mining students directly. They interview them often the next day, they tell them about their company one evening, they interview them for summer internships or full-time positions for the next summer. So, by the time the end of the fall semester rolls around we have everyone placed. Some of them will actually change their mind.

[Laughter.]

Mr. ZISCH. Well, we all know kids.

Dr. ARNOLD. They do that, but so the jobs are there. But we need more students to fill them. Got it. But on the critical mineral——

Senator HICKENLOOPER. Let me switch over to Mr. Zisch, we'll come back around. Over to you Mr. Zisch.

Dr. ARNOLD. Absolutely.

Mr. ZISCH. Thank you, Senator. The Colorado School Mines also has programs where we have relationships with particularly three community colleges, which provide opportunities for students to have then an entrance into School of Mines.

Those are working relationships that we have, provides an opportunity for students to get their kind of feet on the ground. It's a lower cost option for them as well.

The other thing that we use a lot of those programs for, is for targeting underrepresented students coming into mines. It's a great avenue for us to reach out to them and have them come through, what is a non-traditional approach sometimes, that's been very effective on our underrepresented opportunities.

Senator HICKENLOOPER. Great, thank you. I'm going to step back, but I'm not through. Gracelin, I will be back to each of you actually. So, I'm going to turn it over to my co-chair, Senator Braun.

Senator BRAUN. It's because you're a geologist, right? You, you've got several rounds, so.

Senator HICKENLOOPER. Exactly.

Senator BRAUN. I'm an entrepreneur, business owner, and workforce has been a challenge in all areas, I mentioned that earlier. Depressing when you hear, did you say 12,000 was the number from China?

Dr Arnold. Yes, students enrolled.

Senator BRAUN. We were like, how many was that again?

Dr Arnold. 162.

Senator BRAUN. I mean, that is unbelievable. And then I think someone else mentioned, it might have been you, Dr. Baskaran, about the stigma associated with sadly farming was in there too. And that's the hardest small business that God ever created. And of course, that has gotten more intensive with capital and equipment and less labor intensive. That's the only way we keep up there.

Then I think back, because I always like to get to the root of a problem. When coal was our primary mineral that we were mining and using to generate electricity, I don't seem to remember issues getting people into the field. Our neighboring county was the highest income county per capita in our State of Indiana, which is the biggest manufacturing state per capita now. And that's almost all gone. So, how much of the skills you need for mining in general, would've been because we had a vibrant coal industry back many years ago?

Does that have anything to do with why we don't have as many kids interested in it? Because they seem to be interested then because they were good paying jobs. Whoever feels comfortable answering that, I'd like to get your opinion.

Dr. BASKARAN. I'm happy to go for it. I think globally we see a phenomenon where young people, urbanization. I mean, there's just been a changing phenomenon where people are moving to cities. So, there was once a time, I think at the height of the coal boom in the United States, but mining more broadly, where you kind of use place-based, right? You stay where you grew up and where there was that mining industry, you stayed there.

But now we're just seeing a global trend where people are moving to cities. There are more attractive fields that have emerged in the last few decades in tech, remote work, all of these things. And these are really kind of shifting.

To the second part now, that's different then, is mining now requires a lot more STEM skills than it used to. Because we used to use a rock blaster, like a person would go place the blast and blast it. Now it's done by an engineer in a different space. So, the type of skills that's attracting is different, and that's also going to require more emphasis on STEM than it did before.

Senator BRAUN. It wasn't our policy that initiated the fact that we've pretty well said we don't want to use coal anymore? And I look at China where they're building all the green energy stuff and they're fueling it with fire or coal fired plants, building you hear, one a week, in terms of electric generation fueled by coal, India as well.

How much of that, and now that our policy has changed and you need the skills that are critical that you used to get, wasn't coal

mining a large percentage of our total mining that we used to do in the U.S.? It seems like it had to be. Anybody want to comment on that?

Dr. ARNOLD. Sure. I can take that question. Overall, we mine a lot of material and actually iron ore is the biggest metallic mineral that we mine, but we actually mine more aggregates than anything else. There's this one——

Senator BRAUN. Are they hurting for workforce too?

Dr. ARNOLD. Oh, everybody is.

Senator BRAUN. Something has occurred to where anything that you're extracting out of the ground, we just have been lagging on it. So, it's kind of across the board.

Dr. ARNOLD. It's across the board. It absolutely is.

Senator BRAUN. Then that sounds like it's mostly going back to how we've maybe stigmatized, the reason farming it's easy to explain. It's gotten to where you've been able to substitute capital and equipment for labor, and we produce more here. Here, we've not been able to do that, and then it may get to be the nature of the job.

I'm guessing that issue's not the same in other countries. So, looks like until we get to the bottom of that we're going to have a lot of trouble regardless of what we're trying to extract.

Mr. EVANS. It's very hard to open mines in the U.S., Senator. The ones that we had have declined. Opening a new one takes a long time. It's hard to finance, and then the workforce is aged and you're left with a lot less people than you had before.

Senator BRAUN. Then one final question before I give it back. How much has government policy been a factor in making it more or less difficult?

Mr. EVANS. Sir. I'll answer that.

Senator BRAUN. You are here with the government, so.

Mr. EVANS. I think that the permitting process and the NEPA process is very rigorous and it needs to be. We are going through the process ourselves. The one area that I would look at for permit reform is judicial. In terms of the length of the amount of appeals, it took us four and a half years from start to finish to go through the whole process, and that's supposedly short.

We're both business folks, it's hard to get people to lend you money or give you money when they don't know when they're going to get a return on their investment. There are other mines in this country that have been locked in litigation for 15 or 20 years. Because new cases are brought after other ones are dismissed.

I think that's a key portion of at least the government portion around permitting reform, which it's more than just mines, as we know, it could be transmission lines; it could be everything. It's something we need to address for infrastructure in general in this country.

Senator BRAUN. Thank you.

Senator HICKENLOOPER. Senator Casey, the Senior Senator from Pennsylvania.

Senator CASEY. Mr. Chairman, thanks very much. I want to thank both you and Senator Braun for this opportunity to examine these issues. I'm going to thank each of our witnesses for being here. This is a busy hearing day, so everyone's in and out and moving around. So, I'm sorry I missed your presentations.

Dr. Arnold, I wanted to direct my main question to you. I don't think I have to explain to you or many in Pennsylvania what life was like a while back when we had a lot of communities that were suffering from the ravages of coal mining. When I grew up in Scranton and still live there, the Lackawanna River was not what it is today. We were told to avoid it, don't go near it, it's dirty. Sometimes would turn some form of orange and now it's a place where people come from far and wide to fish there. So, it's been completely turned around.

But we know of the devastation of abandoned or the devastation resulting in abandoned mine lands and all that came with it. We also know that in our state, we have state constitutional provision, which article 1, section 27 of the Constitution mandates that the people have a right to clean air, pure water, and the preservation of the natural scenic, historic, and aesthetic values of the environment. It talks about each of us being trustees of the natural resources of the state.

Eventually the state took that seriously, starting about a little more than 50 years ago, more like 60 years ago now, and started to deal with this abandoned mine land problem in cleaning up the environment. We've got today, more than 40 counties that are of our 67 that are somehow impacted by abandoned mine lands.

It's been devastating for the environment, the land, the community, the economic development that can occur when that is not dealt with. I've worked on these issues a good while here and had some success and Senator Braun and I work together to pass the Stream Act that allows states to use a portion of their abandoned mine land money for acid mine drainage cleanup. And that was a good moment when we did that because we had to fix a little defect in the infrastructure bill.

Leaders like Penn State and the National Energy Technology Lab in Pennsylvania are taking environmental remediation one step further. And they're pioneering ways to extract rare earth elements from acid mine drainage. I even visited Penn State and saw a demonstration.

That's a long lead up into maybe the broad question, what would you hope we could do here by way of new policy? But generally, what would you believe is necessary to leverage what is a great energy workforce in our state, to take advantage of this opportunity that we have to actually take extract from in those communities, those rare earth elements?

Dr. ARNOLD. Well, Senator, you absolutely hit it on the head with what we're doing as far as recovering rare earth elements and other critical minerals from acid mine drainage in the project that we're doing right now.

To leverage our energy workforce, I think it's actually going to be difficult because our energy workforce is actually aging. They're

the 220,000 that are going to retire. And how do we bring new people into the pipeline? And that's critical.

We actually hide our mines. We've got to the point where you drive down the road and you don't know that there's a mine behind the hill. Now there're still in eastern Pennsylvania, there are still combustors, and we still need to address those, and we are.

Some of those fluidized bed combustor plants are doing a job of recovering that, creating energy at the same time, and then putting that material back better. But we need to figure out how to get more people into that workforce as well.

We can do everything we can on the automation side, and we are introducing a lot of automation and control, a lot of virtual types of technologies. But, how can we actually get younger people to do that, to go into those careers? It's going to be a combination of curriculum for K–12, letting them know that all of these elements that we're trying to go after are critical to high tech jobs. And so that message isn't getting out there.

I think it's a curriculum thing. I think it's also—and not necessarily just to go into mining engineering programs or mineral processing programs. It's to go into manufacturing, it's to go into energy. It's just at this point it's difficult to get them to think that those jobs are actually environmental jobs.

Senator CASEY. Well, you've given us a lot to think about and to strategize about. But thanks very much. Thank you, Mr. Chairman.

Senator HICKENLOOPER. Indeed. Thank you. Dr. Baskaran, it's estimated that the critical minerals workforce will need to double if we're going to meet our energy goals, some people say even higher than that. I think many of our international partners have been working for a pretty good while building up their workforce.

What challenges have other countries faced in recruiting and retaining a skilled, robust workforce that can do what needs to be done? And what are some of the best practices you've seen at work in these other countries to address some of the challenges we've all been talking about?

Dr. BASKARAN. Thank you, Senator. I always think about Australia, because it was probably about 15 or 20 years ago that Australia decided that they were going to be a mineral center of excellence. And when you look at Australia's economy, it's about 15 percent of GDP is mining because you have your inputs, your machinery, your production, your processing.

Our DOD DPA Title III grants actually go to Australian companies. But what they also did is they really aimed to build a robust workforce. So, if you look at a lot of mining graduates abroad, they're Australian. And I think a lot of that again is that prioritization of a long-term strategy that in many ways the U.S. has lacked to developing that workforce.

If I were to think about two things that I think about that we need to realize though, with an Australian model of retention is, people don't live at the mines, they fly you in and they fly you out, right? And I think that's a big change over time, is mines are not,

you and I both know, mines are often not an exciting place, right? They're not the easiest places to attract it.

Australia's used other mechanisms, in public health, to get doctors into places where there's Aboriginal health problems. They also have to use similar mechanisms. We need to acknowledge that mines are in hard places, and we need to develop a system where there's two things.

First, outreach is really important. We've said a lot here, like, young people don't know mining as a career. It's not an industry that we think about. So, first is going in and doing the outreach.

Second is financially incentivizing it, not just from—between the age of 17 and 22, your brain looks vastly different. When you're 22 you're thinking about how much money you need to make to pay your rent. When you're 17, you're not thinking about that. So, it's actually going in and scholarships, bursaries, co-ops, internships, paid experience, becomes super valuable.

Then I think the other thing is like we think a lot when we think about banking, like our friends who ended up in investment banking. They finished college and they went and got their signing bonus. This information needs to be pulled forward so that we can do that.

Then the last thing I think is cross pollination. So, when I look at Australia, when I look at Canada, I looked at the top 12, sorry, Penn State was 13, so it's not in my numbers, apologies. But when I looked at the top 12 mining engineering programs, school of mind is No. 1. And then we have four Canadian, four Australian, couple British, Saudi, right? Is that actually we need to cross pollinate knowledge better so that people see globally, like mining is big.

I mean, I've been very fortunate to have an extremely international career. I spent all my twenties abroad, and that was mining, right? But that's not something I would've thought of when I was 17 or 18 years old. So, bringing that exposure to the fact that mining is not living in Rural West Virginia anymore is really important to changing that narrative.

I think Australia's gotten it right. They too are having an aging workforce. Canada has an aging workforce. This is a global dilemma. However, what we are seeing is if you put that architecture and plumbing into place, it's a gift that keeps on giving.

Senator HICKENLOOPER. I appreciate that. And I would argue that I think many times mines are the most beautiful places. And some of Wallace Stegner's novels, if you've ever read Angle of Repose or even Crossing to Safety, they get into that a little bit further.

Each of you in your distinct ways are leading important efforts to move this, the critical minerals workforce, forward. Can maybe each of you speak briefly about the policies that you think Congress should support to help accelerate this development of the workforce? Why don't we start with you, Mr. Zisch. We'll go along this way.

Mr. ZISCH. Yes. Thank you, Senator. I think certainly that some of the policies that should be out there need to get at and talk to this. Actually, Senator Braun, talked about the stigmatism and

somehow incorporating these mines as part of the solution and part of the contribution to solving our energy issues.

I would think that policies that can help to deal with that stigmatism and the industry perspective would be very helpful. I would also think that when, from a standpoint of anything we can do to encourage the scholarships, internships, et cetera would be very helpful.

Senator HICKENLOOPER. Good point.

Mr. Evans.

Mr. EVANS. Yes. My focus has been really local. Mining is a very local thing. And they are in areas that are very rural.

Focusing on programs where the Federal Government assists with local or state or county governments with community colleges. I gave the example of Great Basin College; I was amazed to see what they put together on a shoestring. Basically, in some cases with donations, with some small grants. But if they had more opportunities and more resources, I think they could do more.

There's a number of, when younger kids, they want to leave, they don't come back, but there's also nothing for them. So, if you can show them a path, you can start to identify that in high school not only trades training, but also some of the more sophisticated whether it be around instrumentation.

Then to the point which we've heard from the larger universities as well. These jobs are technical, so the mining done by us is actually done by a coal company. So, that's another thing that we can do here, is that you actually bring in allied industries that—it's the same thing. We're doing surface mining. We're using North American coal. It's 120-year-old company out of Cleveland, Ohio that does late night mining and phosphate mining in the U.S.

But the STEM students, they can go to Apple, they can go to others. We have a very sophisticated operation. I could run our control room from Reno, Nevada 200 miles away. Bringing that where these industries are growing, they're developing, I think you need both. You need the professional STEM folks, but also it all starts local. The folks that are going to live every day around that facility grow families there. And actually, hopefully some folks come home.

Senator HICKENLOOPER.

Dr. Baskaran.

Dr. BASKARAN. Money makes the world move. And I think appropriations are really important because we have so many existing programs and mechanisms in place. But a lot of these were developed before—were not made fit for purpose for mining. Because they were not at a point. It was really what, the last 15 years when we discovered minerals could be weaponized and we went into a panic, I mean, maybe 15 years is generous might be like 7.

When I think about this, what I had kind of mentioned earlier, was like our Fulbright program has expanded so many times, and it's such a good way to get academics, practitioners, and students to move and cross pollinate that information.

National Science Foundation, I grew up in a academic household, always heard like programs fail or succeed on the basis of the

amount of money they have available, to be able to execute good teaching, good research, good learning.

I think the third area I would suggest, again, is appropriations to our U.S. military academies for minerals. This is something we're working on at CSIS. These are our future executives, Ambassadors, cabinet leaders, and they have fantastic STEM graduates.

Making sure that we're giving exposure, I mean, to all universities, but also to these militaries because they will go on to be leaders and giving them the exposure—I spoke at something at West Point in February, the amount of interest that peaked that now we're doing subsequent events was really exciting for me. So, I think we have the avenues, but sometimes we just need to increase the funding to allow—to make them fit for purpose.

Senator HICKENLOOPER. Got it.

Dr. Arnold.

Dr. ARNOLD. Certainly. So, there is a Mining Schools Act that is making its way through Congress. If we could get that passed, I think that would be fabulous. And beyond that, I certainly agree with what the other witnesses have said. It's expanding some of the things that we have directly and focusing them on mining. We don't need to have essentially new programs, but making sure that mining is included in a lot of those.

Senator HICKENLOOPER. Got it. More of everything. You guys actually sound like a bunch of mayors and Governors. That's what they always comment.

[Laughter.]

Senator HICKENLOOPER. I just want more of everything. Senator Braun, got more questions.

Senator BRAUN. Couple fun facts. You said 15 percent of Australia's GDP mining, ours is currently 1.4 percent. In 1947 it was 2.3, I thought it'd be more than that. 1957 it was 2.3, 1967 it dipped to 1.4, popped back up to 2.1 in 1977. 1987 it was 1.5 and currently it's 1.4. Healthcare in 1987 was about 6 percent of our GDP. Now it's 18 percent. So, that shows you how economies change.

What's the one thing other than permitting and like each of you, and do it fairly quickly, because then I want to go to the second question. What's the one thing the feds could do to make it better for the issues we're talking about?

Then No. 2, when it comes to actually fixing workforce, to me it looks like that should be the solution of the states, and the bailiwick of education would be states. And most of your particular programs are there. Can that be done between states and their educational systems on correcting this. Second question, but No. 1, what is the most important thing the feds could do to make life easier? I'll start with Dr. Arnold.

Dr. ARNOLD. Well, the most important thing that the Federal Government could do would be to, oh my—wasn't thinking we'd be getting a question like this, but how about actually making mining more prominent in all of the programs that we talk about. I mean, that it is important. Just the importance of mining.

Senator BRAUN. Sounds like we ought to be doing better at that, especially when we're wanting to be so involved in new ways of energizing stuff that's going to involve critical minerals.

Dr. Baskaran.

Dr. BASKARAN. We need a coordinated strategy for how we're going to do this at a national level. Right now, when I look at critical minerals, I think we counted recently, there were like 12 departments and agencies working on minerals. And ultimately, they each have a little bit of a different angle.

DOD, DOE, state, you need a coordinated approach to workforce development that all of these entities can weigh in on. Because DOD needs are a little bit different from DOE needs in terms of the education required.

Department of Education is a great place to hold a pin on that. But there does need to be coordination between the government or we overlap mandates and we're not doing it efficiently; we discover these gaps. Department of Labor has grants that go to mining, but it doesn't overlap. Coordinated strategy, Federal one document, this is how we're going to do this across agencies.

Mr. EVANS. I'll go back to the local level. Push trades between the state and Federal Government, folks coming out of high school now you can make a choice. You can go to college; you get a 4-year degree or where you can go be a trades person in general. Trades wages pay higher.

Perhaps some grants or other incentives at the Federal Government along with the state, through facilities and so forth, can push that to offer another choice to graduating seniors in high school, which is going to give them a career that they eventually can go on and start their own business with. We're going to have to build a lot of stuff.

I mean, I look at things more holistically. There are not only mines, but plants, there's transmission lines, and we have a lack of skilled trades in this country and those are the same people. Primarily when I look at our 350 folks, you need those skilled trades, not only to build but to operate the facilities like this.

Mr. ZISCH. Senator, I think one of the key issues is that there's going to be, research funding is critical for mining in the future. And I think from a government standpoint, support of any research funding would be exceptional.

Then I think we also need to remember at least conceptually, when we talk about mining, it's a very broad area, it's not just the mines. There's a lot of other things, processing is certainly essential with regard to critical minerals, rare earth, et cetera. And if we can take a look at doing something to help the establishment of processing facilities, that can be quite helpful, I would think. But research is significant.

Senator BRAUN. Research would seem to be something maybe that would have to be coordinated broadly. In my opinion, when it comes down to the successful industries that have addressed this, that would be larger parts of our economy, they're not waiting on this place to coordinate it. They're even not waiting on this place to pay for it since we're borrowing 30 cents on every dollar that we

spend currently. So, I think I'd maybe look for a different business partner there, financially.

Most of them have finally put it together. And I'm going to cite a company that's a big one, Toyota near where we live, went into a rural area, and immediately got in business with their local school districts. And then started initiating apprenticeships summer jobs, jobs after school. And they are a large employer in a rural area that was in the heart of coal country that's figured it out without any help from this place.

Much of it, I've observed, business has expected our school systems to spit it out. You don't have the natural proclivity toward trades in the way it used to do when we were the No. 1 manufacturing company. We've never been that large in the mining arena. My advice would be for the companies in this business, don't wait on this place. Get busy with where you are in the states you're involved with, and I think you can craft most of the solutions that we're talking about, and you'll get it done a lot more quickly.

If the Federal Government keeps pushing for all of this and has not been very quick at permitting, has made it tough to mine generally, due to their other policies, they better wise up, they can't have their cake and eat it too. It's been a great discussion. That'll be all the questions I have.

Senator HICKENLOOPER. Great. This is a more philosophical question, because I think what Senator Braun described is that shift toward other priorities, which is healthcare in this case, that's a dramatic change and certainly that's a reflection of some level of the affluence the success of our Country.

That we can now do a lot more mining with less people. We can do a lot more farming with less people. So, those show up as a smaller percentage of the workforce and the jobs. But at a certain point, just to ask your opinion. Does the swing have—once it creates a momentum of contraction in these jobs, does it put us in a position of vulnerability? And I guess I think that's what I've been hearing is that now we're going to have to import an awful lot of these workers.

If you want to build a mining infrastructure that is resilient and protects us from being at the mercy of adversarial nations, if we're going to import the workforce, at what point do we begin to counteract that?

I understand more money into research, more money into the education system, closer connection with business the various incentives. Is that enough? The pendulum is swinging and now we've contracted, now we're probably past the point where we have the sufficient numbers, our education system or workforce training system that provides the workers we need, we probably are significantly understated. And yet it's still contracting, right? It's not really expanding yet. If I'm right. How do you guys measure that? Or am I wrong? It's a just a philosophical point.

Mr. ZISCH. Senator. I'll take that question. I think from the standpoint of vulnerability, I don't think you're wrong to start with, but I think part of the answer is actually automation and technology. We should be able to run these mines with less people in

the future. The things that are happening in Australia and other places where they're running remotely, I think is part of the answer.

But that means we need to get these students coming into the universities that see automation technology and all, as part of the solution, and are going to come into mining to apply those technologies and that applied research, because I think there's a lot of opportunities out there from automation technology, robotics, a lot of things going on.

Mr. EVANS. I think as well, I'll just kind of go to a higher level. I think the Federal Government and state governments, those alliances doing something like this, you need to build allies. So, you need a bit of a stamp of approval from the Federal and state government, this is important mining and infrastructure.

From there, I think companies are happy to partner and we've started that already with local institutions, even funding some of that at a local level with grants and so forth. But the environment needs to be enticing where private capital is going to come into this industry and actually fund all this. So, big companies like Toyota come in, they speak to the state government, the county, they're welcomed. It's great. You cut ribbons. This is an industry which has a stigma right now, and it's difficult. A lot of folks don't really want to come to your ribbon cutting and really want to get it done.

But the goal is to have private capital fund all this. I mean we're a recipient of the ATVM Program. It's hard to even get funding for stuff like this because of the unknowns, because of how much time it takes and hopefully it's just temporary. So, you have a rush of private capital in here and then all those things that businesses can self-fund that themselves because it's in their own interest to do it. Right.

Dr. BASKARAN. Thanks Senator. It's a very philosophical question, so I think I'm going to go home and think about it for a bit, but I think there's a couple quick points that jump out to me.

One is, there's a balance also between public and private. I can appreciate that. We can't spend our way out of everything. One of the models that's worked really well in a number of countries is the idea of a skills levy. So, for example, South Africa, where there's many mining companies run by South African CEOs. They charge a 1 percent skills levy to mining companies that turns around and goes into a pot of money that essentially then funds all of building the pipeline. And South African mining engineers are everywhere in the world. And I think a lot of that was because they took that capital and put it back in to kind of create a circular system.

I think what we don't want is to get to a point, and my fear is this, and I'm probably not alone, but we see countries where there's a real workforce impediment. See Brownfield and Greenfield mine just dry up. Because especially in a place where you can't permit and if you don't have the workforce development, you can't look. The U.S. has significant amounts of lithium, it's not at the high end of a lithium because of these various barriers. So, we as a U.S. Government, if we want to be serious about, I don't know catching up to like and compare advantage, there's multiple work streams

that need to push forward, but if we don't, we're going to choke ourselves off on the mining front.

Senator HICKENLOOPER. Dr. Arnold.

Dr. ARNOLD. Certainly. One of the other things though I think we need to be thinking about is grassroots. We need to get into the schools and make sure that they know about the need for the workforce, that it is high tech, I mentioned that in my opening remarks.

In Pennsylvania, there is an opportunity before next June 30th or something like that, to go in and actually address the STEM curriculum. It's actually called Science, Technology, and Environmental Literacy and Sustainability Standards, STEELS, there's more than just STEM.

I will be working with some of the folks in our education department at Penn State to see if we can get some of the minerals information into the curriculum. And then I forget who mentioned veterans, or the military academies. That's the next one of the other pieces is to go and talk to our veteran's department on campus, to see if those students who have already chosen Penn State might not consider a career in mining. So, there's some grassroots things that I think we can all do local, because every bit is local.

Senator HICKENLOOPER. Yes, I guess you could say all mining is local, to turn a phrase. You have anything else you want to—any points you would like to add? Great.

Again, thank you so much. To each of you, I know how busy you are, and I know it takes a lot of time to get here and to ramp up and be prepared. But it adds value and this gets captured on C-SPAN, and who knows where, what supermarket you'll be shopping in. Someone says, hey, aren't you Mr. Evans? Didn't I see you? Don't you have something to do with lithium? Anyway, thank you all, I appreciate that.

That's going to end our hearing today. I'd like to thank our colleagues and again, our panel, and also anybody, the in-person, viewers, and anyone watching online. For any Senators who wish to ask additional questions, questions for the record will be due in 10 business days, so, until June 26th at 5 p.m.

Senator HICKENLOOPER. The Subcommittee now stands adjourned.

ADDITIONAL MATERIAL

STATEMENT FOR THE RECORD

THE UNITED STEEL, PAPER AND FORESTRY, RUBBER, MANUFACTURING, ENERGY, ALLIED INDUSTRIAL AND SERVICE WORKERS INTERNATIONAL UNION (USW)

Chairman Hickenlooper, Ranking Member Braun, and Members of the Committee on Health, Education, Labor, and Pensions' Subcommittee on Employment and Workplace Safety on behalf of the United Steelworkers (USW) 850,000 members, we want to thank you for holding this important hearing on workforce training issues in our critical minerals sector. As the largest mining union in the United States—and with thousands more mining members in Canada—many of these issues are top priorities for USW.

USW miners have a long history of responsibly extracting and refining a variety of metal and non-metal substances, including iron ore, copper, platinum, silver, potash, trona, salt, limestone, sand, clay, and more. Jobs in mining are unique in that they cannot be outsourced. Mine operators need a highly skilled, local workforce to safely work in mines and, ideally, in co-located minerals processing facilities.

Union mining jobs are typically high-wage jobs that require a workforce that is skilled and uniquely attuned to safety on the job and safety for the community. Most mining jobs are located in rural communities, making it challenging to recruit a skilled workforce from elsewhere and necessary to train within the local community.

Our Nation's principal workforce training legislation—the Workforce Innovation and Opportunity Act (WIOA)—has not been updated since 2014. In that time, the economy has evolved dramatically, and yet the tools available to workers to adapt to this shifting landscape have remained stuck in place. In this era of advanced manufacturing, new clean technology, and an ever-changing service sector, workers and their employers must have access to high-quality training programs. Accordingly, USW is glad that the HELP Committee is taking action to update our current workforce training system and address its shortcomings.

In this statement, we wish to outline our union's priorities when it comes to workforce training, with lessons learned from a variety of industries and opportunities on the horizon for critical minerals workers.

We Need a Multi-Faceted Approach to Workforce Training for the Critical Minerals Workforce

A major tenet of USW's philosophy on workforce training is that a one-size-fits-all model does not work. Our membership is one of the most diverse in the country, impacting all economic sectors: we have members in sectors as wide-ranging as manufacturing, mining, professional services, construction, healthcare, transportation, and so many more. Each of these sectors—let alone the individual workplaces within them—are all different, and as such, they require different skills and techniques to be successful.

No one training model can work for all of those sectors. For example, Registered Apprenticeship (RA) programs are often referred to as the "gold standard" for workforce training in certain sectors—and rightly so. For workers in the building trades, a strong, union-sponsored RA program is the best form of training we have. This Registered Apprenticeship structure also works in certain industrial settings.

The reason this model works is because workers are trained in a specific trade that is broadly applicable across workplaces. For example, if a worker goes through an RA program and eventually becomes a journeyperson as an ironworker, they can then use those skills as an ironworker on a number of projects, regardless of the specifics of the workplace (e.g., repairing a bridge or building a skyscraper).

However, there are just as many, if not more, industries where a Registered Apprenticeship model does not work. Take two of our union's larger sectors: mining and paper. Both are large-scale industrial sectors where maintenance is an essential job function to make a facility work. However, being a maintenance worker at a mine requires a very different set of skills than being a maintenance worker at a paper mill. As such, a standardized Registered Apprenticeship model would not work to effectively train a worker in these settings.

Instead, what is needed is a workforce training system that is as diverse as our economy. An optimal workforce training system built for the 21st century economy must leverage all of the skills, talent, and techniques that make our Country the strongest economy in the world. This includes investments in effective training programs like Registered Apprenticeships, while also directing resources toward other proven training programs that develop the specific skills needed by employers.

USW has high-quality training programs across the country that can serve as inspiration for the types of training in mining and minerals processing that need more Federal support. For example:

- **Incumbent Worker Training**: USW Local 135L negotiated with Sumitomo Rubber in Tonawanda, NY to stand up a Junior Electrician program, which made it easier for workers to earn a credential through an accelerated education and on-the-job training program. Although not an official Registered Apprenticeship program, this arrangement works with both the employer and the workers to upskill in a way that benefits both parties.
- **Partnerships With Local Community Colleges**: USW collaborates with Cleveland Cliffs and Ivy Tech Community College in Valparaiso, IN to sponsor an "Interdisciplinary Industrial Workforce Certificate Program" course worth 40 credits. The program is a pre-employment training

opportunity that offers a mix of coursework through Ivy Tech Community College and on-the-job paid internships at Cleveland Cliffs.

- **Using DOE Grants to Provide Community Members With Credentials**: Funded by a Department of Energy (DOE) National Institute of Environmental Health Sciences (NIEHS) grant, USW Local 8–550 and Local 1–689 have partnered with West Kentucky Community and Technical College to run a free, 240-hour Radiation Control Technician training program to community members in Paducah, KY. Launched in 2021, the graduates earn a DOE-recognized credential, and fully 90 percent of the first cohort are now employed as USW members at the Paducah plant.

These are just a few instances that underscore the multitude of effective, union-sponsored training programs that are not Registered Apprenticeships. As Congress considers legislation to update our workforce training system, it is imperative that they complement the benefits of Registered Apprenticeship programs by also investing in alternative proven, union-sponsored programs like the ones described here.

Labor-Management Partnerships Are on the Horizon

Our union has signed memorandums of understanding (MOUs) and partnership agreements with multiple companies in the battery materials supply chain, all including the goal of jointly recruiting and training a diverse, local workforce to fill these new jobs.

One exciting example is our partnership with Talon Metals, a company in the permitting process for an underground nickel mine in Tamarack, MN, that will employ approximately 300 workers. Talon has also been selected for funding from the DOE's Battery Minerals Processing Grant Program under the Bipartisan Infrastructure Law to process nickel at a facility in North Dakota. USW and Talon are collaborating on how to identify needed skills, develop local workforce development partnerships, and recruit a local workforce for training. While the Talon project is still a couple of years away from hiring most of its workforce, USW expects that this partnership can serve as a model for other parts of the industry.

We Need to Improve Our Current Workforce Training System

It is important to put our current situation into a historical and global context. Historically, one study found that "Federal Government spending for workforce services and training have dropped by two-thirds despite the fact that the labor force has grown by about 50 percent since that time".[1] Looking across the world, that same study found that many industrialized nations spend as much as five times more of their gross domestic product (GDP) than the United States on such active labor market policies.[2] We need significantly more investment if we want to provide our workers with the best-in-the-world training that they need to succeed in our 21st century economy.

Another shortcoming of our existing system is the limited role that labor plays in shaping workforce training programs. When it comes to on-the-job training, a simple truth emerges: workers know best how to do their jobs, and by extension, they also know what skills they could benefit from.

However, our current approach is not set up in a way that recognizes this fundamental truth. For example, under WIOA, state and local workforce development boards are overrepresented by industry and underrepresented by labor. With such imbalance between employers and labor, it is no wonder that our current workforce training system is failing to meet the needs of workers.

In addition to labor's underrepresentation on state and local workforce boards, another key limitation of our current system is that it does not prioritize funding labor intermediaries and joint labor-management programs. Labor-sponsored programs, for the same reason mentioned above, are the best-known forms of effective workforce training. As such, we strongly urge you to include priority funding for labor-sponsored programs, as well as labor consultation and/or concurrence language in any update to WIOA.

These represent a few of our union's major priorities as it relates to workforce training. We appreciate the efforts that the HELP Committee is taking to update

[1] *The Brookings Institution*, "Should the Federal Government spend more on workforce development?" May 23, 2023

[2] Ibid.

and improve our workforce training system, and we urge the Committee to implement our union's priorities in any such effort.

We Need Other Policies That Support Effective Workforce Training

Lastly, in addition to strong investments in our principal workforce training system, there is also a need to improve related policies that we have to support workers. Market concentration by China has the potential to create significant shifts in global prices, and therefore operations in the United States. We only have to look at recent history of Chinese market pressures on the steel industry, rare earths, and other materials to see the impacts it can have on U.S. businesses and workers. From USW's perspective, reforming the Worker Adjustment and Retraining Notification (WARN) Act and reauthorizing Trade Adjustment Assistance (TAA) are key to protecting the critical minerals workforce.

The WARN Act was passed into law back in 1988 with the goal of providing workers advanced notice in the event of a plant closure or mass layoff, so that they would have time to enroll in retraining programs and/or look for a new job. Although noble in its intent, the WARN Act has several loopholes and shortcomings that limit its efficacy. For example, the law exempts certain "smaller employers" and only requires 60 days notice. Also, there are limited enforcement mechanisms when employers fail to give adequate notice. To address these limitations, USW has long endorsed the Fair Warning Act, which would expand the number of firms required to give WARN notice, and it would increase the notice timing from 60 to 90 days. USW has also been supportive of legislative solutions to provide the Department of Labor (DOL) with investigative and enforcement powers related to WARN violations. These reforms would ensure that workers are actually provided with the necessary time and resources to transition if their workplace is to close.

Reauthorizing TAA is also critical to supporting workers who need training after losing their job due to a trade-induced shock. These workers, much like those impacted by WARN closures, have lost their job through no fault of their own. Historically, these trade-displaced workers could rely on TAA to provide income replacement, as well as training opportunities. Much like Registered Apprenticeships for the construction trades, TAA has often been called "the gold standard" for job retraining. Its efficacy in linking workers with strong retraining programs make it a highly impactful benefit for workers. According to a study by the Census Bureau, TAA recipients earn an average of $50,000 more in income over a 10-year period compared to workers who did not participate in the program.[3] However, TAA lapsed at the end of Fiscal Year (FY) 2022. Since then, any worker who has lost their job since June 30, 2022 has been unable to access TAA benefits. As of June 2024, DOL estimates that 745 petitions covering 118,057 workers are on hold, awaiting TAA to be reauthorized. USW has strongly pushed for TAA to be reauthorized to ensure that those workers can access these much-needed benefits.

Taken together, each of these policy initiatives, in conjunction with enhanced resources for workforce training, would help position the U.S. critical minerals workforce to lead the world in responsible extraction and processing.

Conclusion

In closing, workforce training is essential to ensuring that the U.S. can build the needed workforce to mine and process critical minerals necessary for the clean energy economy. To achieve this goal, policy must guarantee that there are adequate seats at the table for labor, increase funding for workforce training, and ensure that workers are trained for the jobs available in their communities. Further, we need to make sure the complementary policies align with these goals. USW looks forward to working with Congress to ensure that the critical minerals workforce is highly skilled and sufficient to meet demand. We thank you again for the opportunity to submit this statement for the record on this essential hearing.

[3] *U.S. Census Bureau*, "Census Working Papers—Can Displaced Labor Be Retrained? Evidence from Quasi-Random Assignment to Trade Adjustment Assistance", February 2022.

MP MATERIALS CORP,
June 10, 2024.

Hon. JOHN HICKENLOOPER, Chairman,
Hon. MIKE BRAUN, Ranking Member,
U.S. Senate Subcommittee Employment and Workplace Saftey,
U.S. Senate Committee on Health, Education, Labor, and Pensions,
Washington, DC.

RE: STATEMENT FOR THE RECORD OF MP MATERIALS CORP. ON WORKFORCE DEVELOPMENT IN THE CRITICAL MINERALS SECTOR

Chairman Hickenlooper, Ranking Member Braun, and distinguished Members of the Senate Subcommittee on Employment and Workplace Safety, MP Materials Corp. ("MP Materials" or "Company") appreciates this opportunity to provide this written statement and supplement the record in advance of the Subcommittee's June 12 hearing, "Digging Deeper: Building Our Critical Minerals Workforce."

Introduction to MP Materials

MP Materials, headquartered in Las Vegas, Nevada, is the largest rare earth materials producer in the United States. The Company owns and operates the Mountain Pass Rare Earth Mine and Processing Facility ("Mountain Pass"), located in San Bernardino County, California. Mountain Pass is one of the world's largest integrated rare earth production sites and the only major active resource in the United States. MP is a publicly traded U.S. company listed on the New York Stock Exchange with approximately 730 U.S. employees.

MP Materials' mission is to restore the full rare earth supply chain to the United States. Rare earth elements ("REE") are a group of 17 chemical elements (15 lanthanides and two transition metals) with a wide range of high-tech applications. Neodymium magnets, which are manufactured from an alloy containing REEs, are the strongest and most efficient permanent magnets commercially available. These magnets enable the conversion of energy into motion (and motion into energy) inside motors, actuators, and generators found in hybrid and electric vehicles, critical defense systems, robotics, wind turbines, drones, and electronics. As electrification and autonomy take hold across the global economy, demand for REEs and permanent magnets is growing.

MP Materials was founded in 2017 to acquire Mountain Pass, after severe operational and financial challenges forced the site's previous owner into bankruptcy. At the time, the facility was idle with just eight employees. Since restarting operations from cold-idle, MP Materials has increased production at Mountain Pass dramatically. In 2023, MP Materials produced approximately 12 percent of global rare earth content at Mountain Pass. We believe Mountain Pass is now the world's second most productive rare earth mine. Additionally, in 2023, we began producing separated and refined rare earth products at newly commissioned processing facilities collocated at Mountain Pass, thereby filling a critical void in the midstream of the supply chain.

To fulfill our mission to restore the full supply chain, MP is currently constructing and equipping the first fully integrated neodymium magnet manufacturing facility built in America in decades, in Fort Worth, Texas. This facility will transform rare earth materials produced at Mountain Pass into metals, alloys, and finished neodymium magnets for General Motors and other American manufacturers.

Efforts to Build Our Workforce

At MP Materials, our workforce is the backbone of our operations. We are dedicated to building a talented, committed, and skilled team that drives our mission forward. Since relaunching production at Mountain Pass in July 2017, we have grown from eight contractors to approximately 730 full-time employees. This significant increase in our workforce reflects our rapid business expansion and a commitment to fostering a culture that prioritizes ownership, safety, and professional growth.

Central to our operations is the "owner-operator" philosophy we promulgate, which empowers every employee to take ownership of their work and the Company's success. We believe that when employees are stakeholders, they are more engaged, motivated, and aligned with our mission. This culture fosters innovation, accountability, and a shared commitment to excellence. Our employees are encouraged to think and act like owners, which drives continuous improvement and operational

success. To align incentives, every full-time employee of the company receives equity compensation.

Retention is a critical component of our workforce strategy. We recognize that retaining skilled employees is essential for maintaining operational excellence and achieving long-term goals. To this end, we offer competitive pay and comprehensive benefits that include health management programs and an Employee Assistance Program (EAP) to support the mental and physical health of our employees and their families. Our efforts have resulted in a retention rate of over 90 percent, underscoring our success in creating a supportive and rewarding work environment.

To ensure our employees are equipped with the necessary skills and knowledge, we provide comprehensive training and development programs. All new employees undergo a minimum of 24 hours of training during onboarding, followed by annual refresher courses and specific field training. In 2022, our employees completed over 7,500 hours of new hire and refresher training and 1,792 hours of emergency medical response training. Our employees' career progression is based upon continuous skill development and mastery through field and computer-based training. We also offer apprenticeship programs that combine classroom education with practical field experience. These programs, particularly in electrical and instrumentation, allow employees to obtain journeyman licenses, enhancing their professional opportunities and earning potential.

Our workforce development initiatives include partnerships with local high schools, community colleges, and universities to create tailored recruiting and training programs that meet our industry's needs. These partnerships help establish a talent pipeline and provide students with practical experience and job opportunities upon graduation. By collaborating with educational institutions, we support local workforce development and create pathways for students to enter high-demand fields.

The health and safety of our employees is paramount. Every staff meeting begins with a "safety share," where employees are encouraged to discuss recent safety observations, potential hazards, and preventive measures. Our annual calendar features safety-focused art drawn by the children of our employees. The finished product serves as a vivid and daily reminder of the importance of returning home safely. This relentless focus on safety has contributed to an impressive record—in more than 4 years, no employee of MP Materials has experienced a lost time injury.

By investing in our workforce through training and development, we create pathways for career advancement and professional growth. Our employees benefit from a supportive work environment that encourages continuous learning and skill development, helping them progress in their careers and contribute to the Company's long-term success. This focus on professional growth from within is key to our retention strategy, as employees see clear career paths and opportunities for advancement within the Company.

Recommendations to Cultivate an Effective Workforce

The mining and mineral processing industry suffers from a critical shortage in skilled labor. In addition, skilled trades (machinists, mobile and stationary equipment mechanics, electricians, instrumentation technicians, millwrights, etc.) are increasingly difficult to retain, resulting in low labor productivity and underutilization of assets. U.S. critical material producers must compete in global commodity markets, and this directly impairs U.S. competitiveness and therefore mineral security. We recommend further investments by the U.S. Government into developing the skilled trade workforce in regions involved in critical minerals production. To address this challenge and ensure the sustainability of the industry, we recommend the following government actions:

Support for Education and Training Programs: The government should increase funding for education and training programs focused on industrial equipment used in mining, mineral processing, and related fields. Partnerships with middle schools, high schools, community colleges, vocational schools, and universities can help develop specialized curriculums that align with industry needs. Apprenticeship programs, similar to those we have implemented, should be supported and expanded to provide hands-on training and professional certification opportunities. At MP Materials, starting operator wages, excluding voluntary overtime and benefits, offer equivalent compensation to entry-level positions that require a 4-year college degree. Rates of growth in compensation significantly above inflation are achieved through lines of progression tied to on-the-job training. At the

same time, skilled trades-people have wages that reach well into the six figures. Having educational institutions inform young people of this potential rewarding career path while also providing basic skills necessary for success would be a huge benefit to U.S. critical minerals development.

Incentives for Workforce Development: Offering tax credits or subsidies to companies that invest in workforce development can encourage businesses to prioritize training and education. These incentives can help offset the costs associated with comprehensive training programs and make it more feasible for companies to invest in their employees' professional growth.

Promotion of STEM Education: Encouraging STEM (Science, Technology, Engineering, and Mathematics) education from an early age is crucial for developing future talent. Government initiatives that promote STEM programs in schools, provide scholarships for STEM students, and support extracurricular activities like robotics clubs and science fairs can inspire the next generation of professionals in the mining and mineral processing industry.

Support for Advanced Research and Development: Investing in research and development (R&D) can drive innovation and efficiency in the mining and mineral processing industry. Government grants and funding for R&D projects, particularly those focused on technologies capable of creating meaningful commercial outcomes in mineral processing in the near and medium term, will help companies stay competitive and attract top talent interested in working with cutting-edge technologies.

Implementation of National Workforce Development Strategies: The government should develop and implement a comprehensive national workforce development strategy for the mining and mineral processing industry. This strategy should include a clear vision, goals, and action plans to address current and future workforce needs. Regular assessments and updates to the strategy will ensure it remains relevant and effective.

Conclusion

MP Materials is dedicated to restoring the full rare earth supply chain to the United States and to building a talented, committed, and skilled workforce. We believe that with a level playing field and the right support, American producers can work with educators to address the critical skills shortage and ensure the sustainability and growth of the domestic critical minerals mining and processing industry. Although the industry faces headwinds, we are optimistic that the growth and community enrichment that has occurred in Mountain Pass, California, can be replicated across the country.

Thank you for the opportunity to provide this written testimony. We would be pleased to further engage with the Subcommittee on the issues and opportunities and look forward to working together to achieve these goals.

Respectfully submitted,

MATT SLOUSTCHER,
SENIOR VICE PRESIDENT,
COMMUNICATIONS AND POLICY,
MP MATERIALS CORP.

[Whereupon, at 3:50 p.m., the hearing was adjourned.]

○