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Challenges in Critical Mineral Tradeoffs

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Challenges in Critical Mineral Tradeoffs

IDA Ideas host Rhett Moeller spoke with guest Ashley Nunes on the economic and political challenges involved in critical mineral tradeoffs. Ashley is a researcher at the Science and Technology Policy Institute (STPI), an IDA-operated federally funded research and development center. Ashley is an expert in energy and the environment. He holds a doctorate in engineering psychology from the University of Illinois Urbana-Champaign. During their discussion, Ashley describes the constraints entailed in the acquisition and tradeoff of strategically and economically important rare minerals. From iPhones to vehicle batteries, the impact of critical minerals has risen in prominence since the days of World War I, when the U.S. government realized the pressures that conflict placed on resources integral to energy and security needs. With nations moving away from fossil fuels and focusing on decarbonization targets, a greater emphasis is placed upon the use of battery-powered transportation. Ashley elaborates on how policymakers need to reconcile their goals of energy security with affordability and the different priorities of allies, who are determining their own decarbonization targets.

[Begin Transcript]

Rhett Moeller: Hello, listeners. I'm Rhett Moeller, and I'm the host of IDA Ideas, a podcast hosted by the Institute for Defense Analyses. You can find out more about us at www.ida.org. Welcome to another episode of IDA Ideas. Today, we're … [going to] look at the subject of critical minerals. In this time together, we'll talk about what we mean by this and why it's an important consideration.

I'm in our studio with Ashley Nunes, a Research Staff Member at IDA's Science and Technology Policy Institute, or STPI, which serves the important role of providing direct policy expertise in support of the … Office of Science and Technology Policy. Ashley, could you take a moment to introduce yourself?

Ashley Nunes: Thank you so much for having me. My name is Ashley Nunes. I'm a Research Staff Member at the Science and Technology Policy Institute, and my areas of expertise are energy and the environment.

Rhett: Great. Welcome to the show. Thank you so much for making the time to chat with us today. There's a lot to cover, Ashley, so we're … [going to] get right into it. When I think about resources, obviously, there are some that are more valuable than others. Precious metals, things like oil come readily to mind as being especially important.

The value usually depends on how readily available they are. So, what are we talking about when we say critical materials? And what is our history when it comes to defining what we consider critical?

Ashley: Well, the idea of mineral criticality … is a designation that largely comes from the [U.S.] Secretary of the Interior. And if we look at that designation, there are really two factors that are at play. The first is how vulnerable is that mineral to supply chain disruption. And the second is how important is that particular mineral to our economic and our national security? We do have a list of approximately 50 critical minerals that have been designated as being crucial to the proper functioning of our economy.

This list has everything from minerals that the public might be very familiar with … (think aluminum, tin or titanium), to some minerals that the public might be less familiar with, like nickel, manganese and cobalt. How critical a mineral is, of course, ebbs and flows depending on a range of different factors, including supply and demand.

Rhett: Okay, so it sounds like the definition of critical depends on really any number of factors. And different countries, or at least different microeconomic levels and industries, could have different definitions of what criticality is. Is that accurate?

Ashley: I think that is a fair assessment. … If we look at efforts to temper climate change, just as an example, in that particular case, different countries have different decarbonization targets. And different decarbonization targets influence, for example, the number of batteries that you would require. And the number of batteries that you require … directly impacts how much of the mineral you actually need.

Rhett: Sure.

Ashley: So, if the decarbonization target is sufficiently tempered, then it may well be the case that a country does not necessarily view a mineral as being critical to its long-term economic and national security needs. There is a considerable amount of ebb and flow. This is because different countries have different priorities, and a country may not necessarily only rely on a mineral to facilitate its long term decarbonization targets. It may also be the case that a country wants to use its access or its supply of critical minerals to draw foreign investment to its shores.

Rhett: … So, is it an oversimplification to say that the status of criticality really comes down to a question of availability?

Ashley: When we think about availability, there are really two parts of the equation. The first is talking about mining. Specifically, where is the mineral physically extracted from the ground? And that is a geographical constraint. The second part is talking about the processing, which is … what happens when you take that mined mineral, and you turn it into a usable form. So, when we think about the availability of these minerals, we want to consider both where the mineral is mined, and secondly, we want to think about where is the mineral actually processed. A good example of this is lithium. So, if we look at lithium, China currently is responsible for mining approximately nine percent of the world's lithium. But China is also responsible for processing over 60% of the world's lithium. So … I think that's one way to think about the availability of these minerals.

The other factor that matters is considering how vulnerable the supply chains are, in terms of making sure these minerals get to market. When we think about supply chain risks, specifically, what we think about and what we talk about very often in the policy space is the diversity of the supply chain and the capacity of the supply chain.

When we think about the diversity of the supply chain, we are really thinking and we are talking about how many vendors effectively can we go out and source this particular mineral from. When we think about the capacity, what we are thinking about and what we are talking about is: for the vendors that we source our minerals from can they provide us with as much of the mineral as we actually need.

And the two have to be treated very separately, right? Sixty percent of the world's lithium is mined in Australia. Australia is an ally of the United States. We have a free trade agreement with Australia, but Australia does not process the majority of the world's lithium. So, I go back to what I said earlier where we want to emphasize and we want to distinguish between mining and processing, and then we want to consider the diversity of the supply chain and the capacity of the supply chain itself.

Rhett: Makes sense to me. … Can you tell us a little about the constraints on the availability of these materials [and] these minerals?

Ashley: Well, I think there is a fair amount of literature, very compelling literature, to suggest that there is more than enough mineral available to go around. The challenge isn't necessarily with … [whether] there [is] enough mineral physically in the ground. The challenge[s] … [are whether] we [can] get those minerals solely from countries that we consider to be our allies and [whether we] can … process those minerals in countries that we consider to be our allies. And those answers have implications for other factors, like cost of the technology.

Rhett: Right, that makes absolute sense.

Ashley: The … challenge currently is that because so many countries have set decarbonization targets and are relying on semiconductor chips, etc., all of those technologies rely on the same list of critical minerals, right? And as a result of that, many of these countries consider the same minerals to be critical. … An alternative explanation is the fact that … China, for example, by virtue of … controlling a large percentage of graphite production, might not necessarily consider it to be critical. However, they might consider it to be critical from the vantage point of using their muscle, if you will, to lure foreign investment to their shores.

Rhett: Sounds like there's a lot of potential for … international tension based on … countries striving for the same materials.

Ashley: Well … certainly if … we look at many of our allies, it is important to remember that our allies have policies of their own that they wish to implement: policies that rely on the same critical minerals that we … rely [on]. So, let's just take Australia. Australia produces 60% of the world's lithium. We require lithium to build electric vehicle batteries. But Australia is also keen to

decarbonize its economy, also keen to deploy electric vehicles on its roads. And this raises this interesting question. … Australia may be our ally, but just because they are allies that doesn't compel them to give us all the mineral that they have.

Rhett: Right, so this is all very interesting. … Can you tell us a little about some of the recent work you've done related to this topic?

Ashley: Well, recently, my colleagues and I have been trying to better understand the extent to which the United States has sufficient critical minerals to service its decarbonization targets. So, if we look at the Environmental Protection Agency just as an example, the agency recently issued very aggressive tailpipe emission standards that require the deployment of millions of electric cars on America's roads by 2032.

And this raises a very interesting question, which is, "Where are we going to find all the critical minerals from for these batteries, right?" (Electric vehicle batteries, specifically.) And what we set out to do was understand the extent to which the mineral supply in the United States, and among our allies, is sufficient. Or we asked the question, rather, "Is the mineral supply sufficient to address the decarbonization targets that the administration has set out?"

And the answer, unfortunately, is it is not. And it is not that it is not by a little, it is not by a lot. So … between 2027 and 2032 we estimate you would require at least 10 million electric cars to hit the road to comply with the EPA tailpipe emission standard. Our best-case scenario is that we would have sufficient critical mineral supply to deploy — or to manufacture, rather — approximately 5 million electric vehicles. And that's a best-case scenario.

When I say it's a best-case scenario, I am assuming, or my colleagues and I assume, that all the minerals we could possibly find in the United States and all the minerals we could possibly find among our allies would be used solely for the purpose of building electric vehicles. So that's a very, very generous assumption.

Rhett: Ashley, as you've been discussing these things with me, I've had numerous things coming to mind of how complicated this issue really is. Not only in terms of procurement but also of international relations and everything. … I can imagine that this subject of critical minerals creates a lot of challenges for policymakers.

Ashley: It certainly does. I think the principal challenge that policymakers have today is reconciling goals of energy security, energy affordability and, more recently, at least aggressive decarbonization targets. You know, one question that is very seldom asked is, "How critical are these minerals, or rather, are they any more critical today than they were 10 years ago or 20 years ago?"

It is important to remember that we have long relied on critical minerals to service our economy. Many of the critical minerals we use in cell phones today — nickel, manganese and cobalt, to name a few — are also used in electric vehicle batteries. The challenge we have is [that] the

magnitude or the sheer quantity of critical minerals used in many of these newer technologies, like electric vehicle batteries, is just so much higher.

If we look at an iPhone, for example, an iPhone has something in the order of about 100 grams of critical minerals in it. If we look at an electric vehicle battery, we are talking about 170 kilograms of critical minerals in it. You take the magnitude of minerals in an electric vehicle battery, and now you multiply that value by the number of electric vehicles that, for example, the current administration is hoping to deploy on America's roads. And you get a sense of how large of a quantity of critical minerals … [is] actually required to comply with many of these standards.

Rhett: Ashley, I hope that … you can take us back a little bit and look at the history of this as we've been talking. I've been wondering, when did this start? The idea of critical mineral lists, can you help us to understand where this idea came from?

Ashley: Well, most recently, if we look at the Energy Act of 2020, this is an act that effectively sets the standard for what we consider to be critical … and gives the Secretary of the Interior the authority to designate certain minerals as being critical.

But if we go back even further … the first hints of critical minerals can actually be traced back to World War I. At the onset of the war, the United States believed that the war would not take a lot of time. And at some point, it became clear that it was taking much, much longer. And at that point, the government realized this was putting pressure on many of the mineral requirements and the needs, the material needs of the economy. And [it] took steps to define, to specifically say that there were certain minerals and materials that were integral to our energy and our national security needs.

Rhett: So, I'm seeing a lot of things tied into this whole concept: access, environmental, energy, political, economic. There're so many factors that are being worked into this concept of critical mineral lists.

Ashley: Well, I think it's important to emphasize that tradeoffs are everywhere. One of the things we hear a lot these days is the idea of friendshoring, right? Let's start sourcing these minerals and processing these minerals, either domestically or amongst our allies. …

It's important to remember that when we do something like that, one of the questions we are inevitably forced to answer is, "What is the impact on cost?" Because it may well be the case that as a result of having higher labor standards [and] more environmentally conscious regulations, our prices are higher. And when our prices are higher, what this may do is disincentivize consumers from actually adopting the technology. So that's something I always come back to. It's the idea that tradeoffs are everywhere.

Rhett: Thanks for enlightening us about the work that you've been doing. Is there any ancillary work or other projects that you would like to … see happen in this sphere?

Ashley: Well, I think one of the more fascinating questions is trying to better understand what types of battery improvements might we require to decarbonize other parts of our economy. The

aviation sector, of course, is one of the most notable, because it is one of the few sectors where emissions are projected to rise over time.

Emissions go up largely because … people get richer, countries get richer, and as incomes go up over time, people want to travel. So, one of the questions my colleagues and I have been trying to understand is, "What types of breakthroughs do we need to see in battery technology to make concepts like electric airplanes more viable?"

Historically, the notion of electric flight has largely centered around getting the airplane up into the air.

The factor that people look at the most is energy density of batteries. We are certainly looking at the energy density of batteries, but one other aspect that my colleagues and I are looking at is the price point of electric flight. If the price point is not attractive to consumers, you can have the best battery in the world and it's not … [going to] make any difference when it comes to emissions reductions.

Rhett: Well, thank you, Ashley, for taking the time to discuss this topic with us and for sharing your expertise. It's been most illuminating.

Ashley: Thank you so much for having me.

Rhett: As always, if you want more information on IDA and its ongoing work, please check us out @IDA.org. We also have a presence on X, @IDA_org, and we have a channel on YouTube.

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Show Notes

Learn more about the topics discussed in this episode via the links below.

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