



Critical Mass:

Commentary on the White House 100-Day Supply Chain Report
& the Importance of Critical Minerals to the U.S. Technology Base

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critical mass:

crit·i·cal mass | kridekel'mas |

noun

1. a size, number, or amount large enough to produce a particular result

Merriam-Webster Dictionary

2. In nuclear physics -- *the minimum amount of a given fissile material necessary to achieve a self-sustaining fission chain reaction under stated conditions*

Encyclopedia Britannica

On June 8, 2021, the White House released its 100 Day Supply Chain Report — key findings from reviews directed under Executive Order 14017 “America’s Supply Chains” (E.O.14017). Signed on February 24, 2021, the Executive Order instructed President Biden’s economic and national security teams to conduct a 100 day review of four key U.S. supply chains across federal agencies to assess the nation’s [“resiliency and capacity of the American manufacturing supply chains and defense industrial base to support national security \[and\] emergency preparedness.”](#)

While reviewing the risks and vulnerabilities for several key industry sectors — semiconductors, high-capacity batteries, medical supplies and critical and strategic metals and minerals, the report also provided an important window into the dominant role Critical Minerals play in these 21st Century tech sectors, and — by extension — a theme familiar to followers of ARPN: the dangers of relying on adversary nations to supply our Critical Mineral needs.

The “100-Day Report” was released at a critical juncture in time. Several recent studies have made clear that the global pursuit of a low carbon energy future will require massive amounts of Critical Minerals. Meanwhile, the coronavirus pandemic has served as an eye-opener to many Americans with regards to our Critical Mineral resource dependencies. The combination of rapidly rising demand with the U.S.’s deep dependencies for Critical Minerals has prompted a flurry of activity in Washington, D.C., as policymakers scramble to diversify our Critical Mineral sources away from China and begin the difficult work of building and strengthening resilient Critical Mineral Supply Chains.

ARPN has long taken the view that questions concerning Critical Minerals — which “Criticals” are required for which key technologies, what nations are Critical Mineral producers and which are Critical Mineral dependent, and, from a U.S. perspective, what policies will help harness innovation and investment to break dangerous Critical Minerals dependencies — impact the headline-grabbing debates about economic competitiveness, manufacturing might, renewable energy and transition to a post-carbon net zero environment, and of course national security.

Will the 100-Day Report be the document that brings the Critical Mineral issue to critical mass — a combination of analysis and recommendations, combined with a sense of urgency that leads to action? It’s tempting but trite to say that, several years on, we will look back to see whether this was the moment of critical mass. It’s truer to wonder whether the United States will have the luxury of looking back, as — in the second definition of critical mass, the one specific to nuclear physics — the chain reaction of Critical Mineral supply and the risk of Critical Mineral denial may in fact be underway, with self-sustaining consequences.

What follows are the American Resources Policy Network’s initial blog posts on issues raised by the “100 Day report.”All of the posts and much more can be found at www.americanresources.org.

bismuth
indium
strontium
beryllium
tantalum
germanium
antimony
nickel
cobalt
titanium
aluminum
tungsten
lithium
graphite
rare earths elements
scandium
barium
niobium
copper
gallium
magnesium
platinum group metal
chromium
helium

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I. “Indispensable Ingredients”

Critical Minerals at the Heart of Assessment of Nation’s “Resiliency and Capacity of the American Manufacturing Supply Chains and Defense Industrial Base”

A First Glimpse: Biden Administration Releases Findings of Extensive Supply Chain Review

On June 8, 2021, the White House released the findings of its 100-day supply chain review initiated by Executive Order 14017 – “*America’s Supply Chains*” and announced a set of immediate actions it is looking to take in an effort to strengthen U.S. supply chains [*“to promote economic security, national security, and good-paying, union jobs here at home.”*](#)

The [250-page report](#) contains review sections and policy recommendations for four technology sectors deemed critical: semiconductor manufacturing and advanced packaging; large capacity batteries, like those for electric vehicles; Critical Minerals and materials; and pharmaceuticals and active pharmaceutical ingredients (APIs).

The Biden Administration should be commended for acknowledging that *“[f]or too many years, we’ve let our production capacity for critical goods migrate overseas rather than making investments to support U.S. manufacturing and U.S. workers,”* as a senior Administration official recently [told](#) reporters, and for making good on its commitment to thoroughly review bottlenecks, supply risks and possible solutions.

After several news reports that the President and his team would look primarily to America’s allies as sources of critical raw materials and, rather than looking into increasing production domestically, would focus primarily on supporting domestic processing of such imported materials, it is encouraging to see that the White House report also sees a role for new domestic exploration, with the Administration [planning to work](#) to *“identify new domestic sites where such Critical Minerals could be mined with environmental safeguards.”*

This would be consistent with ARPN’s call for an *“all of the above”* approach, most recently [laid out before members of Congress](#) during a virtual panel discussion by ARPN principal Daniel McGroarty.

Of course, the devil is in the details, but the topline is clear: In our Tech Metals Age, secure supply chains are essential to advanced manufacturing, renewable energy, public health and national security. And minerals and metals are the indispensable ingredients in each case.

II. Department of Defense

Critical Minerals & Materials

DoD-led “100-Day” Supply Chain Assessment Concludes We Need “All of The Above” Approach to Critical Mineral Resource Security

From a Critical Minerals perspective, there is a lot to unpack in the 250-page report.

First up: a closer look at the [“Review of Critical Minerals and Materials.”](#) an *“interagency assessment for which the Department of Defense served as the lead”* — not least because we were pleased to find ARPN’s call for an *“all of the above approach”* to mineral resource security echoed in the [chapter](#). Rather than attempting a comprehensive full-chapter summary, we’ll highlight some key findings of interest to followers of ARPN:

The Department of Defense defines Strategic and Critical Minerals as *“those that support military and essential civilian industry; and are not found or produced in the United States in quantities to meet our needs.”*

The agency notes that in the three decades since the end of the Cold War in 1991, the subsequent reorientation of global supply chains has fundamentally changed the landscape for Strategic and Critical Minerals. With the rise of China, and availability of supplies that were previously locked behind the Iron Curtain, *“[t]rade liberalization and global, just-in-time supply chains became the order of the day,”* and the prioritization of economic efficiency over *“diversity and sustainability of supply”* contributed to a slow *“erosion of manufacturing capabilities.”*

While supply chains became more complex, DoD laments that with the the impetus for national mobilization programs falling by the wayside *“core capabilities at non-defense agencies to study, characterize and mitigate risk in the strategic and critical materials sector atrophied.”*

DoD finds that today’s concentration of global supply chains for strategic and critical materials in China — a reality the American public has increasingly become aware of in the wake of the coronavirus pandemic — *“creates risk of disruption and of politicized trade practices, including the use of forced labor.”*

In its assessment of mitigation strategies, DoD looks at various sources of supply and concludes that *“[t]hough increasing recycling rates for strategic and critical materials is advantageous, recycling alone is typically inadequate to supply the volumes of material required for domestic consumption. Even if 100 percent recycling rates were achieved for a particular supply chain, increasing demand necessitates primary production.”*

The agency notes that *“complex extraction, chemical, and refining operations, establishing strategic and critical material production is an extremely lengthy process. Independent of permitting activities, a reasonable industry benchmark for the development of a mineral-based strategic and critical materials project is not less than ten years.”*

II.

In its risk assessment, aside from looking at “concentration of supply,” “skills and human capital development gaps” and “conflict minerals,” as well as trade and market dynamics, DoD also highlights the importance of “byproduct and coproduct dependency,” an [issue complex](#) of which followers of ARPN are well-aware.

To alleviate risk, DoD suggests the following:

“Reliable, secure, and resilient supplies of key strategic and critical materials are essential to the U.S. economy and national defense. The United States needs an ‘all of the above’ comprehensive strategy to increase the resilience of strategic and critical material supply chains that both expands sustainable production and processing capacity and works with allies and partners to ensure secure global supply.”

Specifically, the agency recommends a strategy focused on the following:

- Developing and Fostering New Sustainability Standards for Strategic and Critical Material-Intensive Industries
- Expanding Sustainable Domestic Production and Processing Capacity, Including Recovery from Secondary and Unconventional Sources and Recycling
- Deploying the DPA — specifically Title III — and Other Programs
- Convene Industry Stakeholders to Expand Production
- Promote Interagency Research & Development to Support Sustainable Production and a Technically-Skilled Workforce
- Strengthen U.S. Stockpiles
- Work with Allies and Partners and Strengthen Global Supply Chain Transparency

DoD’s conclusion:

“Today, at the beginning of the third decade of the 21st century, a new industrial era of low-carbon and increasingly energy efficient products is converging with autonomous and Internet-of-Things devices, which may lead to massive gains in productivity and economic growth. If the United States wants to capture the full benefits of this new era, we must also look to the sustainability of our strategic and critical materials supply chains. The Department of Defense can play an important role, but the Department cannot carry-out this task alone. This is a task for the Nation.

The U.S. Government, collectively, has examined the risk in strategic and critical materials supply chains for decades. Now is the time for decisive, comprehensive action by the Biden-Harris Administration, by the Congress, and by stakeholders from industry and non-governmental organizations to support sustainable production and conservation of strategic and critical materials.”

In the wake of several media reports that the Biden Administration would pursue a more selective strategy focused primarily on domestic processing rather than also supporting increased domestic production, it is encouraging to see DoD — and the Biden Administration as a whole — endorse a broad-based “all of the above” approach to mineral resource security.

With the strategy now in place, ARPN will look for signs that the U.S. Government will transform those recommendations into reality, via policy, programs and projects that address the deep shortfalls in Critical Mineral supply.

III. Department of Energy

Large Capacity Batteries

DoE Chapter of 100-Day Supply Chain Report Calls for Immediate Investment in “Scaling up a Secure, Diversified Supply Chain for High-Capacity Batteries Here at Home”

The Biden Administration made clear early on that it is committed to pursuing a low-carbon energy future, and battery technology is a key driver underpinning the shift away from fossil fuels. When touting his infrastructure package at Ford’s electric vehicle plant in Dearborn, Michigan, earlier this summer President Joe Biden [declared](#): *“The future of the auto industry is electric. There’s no turning back.”*

Thus, it came as no surprise that President Biden’s February 2021 executive order launching a 100-day review of supply chain vulnerabilities for four key products targeted advanced batteries. The Department of Energy has now completed its review, with the findings released as part of a comprehensive [100-Day Supply Chain Report](#).

As DoE points out:

“Advanced, high-capacity batteries play an integral role in 21st-century technologies that are critical to the clean energy transition and national security capabilities around the world—from electric vehicles, to stationary energy storage, to defense applications. Demand for these products is set to grow as supply chain constraints, geopolitical and economic competition, and other vulnerabilities are increasing as well.”

In its report chapter, DoE notes that

“The rationale for supporting the U.S. supply chain now is clear: demand for EVs and energy storage is increasing, investors are increasing investment in the clean economy, and the pandemic has underscored the fragility of some U.S. supply chains. China and the European Union (EU) – in contrast to the U.S. approach – have developed and deployed ambitious government-led industrial policies that are supporting their success across the battery supply chain. China has also moved beyond conventional policy support with practices involving questionable environmental policies, price distortion through state-run enterprises to minimize competition, and large subsidies throughout the battery supply chain.”

In other words, as ARPN expert panel member and Benchmark Mineral Intelligence managing director Simon Moores [told](#) members of Congress a while back:

“We are in the midst of a global battery arms race.”

Moores [had told](#) members of Congress that *“[i]t is not too late for the US [to secure global supply chains post-COVID] but action is needed now.”* – a sentiment DoE echoes in its report chapter:

“However, the opportunity for the United States to secure a leading position in the global battery market is still within reach if the Federal Government takes swift and coordinated action.”

III.

While less explicit about the “*all of the above*” approach than the Department of Defense, DoE [notes](#) that:

“With the global lithium battery market expected to grow by a factor of five to ten by 2030, it is imperative that the United States invests immediately in scaling up a secure, diversified supply chain for high-capacity batteries here at home. That means seizing a critical opportunity to increase domestic battery manufacturing while investing to scale the full lithium battery supply chain, including the sustainable sourcing and processing of the Critical Minerals used in battery production all the way through to end-of-life battery collection and recycling.”

Through strong collaboration across the federal government, with U.S. industrial stakeholders, the research community, and international allies, the U.S. must develop a durable strategy that invests and scales our potential industrial strengths to meet this challenge.”

Among the Agency’s key recommendations for immediate and future action to strengthen the domestic advanced battery supply chain are:

- Strengthening U.S. manufacturing requirements in federally-funded grants, cooperative agreements, and research and development (R&D) contracts.
- Procuring stationary battery storage.
- Providing financing to the advanced battery supply chain for electric vehicles.
- Releasing the National Blueprint for Lithium Batteries by the Federal Consortium on Advanced Batteries (FCAB).
- For Congress to catalyze private capital with new federal grant programs to support battery cell and pack manufacturing.
- The electrification of the nation’s school bus fleet, and the acceleration of the electrification of the nation’s transit bus fleet.
- Providing consumer rebates and tax incentives to spur consumer adoption of EVs.
- Investing in the production of high-capacity batteries and products that use these batteries to support good-paying, union jobs.
- Developing strong environmental review permitting practices for the extraction of Critical Minerals.

Under the sub-head “*Mapping the Supply Chain*,” while the Department zeroed in on the usual suspects — notably Lithium, Cobalt, Graphite, Manganese — all of which were officially deemed critical on the U.S. Government’s official 2018 Critical Minerals List — DoE also prominently features Nickel and Copper. For Nickel, DoE even notes that “*if there are opportunities for the U.S. to target one part of the battery supply chain, this would likely be the most critical to provide short- and medium-term supply chain stability.*”

Which would make Nickel the most critical “*non-Critical*” — a status consistent with the [word cloud](#) we created based on the number of 100-Day Report mentions (footnotes included) of the metals and minerals that made the official U.S. Government Critical Minerals List of 2018 — and the two that didn’t but should have (Nickel and Copper).

III.



As we noted in a previous [post](#), the Biden Administration is right to give prominence to Nickel and Copper in its strategy.

After all, as Reuters’s Andy Home has pointed out,

“There is no domestic nickel processing capacity outside a limited amount of by-product salt production.

Yet this particular battery metal is the one likely to experience the most significant demand increase over the coming years, the report says, with ‘market indications that there could be a large shortage of Class 1 nickel in the next 3-7 years.’

Indeed, with nickel content rising in battery cathode design, not having enough of the right kind of nickel ‘poses a supply chain risk for battery manufacturing globally, not just in the United States.’”

And for Copper, the latest IEA report has estimated that — largely driven by the EV revolution — demand will be 25 times greater in 2040 than it was in 2020.

Thankfully, there are opportunities to alleviate our supply chain vulnerabilities and to begin the “*sustainable sourcing and processing*” here at home, both for Nickel and Copper, as well as for the other battery “*Criticals*,” and many other metals and minerals.

With the Administration having endorsed an “*all of the above*” strategy to secure our supply chains “*soup to nuts*,” as Secretary of Energy Jennifer Granholm [phrased](#) it recently, here’s hoping that this broad-based approach will find swift application via policy, programs and projects.

IV. Department of Commerce

Semiconductor Manufacturing and Advanced Packaging

“Supply Chain” Begins with “Supply:” Department of Commerce 100-Day Report Chapter on Complex Semiconductor Supply Chain

Current news coverage may have you believe that when it comes to Critical Minerals, all we’re talking about is Rare Earths and battery tech metals, such as Lithium, Cobalt, Manganese, Nickel and Graphite. However, while certainly extremely important for 21st Century technology, these materials and the sectors in which they find key applications only represent the tip of the proverbial iceberg when it comes to securing Critical Mineral supply chains.

In its 100-Day Supply Chain Report, the Biden Administration dedicated an entire chapter to the supply chains of semiconductors — for good reason.

Semiconductors have become indispensable components for a broad range of electronic devices, and their importance cannot be overstated. The Department of Commerce-led chapter in the report cites the transformational impact of the colloquial computer chip as the launching point of its review:

“Semiconductors are the material basis for integrated circuits that are essential to modern day life and are used by the typical consumer on a daily, if not hourly, basis. The semiconductor-based integrated circuit is the ‘DNA’ of technology and has transformed essentially all segments of the economy, from agriculture and transportation to healthcare, telecommunications, and the Internet. (...)

In addition to the central role they play in the U.S. economy, semiconductors are essential to national security. Semiconductors enable the development and fielding of advanced weapons systems and control the operation of the nation’s critical infrastructure. They are fundamental to the operation of virtually every military system, including communications and navigations systems and complex weapons systems such as those found in the F-35 Joint Strike Fighter. They are key to the ‘must-win’ technologies of the future, including artificial intelligence and 5G, which will be essential to achieving the goal of a ‘dynamic, inclusive and innovative national economy’ identified as a critical American advantage in the March 2021 Interim National Security Strategic Guidance.”

According to the report, the supply chains for these highly specialized hi-tech components are extremely complex, as the manufacturing of semiconductors *“requires hundreds of essential inputs, many of which are raw materials, chemicals, and gases. These materials have their own complex supply chains, and likely contain hidden choke points that could disrupt production.”*

The manufacturing of semiconductors begins with polysilicon, for which the U.S. currently has some production capacity. However, according to the Department of Commerce, *“U.S. technological leadership and production of semiconductor-grade polysilicon is at risk due to China’s actions to increase its dominance of both the semiconductor and solar supply chains.”* That risk is further heightened now that [China is under U.S. import sanctions](#) for producing polysilicon using forced labor in the Province of Xinjiang. U.S. companies importing Chinese products containing polysilicon from Xinjiang risk having those products impounded at American ports by U.S. Customs and Border Protection.

IV.

Two other key semiconductor materials are Gallium and Indium — for both of which the United States is 100% import reliant, both of which made the 2018 official U.S. Critical Minerals List released by the Department of the Interior, and both of which are primarily sourced from China.

Due to the extremely complex and geographically dispersed nature of the semiconductor supply chain (which results in the typical semiconductor production process spanning multiple countries and products crossing international borders up to 70 times according to the Department of Commerce), there are many access points for supply chain vulnerabilities along the way.

To address the semiconductor supply chain challenge, the Biden Administration seeks to “*bolster its partnership with the private sector in domestic semiconductor manufacturing and R&D,*” and “*strengthen engagement with allies and partners to promote fair semiconductor chip allocations, increase production, and promote increased investment.*”

However, let’s be clear: As ARPN’s Daniel McGroarty [pointed out](#) last year against the backdrop of excitement over the recent announcement of Arizona as the site for Taiwan Semiconductor’s new next-gen semiconductor factory to manufacture their new 5-nanometer (5nm) chips: “*the first word in supply chain is ‘supply.’*”

As the Biden Administration begins to tackle the complex semiconductor supply chain challenge in the context of its “*all of the above*” approach to decouple from adversary nations, it must begin at the beginning.

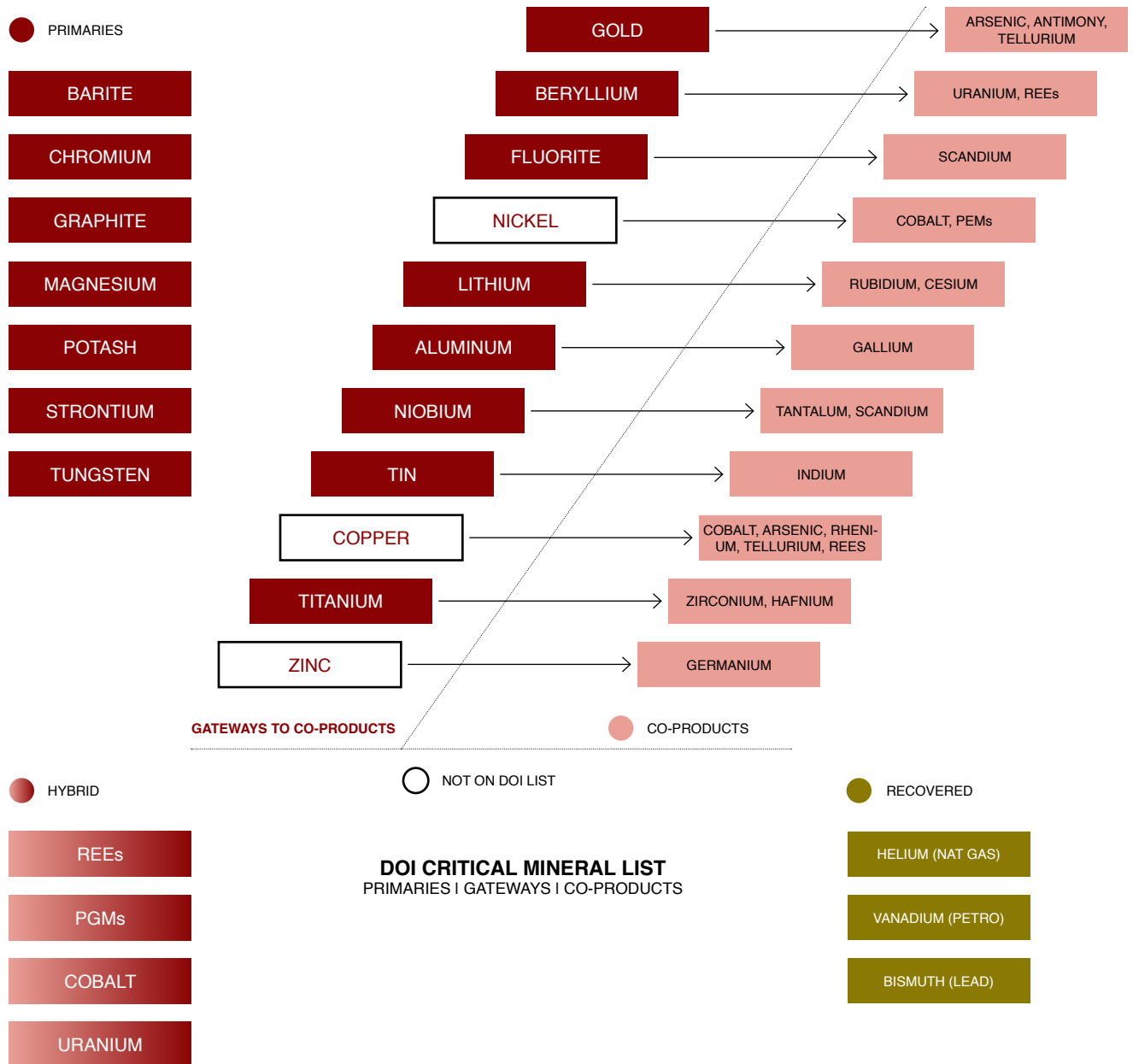
Thankfully, the U.S. is not only in the fortunate position to have known resources for both Gallium and Indium (in Texas and Alaska, respectively), both metals can also be “*unlocked*” in the “*co-product*” development of their Gateway Metals Aluminum (for Gallium) and Zinc and Tin (Indium) — another reason stakeholders should focus more on the inter-relationship between [Gateway Metals and the critical co-products they unlock](#).

V. Time to Ditch the “By-product” or “Minor Metals” Labels

On the Importance of Gateway and Co-product Metals

*** to learn more about the role and inter-relationship of Gateway Metals and their Co-products, refer to ARPN's 2018 [“Through the Gateway”](#) report ***

McGroarty
March 8, 2018



V.

DoD Chapter of 100-Day Supply Chain Report Acknowledges Gateway/Co-product Challenge

Friends of ARPN will know that *“much of our work is grounded in a conviction that the Technology Age is driven by a revolution in materials science – a rapidly accelerating effort that is unlocking the potential of scores of metals and minerals long known but seldom utilized in our tools and technologies.”*

In this context we have long argued that while it is essential to focus on the metals and minerals that are driving headlines, such as the Rare Earths and battery tech metals like Lithium, Cobalt, Nickel, Manganese and Graphite, we must not forget about the inter-relationship between what we have been calling *“gateway metals”* and their *“co-products.”*

Gateway metals – which include mainstay metals like Copper, Aluminum, Nickel, Tin, and Zinc, are not only critical to manufacturing in their own right, but *“unlock”* tech metals increasingly indispensable to innovation and development. For too long, these *“unlocked”* tech metals were dubbed *“by-products,”* or even *“minor metals”* – labels that don’t do these materials and their increasingly broad applications justice.

Courtesy of the ongoing materials science revolution, both groups of metals and minerals are increasingly becoming the building blocks of 21st Century technology, which is why we believe the *“by-products”* should be referred to as *“co-products.”* Meanwhile, many of them are fraught with similar dependency issues like the news-grabbing Rare Earths or battery tech metals.

As such, we were pleased to see that the [DoD-led chapter of the White House’s 100-Day Supply Chain Report](#) not only draws attention to this issue complex, but also appears to have embraced the *“co-product”* label – using it interchangeably with the term *“byproduct.”* Under the header *“Byproduct and Coproduction Dependency,”* the DoD chapter argues that

“[b]yproduct production of strategic and critical materials can add significant value to an existing production operation and improve the business case for a nascent producer. However, some strategic and critical materials are derived exclusively from byproduct production, which means a fairly small market depends on the prevailing dynamics of a separate but much larger commodity market. (...) In some cases the concentration of supply can be so extreme that U.S. or global production is concentrated in a single source. (...) More generally, in DoD modeling of strategic and critical materials under national emergency conditions, a domestic sole-source provider exists for 29 of the 53 unclassified shortfall materials, and 18 materials have no domestic production at all.”

This is a significant development, because unlike the recently released Canadian government’s official Critical Minerals list, the U.S. Government’s List of 35, released in 2018, [did not acknowledge](#) the connection between primary mining materials and their critical-co-products.

With the gateway/co-product challenge finding its way into public discourse by way of the 100-Day Supply Chain report, there is hope that the drafters of a forthcoming updated U.S. Government Critical Minerals List will acknowledge the importance of Gateway Metals — and that policy makers will factor this issue complex into the *“all of the above”* approach. As yesterday’s *“minor metals”* become major materials in tech applications, America’s mineral resource security may well hinge on encouraging innovative sources of supply.

VI. Critical “Non-Criticals:”

Copper and Nickel in the 100 Day Report

Biden Administration 100-Day Supply Chain Report Holds Surprise for Some: And the Winner is... Nickel?

Critical Minerals policy-wonks: if you wagered that Rare Earths would be the leading elements in the Biden 100-Day Report in terms of mentions, you’d be wrong.

That’s right — we took a look at the Biden Administration’s [100-day supply chain assessment](#), and created a word cloud based on the number of mentions (footnotes included) of the metals and minerals that made the official U.S. Government Critical Minerals List of 2018 — and the two that didn’t but should have (Nickel and Copper).

Here’s what it looks like:



It may come as no surprise that Lithium and Cobalt are prominently featured (Lithium is mentioned 315 times and Cobalt appears 167 times) — after all we find ourselves in a [“battery arms race.”](#)

And, of course, the Rare Earths made the cut with 105 mentions[1], but what may surprise you is that Nickel — a non-Critical, at least in terms of the official U.S. Government Critical Minerals List of 2018 — takes the bronze with a whopping 146 references. And fellow non-Critical Copper also racks up a Top Ten appearance, with 29 references.

In the Department of Energy-led supply chain assessment chapter, DoE notes under the Nickel sub-header for *“Mapping the Supply Chain”* that *“if there are opportunities for the U.S. to target one part of the battery supply chain, this would likely be the most critical to provide short- and medium-term supply chain stability.”*

VI.

DoE continues:

“In contrast to cobalt, nickel content per battery will increase in the coming years, as R&D focused on high-nickel in cathodes has shown significant and accelerated commercial adoption. The potential shortfall from this increase in demand poses a supply chain risk for battery manufacturing globally, not just in the United States; given the pervasive need, the established nickel industry is ramping up production and processing, and the United States is falling further behind China in this critical material.”

Copper is highlighted in the 100-Day Report as an integral component of Lithium-ion battery technology, in the context of being what we have called a “gateway metal” to other critical materials, and for its

“use across many end-use applications aside from lithium-ion cells, including building construction, electrical and electronic products, transportation equipment, consumer and general products, and industrial machinery and equipment.”

ARPN followers can claim an I-told-you-so here. After all, ARPN’s Daniel McGroarty urged the U.S. Government to include both Nickel and Copper in the 2018 official government list of Critical Minerals in his [Public Comment submission](#).

With that brief moment of vindication, let’s move on to say that the Biden Administration is right to give prominence to Nickel and Copper in its strategy.

As Reuters’s Andy Home [points out](#),

“Nickel isn’t on the U.S. list of critical minerals. Although the country depends on imports, 68% of supplies come from what the report calls “allied nations” such as Canada, Australia, Norway and Finland.

But the Department of Energy (DOE) has identified Class 1 nickel, the type best suited to lithium-ion batteries, as both a key vulnerability and key opportunity. (...)”

As the White House 100-Day Report notes:

“Eagle Mine is the only active nickel mine in the U.S. today, and its lifetime is set to end in 2025.”

Home acknowledges this fact and continues:

“There is no domestic nickel processing capacity outside a limited amount of by-product salt production.

Yet this particular battery metal is the one likely to experience the most significant demand increase over the coming years, the report says, with ‘market indications that there could be a large shortage of Class 1 nickel in the next 3-7 years.’

Indeed, with nickel content rising in battery cathode design, not having enough of the right kind of nickel ‘poses a supply chain risk for battery manufacturing globally, not just in the United States.’”

VI.

For Copper, one need to look no further than the latest IEA report which estimates that, driven by the Electric Vehicle revolution, copper demand will be 25 times greater in 2040 than it was in 2020.

Thankfully, the U.S. does not have to look far for opportunities to strengthen our position for both Nickel and Copper. [The Tamarack Nickel project](#) in Minnesota hosts a high-grade Nickel deposit, along with Copper and Cobalt as co-products. As for Copper, [several](#) of our [recent posts](#) provide an insight into domestic opportunities.

As the Department of Energy concludes:

“The United States must adopt a set of tools to increase domestic battery manufacturing while improving the resilience of the lithium battery supply chain, including the sourcing and processing of the critical minerals used in battery production.”

It’s a behemoth task, but, the good news is that in light of the United States’ mineral riches and technical knowhow the *“all of the above”* approach embraced in the Biden Administration’s strategy can start at home.

[1] For the purpose of this word cloud, we counted all mentions of “Rare Earth(s)” as a group in both text and footnotes. We did not include mentions of the individual Rare Earth Elements with the exception of Scandium, which is also treated separately by the 2018 official U.S. Government list of 35 Critical Minerals. Note that our word cloud generator left off several of the 35 Critical Minerals because they were either not mentioned at all or received very few mentions.

Decarbonization Goals Expose Bottleneck in Critical Mineral Supply Chains – Us

“The road to decarbonisation will be paved with copper (...) and a host of other minerals, all critical for electric vehicles (EVs), solar panels and wind farms,” writes Andy Home, whose work we’ve highlighted [here](#) before, in a [piece](#) for Reuters.

Reporting from a European perspective, Home writes that stakeholders have begun to realize that levels of import reliance for these Critical Minerals on nations like China is not *“sustainable,”* and access to raw materials (from production to refining) is viewed as *“strategic”* by the European Commission. He says the big problem, however, is *“Us”* — meaning that *“[t]he paradox of the green revolution is that public opinion is firmly in favour of decarbonisation but not the mines and smelters needed to get there.”*

Home points to the United States, where, by way of example, global miner Rio Tinto has been *“trying for over a quarter century to win approval for its Resolution copper mine in Arizona”* against *“stiff opposition”* from Native Americans and environmentalists in what is a traditional mining state and generally considered a mining-friendly jurisdiction. As friends of ARPAN will know, the U.S. is presently import-dependent for 35% of its annual Copper demand or 650,000 metric tons a year — and demand is growing: According to the [recent IEA Report](#), driven by the Electric Vehicle revolution, Copper demand will be 25 times greater in 2040 than it was in 2020.

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Environmental concerns are a legacy issue the mining industry has been grappling with. Technological advances and commitments to more sustainable practices are changing the landscape, but, as Home writes, “[i]t’s not hard to understand why the political desire to reshore Critical Minerals production is running into popular resistance,” which is why European Commission plans to accelerate mine permitting are being drawn up in the context of a “responsible resourcing code in a bid to win hearts and minds.”

Home points to a recent CSIS study which contends that while fully decoupling from China “is impossible today (and) in the future, it is improbable and likely expensive,” and that Western nations should instead focus on areas where they can “compete in parts of the green technology supply chain and accept a level of inter-dependence with China.”

He concludes that dealing with a certain level of quid-pro-quo with China might be “unlikely to please those who contend that the United States and Europe must completely reshore their minerals production. But it may be no more than a statement of fact until we collectively accept the need for more mines and metals plants somewhere close to our back yards.” In other words, we are the “human bottleneck in critical mineral supply chains.”

Our idea of having our cake, and eating it, too, will have no place in the post-petro Tech Metals Age. The hard truth is that achieving decarbonization goals while at the same time reducing the U.S.’s over-reliance on Critical Minerals from China will require an “all of the above” approach we’ve come to know from the energy debate, a notion that is supported by the [IEA study](#) on achieving carbon neutrality goals by 2050.

This is why we’re encouraged by the Biden Administration’s 100-Day Review Report of critical supply chains — which, in the Department of Defense’s outline of policy recommendations to alleviate Critical Mineral supply chain vulnerabilities, explicitly [calls for](#) embracing such an approach: “Reliable, secure, and resilient supplies of key strategic and critical materials are essential to the U.S. economy and national defense. The United States needs an ‘all of the above’ comprehensive strategy to increase the resilience of strategic and critical material supply chains that both expands sustainable production and processing capacity and works with allies and partners to ensure secure global supply.”

Recent media reports had indicated that the Biden Administration might not incorporate new domestic Critical Minerals production into its strategy and rather focus on the processing side of the supply chain relying on imports from allied nations. However, the review report does see a role for new — sustainable — domestic mining, which, as [we’ve previously pointed out](#), is feasible with industry having made strides towards reconciling environmental concerns with meeting supply needs.

It appears that the message that in our Tech Metals Age, minerals and metals are the indispensable ingredients to securing supply chains vital to advanced manufacturing, renewable energy, public health and national security has registered, and it is good to see that the Biden Administration appears willing to unkink the bottlenecks.

To learn more about the “all of the above” approach, which ARPAN’s Daniel McGroarty recently discussed at a congressional virtual forum, [click here](#).

VII. “All of the Above:”

Engaging Industry and Allies

Secretary of Energy Jennifer Granholm Commits to “Soup to Nuts” Strategy, with Critical Minerals Being “Part and Parcel” of Renewable Energy Production

During a recent Senate Committee on Energy and Natural Resources hearing on President Joe Biden’s FY 2022 budget request for the Department of Energy, Senators questioned Secretary Jennifer Granholm on the Department’s view on the role of Critical Minerals in energy production.

[Watch the archived webcast here.](#)

Sec. Granholm stated that Critical Minerals are “*part and parcel of how we are going to be able to electrify the electric vehicle supply, it is part and parcel of making sure that we have the means to [support] the full stream of technology products for clean energy,*” domestically.

While stressing the need for recycling and substitution, when pressed by Sen. Steve Daines (R-Montana), Sec. Granholm expressly rejected the notion of an “*anti-mining,*” “*anti natural resource development*” sentiment in the Biden Administration.

She pointed to page 18 of the recently-released National Blueprint for Lithium Batteries by the Federal Consortium for Advanced Batteries, which stipulates “[*s]ecure access to raw and refined materials and discover alternatives for critical minerals for commercial and defense applications*” as the number one goal and lists the following near-term objectives:

1. Work with partners and allies to establish reliable sources and supplies of key raw materials for batteries, including Critical Minerals, both domestic and international
2. Increase U.S. safe and sustainable production capacity of critical battery minerals (Lithium, Nickel, and Cobalt) by supporting R&D and mining efforts
3. Develop federal policies to support the establishment of resilient domestic and global sources and supplies of key raw materials

Calling DOE’s approach a “*wrap-around strategy*” that includes recycling and substitution, as well as mining, she said:

“This is the United States. We can mine in a responsible way. And many places are doing it. And there are some places where there are more challenges, but we can do this.”

It’s a welcome affirmation of the comprehensive “*all of the above*” approach ARPN and many others have been calling for, in keeping with the objectives the Biden Administration has embraced in its [100-Day Supply Chain Report](#).

As Secretary Granholm rightfully says, mining (and processing for that matter) can be done — and is being done — in a sustainable and responsible way in the U.S.

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The Mining Industry is Ready to Strengthen American Supply Chains

With the release of its 100-Day Supply Chain Report, the Biden Administration has sent a strong signal that it is serious about stepping up U.S. efforts to secure domestic supply chains — especially for the four areas covered by the report: semiconductor manufacturing and advanced packaging; pharmaceuticals and active pharmaceutical ingredients (APIs), and, of particular interest for followers of ARPN, large capacity batteries, as well as Critical Minerals and materials.

In its commitment to ensure a stable supply for these tech sectors, the Administration has embraced an *“all of the above”* approach to Critical Mineral security, which spans all segments of the supply chain and a broad array of strategies. In the run-up to the Report’s release, there were news reports that the Administration would focus on expanding domestic processing and rely on allies and other nations to mine the minerals and metals. However, both the 100-Day Supply Chain Assessment and subsequent statements by Administration officials like Secretary of Energy Jennifer Granholm have made clear that the *“all of the above”* referenced by DoD, or the *“wrap-around strategy”* Sec. Granholm has touted, would not only include recycling and substitution as well as partnering with close allies such as Canada and Australia, but also new domestic mining — with the caveat that it be *“sustainable”* and *“responsible.”*

This is good news for the mining sector, which has [recognized](#) *“[its] responsibility and [is] trying to meet the increased expectations of consumers, society and governments”* to contribute towards the push towards a greener energy future and has increasingly been harnessing advances in materials science and technology to meet the challenge of developing a domestic Critical Minerals supply while maintaining and advancing responsible mining practices.

Over the past few months, ARPN has been highlighting initiatives by mining companies to sustainably green the future, ranging from overhauling supply chain policies to ensure suppliers conform to certain environmental and social standards, to incorporating renewable power sources into their operations to offset some of the carbon costs of resource development. With the 100 Day Report focusing a new level of attention on Critical Minerals supply chains, ARPN is spotlighting several new initiatives across the entire spectrum of the supply chain, from upstream to downstream.

- DoE has [provided funding](#) for BHE Renewables’s Lithium extraction efforts from geothermal brine at its operations in the Salton Sea, California, where the almost \$15 million award will go towards constructing a demonstration plant to convert Lithium chloride into battery-grade Lithium hydroxide.
- U.S.-based precious metals producing and processing group Comstock Mining [has partnered](#) with others to *“deploy novel [clean energy] technologies for gold processing and extraction across its portfolio”* and aims to *“efficiently reprocess and renew silver and other strategic metals as part of a ‘clean energy transition’ towards ‘climate-smart mining.’”*
- Having developed a patented process for recycling cathode materials from spent Lithium-ion batteries, Canada-based American Manganese, an industry member of the U.S. Department of Energy’s Critical Materials Institute (CMI), [is working](#) with U.S. National Labs to *“promote a circular economy for the lithium-ion battery supply chain and set the standard for high recovery and purity of cathode materials from spent lithium-ion batteries.”* American Manganese’s battery recycling work even received a *“shout-out”* in the [White House’s 100 Day Report](#).

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- Rio Tinto has announced [plans](#) to construct a new plant to recover Tellurium, a co-product of Copper refining and a material critical to the green energy transition, at its Kennecott mine in the Utah. By harnessing an innovative extraction process at an already existing mine site, the company is able to reduce waste while adhering to federal and state environmental standards and minimizing the carbon footprint of the operation – achievements that align well with the 100 Day Report’s objectives.
 - Epiroc, a Europe-based developer/producer of drill rigs, rock excavation and construction equipment, has updated its North American [underground mining market strategy](#) to reflect “increasing demand for electrification solutions that deliver savings on maintenance, ventilation and cooling while lessening environmental footprint.” The strategy seeks to support North American mining operations through battery-electric, zero-emission equipment.
 - Clean energy start-up Heliogen has announced [a partnership with Rio Tinto](#) to deploy its solar technology at the largest open pit mine in California, the company’s borate project in Boron, California. Using artificial intelligence and computer-vision-controlled mirrors, Heliogen will harness the power of the sun to power operations while cutting the project’s carbon footprint.
 - And more is happening at Boron: Drawing on its longstanding partnership with DOE’s CMI, Rio Tinto [has begun producing](#) battery-grade Lithium at a demonstration plant located at the operation using a new extraction process developed on-site. As part of the company’s [full-value mining strategy](#), the global miner seeks to recover Lithium out of waste piles stemming from more than 90 years of mining at the site.
 - Barrick Gold Corporation is looking to [reprocess tailings](#) at the currently-closed Golden Sunlight Mine in Montana. The project would focus on removing and concentrating sulfur (iron pyrite) —a source of potential water pollution from the mine site. The sulfur would then be sold to and used in gold production by Nevada Gold Mines (NGM). According to Barrick company statements, the combination of rehabilitation with value creation would serve as a model for Barrick’s future mine closures.

Of course, more can and should be done. But, as Secretary Granholm [told](#) U.S. Senators:

“This is the United States. We can mine in a responsible way. And many places are doing it. And there are some places where there are more challenges, but we can do this.”

100-Day Supply Chain Report — Striking a Balance Between Strengthening Domestic Resource Development and Cooperation with Allies

In its 100-Day Supply Chain Report, the Biden Administration has committed to an “*all of the above*” approach to Critical Minerals — a “*wrap-around strategy*” that includes recycling, substitution, as well as new mining, as Secretary of Energy Jennifer Granholm [told](#) U.S. Senators in June of 2021.

While investing in “*sustainable production, refining, and recycling capacity domestically,*” the Administration [will also](#) seek to “*diversify supply chains away from adversarial nations and sources with unacceptable environmental and labor standards*” by working closely with allies and partners.

With recent studies having made clear that the global shift towards a green energy future will require massive material inputs, it makes sense to see the goal of decoupling from “*adversarial nations*” like

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China in a North American context. U.S. domestic production and processing can and should be strengthened, but we are in the fortunate position to also leverage close relations with allied nations. Enter Canada — a resource-rich nation that is not only on our doorstep, but the linkage with which legally codified, at least in terms of national defense.

As ARPN's Daniel McGroarty [outlined](#) in a piece for Investors' Business Daily:

"The linkage [between the U.S. and our neighbors to the North] is enshrined in U.S. and Canadian law. Unlike any of America's other allies, Canada has long been part of a special relationship, linking the two country's defense industrial bases as one.

The defense union dates back to the months preceding America's entry into World War II: In 1941, FDR and Canadian Prime Minister Mackenzie King agreed to allow American-made war materiel produced in Canada to flow to embattled Britain under Lend-Lease. As the war wore on, Canadian aluminum production ramped up at the massive Saguenay, Quebec, complex, eventually accounting for 40% of all allied aluminum production.

U.S.-Canada industrial collaboration continued through the Cold War and beyond. Twenty-five years ago, the U.S. federal code formally recognized Canada as a part of the U.S. National Technology and Industrial Base (NTIB) for national security and defense planning purposes.

As a result, our two countries share the world's most integrated defense industrial base. And in a nod to our long alliance, the Canadian air base at Bagotville, Quebec — built in 1942 to protect the aluminum production facilities during World War II — is today part of the joint U.S.-Canadian North-American Air Defense network, better known as NORAD."

While as such, our relations with Canada will be the most natural fit for Critical Mineral resource cooperation, the U.S. also has a strong ally in Australia, with whom the U.S. has also entered into cooperative agreements, and will be able to leverage another framework for allied cooperation — the National Technology Industrial Base (NTIB). Originally established to strengthen technology links between the U.S. and Canada in 1993, and which was expanded in 2016 to include the United Kingdom and Australia.

As ARPN's McGroarty [noted in an opinion piece for The Hill](#) in 2018, when discussing the findings of the DoD's then-released Defense Industrial Base report:

"This four-country economic colossus — with a combined GDP of more than \$25 trillion — constitutes a vast reservoir of economic might to draw on for collective national security. With defense technology driven by the rapid development of materials science, the four NTIB nations also host production or known resources of all 35 of the minerals and metals on the U.S. Government's newly-established Critical Minerals List. As the DIB report notes, Congress has ordered 'DoD to [develop] a plan to reduce the barriers to the seamless integration across the National Technology and Industrial Base.' Given the dangers of what the Pentagon Report calls China's 'economic aggression,' it's time to put this integration into overdrive."

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Strengthening domestic resource production as well as processing and closer cooperation with our friends and allies should not be considered mutually exclusive strategies. Striking the right balance will be key as the Administration moves forward to implement the recommendations from its 100 Day Supply Chain Report.

What ARPN's McGroarty [told](#) members of Congress about a decade ago still rings true today:

"We cannot maintain our modern economy without a steady supply of metals and minerals. Those we do not possess here at home, we must source from other countries. But those we possess but choose not to produce perpetuate a needless foreign dependence – leverage that other [adversarial] nations may well use to America's disadvantage."

VIII. The Continuing Challenge

Caught in the “Green Dilemma” of Securing Critical Mineral Resource Supply Chains

A few months ago, when the Biden Administration stepped up its efforts to promote its ambitious renewable energy agenda, Forbes analyst David Blackmon [suggested](#) that we might be about to “witness a replay of the politics of the Shale Revolution, only this time those politics will be playing out around the mining of the country’s own supplies of rare earth minerals.”

Blackmon argued that with the green energy transition requiring vast amounts of Critical Minerals, sparks would “inevitably fly when the traditional priorities [of the anti-development green lobby and the politics that push a rapid net zero carbon transition] collide with realities on the ground.”

It appears we have reached that moment.

With the release of its 100-Day Supply Chain Report, the Biden Administration embraced an “*all of the above*” approach to Critical Mineral resource security. Against earlier concerns that it would pursue a more selective strategy, this approach [encompasses](#) both investing in “*sustainable production, refining, and recycling capacity domestically,*” AND working to “*diversify supply chains away from adversarial nations and sources with unacceptable environmental and labor standards*” by cooperating closely with allies and partners.

A recent Financial Times [story](#) outlines the “*green dilemma*” the Administration is facing as it pushes to build out the United States’ Rare Earths capacity. Pointing to negative reactions towards a recent announcement that Lynas, an Australian Rare Earths company, had received a \$30m U.S. Government grant to open a new processing facility with U.S. company Blue Line in Texas, the Financial Times story says it illustrates the dilemma President Joe Biden is facing: “*while rare earths such as cerium and yttrium are needed for green technologies, the mining and processing to obtain them, which takes place mostly in China, has a reputation for being polluting and environmentally damaging.*”

As the piece points out, the United States currently only has one operational Rare Earths mining site — and no processing capacity, so that currently Rare Earth concentrate sourced in California [has to be shipped to China](#) for processing.

To meet soaring demand and develop supply chains that are not reliant on adversary nations, both new domestic mining and processing capabilities should be boosted, but, as one mining executive quoted in the FT piece put it, while domestic — responsible — mining would be preferable to outsourcing it to China, “[e]nvironmentalists want to have their cake and eat it. They want these materials for the EV sector — but if they’re causing environmental devastation [in China], then how are you going to put them into green technologies?”

The FT piece points to public private partnerships funded by the Department of Energy and the Pentagon to develop new technologies and methods that would extract and process Rare Earth Elements from existing mining waste. However, while that is a welcome development, “*recycle, reuse and substitute*” can only be one part of a comprehensive “*all of the above*” strategy, because the material inputs required to achieve a net zero carbon transition are simply too immense.

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Caught in the “*green dilemma*,” the Biden Administration, according to a consultant cited by the Financial Times, will deny funding to companies that do not have an “*environmental element*” — this would be a “*non-starter*.”

The good news is that the mining industry of today is not your grandfather’s industry anymore, and has “*recognized [its] responsibility and [is] trying to meet the increased expectations of consumers, society and governments*” to contribute towards the push towards a greener energy future.

As such, the industry has increasingly been harnessing advances in materials science and technology to meet the challenge of developing a domestic Critical Minerals supply while maintaining and advancing responsible mining practices — current examples of which can be found [here](#).

As we have previously [stated](#):

“Recent studies — we featured the latest IEA study [here](#) — and [policy experts agree](#): against the mounting pressures of the 21st Century [Tech Metals Age](#), keeping it all in the ground is too simplistic, and a holistic ‘all of the above’ approach to energy and Critical Minerals is the only viable path to success.”

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