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Attachment—Additional Questions for the Record

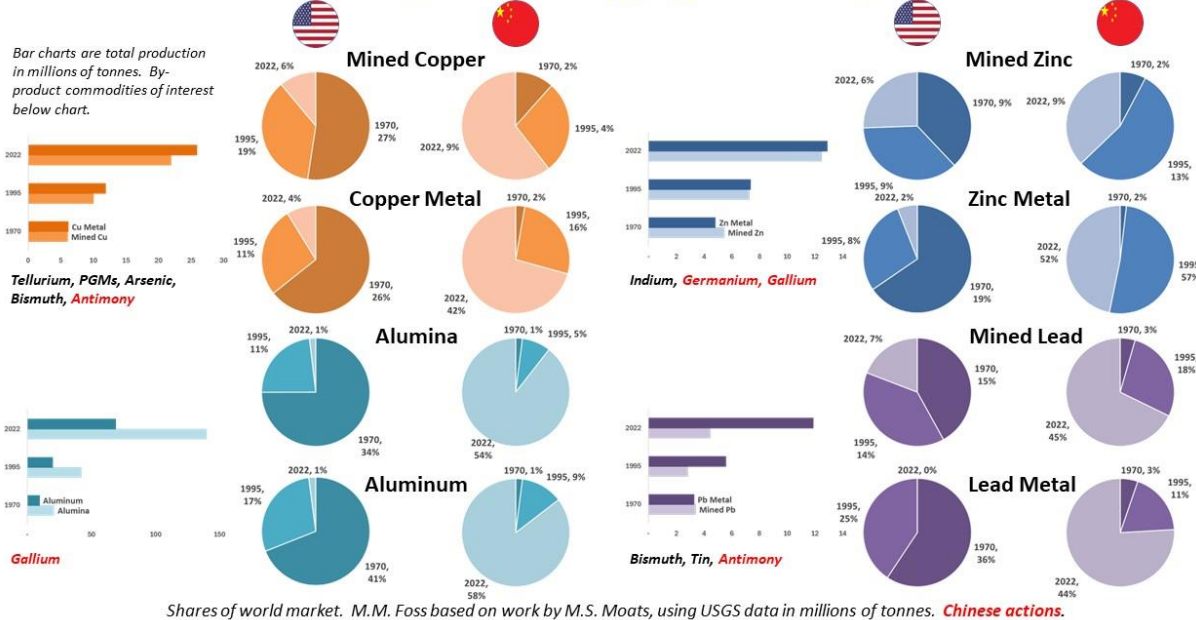
The Honorable Earl L. “Buddy” Carter

1. Rather than try to replicate China's approach, can we leapfrog them by developing new materials and methods to extract minerals? Do you have any examples?

For all of the members' questions, it is important to acknowledge the context. China has built large global supply chains for industrialization. As I noted in my testimony, China's dominance is a consequence of their willingness to fully deploy their domestic resources while investing abroad. That combination has allowed them to take controlling positions in key commodities. By comparison, our mining industries have been in general decline, a post-World War II adjustment that accelerated in the mid-1980s as higher costs at home (mainly labor and environmental oversight but also cost of capital during the mid-1970s to early 1980s era of high inflation) rendered U.S. businesses uncompetitive against newer, cheaper capacity abroad, including in Asia and eventually China. Our heightened attention to minerals and their supply chains is an artifact of mandates and targets for alternative energy technologies like wind, solar, and batteries for grids and for mobility (EVs). Initially, no one cared where we sourced the raw materials or the equipment.¹ In fact, for many, China's dominance is essential for keeping alt energy tech affordable. Sensitivity around China's dominance only happened because we voters/taxpayers are being exposed to substantial commercial risks associated with USG-backed manufacturing investments driven by targets and mandates. Promises of domestic content for those manufacturing investments triggered scrutiny of materials sourcing and supply chains. Links to defense are amplifying concerns amid growing tensions in IndoPac and elsewhere and clear Chinese willingness to test our insecurities, both hard and soft.

Since the June 13 hearing, we have published an extensive overview report on minerals and materials². Below is a summary depiction of where things stand, based on Table 2 of that report. In this chart, I depict mined and processed (final) metal for four commodities that include much else of interest in their value chains. For instance, with copper, lead, zinc we also can get cobalt, silver, gold, nickel, and other commodities. The byproduct commodities noted in red are important for many tech applications, are on the U.S. critical minerals list because we do not produce them, and have been targeted by China for control. Note that operating in the U.S., we have three copper smelters, one alumina refinery (the aluminum value chain typically originates with bauxite, for which we have no comparative advantage in resource occurrence, refined to alumina and then smelted into finished aluminum), four aluminum smelters, one zinc smelter, and no lead smelters, all considerable reductions from the mid-1980s.

Where We Stand (and the 45x problem)



At this point, I see growing resistance to the idea that we can diversify our minerals and materials supply chains any time soon.³ A variety of non-exclusive options seem apparent.

One, we could change the game by backing away from aggressive mandates and targets, reducing pressure on minerals and materials supply chains. This would undermine commodity prices, but it would also reduce cost pressures on operators. U.S. producers can survive lower commodity prices if they face more favorable cost structures. A “cooling off” of the “green energy rush” would affect China’s suppliers and manufacturers as well. It would force a reckoning on speculative over-capacity in China that effectively has been getting exported to the detriment of U.S. (and other) industries and businesses worldwide. As China deals with its current economic downturn and works to avoid Japanese-style property-led deflation and economic malaise, downsizing its raw materials and manufacturing businesses and industries will need to be part of the picture. Before the pandemic, all economic intelligence indicated that China was preparing to graduate from its industry led export economic model to grow services and internal consumption.

Two, rather than trying to surpass China, achieve a willingness to at least hold our own. That means, in my view, a willingness to look hard at how to provide the best platform to facilitate private sector-led investment in the U.S. that does not depend upon “taxpayer derisking” (i.e., USG funding support) or, at least, needs much less in order to survive and thrive. To be frank, this means a hard look at labor and environmental costs, and not just permitting but the gamut of requirements faced by miners, minerals processors, fabricators, recyclers, manufacturers. It also means an active review and test of whether we have the right priorities on the energy front in the first place.

To the question posted by Chair Carter, **three**, pursue a leapfrogging strategy.

Importantly, the Chinese are as interested as we are in advances in materials and extraction methods. This is a fact.

A number of **materials advances** are underway. Examples include:

- Graphene, which can substitute for natural graphite (also Chinese controlled) in many applications; carbon nanotubes (CNTs), which can substitute for metals (they can be as conductive as copper, have greater tensile strength than steel and are better for thermal expansion), and be incorporated into batteries, high voltage cable core for anti-sag, building materials, vehicles and aircraft in myriad ways along with many other products.
- Ferroelectrics, which can harden chips against cyber-attacks and other insecurities.
- Advanced composites, which push the envelope on vehicle lightening and many other apps and can benefit from addition of CNT fibers. Composites have long been used as substitutes for metals, a trajectory that will continue and grow.
- Considerable R&D is underway for alternative materials platforms for advanced chip designs and microelectronics.

The U.S. has some advantages in all of these and other materials advances but we need a better ecosystem from lab to commercial deployment at scale.

Advances also are happening for existing materials like steel, copper, aluminum, and titanium. However, we are not in as strong a leadership position as we could be on this front. For all of the controversy surrounding the U.S. Steel/Nippon merger, Japanese and South Korean partners could help us make more progress on advanced alloys that can stave off corrosion, increase durability, improve overall performance. Japan and Korea also are useful partners for geopolitical balancing.

When it comes to **new methods for minerals extraction**, like us, Chinese companies and investors are exploring direct lithium extraction (DLE) to produce lithium and other minerals from brines. They are, and have been, testing and experimenting with *in situ* mining (subsurface recovery of minerals using fluids, which we have used in the U.S. for uranium) often called “deep mining” when applied to the problem of minerals recovered from deep, hard rock deposits. As in mining everywhere, including at U.S. operations, Chinese operators are pursuing recovery of metals from waste including slags. They are aggressively pursuing hydrometallurgy approaches for processing. Chinese companies and investors are testing and deploying automation and robotics (to reduce labor cost and improve safety) – the concept of the “digital mine” for optimization is a worldwide ambition for the industry. The challenge for us in America is that Chinese entities can test and vet approaches and ideas in their own domestic operations as well as abroad from a lower cost structure to begin with, and move more quickly to build commercial scale so as to reduce unit costs. The Indonesian nickel and DRC cobalt expansion projects are prime examples, both referred to during the June 13 hearing.⁴ China’s comparative advantages show up in lower prices for commodities, providing benefits to customers. On our shores, they threaten U.S. producers that must operate from a much higher cost deck.

Four, we figure out how to get beyond the tensions and look for areas of cooperation and mutual benefit with China, while protecting, and hardening, our interests. Which is what so many other nation states seem to be attempting to do in response.

2. Regarding critical materials, is it economically possible for the United States to supplant China’s market domination? Why or why not?

As the question pertains to our domestic industry, I find this to be unlikely, for all of the reasons above. A fair counterpoint is whether such a posture is even desirable.

While we have substantial resource endowments, we worked our main metals districts pretty hard during WW2 and face maturity in both ore deposits and facilities. It would take a serious effort to reduce domestic industry cost structure, and robust political will to engage in a true “mining renaissance”. Our pursuit of “industrial policy” already is a misguided intrusion of government into markets in ways that stifle competitive drive and risk-taking. In general, we are imposing rules and regulations that make industry less competitive (labor, environment/ESG, other) and then redistributing from taxpayers through tax credits, loans and grants, and other mechanisms to try to instill some modicum of profitability.

We also would be setting aside any or all gains from trading with China as the global low-cost producer/supplier.

A possible solution is one we have been pursuing, international minerals partnerships. When it comes to these, we could easily bankrupt our future trying to match China in every location. We clearly need to be selective.

Our challenge is twofold – rebuilding and strengthening domestic supply chains and boosting manufacturing competitiveness. Many of the critical minerals of interest come to us in manufactured goods. Focusing on minerals supply chains does not help cure national and economic security if we do not also have manufacturing offtake. A good illustration is rare earth elements (REE), which are not included in the previous graphic.⁵ For some time, we have been extracting REE and shipping concentrates to China for processing. We then import neodymium magnets and other REE containing goods. Expanding REE extraction in the U.S. does little good if producers have no domestic customers. REE also is a great case study for the complexities of byproducts, in this situation thorium, which has a long and involved history. Likewise, an idea currently in the mix is to expand alumina refining capacity in order to achieve domestic supply of gallium, but that requires sufficient manufacturing offtake to support commercial scale. In these and other examples, U.S. suppliers would need to be able to export in order to sustain operations.

a. How do you suggest that we reverse this trend?

I can offer two suggestions.

(1) Understand our position in advanced materials and focus like lasers on building the most robust ecosystem for R&D to commercialization we can devise. For instance, graphene and CNT were invented in part at U.S. institutions. We have retained an edge in production and use of these materials, but China is close behind and could easily surpass the U.S. (and Europe) in capacity and competence.

(2) Pursue the actions needed to reduce the cost deck for U.S. operators. For many of the approaches mentioned above, mine operators and processors are faced with cultivating competitive work force capacity, mitigating occupational risks, and management of hazardous materials. Many of the more interesting possibilities for recovery of commodities from wastes and recycling involve remediation of brownfield and, in some locations, Superfund sites. Our protections are admired worldwide and often pointed to as the rationale for why the U.S. should

host an active and robust mining industry. But our style of oversight is expensive, and needs rethinking in order to provide a cost-competitive platform.

3. It seems the current, preferred policy direction of many in the United States is to link our future to the use of critical materials.

a. Considering how reliant we are on countries that wish us ill, do you believe that is the right choice and why?

No – for the reasons stated above regarding alt energy tech and the unbalanced tradeoff between energy and materials inputs relative to energy outputs.

b. What do you consider the advanced materials that we can produce now in America that will make us a global leader?

See my comments above on graphene and CNT, and suggestions on advanced alloys.

4. It seems like the current situation is a no-win situation that sets up a dichotomy where we are forced to use cheap materials and finished products from China or struggle to build more expensive ones here in America.

a. Is the Chinese government's economic policy realigning the world?

Yes, to some extent, but there are many considerations in places where Chinese companies do business. Economic influence is largely incidental to China's apparent, main strategic intent (supporting their industrial base and decoupling from imported oil given IndoPac shipping lane security issues and U.S. presence). International political influence has not seemed to be their main objective, at least initially. However, China's stance, and influence, are evolving. For instance, the Brick & Road Initiative, BRI, was a response to managing undisciplined Chinese investing abroad. Later, BRI became a banner for Chinese economic posturing.⁶

c. Is the United States, on its own, able to change China's behavior on the environment and labor standards?

Absolutely not. Nor can we expect support from multilateral institutions – they tend to defer to Chinese influence.

d. What do you think will make China change its behavior?

Rebuilding our domestic capacity should be delinked from energy imperatives. Competitiveness in materials supply chains is a national imperative, for all of the needs and challenges that lie ahead in energy, defense, and other sectors.

Thus, we should pursue option **one** in my non-exclusive list above – change the energy game. China's position has flourished in a world obsessed with climate, plagued by “emissions tunnel vision”. We need to be more realistic, reduce the impetus, cool things off, see how they react. Voters here and in Europe have provided plenty of evidence that views on accelerating expensive energy transition policies and mandates are not nearly in their bucket of priorities.

A breather could be combined with other tactics, such as a more meaningful, concerted effort to support our domestic businesses by making our domestic more competitive (tax reductions and

reform, reduced and streamlined regulatory oversight) in order to unleash animal spirits. We could offer some strategic partnerships with China as incentive – it is extremely difficult to ignore China’s growing excellence in R&D and commercialization – and be more strategic in our international minerals and materials partnerships.

e. What does it take for us to approach China on economic policy and not be in a position of weakness?

It will require rebuilding our cost structure in order to be more competitive, building a robust advanced materials ecosystem, and being more accepting of international mergers that can give us a leg up on strategic and advanced materials.

5. Some people are supportive of Extended Producer Responsibility programs, where a fee is added onto the sale price of electric items with critical minerals. The funds raised from EPR would then go into paying to build the infrastructure used to collect, recycle, and process critical materials from those items.

a. Besides raising prices, would such a system guarantee we have the domestic infrastructure to fully process those materials here in the United States?

No – EPR is too complicated, too expensive and burdensome for producers and recyclers to be useful. Many sources have indicated they expect a rollback or even reversal of some of the more aggressive EPR laws on the books in various states.

b. What is the maximum percentage of critical minerals that we can obtain from recycling used electric devices?

It varies widely by type of metal and feedstock. Copper can be recovered to a high degree. Lithium is much smaller. The reality is that recycling facilities have just as many considerations in risks and hazards as any industrial facility. The recent explosion and fire that destroyed the Critical Mineral Recovery plant in Missouri is a great example, https://response.epa.gov/site/site_profile.aspx?site_id=16725.

We estimate that only about 17% of all global electronic waste is recycled, <https://www.bakerinstitute.org/research/call-action-recycling-and-waste-management-across-alternative-energy-supply-chains>. Good resources on recycling recovery from REMA/ISRI, <https://www.isri.org/recycled-commodities/recycling-facts-figures>.

c. Would the United States need to place limits on owning items with critical materials to ensure they are timely discarded, so the necessary level of critical minerals get into the system to meet our domestic needs?

As societies progress along the development curve, energy use per unit of gross domestic production (GDP) tends to decline as does materials use, in part because advanced economies tend to encompass more services and because manufacturing becomes more efficient. One aberration of activities like battery manufacturing is the large amount of waste generated (and energy intensity) per unit of useful product.

This idea of “timely disposal” seems to hint at early retirement of goods, rather than the reverse path of increasing durability and lengthening useful life. The outcome would be pressure to extract more virgin material in order to keep the market supplied with all of the equipment and devices – including alt energy tech – people might want or could be forced to use.

A better alternative is repurposing. For instance, a large format battery for a BEV can store and discharge energy beyond its warranty. It is more likely that pre-owned BEV markets will emerge and grow, or that large format batteries are harvested for other uses. These nascent secondary and tertiary markets need to be encouraged.

6. What are some other examples of world-class mineral resources we are blessed to have under our feet, but that we are currently not developing?

The commodities indicated in red text in the preceding chart are prime examples and point to the dual challenge of achieving viability for both mining and processing. The latter may actually be more difficult given sensitivities associated with processing sites.

We also have world class fuel minerals – coal, hydrocarbons (oil and gas), uranium. To the extent that policy and regulatory actions preclude access and development of these minerals resources, we are burdening both economic and national security for both energy and vital materials.

a. What do you anticipate will be the impact to our economy and national security if we do not develop these supply chains domestically?

Not having robust domestic supply chains certainly makes us more dependent upon alliances and foreign suppliers. Again, the problem is twofold – raw materials and manufacturing. Also, it is not necessary to return the U.S. to our former dominance as premier producer and supplier. It will be a tough act to preserve, and attain some expansion in, existing capacities.

7. The World Bank released a report showing that since the passage of the Inflation Reduction Act, China increased its percentage of foreign direct investment in countries with a U.S. Free Trade Agreement from 4% to 31% in just one year.

a. Do the critical mineral sourcing requirements in the IRA, which are predicated on Free Trade Agreements, effectively reduce reliance on China?

The World Bank report notes that China’s growth in share “was likely an effort to avoid IRA restrictions on Chinese-affiliated suppliers”. The authors also point out that “These findings underscore the powerful effect that policies in major economies can have on steering investment and trade flows. While the IRA aims to incentivize supply chain resilience, it also risks diverting investment away from the mineral-rich developing countries that could be vital suppliers in the energy transition”.⁷

There is much to complain about regarding the IRA overall, perverse incentives in the legislation, and how these are playing out in complexity, cost burdens, unintended consequences, and increased risks across the board. A full review of the legislation, its merits, and regulatory requirements for implementation is justified.

b. In your opinion, is this a trend that will continue?

We indeed face that possibility.

- c. Have we simply given them the playbook for getting around what are supposed to be trade barriers?

Throughout the history of human economies, a harsh lesson is that attempts to engineer desired outcomes through policy and regulatory fiat, especially when they incorporate selective targets, never achieve the desired outcome. The same applies to tariffs. It is far better to focus on key elements of domestic competitiveness and how best to sustain them.

The Honorable Rick W. Allen

1. What would be the implications for the U.S. economy and consumers if:

- a. China quit buying minerals from Western mining companies and how long would it take for the worst of the effects?

China is the major customer for all of the largest, and a number of junior, mining companies. The industry would collapse and consolidate in short order.

- b. Has China suggested its intention to use its critical minerals supply chain only for in-country uses by 2032 – the same year the EPA electric vehicle mandate becomes effective in the United States?

Many ideas are floating around regarding what China might, or might not, do with its huge raw materials and manufacturing capacities. Currently, evidence points to their tendency to export, or even to dump, excess production. Chinese holders of inventories of mineral concentrates and metals for which prices are falling will act logically to sell off those inventories. Excess capacity for wind, solar, batteries and goods such as BEVs are spilling out of China into other countries. All of this is an artifact of what China built to decouple from oil imports and related security risks and costs. If, as many expect, China pursues the shift toward growth in services and increasing domestic consumption, mentioned earlier, that will affect capacity balances.

Meanwhile, the EPA EV mandate deserves a full review and reconsideration.

3. Is reliance only on government grants for certain activities in the supply chain a path to success?

To me, this is an enormous impediment and source of many of the unintended consequences already in evidence. The problem is the tendency to try to pick winners, to ignore linkages and complex relationships in supply chains, to focus only on actions that seem politically palatable. A broad, encompassing view and understanding of competitiveness would be a far better approach. “Do no harm” ought to be the mantra.

- a. What role does access to processing have in planning and financing new mining activities?

As I noted in testimony, and in our report⁸, U.S. producers currently mine commodities that must be exported for processing. This makes no sense, and contributes to our vulnerabilities. Likewise, trying to stimulate mining without solving processing capacity shortages is suboptimal. The full supply chain must be considered, along with the key ingredients for competitiveness. To repeat,

U.S. producers and processors can be competitive, even in unfavorable market conditions, if cost structures are low and have more flexibility.

- b. Would it help to treat mining, extraction, and processing projects as one big, complex delivery system project that needs to be concurrently synchronized to maximize the important commercial and security benefits they will bring?

Materials supply chains exist in complex markets. Market participants need to be able to optimize, maintain maximum flexibility and “optionality” which means access to resources, inputs, and open trade to balance supply and demand. No amount of government oversight or control in attempts to synchronize will succeed. The commercial and security benefits will come if the industry platform is as cost competitive as it can be, and no amount of redistribution from taxpayers can compensate for government dictates that work against competitiveness.

¹ Note my analysis of the “disconnect” between energy aspirations and materials requirements and commentary on China in our Energy Insights 2024, <https://www.bakerinstitute.org/research/slicing-gordian-knot-energy-minerals-and-materials-outlooks>.

² See <https://www.bakerinstitute.org/research/minerals-and-materials-challenges-our-energy-futures-dateline-2024>.

³ For instance, see Lithium producer says west cannot end reliance on China in critical minerals, <https://www.ft.com/content/13130f5a-d91e-4bc6-a4a1-dc868aad19bb>. Albermarle and Piedmont also announced work force reductions, <https://www.charlotteobserver.com/news/business/article295425414.html>.

⁴ As noted in my testimony, see <https://www.bakerinstitute.org/research/need-nickel-how-electrifying-transport-and-chinese-investment-are-playing-out-indonesian-archipelago> for a case study of how Chinese investors have deployed high pressure acid leaching (HPAL) to achieve nickel recovery from low grade deposits in Indonesia.

⁵ See <https://www.bakerinstitute.org/research/chinese-behemoths-what-chinas-rare-earths-dominance-means-us>.

⁶ See links in <https://www.bakerinstitute.org/research/chinese-firms-position-energy-transition-copper-supercycle>. In particular, <https://www.bakerinstitute.org/research/road-nowhere-problems-chinas-belt-and-road-initiative>.

⁷ <https://blogs.worldbank.org/en/psd/critical-mineral-investments>.

⁸ See endnote 2.