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Getting De-risking "Just Right" on Critical Minerals and Battery Supply Chains

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ABSTRACT

China has come to dominate both the critical minerals space and wider supply chains for the clean energy transition including batteries for electric vehicles and solar panels. With rising geopolitical tension between the two countries, U.S. policymakers have described these not only as risks to the U.S. economy and manufacturing but also as threats to U.S. national security. There are four different dimensions of national security that policymakers have flagged at different points in time with respect to China's domination of supply chains for critical minerals and battery supply chains. The first has to do with *dual use technologies* that have both civilian and military applications. The second involves risks of *coercion* by resource holders. The third speaks to *cybersecurity risks to critical infrastructure* and beyond. The fourth, a new issue, deals with the risks to the *commanding heights* of the economy being dominated by a peer competitor. This memo surveys these four categories of national security risks and draws preliminary conclusions about the merits of these claims.

INTRODUCTION

"We need to end our long-term reliance on China and other countries for inputs that will power the future. And I'll use every tool I have to make that happen. Yes, building a made-in-America clean energy future will help safeguard our national security." - **President Joe Biden**[1]

Through concerted efforts and government support, China has come to dominate both the critical minerals space and wider supply chains for the clean energy transition including batteries for electric vehicles and solar panels. With rising geopolitical tension between the two countries, U.S. policymakers have described these not only as risks to the U.S. economy and manufacturing but also as threats to U.S. national security.

But what they are precisely worried about is not always clear. There are four different dimensions of national security that policymakers have flagged at different points in time with respect to China's domination of supply chains for critical minerals and battery supply chains.

Three of these logics have already been identified by the academic literature. The first has to do with *dual use technologies* that have both civilian and military applications. The second involves risks of *coercion* by resource holders. The third speaks to *cybersecurity risks to critical infrastructure* and beyond. The fourth, a new issue, deals with the risks to the *commanding heights* of the economy being dominated by a peer competitor. It is useful to unpack each of them.

A year or two ago, there were casual invocations of the decoupling of US and China's economies from each other. However, the policy conversation has evolved, as the Biden administration has realized that complete decoupling is neither feasible nor desirable. The conversation now has more to do with de-risking the relationship through diversification of supply chains to include more "on-shoring" (domestic production) and "ally-shoring" (sourcing from friendly countries) of supplies.

[1] (Biden 2022).

This suggests that there has to be a more nuanced conversation about where it is appropriate and where it is not appropriate for there to be Chinese involvement in these supply chains, on national security grounds. While there may be overlapping economic and domestic political rationales for de-risking, national security rationales may be asserted, even in the absence of compelling reasons, because this may reinforce demands for rejecting specific projects or associations. National security rhetoric has the power to silence other competing concerns.

Years ago, former Secretary of Defense Robert Gates suggested that the approach to national security and exclusion from U.S. market participation for potential rivals ought to be one of a "small yard, high fence" for which only a handful of critical areas are subject to export controls. Analysts have applied that concept to China, both for export controls but also in thinking about which technology sectors might be subject to limits for Chinese imports and investments.[2] In recent years, the yard of potentially excluded products has grown larger, beyond areas such as weapons systems, mobile communications,[3] and high-end semi-conductors[4] to batteries,[5] port equipment,[6] and electric vehicles.[7]

The risk is of an ever-expanding yard. While some restrictions may be justified, critics worry that overzealous use of restrictions on national security grounds may slow down the energy transition by adding to the costs.[8] The headline from one piece criticizing restrictions on electric vehicles captured this sentiment, "China Hawks Are Putting the Green Transition at Risk."[9]

Since runaway climate change itself is a national security threat, these concerns are worth taking into consideration. Moreover, interdependence between the United States and China may also function as a firebreak that limits either parties' willingness to go to war, whether it be about Taiwan or something else. For interdependent economies, there are huge potential costs to both sides of a further rupture in their relations.

In practice, what constitutes a national security risk with respect to minerals and battery supply chains may be partially resolved by the emergent rules over Foreign Entity of Concern (FEOC) requirements for access to the Clean Vehicle Credits under the Inflation Reduction Act.[10] But, that guidance itself may be tested when it comes to individual projects when the U.S government will rule on whether those projects meet or fall foul of the criteria for eligibility for tax credits. Additional principles will likely need to be applied to determine whether projects that have some connection to China are still eligible for tax credits. Moreover, not all projects and associations will necessarily be applying for tax credits but could be charged with being seen as national security risks, whether real or imagined.

This memo surveys the four oft-mentioned national security risks, what we know about them, with preliminary judgments as to the relative merits of those claims.[11]

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[2] (Shirk 2018).
[3] (BBC 2022).
[4] (Harris 2023).
[5] (Lawrence 2023).
[6] (LaRocco 2024).
[7] (Tankersley 2024).
[8] (Davidson et al. 2022).
[9] (Brunelli and Moerenhout 2023).
[10] (Internal Revenue Service 2023)
[11] Elsewhere, I have explored these themes in (J. W. Busby and Orszag 2023; Busby, Joshua W. 2023).

National Security Risk 1: Dual Use Technologies

"The Department of Defense should not be dependent on foreign adversaries like China for resources needed to make equipment and ammunition that are essential to our combat readiness and warfare capabilities." - **Senator Gary Peters**[12]

Dual use technologies focus on products, patents, or services with commercial, academic, or non-security intended purposes that can also have military application. Here, the concern is that in the event of a conflict with China, the United States will not be able to import materials necessary to make weapons or equipment that might be essential for a military victory.

The historic parallel that analysts have drawn attention to is the rubber shortage in World War II where Japan cut off access to almost all of U.S. natural rubber supplies.[13] According to the economic historian Alexander Field, that shortage delayed the Normandy invasion by a year as the United States scrambled to repurpose civilian sources of rubber and spin up synthetic alternatives.[14]

In the minerals and batteries space, lithium ion batteries increasingly have military uses from handheld radios to unmanned submersibles with future uses in next generation lasers, directed energy systems, and hybrid electric tactical vehicles. In March 2022, the Biden administration designated five key minerals for batteries as eligible for support through the Defense Production Act, including lithium, graphite, nickel, cobalt, and manganese.[15]

China dominates the minerals space, not so much as the upstream source of minerals but in the minerals processing, core parts production, and the supply of finished batteries. In 2022, China sourced 13% of global lithium supplies but processed 44% of lithium chemicals, sourced less than 1% of cobalt but processed 75% of global cobalt supplies, sourced 18% of refined nickel but 69% of nickel sulphate, 8% of raw manganese supplies but 95% of refined manganese, and 64% of mined graphite but 100% of spherical graphite. China controlled 78% and 91% off cathode and anode production respectively and 70% of battery cell production.[16] China also dominates refining and export of so-called "rare earth" minerals, which have uses in electric vehicles, magnets, among other purposes. While these data reflect the overall global portrait, U.S. demand largely for these materials largely reflects this dependence on Chinese inputs.

In the event of a conflict with China, not only would imports from China be disrupted but wider trade networks for imports from Asia (but potentially beyond) could be delayed or disrupted with contested sea lanes.

In their assessment of dual use national security risks associated with clean energy technologies (carbon capture, green steel, solar photovoltaics, wind, and batteries), Davidson et al. concluded that the dual use risks were low, except for batteries which they judged to be medium given some high-performance military applications.[17]

[12] (Maxfield 2023).
[13] (Reiss 2024).
[14] (Field 2022, 142)
[15] (J. Busby et al. 2023).
[16] (Benchmark Source 2022).
[17] (Davidson et al. 2022).

However, as they recognize, minerals used in the production of clean energy technologies also have other military applications beyond the batteries space. In addition, minerals other than those used in clean energy technologies are relevant for defense purposes.

Which minerals or materials should thus be of highest priority from a dual use national security perspective?

Every three years the US Geological Survey (USGS) develops a list of critical minerals.[18] That list has expanded from 35 minerals in 2018 to 50 items in 2022. The list includes the five key minerals for batteries but other minerals which have uses in military equipment such as lanthanum in night vision goggles, beryllium in targeting and surveillance systems, and titanium in aerospace components.[19]

The criteria for the USGS list include global concentration of supply, U.S. dependence on imports, and important economic sectors with relatively high expenditures on minerals.[20] The USGS assessment notably does not include embodied metals in final finished products, which may substantially understate the risks to the U.S. economy or national security.[21]

The Defense Logistics Agency (DLA) has its own list of "materials of interest," 45 of which overlap with the USGS list. The DLA list includes some 17 materials not on the USGS list, including copper, boron, and lead.[22]

Cullen Hendrix in his assessment questions the efficacy of devising a coherent approach to 67 different materials. He writes: "As the saying goes, if you have more than three priorities, you have no priorities."[23] He suggests that a more focused process for identifying mission critical gaps where small investments could make a difference would be productive. In so doing, the current policy emphasis on minerals for the clean energy transition might not be warranted, as markets for those minerals are comparatively larger than for other materials such as gallium.

Gregory Wischer provided an attempt to narrow the list of militarily important minerals,[24] drawing first on a 2009 study of the "standard materials" that the Department of Defense regularly uses to purchase weapons.[25] From that list, he identified 23 of which were deemed "critical materials" by the Department of Energy. The DOE critical materials list combines 18 materials deemed important for the clean energy transition "the electric eighteen" and the 2022 USGS list of 50 critical minerals.[26] Most of the electric eighteen are already on the USGS with the exception of copper, silicon, and silicon carbide.

Wischer then sought to further parse the list to see which materials would likely be in short supply in the event of three conflict scenarios with China, with different assumptions about likely demand for minerals, drawing on past consumption/production levels as well as current stockpiles of minerals. In the first scenario, minerals consumption in a warfight with China mirrored 2009 levels of consumption and production and 2022 levels of strategic stockpiles. He

[18] (U.S. Geological Survey 2022).
[19] (Bazilian, Holland, and Busby 2023).
[20] (Nassar and Fortier 2021).
[21] (Humprhies 2019).
[22] (Defense Logistics Agency n.d.).
[23] (Hendrix 2023).
[24] (Wischer 2023).
[25] (Institute for Defense Analysis 2009).
[26] (U.S. Department of Energy Undated).

identified six “high risk” materials for shortfalls where consumption would outstrip production and stockpiles, including bismuth, cobalt, two kinds of fluorspar, iridium and titanium sponge. The other scenarios had a slightly different composition of at-risk materials.

However, in separate conversations, he noted that the 2009 list is based on usage patterns of minerals based on military needs circa 2008/2009 when the U.S. was involved in ground combat operations in Iraq and Afghanistan. The kinds of heavy materials munitions and equipment needs such as MRAPs from that era are likely quite different from those needed in a maritime conflict with China where needs might be attack submarines, long-range bombers, mobile missile launchers, and munitions like torpedoes, standoff missiles, and long-range missiles and rockets.[27]

This discussion is indicative of the kinds of analysis both Hendrix and Wischer suggest the U.S. government should be regularly supporting, if it is not already. As both acknowledge, the U.S. government has reasons to keep details of these perceived vulnerabilities classified, but both see more public transparency as providing defense contractors and agencies across the U.S. government information signals on key gaps and how to fill them.

Both Hendrix and Wischer are on some level privileging the minerals needs associated with a China conflict as the paramount security concern to prepare for, which is likely consistent with how the Department of Defense sees the imperative (at least looking beyond supporting Ukraine in the current conflict with Russia).

However, if one sees the climate problem as an existential national security risk in the long-run, then prioritizing access to minerals and materials for the clean energy transition has an independent security logic of its own. That makes a narrow focus on mission critical gaps for the China warfight which hopefully will not happen less compelling than the climate security threat which is happening and will get worse without a move to zero carbon energy sources. Perhaps the Administration’s long list of critical minerals which includes key minerals for batteries and others essential for warfighting reflects this reality that both threats command serious attention.

National Security Risk 2: Energy Security/Coercion

“Clean-energy supply chains are at risk of being weaponized in the same way as oil in the 1970s, or natural gas in Europe in 2022.” - **National Security Advisor Jake Sullivan**[28]

As part of tit-for-tat trade responses to U.S. restrictions on semi-conductors, China demonstrated its willingness in 2023 to use its control of mineral supply chains to impose costs on the U.S. by subjecting exports of germanium, gallium,[29] and graphite[30] to new restrictions, starting with more burdensome paperwork and licensing requirements. Graphite is a critical component in anodes in batteries, and both germanium and gallium are critical metals in semiconductors, which are widely used in energy systems but of course have wide uses.

These efforts underscore the potential risks to energy security from economic coercion, what scholars Henry Farrell and Abe Newman have termed “weaponized interdependence.”[31]

[27] Personal communication, March 26, 2024.
[28] (Sullivan 2023).
[29] (Ziady and Xu 2023).
[30] (Benson and Denamiel 2023).
[31] (Farrell and Newman 2019).

Countries can use their privileged nodal position in markets to seek to extract political concessions from partners.

In the energy space, analysts frequently reflect, as National Security Advisor Jake Sullivan did, on the experience of OPEC's actions in the 1970's or Russia's more recent efforts to try to strategically withhold gas exports during critical moments to neutralize opposition to its actions.

While Davidson et al. classify these risks of coercion as economic rather than national security risks, policymakers treat energy security as a national security concern, not least of which to provide energy resources to support their militaries but more broadly to sustain a country's economy and way of life. Japan's willingness to bomb Pearl Harbor in 1941 or the U.S. response to Saddam Hussein's invasion of Kuwait in 1990 would not make much sense if energy security were merely an economic issue.

The relevant questions with respect to critical minerals and batteries is whether China could or would seek to use its privileged market position as the primary mineral processer and battery maker for the world as a source of leverage. Would China want to threaten to withhold or impose export restrictions on these products? And, if so, what effect would these actions have? We already have a provisional answer as to their willingness based on the new licensing restrictions for germanium, gallium, and graphite. China's efforts in the early 2010's to use "rare earths" as a source of leverage against Japan is also often-cited as an instructive example.

Whether these moves will have their desired impact is another story. As analysts have noted, fossil fuel energy systems are inherently more vulnerable to these forms of coercion than clean energy systems.[32] Fossil fuel systems require constant resupply of fuel stocks, lest there be crippling blackouts, heating outages, and gasoline rationing. By contrast, disruptions to exports of clean energy supplies mostly affect future production of additional energy (and repairs to existing systems), with existing energy systems unaffected by said controls.

As Jason Bordoff and Meghan O'Sullivan wrote: "But inputs for clean energy products that produce or store energy are not the same as the energy itself. If China did restrict exports of solar panels or batteries, the lights would not go out."[33] Indeed, Davidson et al. note that greater availability of low-cost renewables and other green technologies from China insulates countries from energy security risks from volatile fossil fuel markets.[34]

That said, there are risks other than energy security associated with such coercion. Germanium is used in infrared devices and solar panels on military satellites.[35] Gallium is used in semiconductors that are components in missile guidance systems, cyberwarfare, and artificial intelligence capabilities. China is responsible for about 98% of raw gallium production and 68% of germanium processing.[36] Thus, on some level, disruptions in these supplies could undermine military effectiveness, which reduces the coercive risk to the one associated with dual use technologies.

However, here the evidence on China's experience with rare earths with Japan suggests minerals coercion is unlikely to be successful. Given Japan's degree of dependence on China,

[32] (Davidson et al. 2022).
[33] (Bordoff and O'Sullivan 2022).
[34] (Davidson et al. 2022).
[35] (Bazilian, Holland, and Busby 2023).
[36] (Rao 2023).

scholars Eugene Gholz and Llewelyn Hughes deemed that episode as a most likely case for successful coercion, but they argue Japan was able to diversify sources and modify production processes relatively quickly to encourage substitutes and recycle existing supplies.[37] This adjustment wasn't inevitable or automatic but, as Farrell and Newman argue, required a capable government bureaucracy with both key officials and strategy positioned to safeguard the country's economic security.[38]

Similarly, analysts believe China's efforts with respect to gallium and germanium are also unlikely to succeed. Neither mineral is that hard to find, as gallium is often extracted as a by-product as bauxite is refined into aluminum.[39] Germanium can be extracted as by-product of zinc, lead, or coal mines. Tim Worstall wrote: "With germanium and gallium, China's export ban will again cause a several year blip, nothing more." In the meantime, Western countries can build up alternative sources, particularly processing facilities which is generally the major advantage the Chinese enjoy.[40]

Already, these moves by China are just further incentivizing the U.S. government to prioritize de-risking, both through enhanced support for processing, such as the graphite processing facility on the Gulf Coast of Louisiana that DOE is supporting with $102 million dollars,[41] as well as ally-shoring of new minerals supplies as the U.S. is using the Minerals Security Partnership and other actions to try to source graphite from Africa,[42] including $150 million from the Development Finance Corporation to support a graphite mining project in Mozambique.[43]

While these metals and inputs are relatively minor parts of U.S. energy systems, disruptions may be reasonably manageable, but when these materials become more ubiquitous like semi-conductors, a supply chain disruption could have more deleterious consequences. The COVID-related supply chain disruption in 2021 was estimated to cost the U.S. economy some $240 billion.[44]

In terms of energy systems, what impact on energy systems would a disruption in supply chains have in 2040 or 2050 when batteries are as ubiquitous as chips and if the U.S. lacks its own mining/processing capability and if supplies from friendly countries is foreclosed? In those circumstances, necessary repairs and outages to battery storage might have to be postponed while minerals and materials are diverted from the civilian economy to support defense applications. Indeed, the operational impacts on military capability presumably would be more severe and urgent as battery-related systems in military applications become more common (though how common is subject to wide uncertainty).[45]

It should also be mentioned that when arguments about China's potential economic leverage are made, they mostly emphasize U.S. vulnerability to Chinese pressure, but China has become a major importer of natural gas from the United States, which it has used to deal with price volatility in the wake of Russia's invasion of Ukraine.[46]

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[37] (Gholz and Hughes 2021).
[38] (Farrell and Newman 2023).
[39] (Rao 2023).
[40] (Worstall 2023).
[41] (U.S. Department of Energy 2022).
[42] (U.S. Department of State 2024a).
[43] (Burkhardt 2023).
[44] (Villafranca 2022).
[45] (Bashian 2023).
[46] (Hui 2023).

As noted earlier, deep trade ties between the two countries provide an incentive to both countries to prevent conflicts from escalating to a war that would be incredibly costly. At the same time, the U.S. may possess some leverage with respect to gas exports to China. The U.S. accounted for 43% of Chinese LNG sales and purchase agreements in 2021 and 2022.[47] Given the nature of the resource, China's energy security thus is inherently more vulnerable to U.S. coercion than U.S. energy security is to Chinese coercion.

National Security Risk 3: Cybersecurity and Critical Infrastructure

"The growing presence of CATL and other Chinese products in U.S. infrastructure is concerning, but it is inexcusable on U.S. military installations…. The CCP's pattern of espionage leaves little room for doubt that CATL products pose a threat to national security at any base where they are installed." - **Senator Marco Rubio**[48]

In March 2023, US Marine Corps Base Camp Lejeune had a ribbon cutting ceremony for their new battery energy storage system (BESS), built by Duke Energy which connected with the installation's current solar power infrastructure to enhance the base's energy resilience. However, by December 2023, the new BESS was shut down due to concerns over infrastructure vulnerabilities from equipment from the Chinese company known as CATL.[49] Contemporary Amperex Technology Company (CATL) has dominated the battery industry, playing an essential role in the electric vehicle sector. CATL is the primary supplier for Tesla EVs and has partnerships with General Motors, Volkswagen, BMW, and Volvo.

As a Chinese company that is closely aligned with the CCP and the CCP-led All-China Federation of Industry and Commerce (ACFIC), lawmakers believe CATL batteries could be used to install malware, phishing, ransomware, in battery-powered technologies. As examples, CATL could gather sensitive data on owners, disable targeted vehicles, or shut-down charging and energy storage stations causing blackouts affecting critical infrastructure sectors. CATL dismisses allegations from US lawmakers, arguing their batteries do not collect, sell, or share information or interact with the grid.[50]

Nonetheless, the risks of cyberattacks to critical infrastructure has become a more salient concern in light of the Colonial Pipeline cyber attack of 2021 where a ransomware attack shut down an oil pipeline for nearly a week.

Because clean energy systems are networked, there are fears that renewables and even electric vehicles could be subject to cyberattacks or exploited in other ways through hidden backdoors. How seriously we should treat these risks?

From a cyber-security perspective, a prominent analyst we spoke with suggested that there is a continuum of risk with respect to clean energy systems. On the lower risk side are solar panels, which are relatively "dumb computers," even though they are tech-infused with semiconductors.[51] Because they aggregate up into inverters and controllers, those can serve to mitigate risk, so the risk-reward favors continued reliance on Chinese supply chains, because

[47] (Hui 2023).
[48] (Kearney 2023).
[49] (Colthorpe 2023).
[50] (Colthorpe 2023).
[51] Personal conversation with a senior Biden Administration cyber-security expert, February 22, 2024.

the lower cost of Chinese solar panels will allow the U.S. continue to deploy clean energy quickly.

On the high risk side is cloud management software for distributed energy, which determines who controls distributed energy environments. The United States should have high confidence in those systems. In terms of battery storage, their specific risks may be less well understood, but they potentially pose higher risks than solar panels because they have battery management software and hardware. Since these devices can provide electricity to the grid and receive electricity, a mistimed withdrawal or addition could pose problems. However, because these are commoditized, they might be more subject to standardization and any hidden backdoors more easily detectible. The risks posed by a battery supporting a military base's electricity may be trickier to assess, but the optics do not look good.

The Cybersecurity and Infrastructure Security Agency (CISA) identifies 16 critical infrastructure sectors considered 'so vital,' that 'their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.' These critical infrastructure systems consist of: Chemical, Commercial Facilities, Communications, Critical Manufacturing, Dams, Defense Industrial Base, Emergency Services, Energy, Financial Services, Food and Agriculture, Government Facilities, Healthcare and Public Health, Information Technology, Nuclear Reactors, Materials, and Waste, Transportation, Water and Wastewater.[52]

For their part, Davidson largely et. al dismiss some of these concerns associated with critical infrastructure and clean energy technologies, given their low system-wide impacts. Only in the wind power sector do they consider these risks to clean energy to have a medium risk.[53] This discussion begs the question whether there are key nodes that could be subject to backdoor hacking or meddling. The possibility of micro-level local scale disruptions to services would seem not to rise to the level of national security risks, but this seems like an area where more deliberate study is warranted.

The Biden administration also recently evoked potential national security risks associated with imported Chinese electric vehicles. While vehicles themselves are not critical infrastructure, the rationale – of supposed cyber-risks – is similar. In February 2024, President Biden ordered the Commerce Department to conduct a study to assess the risks from Chinese vehicles to national security, based on fears these vehicles could send sensitive operating information to China or even be remotely disabled.[54]

Commerce Secretary Gina Raimondo raised the specter of China remotely disabling vehicles en masse: "Imagine if there were thousands or hundreds of thousands of Chinese-connected vehicles on American roads that could be immediately and simultaneously disabled by somebody in Beijing."[55]

In 2019, the U.S. Congress previously invoked cybersecurity concerns among other issues when it imposed restrictions on federal funding for the Chinese automaker BYD for municipalities that wanted to buy the company's electric buses.[56]

[52] (Cybersecurity and Infrastructure Security Agency n.d.).
[53] (Davidson et al. 2022).
[54] (Tankersley 2024).
[55] (Hanley 2024).
[56] (Duncan 2021).

What to make of these concerns? The Chinese for their part have restricted Teslas from military bases, as well as certain transportation corridors, including airports, industrial zones, and sporting events.[57] This could merely be tit-for-tat escalatory protectionism that makes both countries worse off.

While these moves are ostensibly about cybersecurity risks, BYD in 2024 recently released a low cost EV that sells for about $11,000 in China.[58] Even with the current 27.5% tariff, it might be economical for Americans to buy these cars, though Chinese carmakers do not have much if any presence in the U.S. as of early 2024. However, building these cars in Mexico, a free trade partner of the United States, would allow those cars to be imported in to the U.S. without tariffs and potentially make them eligible for some of the tax credits under the IRA.[59] A finding from the Commerce Department that Chinese cars pose a national security risk might be a way to trump these rules. In any case, the move arguably may have more to do with protecting the U.S. automobile sector than cybersecurity, which may have a separate national security logic, what we call the commanding heights.

National Security Risk 4: Commanding Heights

"China's rise in power is aided by its monopolization of raw materials and we're putting our national security and economic vitality at risk by relying on countries like China for critical minerals." - **Senator Mitt Romney**[60]

What is old is new. The notion of "commanding heights" of the economy, of strategically important sectors that states want to sustain, was ridiculed as an artifact of a bygone era of heavy state intervention in Western economies and the failed policies of communism in the Soviet Union.[61]

However, China's success and ability to change its source of comparative advantage through patterns of state subsidy and investment and dominate whole industries has changed the conversation, particularly in an era when the market alone will not deliver the clean energy transition as quickly as is required to avoid dangerous climate change.[62]

Industrial policy, the intentional efforts by states to support certain industries and discourage others, has become integral to efforts to hasten the clean energy transition.[63] Alongside that change is the COVID-era realization that globalization wrought undesirable supply chain vulnerabilities that could only be addressed with more on-shoring and ally-shoring of production and exchange.

The material basis of state power is partially military and partially economic. Economic power is fungible into military capability. States have an interest in nurturing strategically important sectors that can generate wealth to finance their militaries. In the push to globalization of the last forty years, markets were left to decide what economic sectors would be profitable, but the

[57] (Westbrook 2024).
[58] (Matthews 2024).
[59] (Hanley 2024).
[60] (Maxfield 2023).
[61] (Yergin and Stanislaw 2002).
[62] (Meyer 2024).
[63] (Roberts 2024).

multinational companies that made those decisions were loyal to themselves and their profits rather than the welfare of the citizens or the tax basis of states.

States are now seeking to reclaim a more explicit role in directing which industries to attract and support, to generate tax revenue to pay for services, to provide good employment, and to support other public purposes such as environmental sustainability. For the Biden Administration, this "foreign policy for the middle class" is the embodiment of this revived role for the federal government with Bipartisan Infrastructure Act, the Inflation Reduction Act, and the CHIPS Act among the legislative drivers to enact that vision.[64]

The notion that some sectors are more strategically important than others requires justification, lest it become a "get out of jail free" card to justify protection of national industries at the expense of foreign competition. Such moves might ultimately be self-defeating if a country, even with aggressive subsidies and protection, cannot generate a viable industry.

Industries that produce components and inputs that generate military capability have stronger claims of being strategically important. This includes aviation and ship-building but is also a major reason why the U.S. Congress and the Biden Administration supported the CHIPS Act, with semi-conductor chips having so many military applications. Having high-end chip manufacturing concentrated in in a single company in Taiwan or advanced lithography from a single supplier from Netherlands was seen as a strategic vulnerability, enough to warrant a $53 billion government investment.[65]

It is not clear that supply chains for batteries have quite this degree of sole supplier industry concentration (and industry concentration figures for batteries and minerals are not easy to find). Chinese dominance of batteries and solar technology is relatively recent, driven by state action. Moreover, the scale of those industries is only a small fraction of what those industries will ultimately become.

If more sectors of the economy (the power sector and transportation to start) electrify, then batteries will become cornerstones of the 21st century economy in the way that chips were in the 20th century. While there may be other industries that emerge as core economic sectors and sources of productivity, battery production and electric vehicles will certainly be among them.

The lithium-ion battery market was valued at $56.8 billion in 2023 with growth by one estimate expected to rise to nearly $187.1 billion in 2032.[66] Similarly, the global solar photovoltaics panel market was nearly $184.9bn in 2021 and estimated to grow to almost $300 billion by 2028.[67]

The global EV market in 2022 was valued at $425 billion in 2022, capturing 14% of new vehicles sales with 60% of those sales in China.[68] By one IEA forecast, as much as 35% of new car sales could be electric by 2030.[69] Bloomberg NEF projects EV sales will be $8.8 trillion by 2030 and $57 trillion by 2050.[70] While China's internal sales may account for a large proportion of

[64] (Sullivan 2023).
[65] (The White House 2023b).
[66] (Marketsandmarkets 2023).
[67] (Skyquest 2022).
[68] (International Energy Agency 2023).
[69] (McCarthy 2023).
[70] (Scott et al. 2023).

that, rising EV demand around the world will be a major source of economic dynamism in countries that manage to export these vehicles.

Ceding most of these markets to international actors, primarily China, would mean the United States would forgo revenue from a major growth industry. Once these industries are as pervasive as chips, the United States could face more systemic risks in the event of a disruption in supply chains. Most important, it would be comparatively poorer than it otherwise might be, though that might be difficult to quantify with any economic precision, as other sectors such as artificial intelligence also might generate growth and profits.

In international relations speak, China's domination of solar, batteries, and cars would confer large relative gains with which China could finance military expenditure.[71] From a geo-strategic competitive perspective, that would allow China to close the gap in military capability with the United States and perhaps contribute to an even more dangerous power transition moment.

However, it is one thing to say that the U.S. needs to have mining, processing, and manufacturing capacity all along the battery supply chain and an automobile industry, it is another to exclude Chinese minerals, parts, and finished products from the U.S. market (or U.S. companies with connections to Chinese firms from eligibility for any tax credits associated with the Inflation Reduction Act).

In February 2023, Ford and the Chinese battery manufacturer CATL announced a licensing agreement to build lithium iron phosphate (LFP) batteries in Michigan at a new $3.5 billion plant.[72] That agreement came under criticism for Chinese involvement, including investigations by two Congressional committees. In the midst of labor action, Ford announced a pause on the plant in September 2023.[73] In November 2023, in light of rising costs and softer demand for EVs, Ford said it would proceed but scale back its investment to $2 billion.[74] One of the open questions was whether it would be eligible for tax credits given Chinese involvement, with the draft rules on foreign entities of concern at the time still pending.

While there may be questions about this particular project, it cannot be that any Chinese involvement is necessarily incompatible with U.S. interests or even eligibility for tax credits. In this case, CATL had expertise in building LFP batteries with a new lower cost battery chemistry. It wasn't clear that Ford had this expertise. Thus, one principle for Chinese involvement in projects ought to be whether American manufacturers can learn valuable knowledge, in the same way that China used domestic content rules with foreign firms to gain expertise.

Implications for Policy

In our assessment, the most serious national security risks associated with minerals dependence are dual use technologies and commanding heights, with coercion/energy security and cyber risks more attenuated.

[71] (Grieco 1988).
[72] (Wayland 2023a).
[73] (Korosec 2023).
[74] (Wayland 2023b).

If decoupling is both infeasible and undesirable, what are the decision rules that should guide whether Chinese firms should be eligible to export to, invest in, or collaborate with U.S. actors with respect to minerals and the clean energy transition.

First, the U.S. needs a better understanding of the nature of the dependence and to what extent the U.S. is reliant on sole suppliers or whether a limited number of Chinese firms have a large market share. Where the aggregate dependency is high and the number of firms is low, the U.S. has, ceteris paribus, some incentives to on-shore or ally-shore.

Second, the U.S. needs a better understanding of the specific stakes associated with dependence on Chinese suppliers. In terms of dual use, what are the uses associated with those minerals or markets for which there is high market concentration? If they are mission critical for a warfight, there are strong incentives to diversify. In terms of critical infrastructure, could the technology be hacked/backdoored in a way that large numbers of users could be simultaneously affected with no means of mitigating those risks? Where these risks cannot be attenuated, there are stronger incentives to diversify. In terms of commanding heights, how large is the potential global market? The larger the market, the stronger the incentive to on-shore.

Third, do Chinese firms possess advanced technological skills in production of the goods in question? Where the answer is yes, then the U.S. should endeavor to encourage technology transfer.

Fourth, *at what cost and with what speed can the U.S. acquire these materials domestically or through ally-shoring?* The United States may be prepared to pay a risk premium to reduce its reliance on Chinese firms but a number of studies have highlighted the implausibility of the U.S. meeting all of its minerals needs through ally-shoring and domestic production.[75] Another consideration is how much more expensive and slower will the transition be? While there is no set threshold, the more expensive and slower on-shore and ally-shored substitute production are, the more the United States should evaluate the stakes of dependence on Chinese products. More expensive, slower prospects for diversification coupled with lower stakes ought to increase the willingness to tolerate Chinese exports, investments, and partnerships.

Fifth, where the U.S. is considering supporting upstream investments in mining either at home or in allied countries, there has to be consideration to what happens with that raw material afterwards. For example, there has been some discussion of $250 million in Development Finance Corporation support to refurbish the railway in the Lobito Corridor from the Democratic Republic of Congo and Zambia to bring minerals to port in Angola.[76] One concern is whether there are also sufficient off-taker agreements and processing plans to ensure that the minerals are either bought or processed by companies from allied countries. In this case, there appear to be plans to do both with a Canadian mining company and a refining plant in Zambia. That said, it would be self-defeating to enhance minerals extraction, only to then see the minerals exported to China for processing.

One practical application of these ideas may be through interpretation of the rules such as the foreign entity of concern (FEOC) associated with the Clean Vehicle Credits of the IRA. Draft FEOC guidelines were released in December 2023[77] which suggest that a foreign entity that is

[75] (Allan, Gordon, and Wang 2023).
[76] (U.S. Department of State 2024b).
[77] (The White House 2023a).

"owned by, controlled by, or subject to the jurisdiction or direction of a government of a foreign country" from a covered nation (which includes China, Russia, North Korea, and Iran) are ineligible for the tax credits under the IRA, with vehicles acquired after 2023 ineligible for credits if batteries were manufactured or assembled by an FEOC.[78] After 2024, the minerals in those batteries cannot have been extracted, processed, or recycled by an FEOC to be eligible for the credits.

Moreover, companies with at least 25% voting interest, board seats, or equity interests held by a current or former government official from a covered nation is also classified as an FEOC and thus ineligible for the tax credits. In addition, companies that have licensing agreements with companies from an FEOC would be considered FEOCs and ineligible for tax credits if the licensing agreement gives the FEOC effective control of the company.

That said, there is some ambiguity about how to treat that 25% threshold where company officials may not be government officials but still have associations with the state. These kinds of concerns are reflected in the 78 public comments that were received by the January 3, 2024 deadline.[79] Critics have complained that Chinese companies can game the threshold by adjusting board representations, voting, or equity stakes, but reducing representation on the board to the required level could alternatively be thought of as compliance.[80] Private Chinese companies in non-FEOC countries say cobalt in DRC and nickel in Indonesia could be eligible for the tax credits, if the Chinese company could demonstrate it wasn't controlled by the Chinese state.

Independent of the FEOC requirements, the IRA also has a schedule for imposing North American content requirements for battery manufacturing and assembly to be eligible for half of the $7500 tax credit.[81] A separate schedule for the critical minerals that go in to the batteries requires a rising share of domestic content or content from countries with which the United States has a free trade agreement. The challenges of tracing supply chains for minerals are already eliciting concern from manufacturers where batches of minerals may come from hard to discern sources. Moreover, the few models that were eligible for tax credits under the IRA immediately decreased from the end of 2023 to early 2024, in part because of the FEOC guideline announcement. The draft rules for batteries entered in to force on January 1, 2024.[82]

The upshot of these observations is that there may be some administrative rule-making on a case by case basis about whether individual projects or transactions involving Chinese companies meet the threshold for an FEOC. Some of the principles sketched out above perhaps could serve as substantive considerations when making such judgment calls.

[78] (Congressional Research Service 2024).
[79] (U.S. Department of Energy 2023).
[80] (Fannon 2024).
[81] (U.S. Department of Treasury 2024)
[82] (Congressional Research Service 2024).

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