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Keeping China at bay and critical minerals stocked: The case for US-Africa defense collaboration

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The Africa Center provides insights and recommendations for investment opportunities and partnerships to strengthen security and expand prosperity on the continent.

Cover

An F-35A Lightning II of the US Air Force stands by before its performance at the 88th anniversary celebration of the Royal Thai Air Force in Bangkok, Thailand. Source: REUTERS/Teera Noisakran, Sipa USA

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Contents

Introduction

The United States is ill-prepared to confront the challenges of an increasingly hostile global strategic environment. A coordinated coalition of adversarial states is working to dismantle the US-led global order, seeking to replace it with one defined by their ambitions and autocratic principles. At the forefront of this effort is China, which is rapidly accelerating its military capabilities and expanding its defense industrial base (DIB) to field sophisticated weapons systems designed to deter the United States globally and secure its goal of national rejuvenation. Aligned with China are Russia, Iran, and North Korea—an increasingly unified axis of authoritarians steadily advancing toward this objective. Compounding these challenges are increasingly frayed traditional US security alliances, notably in Europe, that leave the United States further exposed.

The most effective strategy to contend with such a scenario is through robust preparedness—both immediate and long term. The task of overturning the established global order requires a lengthy and deliberate process, and the axis powers are likely to continue in this pursuit for years to come. While US foreign policy often unfolds in the urgency of the moment, axis nations tend to plan with decades-long strategies in mind. The global strategic environment is therefore poised to worsen before any stabilization or improvement might occur. For this, the United States is unprepared. Decades of "peace dividend" policies have left behind a US DIB that is underfunded and underperforming, unable to meet the scale and sophistication of the axis of authoritarians, and hampered by supply chain vulnerabilities—in particular, by an overreliance on adversarial nations for key inputs, including critical minerals.[1] Of the fifty minerals identified as critical by the US Geological Survey (USGS), the United States is fully net-import reliant for twelve and more than 50 percent dependent for another twenty-nine. Of these, China produces more than 60 percent.[2]

It is untenable that US security hinges on the whims of its foremost adversary. The good news, however, is that there is growing awareness within some corridors of the Pentagon and Congress of these vulnerabilities and the lack of US readiness to confront them. Efforts are underway to identify and develop weapons systems that meet the strategic needs of the current and evolving global environment, while also establishing a reliable supply of critical minerals for their production—and ensuring these minerals are not sourced from authoritarian states, particularly China. The 2025 US National Defense Authorization Act (NDAA) includes a policy statement to assess "emerging technologies or manufacturing processes that would support the modernization or evolution of the DIB of the United States," and to "identify and prioritize promising critical technologies and assets... in need of capital assistance." The current House version of the NDAA, the "Service member Quality of Life Improvement and National Defense Authorization Act for Fiscal Year 2025," also requires the secretary of defense to "develop a strategy to develop a secure and resilient domestic and allied supply chain of critical components... outside of a covered country." Though encouraging, such measures bring with them the considerable challenge of extricating the United States from its reliance on Chinese critical minerals to secure alternative, reliable sources.

Increasingly, US and allied attention has turned to Africa. Africa holds one-third of the world's known mineral reserves, including 80 percent of platinum and chromium, 47 percent of cobalt, and 21 percent of graphite.[5] Of the fifty minerals designated as critical by the USGS, thirty-two are found in Africa. US policymakers have thus begun to explore partnerships with African countries to secure these resources. Yet, despite several promising initiatives, the United States still lacks a coherent and comprehensive policy for engagement—particularly one that could rival the entrenched influence of axis-of-authoritarian states, notably Russia and China, in the continent's mining industry. US-Africa policy remains broadly siloed, focused on single-issue engagements and framed through outdated perceptions of aid,[6] rather than reflecting the

1. In this Atlantic Council report, the term "critical minerals" will assume the inclusion of rare earth elements on the United States Geological Survey (USGS) 2024 list. See: USGS, *Mineral Commodity Summaries* 2024, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf.
2. USGS, *Mineral Commodity Summaries* 2024.
3. National Defense Authorization Act (NDAA) for Fiscal Year 2025, S. 4638, 118th Cong. (2023–2024); and H.R. 5009 § 9025 (c)(2), 118th Cong. (2023-2024) https://www.congress.gov/bill/118th-congress/house-bill/5009/text.
4. H.R. 5009 §162 (c)(3); covered countries listed in § 7705 (d) include China, Russia, North Korea, and Iran.
5. Gracelin Baskaran, "Prospects for U.S. Minerals Engagement with Africa," Center for Strategic and International Studies, August 29, 2023, https://www.csis.org/analysis/prospects-us-minerals-engagement-africa.

region's growing importance as a strategic partner. Many African countries increasingly confront challenges not unlike those of the United States, including those rooted in the geopolitical ambitions of axis nations. In response, many, too, have begun to prioritize the development of their defense capabilities to address them—some, like unmanned aerial systems (UASs), that are also being pursued by the United States.

South Africa's defense strategy, for instance, emphasizes a strengthened national DIB developed in collaboration with the South African National Defense Force and the country's technology sector.[7] In Nigeria, President Bola Tinubu's Renewed Hope Agenda makes it a matter of policy to "reduce dependence on imported foreign military equipment" and "ramp up domestic production of basic and essential military hardware and equipment."[9] Ironically, such efforts—like the US ones focused on Africa—depend on the very critical minerals that Africa holds in abundance. Yet while Africa possesses them, it currently lacks the capacity to process these resources domestically, with raw materials exported abroad, predominantly to China, for refinement. Globally, China accounts for 85 percent of mineral processing capacity. Such a dynamic not only prevents African nations from fully capitalizing on the value of their mineral wealth but also perpetuates a dependency on China within their mineral and defense supply chains—one that in many respects mirrors the United States' own reliance on China. In this tangle, however, lies opportunity.

By supporting African nations in the development of their domestic mineral processing capabilities, the United States could enable them to retain a greater share of their mineral wealth and build self-sufficiency in defense. Such efforts could also diminish China's influence across the continent. For the United States, developing these capabilities could secure a reliable source of critical minerals. This would be essential for maintaining a strong DIB that can meet both immediate and long-term global strategic demands. It could also potentially pave the way for meaningful and sustainable security alliances, with African countries better positioned to confront regional threats independently. Such a vision is neither simple nor swift. It requires overcoming significant governance, infrastructure, and financing hurdles. It is, by its nature, a long-term endeavor that demands strategic and sustained commitment over decades. Yet as the axis states continue to push to reshape the world order, such a long-term perspective is needed. The gravity of the threat, too, should reinforce the shared determination of the United States and Africa to succeed.

This report begins to lay the groundwork for such an effort by:

- Identifying the defense capabilities the United States should prioritize to remain competitive in the evolving global strategic environment and the critical minerals necessary to support them.
- Charting Africa's critical mineral resources relevant to US defense needs and assessing the shifting defense postures of African nations, particularly where the development of their weapons systems and security objectives aligns with US interests.
- Underscoring the importance of US support for building Africa's mineral processing infrastructure, while addressing the structural barriers that have so far impeded such efforts.
- Advancing targeted recommendations for US policymakers to operationalize such efforts and reimagine US-Africa relations for today's global challenges.

6. As of this writing, the Trump administration has put forward a proposal that could significantly reshape the United States's approach to international aid and development. Yet, until March 2025, US policy toward Africa has remained largely anchored in outdated notions of assistance.
7. Thandi Modise, "Minister Thandi Modise: Defence and Military Veterans Dept Budget Vote 2023/24," Government of South Africa, May 23, 2023, https://www.gov.za/news/speeches/minister-thandi-modise-defence-and-military-veterans-dept-budget-vote-202324-23-may.
8. All Progressives Congress (APC), *Renewed* Hope 2023: *Action Plan for a Better Nigeria*, 2023, https://apc.com.ng/img/apc_renewed_hope.pdf.
9. Lina Benabdallah, "China's Role in Africa's Critical Minerals Landscape: Challenges and Key Opportunities," Africa Policy Institute, September 6, 2024, https://afripoli.org/chinas-role-in-africas-critical-minerals-landscape-challenges-and-key-opportunities.

Section 1

US defense needs in an evolving global strategic environment

Near-peer adversaries and new warfare domains

The global strategic environment inherited by the Trump administration is more fragmented and precarious than at any point since World War II. Unlike in the immediate post-World War II-era, when the United States wielded unrivaled military dominance over its peers, that advantage has since been eroded amid the steady emergence of competitor nations and recalibrated global alliances. Today, the United States confronts four principal adversaries—China, Russia, Iran, and North Korea—an axis of authoritarians increasingly united in a determination to dismantle the structures of the free world and replace them with systems reflective of their authoritarian aims. Chinese President Xi Jinping often speaks of "great changes unseen in a century," while internal Chinese Communist Party (CCP) textbooks theorize a "new world order . . . that will surpass and supplant the Westphalian system."[10] Russian President Vladimir Putin has similarly proclaimed the "formation of a completely new world order, nothing like we had in the past."[11] Such rhetoric is reinforced by tangible initiatives such as China's Global Security Initiative and the growing BRICS bloc—which now includes South Africa, as a member state, and Ethiopia, Uganda, and Nigeria as strategic partners—further eroding US influence on the continent. Decades of misguided US-Africa policy have only exacerbated the challenge.

Within the axis, China stands as the dominant actor, its ambitions as expansive as they are clear. At the forefront of its strategy is its aim of achieving "national rejuvenation" by 2049, the centenary of the People's Republic of China. Central to this vision is the annexation of Taiwan, a move that would likely precipitate a US-China military confrontation in the Taiwan Strait. Yet, war games conducted by the Center for Strategic and International Studies (CSIS) suggest that, with its current weapons stockpiles, the United States would exhaust critical systems, such as long-range anti-ship missiles (LRASMs), within just one week of conflict.[12] Taiwan, too, represents just one piece of a broader puzzle. At its core, the CCP seeks to restore China to what it perceives as its rightful place at "center stage"[13] of a new world order, one reminiscent of the hierarchical *tianxia* system of its imperial past.[14] In pursuit of this, China has employed a sophisticated blend of hard and soft power strategies. In Africa, for example, it has constructed strategic infrastructure, including an estimated one hundred dual-use ports frequented by the People's

10. See, for example, Matthew Pottinger, Matthew Johnson, and David Feith, "Xi Jinping in His Own Words," *Foreign Affairs*, November 30, 2022, https://www.foreignaffairs.com/china/xi-jinping-his-own-words.

11. Vladimir Putin, "Meeting on the Socioeconomic Development of Crimea and Sevastopol," President of Russia, November 7, 2023, http://en.kremlin.ru/events/president/news/75521.

12. For an overview of the war games see, for example, Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, *The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan*, Center for Strategic and International Studies, 2023, https://www.csis.org/analysis/first-battle-next-war-wargaming-chinese-in¬vasion-taiwan; Warren P. Strobel, "War Game Finds U.S., Taiwan Can Defend Against a Chinese Invasion," *Wall Street Journal*, August 9, 2022, https://www.wsj.com/articles/war-game-finds-u-s-taiwan-can-defend-against-a-chinese-invasion-11660047804; and Tony Capaccio, "What-If DC War Game Maps Huge Toll of a Future U.S.-China War Over Taiwan," Bloomberg, August 8, 2022, https://www.bloomberg.com/news/articles/2022-08-09/what-if-war-game-for-a-us-china-conflict-sees-a-heavy-toll.

13. Xi Jinping, "Secure a Decisive Victory in Building a Moderately Prosperous Society in All Respects and Strive for the Great Success of Socialism with Chinese Characteristics for a New Era," Delivered at the Nineteenth National Congress of the Communist Party of China, as published by China Daily, October 18, 2017, https://www.chinadaily.com.cn/china/19thcpcnationalcongress/2017-11/04/content_34115212.htm.

14. See, for example, Bradley A. Thayer and John M. Friend, "The World According to China: Understanding the World China Seeks to Create by 2049, When the PRC Turns 100," *Diplomat*, October 3, 2018, https://thediplomat.com/2018/10/the-world-according-to-china/.

Liberation Army Navy (PLAN).[15] It also has expanded its media footprint, advanced military training initiatives, and exported technological platforms—including advanced military systems such as UASs and supersonic aircraft.[16]

Should circumstances demand, China also appears prepared to assert its ambitions through military force. Between 2015 and 2019, China's military expenditures grew nearly twice as fast as its official gross domestic product in real terms,[17] marking the largest peacetime military expansion since the 1930s. The US Department of Defense's (DoD) 2024 China Military Power Report projects that China's nuclear arsenal, which counted six hundred warheads in mid-2024, will reach one thousand by 2030 and 1,500 by 2035, with many capable of striking the continental United States.[18] In 2022 and 2023, China also led the world in defense-related satellite launches[19]—a reflection of its strategic focus on the information warfare domain. Under Xi, China has also prioritized advances in the maritime domain as central to its success in the global strategic environment. The PLAN, already the world's largest navy by fleet size, is therefore expected to field 435 advanced platforms by 2030, when the United States is likely to have just 294.[20] This growing arsenal is to be matched by enhanced maritime anti-access/area denial (A2/AD) capabilities, which are part of the focus of PLAN's increasingly assertive maneuvers.

Africa's waters are a proving ground for such capabilities. Since 2017, China has extended its presence—both legally and illicitly—in the exclusive economic zones (EEZs) of many African coastal states, particularly in the Gulf of Guinea. The region, a vital trade artery and repository of critical minerals in nations like Nigeria, Gabon, and Côte d'Ivoire, has seen an increase in the deployment of Chinese paramilitary actors, including its vast 500,000-strong fishing fleet[21] and civilian shipping vessels—the latter of which the CCP has used for military purposes, including concealing People's Liberation Army (PLA) troop movements and providing logistical support to PLAN outposts in the South China Sea.[22] For the United States, to effectively deter such capabilities, particularly in a vast region like the Indo-Pacific (which faces a tyranny of distance), would require a range of specific weapons systems such as resilient communication networks, long-range strikes from air, land, and maritime platforms, as well as UASs to support these functions.[23] The advanced weapons systems wielded by Iran-backed Houthis in the Red Sea—many additionally supplied by Chinese military technologies, including advanced missile-guidance systems[24]—further underscore the growing salience of these capabilities in both the immediate and long-term global strategic environments.

Current conflicts such as those in the Red Sea, the Middle East, and Russia's war in Ukraine provide a preview of the likely nature of future warfare. The war in Ukraine, for instance, has demonstrated the increasing importance of electronic warfare (EW) and information operations, with Russia having deployed Krasukha-4 EW systems to jam Ukrainian radar and satellite communications, albeit with varying success. The Russian-backed Wagner Group has been engaged in similar information and

15. Monika Chansoria, "Beijing's Naval Expansion into Africa with 100 Seaports," *Japan Forward*, November 22, 2023, https://japan-forward.com/beijing-naval-expansion-africa-100-seaports-monika-chansoria/.
16. International Institute for Strategic Studies, "Chinese Arms Sales in Sub-Saharan Africa," *Strategic Comments* 30, no. 10 (2024): ix-xii, https://www.iiss.org/publications/strategic-comments/2024/12/chinese-arms-sales-in-sub-saharan-africa/.
17. Jacqueline N. Deal and Michael Mort, "China Prefers Guns to Butter," *Foreign Policy*, September 7, 2023, https://foreignpolicy.com/2023/09/07/china-economic-slowdown-pla-buildup-taiwan/.
18. US Department of Defense, 2024 *Report on Military and Security Developments Involving the People's Republic of China*, December 18, 2024, https://www.defense.gov/Spotlights/2024-China-Military-Power-Report/.
19. Theresa Hitchens, "China Tops US in Defense-Related Satellites Orbited in 2022: Report," *Breaking Defense*, January 6, 2023, https://breakingdefense.com/2023/01/china-tops-us-in-defense-related-satellites-orbited-in-2022-report/.
20. Ronald O'Rourke, "China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress," Congressional Research Service, August 16, 2024, https://sgp.fas.org/crs/row/RL33153.pdf.
21. Food and Agriculture Organization of the United Nations, "Fishing Fleet," in *The State of World Fisheries and Acquaculture 2022: Towards Blue Transformation*, https://openknowledge.fao.org/server/api/core/bitstreams/9df19f53-b931-4d04-acd3-58a71c6b1a5b/content/sofia/2022/fishing-fleet.html.
22. J. Michael Dahm, "China Maritime Report No. 25: More Chinese Ferry Tales: China's Use of Civilian Shipping in Military Activities, 2021-2022," *CMSI China Maritime Reports* 25 (2023), https://digital-commons.usnwc.edu/cmsi-maritime-reports/25/.
23. These capabilities inform the US Navy's Distributed Maritime Operations (DMO) operating concept. See, for example, Ronald O'Rourke, "Defense Primer: Navy Distributed Maritime Operations (DMO) Concept," Congressional Research Service, February 27, 2024, https://s3.documentcloud.org/documents/24449760/if12599.pdf.
24. Guy Azriel, "China Helping Houthis Obtain Weapons for Unmolested Red Sea Passage," i24NEWS Hebrew Channel, January 2, 2025, https://www.i24news.tv/en/news/middle-east/artc-china-helping-houthis-obtain-advanced-weapons-for-free-passage.

"gray zone" operations in Mozambique since 2017.[25] Amid rising tensions with Israel in 2023, Iran conducted its first electronic warfare drills in six years, deploying the Murmansk-BN—a Russian system designed for long-range detection and jamming of military radio communications—according to Israeli news outlet Channel 14.[26] The exercise signaled not only Iran's growing technological capabilities, but also deepening EW cooperation among the axis states. For the United States, this suggests it may need to prepare for advanced combat in more than one theater, such as Europe, the Middle East, the Indo-Pacific, or possibly all three. Xi has identified the EW and information domains as the "largest variable[s]"[27] in modern warfare. PLA doctrine points to information as its "fundamental function" and the "basis to accomplish military tasks."[28]

Since 2019, the PLA has additionally pursued its concept of "intelligentized warfare," a multidimensional operational doctrine that integrates capabilities across land, sea, air, space, electromagnetic, cyber, and cognitive domains with the aim of influencing adversarial perceptions and decision-making in combat.[29] Reflecting this evolution, in April 2024, Xi restructured the PLA to create the Information Support Force, a new branch tasked with embedding advanced information capabilities across the PLA's Army, Navy, Air Force, and Rocket Force to facilitate a streamlined joint command structure matched to the strategic needs of the evolving global strategic environment. Yet, conflict scenarios conducted by the US Naval Institute as part of its American Sea Power Project suggest the US Navy, under its current posture and capabilities, would be outmaneuvered in such a sophisticated information-centric conflict with China.[30]

The United States currently lacks the military capabilities to effectively respond and impose costs in a present or future conflict, as well as the means to prevent adversaries from perceiving opportunities to escalate—a foundational requirement for credible deterrence.[31] Closing this gap requires a broad range of munitions, supported by a resilient DIB and a national defense stockpile able to supply critical minerals for the kind of protracted conflict likely to be pursued by axis-of-authoritarian nations seeking to reshape the global order. At present, however, this is not the case.[32] In light of the domains deemed essential to the evolving global strategic environment, particularly the maritime and information spheres, this report addresses three core capabilities: long-range fires (LRFs), UASs, and directed energy weapons (DEWs). While not diminishing the importance of other technologies, these capabilities are key to ensuring the lethality, readiness, and technological superiority of the US Joint Force in both the near-term and long-term global strategic environment. Moreover, with many US partners facing similar challenges, including those in Africa, these technologies present unique opportunities for mining and defense collaboration.

25. Jeffrey Love, "When Private Military Operations Fail: The Case of Mozambique," *Oxford Political Review*, March 6, 2023, https://oxfordpoliticalreview.com/2023/03/06/when-private-military-operations-fail-the-case-of-mozambique/.
26. See, for example, Joe Saballa, "Iran Holds Large-Scale Electronic Warfare Exercise," *Defense Post*, August 28, 2023, https://thedefensepost.com/2023/08/28/iran-electronic-warfare-exercise/?expand_article=1; Daniel Kochis, "Russia's Links with Iran Are Growing Stronger," *Politico*, August 13, 2024, https://www.politico.eu/article/russia-iran-weapons-arms-ballistic-missiles-drones-defense-war-in-ukraine-war-in-gaza/; and Channel 14, "לארשי עב תירשפא המחלמ תארקל ואריא תא תשמחמ היסור :חוויד (Reporting: Russia Is Arming Iran for a Possible War with Israel)," 2024, https://www.now14.co.il/article/990604.
27. People's Liberation Army Daily, "Strive to Build a Strong Modern Information Support Force," April 20, 2020, http://www.mod.gov.cn/gfbw/jmsd/16302172.html.
28. Aleksandra Gadzala Tirziu, "Inside China's Cognitive Warfare Strategy," *Geopolitical Intelligence Service (GIS) Reports*, November 5, 2024, https://www.gisreportsonline.com/r/china-cognitive-warfare/.
29. For more on intelligentized warfare, see, for example, Gadzala Tirziu, "Inside China's Cognitive Warfare Strategy;" Koichigro Takagi, "New Tech, New Concepts: China's Plans for AI and Cognitive Warfare," Commentary, *War on the Rocks*, April 13, 2022, https://warontherocks.com/2022/04/new-tech-new-concepts-chinas-plans-for-ai-and-cognitive-warfare/; and Josh Baughman, "The Path to China's Intelligentized Warfare: Converging on the Metaverse Battlefield," *Cyber Defense Review*, December 19, 2024, https://cyberdefensereview.army.mil/CDR-Content/Articles/Article-View/Article/4012231/the-path-to-chinas-intelligentized-warfare-converging-on-the-metaverse-battlefi/.
30. Vice Admiral T. J. White et al., "The Navy Is Not Ready for the Information War of 2026," US Naval Institute's Proceedings 150, no. 2 (February 2024): 1,452, https://www.usni.org/magazines/proceedings/2024/february/navy-not-ready-information-war-2026.
31. Thomas Schelling, *Arms and Influence* (New Haven, CT: Yale Univer¬sity Press, 2008), 3.
32. US Government Accountability Office, *National Defense Stockpile: Additional Actions Needed to Improve Oversight and Address Employee Misconduct Allegations*, Report to the Committee on Armed Services, House of Representatives, September 2024, https://www.gao.gov/assets/880/871221.pdf.

Select US defense needs and the critical minerals that sustain them

Long-range fires

Long-range fires, unmanned aerial systems, and directed energy weapons are essential to ensuring the United States remains competitive in the evolving global strategic environment. These capabilities are at various stages of development across the US Joint Force, reflecting the strategic priorities of the information and maritime domains in modern warfare. This section provides insight into some of these advancements and key critical minerals on which they depend—most of which are sourced, processed, or controlled by China, including in African countries, many of which hold potential as long-term US industrial and security partners.

Axis states have developed sophisticated over-the-horizon capabilities designed to push US forces to operate at extended ranges—well beyond the effective envelope of most air-delivered weapons systems. For example, China's Rocket Force, the PLA's strategic and tactical missile force, now fields the DF-21 medium-range and the DF-26 long-range anti-ship ballistic missiles (ASBMs). With ranges that exceed 1,500 kilometers (810 nautical miles) and up to four thousand kilometers (approximately 2,160 nautical miles), respectively,[33] such systems allow for precision strikes against both naval and ground targets while offering flexibility to carry either nuclear or conventional warheads. They are integral components of China's A2/AD strategy, designed to deter US intervention in the Indo-Pacific region, and to further enable China to assert maritime influence in the EEZs of strategic African and other sovereign territories.

Russia is similarly advancing its arsenal. Its Kalibr-class family of cruise missiles, for instance, now includes variants capable of ranges up to 2,500 kilometers.[34] In October 2024, as part of a marked escalation in its war in Ukraine, Moscow deployed seven Kalibr missile carriers to the Black Sea and, in November, tested a "never-before-fielded intermediate-range ballistic missile": The missile's design, derived from the RS-26 Rubezh intercontinental ballistic missile (ICBM), has a theoretical range of 5,500 kilometers—enough to strike Europe from southwestern Russia.[35] Iran, too, has expanded its missile capabilities, deploying long-range systems such as the Soumar cruise missile, with an estimated range of three thousand kilometers.[36] Since at least 2009, Tehran has armed the Houthis with similarly advanced systems,[37] including LRFs capable of striking targets up to 2,500 kilometers away[38]—capabilities that the US under secretary of defense for acquisitions and sustainment in November described as "scary,"[39] and that have proven difficult for the United States to parry.

Such developments have placed a renewed strategic emphasis on LRFs within US defense planning, particularly given US vulnerability to the depletion of its critical missile stocks in a conflict with even one major power, let alone the axis of authoritarians in concert. CSIS war games suggest the United States would likely run out of its missile systems, including LRASMs, within just one week.[40] The extended production times for these systems, such as the Tomahawk Block V, for example, can take up to two years to manufacture, raising additional concerns, especially if access to critical minerals for their production were to be curtailed. As a result, the US Navy, for example, has designated LRFs as a top force design imperative[41] and is advancing new capabilities, such as upgraded LRASMs able to deliver precision strikes against high-value maritime

33. O'Rourke, "China Naval Modernization."
34. "3M-14 Kalibr (SS-N-30A)," Missile Defense Project, Center for Strategic and International Studies, August 11, 2016, last modified April 23, 2024, https://missilethreat.csis.org/missile/ss-n-30a/.
35. Guardian staff and agencies, "What Do We Know About Russia's 'Experimental' Ballistic Missile?" *Guardian*, November 24, 2024, https://www.theguardian.com/world/2024/nov/22/what-is-ballistic-missile-russia-ukraine-war-irbm-icbm.
36. "Soumar (Hoveyzeh, Abu Mahdi),» Missile Defense Project, Center for Strategic and International Studies, August 9, 2016, last modified April 23, 2024, https://missilethreat.csis.org/missile/soumar/.
37. Michael Knights, "The Houthi War Machine: From Guerrilla War to State Capture," *CTC Sentinel* 11, no. 8 (2018), https://ctc.westpoint.edu/houthi-war-machine-guerrilla-war-state-capture/.
38. US Defense Intelligence Agency, *Iran: Enabling Houthi Attacks across the Middle East*, February 2024, https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Iran_Houthi_Final2.pdf.
39. Colin Demarest, "Houthi Arsenal Shocks the Pentagon's Top Buyer," *Axios*, November 14, 2024, https://www.axios.com/2024/11/14/laplante-houthi-antiship-missiles-iran.
40. Cancian, Cancian, and Heginbotham, *The First Battle of the Next War*; Strobel, "War Game Finds U.S., Taiwan Can Defend;" and Capaccio, "What-If DC War Game."
41. US Navy, *Chief of Naval Operations Navigation Plan 2022*, https://media.defense.gov/2022/Jul/26/2003042389/-1/-1/1/NAVIGATION%20PLAN%202022_SIGNED.PDF.

targets. Under the Conventional Prompt Strike program, the Navy is also developing hypersonic missiles capable of delivering conventional warheads against hardened or time-sensitive targets.[42] Such efforts are mirrored across the US Air Force, Army, and Defense Advanced Research Projects Agency (DARPA) programs,[43] with the Marine Corps also expanding its LRF capabilities to support Joint Force operations.[44] Such initiatives run parallel to plans to procure and scale existing systems, such as the Navy's aim to scale Tomahawk Block V production to an annual rate of six hundred missiles by 2027.[45]

Tomahawk missiles are heavily reliant on numerous critical minerals, especially those used in their guidance and propulsion systems. For example, the rare earth element (REE) neodymium is crucial to the production of neodymium-iron-boron magnets used in precision targeting; Lithium powers thermal batteries; and tungsten's high melting point makes it indispensable for the construction of propulsion nozzles and turbine blades. Other long-range strike systems, such as LRASMs, similarly depend on minerals like gallium and germanium, which are integral to their advanced sensing and digital anti-jam capabilities. Gallium is also integral to LRF-adjacent capabilities such as the US Navy's AN/SPY-6 radar,[46] which supports the sensor-to-shooter kill chain. For hypersonic technologies, niobium, a REE long used in aerospace applications, is crucial. Its ability to withstand extreme stresses and temperatures above two thousand four hundred degrees celsius[47] makes it a critical component in the construction of hypersonic vehicle structures and pipelines.

The United States remains entirely reliant on imports for niobium, which ranked as the second most important mineral on the US Geological Survey's list of critical minerals. Brazil, which controls about 90 percent of the global supply, is the primary source.[48] However, by 2020, Chinese entities had secured control over approximately 26 percent of Brazil's niobium output, raising concerns about China's geopolitical leverage over this vital supply chain.[49] Similarly, the United States is fully dependent on imports for neodymium magnets and gallium, both of which China dominates in global production. In December 2024, China imposed export bans on gallium and germanium to the United States, strengthening restrictions it had begun to enforce the previous year. While the United States imports less than half of its germanium, 54 percent of its foreign supply came from China between 2019 and 2022.[50] While the immediate effects on US supply appear to be limited so far,[51] such actions underscore the vulnerabilities the nation faces in securing materials for US defense technologies.

The United States also is dependent on tungsten imports, with China providing 27 percent of its supply—making it the largest provider.[52] Meanwhile, US reliance on lithium has varied between 25 percent and 50 percent from 2017 to 2023,[53] as efforts to scale domestic lithium production have gained momentum, supported by federal initiatives such as the Inflation Reduction Act (IRA) of 2022, the Department of Energy Loan Programs Office, and the 2021 Bipartisan Infrastructure Law (BIL). According to the USGS, the United States holds up to nineteen million metric tons of unexplored lithium.[54] If these reserves are deemed

42. Kelley M. Sayler, "Hypersonic Weapons: Background and Issues for Congress," Congressional Research Service, January 2, 2025, https://sgp.fas.org/crs/weapons/R45811.pdf.
43. Sayler, "Hypersonic Weapons."
44. Zach Abdi, "US Marines Stand Up First Tomahawk Battery," *Naval News*, July 26, 2023, https://www.navalnews.com/naval-news/2023/07/marines-stand-up-first-tomahawk-battery/.
45. Sayler, "Hypersonic Weapons."
46. "Air and Missile Defense Radar (AMDR) / AN/SPY-6," Missile Defense Project, Center for Strategic and International Studies, last modified June 23, 2021, https://missilethreat.csis.org/defsys/amdr/.
47. Domaille Engineering, "Niobium & C-103: What Makes It Unique for Hypersonics?," accessed November 13, 2024, https://www.domailleengineering.com/niobium-c103-unique-hypersonics/.
48. USGS, *Mineral Commodity Summaries* 2024.
49. Dalton M. McCaffrey et al., "Embedded Critical Material Flow: The Case of Niobium, the United States, and China," *Resources, Conservation and Recycling* 188, January 2023, https://www.sciencedirect.com/science/article/pii/S0921344922005316.
50. USGS, *Mineral Commodity Summaries* 2024.
51. Cullen S. Hendrix, "China's Export Controls on Critical Minerals Aren't Starving the United States—At Least So Far," Peterson Institute for International Economics, October 31, 2024, https://www.piie.com/blogs/realtime-economics/2024/chinas-export-controls-critical-minerals-arent-starving-united-states.
52. USGS, *Mineral Commodity Summaries* 2024.
53. Statista, "Net Import Reliance on Lithium in the United States from 2017 to 2023," accessed December 7, 2024, https://www.statista.com/statistics/1294043/us-net-import-reliance-on-lithium/
54. See, for example: David Blackmon, "New Study Confirms Huge U.S. Lithium Reserve - 9 Times Global Demand," Forbes, October 24, 2024, https://www.forbes.com/sites/davidblackmon/2024/10/24/new-study-confirms-huge-us-lithium-reserve9-times-global-demand/.

viable, they would surpass current global demand. This would not only benefit the US DIB but could open avenues for supply chain and industry cooperation with nations like Zimbabwe and the Democratic Republic of Congo (DRC)—both of which hold lithium reserves and could seek to bypass Chinese processors for other arrangements.

UASs and counter-UAS technologies

A renewed focus on long-range fires would equip the Joint Force with a range of defensive and offensive capabilities tailored to the demands of the global strategic environment. In key regions such as the Indo-Pacific, Middle East, and the Sahel—where maintaining situational awareness and a forward security posture remains a priority despite a reduced US troop presence—unmanned systems have also become increasingly critical. UASs in particular are proving essential for surveillance, reconnaissance, and expanding operational reach. Next-generation UASs such as collaborative combat aircraft (CCAs)—semiautonomous, artificially enabled UASs designed to operate alongside fourth- and fifth-generation crewed fighters, either individually or in swarms—also are being developed for counterair, interdiction, and electronic warfare missions.[55] Observations from ongoing conflicts in Israel, Ukraine, and the Houthis' activities in the Red Sea have further underscored their evolving role in modern warfare[56]—as have advancements in axis-of-authoritarian technologies. For example, in November, China unveiled a drone carrier with a six-ton payload, capable of deploying missiles, bombs, and swarm drones.[57]

In response to such pacing threats, the US Army, Navy, Marine Corps, and Air Force[58] have been steadily integrating UAS technologies into their operational frameworks. For example, in collaboration with California-based DZYNE Technologies, the Air Force Research Laboratory has developed the Ultra Long-Endurance Tactical Reconnaissance Aircraft (ULTRA), a long-range UAS capable of sustaining eighty-hour flights without refueling or landing, while carrying payloads of up to four hundred pounds.[59] Similarly, the Army is advancing its UAS capabilities. In joint exercises with the Philippines in May 2024, for example, the Army's 1st Multidomain Task Force tested the Kraus Hamdani Aerospace K1000 for its sensing capabilities across the electromagnetic spectrum[60]—a domain increasingly critical to modern warfare as it allows for control over communications, navigation, and other vital electronic capabilities. Through its Replicator Initiative,[61] the DoD additionally plans to deploy thousands of low-cost UASs in 2025—though, in a conflict with axis nations, success would likely require tens of thousands of such systems to be scaled.

Such advancements rely heavily on critical minerals, for which the United States remains nearly entirely import-dependent, particularly on China and other axis-of-authoritarian countries. For example, samarium—a key component in samarium-cobalt magnets—ensures stable imaging and precision targeting, while dysprosium enhances magnet durability essential for UAS navigation and flight stability. CCAs and more advanced UASs like the ULTRA additionally depend on tantalum for advanced avionics and artificial intelligence (AI) processors, as well as cobalt and lithium for the lithium-ion batteries that power

55. Benjamin Jensen et al., "Cockpits or Command Center? C2 Options for Collaborative Combat Aircraft," Center for Strategic and International Studies, October 29, 2024, https://www.csis.org/analysis/cockpit-or-command-center-c2-options-collaborative-combat-aircraft.
56. In vast theaters like the Indo-Pacific, however, UASs would likely need to be integrated within broader defense frameworks to ensure maritime superiority. While valuable, UASs alone are unlikely to be effective across such expansive areas. Their development should therefore complement, rather than aim to replace, high-end systems such as fifth-generation aircraft and advanced missile defense.
57. Liu Xuanzun et al., "China Unveils Heavy 'Swarm Carrier' UAV at Airshow," *Global Times*, November 17, 2024, https://www.globaltimes.cn/page/202411/1323238.shtml.
58. See, for example, Daniel M. Gettinger, "The U.S. Army's Small Uncrewed Aircraft Systems," Congressional Research Service, November 26, 2024, https://crsreports.congress.gov/product/pdf/IF/IF12668; Ronald O'Rourke, "Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress," Congressional Research Service, December 19, 2024, https://sgp.fas.org/crs/weapons/R45757.pdf; Andrew Feickert, "The 2024 Army Force Structure Transformation Initiative," August 21, 2024 https://crsreports.congress.gov/product/pdf/R/R47985; and Audrey Decker, "Meet the Air Force's Secretive Long-Range Drone That Flies for Days," *Defense One*, July 2, 2024, https://www.defenseone.com/technology/2024/07/meet-air-forces-secretive-long-range-drone-flies-days/397816/.
59. Decker, "Meet the Air Force's Secretive Long-Range Drone."
60. Jen Judson, "US Army Experiments with Long-Endurance Drones, Balloons in Philippines," *Defense News*, May 13, 2024, https://www.defensenews.com/air/2024/05/13/us-army-experiments-with-long-endurance-drones-balloons-in-philippines/.
61. Deputy Secretary of Defense Kathleen Hicks, "The Urgency to Innovate," US Department of Defense, Keynote Address, August 28, 2023, https://www.defense.gov/News/Speeches/Speech/Article/3507156/deputy-secretary-of-defense-kathleen-hicks-keynote-address-the-urgency-to-innov/.

them. Platinum group metals (PGMs) also are increasingly emerging as key components for UAS power systems.

The United States remains heavily reliant on imports for key PGMs, sourcing 83 percent of its platinum and 37 percent of its palladium from abroad. Russia is the largest supplier of palladium, followed by South Africa.[62] Globally, Russia's Norilsk Nickel dominates palladium production, controlling nearly 40 percent of the world's supply, much of which is exported to China.[63] Moscow's draft federal budget for 2025 underscores plans to further expand its palladium and platinum reserves—Russia is already the world's second-largest producer of platinum—raising concerns that these critical mineral supply chains could become increasingly consolidated within axis-aligned powers. While the United States does produce some PGMs domestically, primarily through the Montana operations of multinational processing group Sibanye-Stillwater, domestic output remains insufficient to meet growing industrial and defense-related demand. Platinum, for instance, is an alternative to tantalum, which the United States imports entirely. In UASs, tantalum is predominantly used in its metallic form, and China supplied 42 percent of US imports in that form between 2019 and 2022. The United States remains similarly vulnerable in REEs, with more than 95 percent import dependence, including for samarium and dysprosium.[65] China accounts for nearly 100 percent of global dysprosium production, most of which is refined at a single facility in Wuxi, near Shanghai.[66]

China also has entrenched its dominance in the global cobalt supply chain, a critical mineral on which the United States is 67 percent import-reliant.[67] Chinese companies have secured significant stakes in three of the world's top cobalt-producing countries: the Democratic Republic of Congo (DRC), Indonesia, and Papua New Guinea. The DRC, responsible for approximately 80 percent of global cobalt production, is of particularly strategic importance. In the southern Katanga region, where nine of the world's ten largest cobalt mines are located, five are owned by Chinese firms.[68] Among these, the CMOC Group holds an outsized role, with an 80 percent stake in the Tenke Fungurume Mine—one of the largest cobalt mines globally[69]—and a 95 percent stake in the Kisanfu Mine, among the highest-grade undeveloped global cobalt deposits.[70] Combined, CMOC controls over one-third of global cobalt supply.[71] In refining, Chinese state-owned enterprises are similarly dominant, processing between 60 percent and 90 percent of global supply.[72] A significant portion of this refined cobalt—67.5 percent[73]—is sourced from the DRC.

The United States, by contrast, has approximately one million tons of identified cobalt resources, primarily concentrated in Minnesota, with additional deposits in Alaska, Idaho, Michigan, Montana, Ohio, and Pennsylvania.[74] In recent years, the DoD has accelerated efforts to support domestic and North American cobalt production under initiatives including the 2021 BIL, the 2022 IRA, and Title III of the Defense Production Act

62. USGS, *Mineral Commodity Summaries* 2024.
63. William Clowes and Yvonne Yue Li, "Palladium Jumps After US Suggests Sanctions on Russian Exports," Bloomberg, October 24, 2024, https://www.bloomberg.com/news/articles/2024-10-23/gold-xauusd-edges-up-after-drop-from-fresh-record-as-bond-yields-rise.
64. "Russia Set to Boost Silver Reserves in Major Precious Metals Strategy Shift," *Jerusalem Post*, October 24, 2024, https://www.jpost.com/business-and-innovation/precious-metals/article-823167.
65. USGS, *Mineral Commodity Summaries* 2024.
66. Keith Bradsher, "China Tightens Its Hold on Minerals Needed to Make Computer Chips," *New York Times*, October 26, 2024, https://www.nytimes.com/2024/10/26/business/china-critical-minerals-semiconductors.html.
67. USGS, *Mineral Commodity Summaries* 2024.
68. Farrell Gregory and Paul J. Milas, "China in the Democratic Republic of the Congo: A New Dynamic in Critical Mineral Procurement," Strategic Studies Institute, US Army War College, October 17, 2024, https://ssi.armywarcollege.edu/SSI-Media/Recent-Publications/Article/3938204/china-in-the-democratic-republic-of-the-congo-a-new-dynamic-in-critical-mineral/.
69. C. Géraude Neema Byamungu, "China's Role in the DR Congo Cobalt Supply Chain: Who's Who?," China Global South Project, October 3, 2024, https://chinaglobalsouth.com/analysis/chinas-role-in-the-dr-congo-cobalt-supply-chain-whos-who/.
70. Jessica Casey, "CMOC's KFM Copper-Cobalt Mine Scheduled to Start Production in 1H23," *Global Mining Review*, July 4, 2022, https://www.globalminingreview.com/mining/04072022/cmocs-kfm-copper-cobalt-mine-scheduled-to-start-production-in-1h23/.
71. Rhiannon Hoyle and Yang Jie, "This Chinese Miner Dominates Global Cobalt Supply. The U.S. Is Crying Foul," *Wall Street Journal*, October 10, 2024, https://www.wsj.com/business/this-chinese-miner-dominates-global-cobalt-supply-the-u-s-is-crying-foul-61b4274b.
72. Brian Deese and Jason Bordoff, "How to Break China's Hold on Batteries and Critical Minerals," *Foreign Policy*, October 4, 2023, https://foreignpolicy.com/2023/10/04/ev-electric-china-us-batteries-critical-minerals-energy-oil-renewable/.
73. Claude Kabemba, "China-Democratic Republic of Congo Relations: From a Beneficial to a Developmental Cooperation," *African Studies Quarterly* 16, no. 3–4, December 2016.
74. USGS, *Mineral Commodity Summaries* 2024.

(DPA).[75] In late 2024, the Biden administration also sought to generate US investor interest in Chemaf, a major non-Chinese cobalt producer in the DRC, which was listed for sale in 2023.[76] The DRC government rejected a bid from China's Norin Mining to purchase the mine in August 2024, signaling Kinshasa's potential intent to reduce China's dominance in its cobalt industry. However, as of this writing, Chemaf remains unsold and North American cobalt supplies remain insufficient to meet rising demand.

Directed energy weapons

Addressing such bottlenecks while simultaneously countering current drone threats and developing countermeasures for future advancements is difficult. This complexity becomes even more pronounced in scenarios where hundreds of UASs could be deployed simultaneously in swarms, overwhelming traditional defenses. The United States currently has limited options to counter such tactics. One approach is the deployment of layered defense systems that integrate radar, laser range finders, and interceptors to detect and neutralize threats across multiple engagement levels. Another emerging solution lies in directed energy weapons (DEWs) that use concentrated energy, such as lasers or microwave beams, to disable drones. While still in the early stages of development and deployment, DEWs have the potential to offer effective counter-UAS capabilities. DEWs also offer potential applications in missile interception and in the degradation or destruction of the electronic systems that underpin A2/AD strategies.[77] In their ability to target electronics, too, DEWs could play a crucial role in countering increasingly advanced EW capabilities wielded by the axis of authoritarians.

China's focus on information and intelligentized warfare underscores the growing significance of EW tactics in securing control of the electromagnetic spectrum (EMS),[78] a critical "maneuver space"[79] for military operations. EW operations are broadly categorized into three functions: electronic support (ES), which includes intelligence, surveillance, and reconnaissance (ISR) activities; electronic protection (EP), focused on threat suppression to prevent EW systems from adversary jamming or deception; and electronic attack (EA), which seeks to neutralize enemy electromagnetic operations, effectively denying them control of the EMS through, for instance, the introduction of deceptive information to mislead or confuse. While such tactics are not new, their sophistication and frequency have increased in recent years amid technological advancements, lower entry barriers, and increased EW collaboration among axis-of-authoritarian states and their proxies, such as that seen between Iran and Russia in 2023.

In response to such vulnerabilities, the DoD in 2020 introduced its Electromagnetic Spectrum Superiority Strategy, designed to synchronize EMS "resources, capabilities, and activities"[80] across the services to secure US operational dominance. A key element of this strategy is the pursuit of "advanced capabilities in directed energy" to "provide future commanders with scalable options to achieve EMS superiority."[81] Reinforcing the strategy, section 232 of the Fiscal Year 2025 NDAA, mandates a five-year plan to enhance the DoD's EMS and EW capabilities, including, notably, expanded "engagement with military partners from developing countries."[82] Further, sections

75. See, for example, US Department of Defense, "Department of Defense Awards $147 Million to Enhance North American Cobalt and Graphite Supply Chains," Press Release, October 20, 2024, https://www.defense.gov/News/Releases/Release/Article/3777044/department-of-defense-awards-147-million-to-enhance-north-american-cobalt-and-g/; US Department of Defense, "DoD Enters Agreement to Expand Domestic Manufacturing and Strengthen US Cobalt Supply Chain," Press Release, June 15, 2023, https://www.defense.gov/News/Releases/Release/Article/3429442/dod-enters-agreement-to-expand-domestic-manufacturing-and-strengthen-us-cobalt/; Leyland Cecco, "U.S. Military Backs Plan for Cobalt Refinery in Canada to Counter China," *Guardian*, August 21, 2024, https://www.theguardian.com/us-news/article/2024/aug/21/us-military-cobalt-refinery-canada; and US Department of Defense, "DoD Awards $7 Million to Enhance Domestic Nickel and Cobalt Supply Chains," Press Release, August 30, 2024, https://www.defense.gov/News/Releases/Release/Article/3708859/dod-awards-7-million-to-enhance-domestic-nickel-and-cobalt-supply-chains/.
76. Alexandra Wexler and Julie Steinberg, "How the U.S. Is Trying to Challenge China's Cobalt Chokehold," *Wall Street Journal*, October 15, 2024, https://www.wsj.com/world/africa/american-companies-cobalt-mine-congo-china-ff5a1560?mod=WTRN_pos1&cx_testId=3&cx_testVariant=cx_166&cx_artPos=0.
77. Mark Gunzinger and Chris Dougherty, "Changing the Game: The Promise of Directed-Energy Weapons," Center for Strategic and Budgetary Assessments, 2012, https://csbaonline.org/uploads/documents/CSBA_ChangingTheGame_ereader.pdf.
78. The EMS is organized by frequency bands, including radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, x-rays, and gamma rays.
79. US Department of the Army, FM 3-12: *Cyberspace Operations and Electromagnetic Warfare*, August 24, 2021, https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN33127-FM_3-12-000-WEB-1.pdf.
80. US Department of Defense, *Electromagnetic Spectrum Superiority Strategy*, October 2020.
81. US Department of Defense, *Electromagnetic Spectrum Superiority Strategy*.
82. NDAA for Fiscal Year 2025, S. 4638, 118th Cong. (2023–2024), § 232(b)(5).

246 and 247 extend the DoD's Directed Energy Working Group, first established in 2020, and advance the Directed Energy Roadmap to 2031.[83] Washington regards DEWs as a transformative technology for US national security.[84] They are rapidly being developed by the US Air Force, Navy, and Army.

DEWs include high-energy laser (HEL) and high-powered microwave (HPM) weapons. While HELs focus a concentrated beam of energy to heat and melt a target, HPMs disrupt the communications systems and electronics of targets without necessarily causing physical damage. The Air Force's Tactical High-Power Operational Responder (THOR), a HPM counter-UAS system designed to neutralize drone swarms in close-range point defense scenarios, is an example of the latter. During tests conducted by the Air Force Research Laboratory in 2023, THOR successfully disabled multiple drones simultaneously, showcasing its effectiveness in degrading adversary ISR operations.[85] Other Air Force programs such as the Counter-Electronics High Power Microwave Advanced Missile Project (CHAMP)[86] and Counter-Electronic High Power Microwave Extended-Range Air Base Defense (CHIMERA), are also designed for EW. Similarly, the Army is advancing its Indirect Fires Protection Capability High-Powered Microwave (IFPC-HPM) system[87] to address threats posed by Group 1 and Group 2 UASs.[88] Meanwhile, the Navy intends to mount its HPM-based counter-air defense system, METEOR, on one of its vessels as early as 2026.[89]

The first DEW installed by the Navy was a thirty-kilowatt (kW) laser system capable of neutralizing small surface vessels and UASs on the USS *Ponce* in 2014.[90] Since then, the Navy has expanded its efforts to develop more advanced solid-state and fiber-based HELs that could potentially counter sophisticated weapon systems like China's GDF-600 hypersonic vehicle.[91] For example, the Optical Dazzling Interdictor, Navy (ODIN), a solid-state laser designed for counter-ISR missions, emits a high-intensity beam to neutralize UAS sensors. It has been installed on eight Arleigh Burke-class destroyers as of August 2024.[92] The High-Energy Laser with Integrated Optical-dazzler and Surveillance (HELIOS), deployed on the USS *Preble*, similarly combines a 60 kW laser, scalable to 120 kW,[93] with integrated tracking and surveillance systems. HELIOS is designed for countering UASs, ISR operations, and fast inshore attack craft.

The Army and Air Force are also expanding their HEL capabilities. In February 2024, the Army deployed four Directed Energy Maneuver-Short Range Air Defense (DE-SHORAD) prototypes to the Middle East for operational testing. These systems integrate a fifty-kilowatt laser onto Stryker vehicles to counter Group 1 and Group

83. NDAA for Fiscal Year 2025, S. 4638, 118th Cong. (2023–2024), § 246, § 247.

84. See, for example, House Armed Services Committee, US House of Representatives, *Future of Defense Task Force Report* 2020, https://houlahan.house.gov/uploadedfiles/future-of-defense-task-force-final-report-2020.pdf.

85. 1st Lt. Nina Rogers, "AFRL Conducts Swarm Technology Demonstration," Public Affairs, Air Force Research Laboratory Public Affairs, May 16, 2023, https://www.afrl.af.mil/News/Article-Display/Article/3396995/afrl-conducts-swarm-technology-demonstration/.

86. Kelsey D. Atherton, "The Military Is Testing a Weapon That Aims to Destroy Electronics, Not Buildings," *Popular Science*, July 12, 2022, https://www.popsci.com/technology/weapon-targets-electronics/.

87. See, for example, US Department of Defense, *Fiscal Year* (FY) 2023 *Budget Estimates*, April 2022, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2023/Base%20Budget/rdte/vol_2-Budget_Activity_4.pdf; and Ashley Roque, "Army Tweaking New High-Power Microwave Prototype Before CENTCOM Testing Begins," *Breaking Defense*, August 8, 2024, https://breakingdefense.com/2024/08/army-tweaking-new-high-power-microwave-prototype-before-centcom-testing-begins/.

88. Group 1 UAS are "typically hand-launched, portable systems," while Group 2 are "typically medium-sized, catapult-launched mobile systems." For additional information about UAS groups, see, for example: US Army UAS Center of Excellence, *Eyes of the Army: U.S. Army Roadmap for Unmanned Aircraft Systems 2010–2035*, 12–13, https://irp.fas.org/program/collect/uas-army.pdf.

89. Zach Abdi, "Navy to Test Microwave Anti-Drone Weapon at Sea in 2026," US Naval Institute, March 27, 2024, https://news.usni.org/2024/03/27/navy-to-test-microwave-anti-drone-weapon-at-sea-in-2026.

90. Sam LaGrone, «U.S. Navy Allowed to Use Persian Gulf Laser for Defense," US Naval Institute, December 10, 2014, https://news.usni.org/2014/12/10/u-s-navy-allowed-use-persian-gulf-laser-defense.

91. Gabriel Honrada, "China's New Hypersonic Weapon Could Black Out US, Taiwan," *Asia Times*, November 13, 2024, https://asiatimes.com/2024/11/chinas-new-hypersonic-weapon-could-black-out-us-taiwan/.

92. Ronald O'Rourke, "Navy Shipboard Lasers: Background and Issues for Congress," Congressional Research Service, December 19, 2024, https://sgp.fas.org/crs/weapons/R44175.pdf.

93. Richard R. Burgess, "HELIOS Laser Weapon System Delivered for Installation on *USS Preble," Seapower*, March 31, 2022, https://seapowermagazine.org/helios-laser-weapon-system-delivered-for-installation-on-uss-preble/.

3 UASs, as well as incoming rockets, artillery, and mortar fire.[94] In April, the Army also deployed a 20 kW Palletized HEL to an undisclosed overseas location, where the system reportedly demonstrated success in certain fixed-site defense scenarios.[95] This was the first publicly acknowledged deployment of a DEW system for air defense in US military history. Yet the continued development and expansion of HPM and HEL capabilities is contingent on the steady supply of minerals, including lithium, graphite, cobalt, manganese, and nickel, which are essential for the power sources that drive these systems. Aluminum is additionally crucial for HPM antennas that connect systems to their targets, while copper is essential for the thermal systems and electrical wiring in HELs due to its superior conductivity. Barium titanate, a synthetic compound derived from barite and titanium processing, is also used in generators within pulsed-wave HPMs, which emit precise bursts of microwave energy.[96]

In 2023, the United States depended on imports of refined copper for 46 percent of its domestic demand. Yet with that demand projected to double by 2035, this reliance could increase to as much as 67 percent.[97] Compounding this vulnerability is China's dominance in the global copper supply chain, particularly in downstream processing. Since 2019, China has been responsible for 97 percent of global additions in smelting and refining capacity—80 percent in semimanufactured products.[98] Chinese companies also control 84 percent of nickel output in Indonesia, the world's largest nickel producer.[99] The United States is more than 50 percent import-reliant on its nickel supply.[100] Such reliance extends to other critical minerals crucial for the production of HELs and HPMs, including germanium—essential for infrared optics—titanium, barite, manganese, and graphite. The United States imports more than 75 percent of its barite and titanium and is fully reliant on foreign sources for graphite and manganese.[101] Between 2019 and 2022, nearly half of all US graphite imports came from China, which accounts for around 77 percent of global graphite production.[102]

94. Ashley Roque, "Strykers with 50-Kilowatt Lasers in CENTCOM for Experiment, Army No. 2 Says," *Breaking Defense*, March 1, 2024, https://breakingdefense.com/2024/03/exclusive-strykers-with-50-kilowatt-lasers-in-centcom-for-experiment-army-no-2-says/.
95. Jared Keller, "The Army Has Officially Deployed Laser Weapons Overseas to Combat Enemy Drones," *Military.com*, April 24, 2024, https://www.military.com/daily-news/2024/04/24/army-has-officially-deployed-laser-weapons-overseas-combat-enemy-drones.html.
96. There are two primary types for HPM weapons: pulsed wave and continuous. Continuous-wave HPMs deliver a constant stream of microwave energy in a wide area. For more information, see Major Jack McGonegal, "High Power Microwave Weapons: Disruptive Technology for the Future," Air Command and Staff College, 2020, https://apps.dtic.mil/sti/pdfs/AD1107488.pdf.
97. S&P Global, *The Future of Copper: Will the Looming Supply Gap Short-Circuit the Energy Transition*, July 2022, https://cdn.ihsmarkit.com/www/pdf/0722/The-Future-of-Copper_Full-Report_14July2022.pdf.
98. Nick Pickens et. al., *Securing Copper Supply: No China, No Energy Transition*, Wood Mackenzie, August 2024, https://www.woodmac.com/siteassets/horizons/2024/august-2024/horizons_aug-2024-whitepaper-final.pdf.
99. Karan Bhuwalka and Elsa Olivetti, *Nickel Market Dynamics and the Security of the Battery Supply Chain*, Strauss Center, September 9, 2024, https://www.strausscenter.org/wp-content/uploads/Nickel_Memo_Bhuwalka_Olivetti-Google-Docs.pdf.
100. USGS, *Mineral Commodity Summaries* 2024.
101. USGS, *Mineral Commodity Summaries* 2024.
102. USGS, *Mineral Commodity Summaries* 2024.

Section 2

Shared defense priorities for African self-defense

Of the total manganese that the United States imported between 2019 and 2022—including what is used in the production of HPMs—62 percent originated from Gabon, while another 24 percent came from South Africa.[103] Africa as a whole is estimated to hold as much as 85 percent of global manganese reserves,[104] with the majority concentrated in South Africa, Gabon, Ghana, and Côte d'Ivoire. Overall, the continent is home to approximately one-third of the world's critical minerals, including many essential to US defense capabilities. South Africa alone accounts for more than 80 percent of global PGM reserves. Africa also holds 21 percent of global graphite reserves and six percent of global copper reserves.[105] Though not yet a major lithium producer, Zimbabwe, along with the DRC and Mali, also possess substantial untapped lithium deposits.[106] Table 1 highlights the distribution of these reserves across African countries as of 2024, mapping their relevance to US defense priorities.

Africa holds considerable potential as a strategic partner for the United States in securing critical minerals essential to the DIB. It also faces many of the same geopolitical challenges that confront the United States, including those emanating from China and its axis-of-authoritarian partners, and so requires similar defense capabilities to address and parry them, including UASs and advanced electronic warfare technologies. To date, many of these systems have been imported, with China, Russia, and Iran often serving as key suppliers. Yet, a growing number of African nations—including those rich in minerals critical to US defense priorities—have begun to express growing unease about the strategic implications of such partnerships for national sovereignty and regional stability. For example, in Zambia—which accounted for 6.22 percent of China's total $9.32 billion in arms exports to Africa between 2010 and 2021[107]—the deployment of Huawei- and ZTE-operated surveillance and e-policing systems has enabled China's information warfare activities in the country.[108] Russia, too, is active in this regard.[109] China has also flown UASs, including its CH-3 midrange combat and reconnaissance drones, over Zambian airspace, purportedly for mineral prospecting.[110] This has raised concerns over China's surveillance and information warfare in the country, as well as the broader potential for Chinese drones to exacerbate regional conflicts, such as that between the DRC and Rwanda.[111] The overthrow of Syria's Bashar al-Assad, a key Russian client, and the potential loss of Moscow's naval base in Tartus, has additionally underscored the limits of what Russia and its axis partners can reasonably offer.[112]

103. USGS, *Mineral Commodity Summaries* 2024.
104. Baskaran, "Prospects for U.S. Minerals Engagement."
105. Baskaran, "Prospects for U.S. Minerals Engagement."
106. International Monetary Fund, "Digging for Opportunity: Harnessing Sub-Saharan Africa's Wealth in Critical Minerals," in *Regional Economic Outlook: Sub-Saharan Africa—A Tepid and Pricey Recovery*, April 2024.
107. Amin Mohseni-Cheraghlou and Naomi Aladekoba, "China in Sub-Saharan Africa: Reaching Far Beyond Natural Resources," Issue Brief, Geoeconomics Center, Atlantic Council, March 2023, https://www.atlanticcouncil.org/wp-content/uploads/2023/03/China-in-Sub-Saharan-Africa-Reaching-far-beyond-natural-resources.pdf.
108. See, for example, Dani Madrid-Morales et al., "The Geopolitics of Disinformation: Worldviews Media Consumption and the Adoption of Global Strategic Disinformation Narratives," *International Journal of Public Opinion Research* 36, no. 3 (2024); and Sarah Chiumbu, *Chinese Digital Infrastructure, Smart Cities and Surveillance in Zambia*, Media Policy and Democracy Project, November 2021, https://www.mediaanddemocracy.com/uploads/1/6/5/7/16577624/zambia_report.pdf.
109. Chiumbu, *Chinese Digital Infrastructure*.
110. Zhao Lei, "Chinese Drones Assist African Mine Surveying," China Daily, August 26, 2017, https://www.chinadaily.com.cn/china/2017-08/26/content_31133820.htm#:~:text=The%20China%20Academy%20of%20Aerospace%20Aerodynamics%20refitted%20several%20of%20its,of%20Zambia%20since%20mid%2DJuly.
111. Robert Bociaga, "China Sends Military Drones to DRC Amid Fears of Regional War," *Diplomat*, March 20, 2023, https://thediplomat.com/2023/03/china-sends-military-drones-to-drc-amid-fears-of-regional-war/.
112. See, for example, "Russian Ships Return to Syrian Base Ahead of Expected Withdrawal," BBC, January 23, 2025, https://www.bbc.com/news/articles/c14nk475nd5o; and "Syria Cancels Port Management Contract with Russian Firm, Sources Say," Reuters, January 24, 2025, https://www.reuters.com/world/middle-east/syria-cancels-port-management-contract-with-russian-firm-sources-say-2025-01-24/.

Table 1. The US economy relies heavily on African critical minerals for defense applications

US IMPORT RELIANCE	MINERAL	DEFENSE APPLICATION	MINERAL DEPOSITS IN AFRICA	CHINA LEADS PRODUCTION	CHINESE SHARE OF WORLD PRODUCTION
100%	ARSENIC, all forms	Semiconductors, lumber	Morocco		
100%	CESIUM	Research, development	Namibia, Zimbabwe		
100%	FLUORSPAR	Manufacture of aluminum, cement, steel, gasoline	South Africa	●	65%
100%	GRAPHITE (natural)	Lubricants, batteries	Madagascar, Tanzania, Mozambique	●	77%
100%	MANGANESE	Steelmaking, batteries	Côte d'Ivoire, Gabon, Ghana, South Africa		
100%	NIOBIUM (COLUMBIUM)	Steel, superalloys	Rwanda, DRC, Mozambique		
100%	RUBIDIUM	Research, development in electronics	Namibia		
100%	SCANDIUM	Alloys, ceramics, fuel cells	Guinea, Madagascar, South Africa	●	n/a
100%	TANTALUM	Electronics, components, superalloys	Burundi, DRC, Ethiopia, Mozambique, Rwanda Zimbabwe		
>95%	TITANIUM, sponge metal	White pigment, metal alloys	Kenya	●	67%
83%	PLATINUM	Catalytic converters	South Africa, Zimbabwe		
82%	ANTIMONY, metal and oxide	Lead-acid batteries, flame retardants	South Africa	●	48%
77%	ZINC	Metallurgy to produce galvanized steel	Zambia, Zimbabwe, Madagascar, South Africa, Côte d'Ivoire		
>75%	BARITE	Hydrocarbon production	Morocco		
75%	TITANIUM, mineral concentrates	White pigment, metal alloys	Mozambique, Senegal, Kenya	●	n/a
74%	CHROMIUM	Stainless steel	South Africa		
74%	TIN	Coatings, alloys for steel	DRC, Nigeria, Rwanda	●	23%
67%	COBALT	Rechargeable batteries, superalloys	DRC, South Africa, Zambia		
57%	NICKEL	Stainless steel rechargeable batteries	South Africa Madagascar, Zimbabwe, Zambia		
>50%	TUNGSTEN	Wear-resistant metals	Rwanda	●	81%

Source: United States Geological Survey (USGS) Mineral Commodity Summaries 2024 (Reston, VA: USGA, 2024), 7 (figure 2), 23 (table 5), https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf; and Cliff D. Taylor et al., Geology and Nonfuel Mineral Deposits of Africa and the Middle East (Reston, VA: USGS, 2009).

In April 2024, Zambia and North Carolina signed a US National Guard State Partnership Program (SPP) agreement, which facilitates joint exercises in air defense, disaster response, logistics management, and cybersecurity cooperation. That same year, the US Cyber Command's Cyber National Mission Force conducted its first-ever defensive cyber deployment to Zambia, working with the Zambian Information Communication Technology Authority to identify and counter malicious threats.[113] Zambian President Hakainde Hichilema has prioritized strengthening Zambia's domestic defense sector, advancing plans to establish a National Defense University and develop a domestic arms industry, including UAS production capabilities.[114] Zambia is not alone in its steady pivot away from axis-of-authoritarian states, with other African nations also increasingly seeking to diversify their defense partnerships and develop indigenous defense capabilities. For this, their own mineral resources are needed. This offers a timely opportunity for the United States to strategically align Africa's resource development and defense industrial needs with its own strategic interests, securing access to minerals vital for the US DIB and its priorities.

African drones for African challenges

Much like the United States, many African governments have recognized the growing strategic importance of UASs in modern warfare and have begun to integrate them into their defense arsenals. For example, Ethiopia successfully leveraged such capabilities during its 2020–2022 war against the Tigray People's Liberation Front, deploying platforms such as Iran's Mohajer-6 UAS and Turkey's Bayraktar TB2 armed drones to shift the battlefield dynamic in its favor.[115] Nigeria also has incorporated UASs into its counterinsurgency campaigns against Boko Haram, which has itself demonstrated the ability to field drones. Much of Africa's UAS capabilities remain imported, with China accounting for more than a quarter of the continent's acquisitions.[116] Yet a growing number of governments have also begun to focus on developing domestic UAS capabilities. As of May 2024, approximately 180 locally produced UASs were operational across Africa, the majority of them fixed-wing designs,[117] which are particularly well-suited for long-range, long-endurance missions such as maritime surveillance and border patrol—critical applications in Africa's evolving security landscape.

Ethiopia and Nigeria are among the African nations actively pursuing domestic UAS production, each at different stages of development. In 2010, Ethiopia launched its Negash medium-altitude long-endurance (MALE) program, led by the Metal and Engineering Corporation in partnership with Turkey's Milyaz.[118] While the project was abandoned in 2015 and details remain scarce, it appears to have laid the foundation for subsequent UAS initiatives. Among these, Ethiopia's Dejen Aviation Engineering Industry (DAVI), responsible for maintaining and upgrading the Ethiopian Air Force's fleet, is believed to be developing domestic variants of Israel's WanderB mini-UAS—domestically designated as the MDAV-1. These lightweight, fixed-wing systems, initially acquired in 2010 to establish Ethiopia's

113. Cyber National Mission Force Public Affairs, "CNMF Deploys First Defensive Cyber Team to Zambia," US Cyber Command, May 22, 2024, https://www.cybercom.mil/Media/News/Article/3783991/cnmf-deploys-first-defensive-cyber-team-to-zambia/.

114. See, for example, "President Hichilema Launches 'The Art of War and Peace' at Defence Services Command and Staff College," *Lusaka Times*, November 20, 2024, https://www.lusakatimes.com/2024/11/20/president-hichilema-launches-the-art-of-war-and-peace-at-defence-services-command-and-staff-college/; Paul Shalala, "National Defence University to be Actualised," ZNBC, November 19, 2024, https://znbc.co.zm/news/national-defence-university-to-be-actualised/; Augustine Sichula, "Zambia Set to Establish a Centre for Manufacture of Drones," *Zambia Monitor*, September 22, 2023, https://www.zambiamonitor.com/zambia-set-to-establish-a-centre-for-manufacture-of-drones/; and "Zambia Seeks Indian Help in Manufacture of Small Arms, Ammunition," *Hindu*, October 21, 2023, https://www.thehindu.com/news/national/zambia-seeks-indian-help-in-manufacture-of-small-arms-ammunition/article67443033.ece.

115. See, for example, Declan Walsh, "Foreign Drones Tip the Balance in Ethiopia's Civil War," *New York Times*, December 20, 2021, https://www.nytimes.com/2021/12/20/world/africa/drones-ethiopia-war-turkey-emirates.html.

116. See, for example, Military Africa, *Complete African Drone Procurement Data*, 1980–2024, https://www.military.africa/wp-content/uploads/2024/04/complete-african-drone-procurement-dataset.pdf; Stockholm International Peace Research Institute, "SIPRI Arms Transfers Database," accessed December 4, 2024, https://www.sipri.org/databases/armstransfers.

117. Military Africa, *Complete African Drone Procurement Data*, 1980–2024.

118. See, for example, Stijn Mitzer and Joost Oliemans, "Missed Opportunities: Ethiopia's MALE UAV Programme," *ORYX*, August 20, 2021, https://www.oryxspioenkop.com/2021/08/missed-opportunities-ethiopias-male-uav.html; and Conrad Onyango, "Arms Race: Made-in-Africa Military Drones on the Rise," Bird Story Agency, May 2, 2024, https://africasolutionsmediahub.org/2024/05/02/arms-race-made-in-africa-military-drones-on-the-rise/.

first UAS regiment,[119] are intended primarily for ISR missions. In East Africa, Kenya has also made notable progress in developing its own UAS capabilities, also largely for ISR applications. In collaboration with the Kenya Industrial Research and Development Institute, Kenya's military has successfully reverse-engineered Israel's Aerostar UAS, a medium-altitude, long-endurance system for tactical surveillance. The model, renamed TAI, was unveiled in 2021.[120] Other countries in the region, notably Rwanda, are pursuing similar capabilities.[121]

Israel's Aerostar was Nigeria's first operationally deployed UAS, with nine units purchased in 2006 from Aeronautics Defense Systems to support maritime patrol and ISR operations during the Niger Delta crisis.[122] Since then, Nigeria has emerged as Africa's second-largest producer of domestically made UASs, after South Africa. Nigeria's UAS development began in 2008 through collaboration with the Aerospace Engineering Student Officer Research Project at Britain's Cranfield University, resulting in the Amebo UAS. While the Amebo lacked autopilot and ISR capabilities, it was a critical step toward more advanced systems. In 2013, the Nigerian Air Force Institute of Technology introduced the Gulma, an experimental UAS, and in 2018, the Tsaigumi was launched by the Nigeria Air Force Research and Development Center in collaboration with Portugal's UAVision.[123] The Tsaigumi is designed for ISR, with ten hours of endurance and a range of up to six hundred and twenty miles (998 kilometers).[124] Many of its key components, including electro-optical forward-looking infrared (EO FLIR) sensors, an inertial navigation system (INS), and its lithium-based batteries, are sourced from China, the United States, Israel, and South Korea. These components rely heavily on critical minerals—tantalum, lithium, cobalt, nickel, and copper—which Nigeria itself holds in reserve.

Indeed, the paradox for countries like Nigeria, Kenya, and Ethiopia in their pursuit of domestic defense capabilities is that they must first export the critical minerals required for their technological advancement. These minerals are processed and refined abroad before being reimported as components for the very systems these nations seek to produce locally. A notable exception has been South Africa, which has historically leveraged its mineral reserves to boost its defense capabilities. South Africa holds approximately 91 percent of the world's PGMs, 40 percent of manganese, significant quantities of antimony, and roughly seven hundred and ninety thousand tons of rare earths,[125] more than 10 percent found in its Steenkampskraal Mine.[126] It is also Africa's leading UAS producer, with firms like Milkor and Denel Dynamics producing advanced systems.

South Africa deployed its first operational drone, the "Champion," in 1978, developed by the Council for Scientific and Industrial Research (CSIR) in collaboration with Denel, then known as Kentron. Designed for surveillance during the Rhodesian Bush War, the Champion featured a lightweight airframe with twin tail sections and a rear-facing propeller powered by a two-stroke engine.[127] Four units were produced, and at least two remained in service with the South African Air Force as training aircraft until the 1980s. Today, Denel is Africa's largest UAS manufacturer, producing platforms like the Seeker 400 and its latest rotary-wing UAS (RW-UAS), introduced in October 2024. The Seeker 400 is a multirole fixed-wing drone primarily designed for ISR, with a payload capacity of up to two hundred and twenty pounds (one hundred kilograms). Equipped with advanced systems, including infrared thermal cameras, electronic surveillance technology, and artillery fire control capabilities,[128] it is best suited for long-range operations. The new RW-UAS, which offers similar

119. Stijn Mitzer and Joost Oliemans, "The Israel Connection–Ethiopia's Other UAVs," *ORYX*, August 23, 2021, https://www.oryxspioenkop.com/2021/08/the-israel-connection-ethiopias-other.html.
120. Conrad Onyango, "Arms Race: Made-in-Africa Military Drones on the Rise."
121. See, for example, Emmanuel Ntirenganya, "Rwanda Earmarks Funds to Set Up Drone Operation Centre," *New Times*, May 30, 2024, https://www.newtimes.co.rw/article/17208/news/technology/rwanda-earmarks-funds-to-set-up-drone-operation-centre.
122. David Oliver, "Pioneering Unmanned Fleet in Sub-Saharan Africa," *Times Aerospace*, March 20, 2024, https://www.timesaerospace.aero/features/defence/pioneering-unmanned-fleet-in-sub-saharan-africa.
123. Oliver, "Pioneering Unmanned Fleet."
124. "Nigerian Air Force Inducts Tsaigumi Local-Made Drone," *Global Defense News*, November 6, 2023, https://armyrecognition.com/news/aerospace-news/2023/nigeria-air-force-integrates-tsaigumi-local-made-drone.
125. USGS, *Mineral Commodity Summaries* 2024.
126. Gracelin Baskaran, "Could Africa Replace China as the World's Source of Rare Earth Elements?," Brookings Institution, December 29, 2022, https://www.brookings.edu/articles/could-africa-replace-china-as-the-worlds-source-of-rare-earth-elements/.
127. Darren Olivier, "A History of South African UAVs," *African Defense Review*, August 5, 2015, https://www.africandefence.net/a-history-of-south-african-uavs/.
128. Airforce Technology, "Seeker 400 Unmanned Aerial Vehicle Surveillance System," August 24, 2014, https://www.airforce-technology.com/projects/seeker-400-uav/.

capabilities, is, on the other hand, tailored for short-range, high-precision tasks such as area surveillance and border patrol.[129] It is likely to be integrated into South Africa's recently formed Border Management Authority, part of President Cyril Ramaphosa's efforts to enhance the country's border and maritime security.

More broadly, such efforts reflect a wider strategy to strengthen South Africa's defense self-reliance, as outlined in the latest South African Department of Defense's 2020–2025 Strategic Plan. The plan acknowledges a global strategic environment characterized by "international terrorism," "information warfare," "hybrid forms of conflict," and "maritime threats [including] piracy, terrorism, illegal fishing, and uncontrolled migration"[130]—challenges like those confronted by the United States, many of which originate from China and its axis-of-authoritarian partners. The Iran-sponsored Red Sea crisis, for instance, has resulted in a 74 percent increase in maritime shipping traffic around the Cape of Good Hope, straining South Africa's maritime resources.[131] South African authorities have previously impounded Chinese vessels for illegal squid fishing within its vast 1.8 million-square-kilometer exclusive economic zone, and have endured CCP-linked cyberattacks targeting its telecommunications and financial infrastructure. While South Africa is a member of the Chinese-led BRICS bloc and conducts joint naval exercises with Beijing and Moscow, its relations with China in particular are more nuanced than is often presumed, particularly in the context of its national security priorities and Pretoria's desire for greater self-sufficiency in defense.

Yet South Africa's mining sector has been in steady decline over the past three decades, burdened by a combination of currency volatility, inflationary pressures, unreliable energy supplies, deteriorating infrastructure, and cumbersome regulatory frameworks. This has raised concerns over the sector's ability to continue to support South Africa's DIB and foster the technological innovation necessary to remain competitive in the current global strategic environment. The South African Navy's surveillance systems, for instance, are outdated, limiting its maritime domain awareness capabilities.[132] UASs could offer a solution. Yet in the absence of decisive reforms and renewed investment, South Africa's PGM industry—crucial for UAS production—may have less than thirty years of viability remaining. The country's iron ore reserves could be depleted within thirteen years unless new deposits are identified and developed.[133]

In response, South Africa has increasingly sought to strengthen its public and private international partnerships across its critical minerals value chain. For example, to bolster operational resilience, South African mining firms have begun to diversify their strategies. A notable example is Sibanye-Stillwater's $1.2 billion acquisition of US recycling firm Reldan in March 2024. Reldan specializes in reprocessing industrial and electronic waste to recover metals like silver, platinum, and palladium, offering Sibanye-Stillwater a cost-effective and sustainable source of these minerals. This move could reduce South Africa's reliance on traditional mining operations and mitigate supply chain disruptions, ensuring a more reliable flow of materials for defense-related production. The US International Development Finance Corporation (DFC) has also invested $75 million in equity to support the Phalaborwa Rare Earth Project, which is being developed by the British-based company Rainbow Rare Earths.[134] The project aims to reprocess thirty five million tons of gypsum waste from legacy mining operations to extract and process neodymium, dysprosium, and praseodymium—all essential for UAS production. Outputs from Phalaborwa are shipped to the project's back end in Florida for processing into high-purity separated magnet rare earth oxides,[135] such as neodymium oxide, a core element in DEWs.

129. "Denel Launches New Rotary Wing UAV," *defenceWeb*, October 18, 2024, https://www.defenceweb.co.za/aerospace/aerospace-aerospace/denel-launches-new-rotary-wing-uav/.
130. Department of Defence, Republic of South Africa, *Department of Defence Strategic Plan for 2020–2025*.
131. Dean Wingrin, "South African Navy Calls for Regional Maritime Security Cooperation," *defenceWeb*, September 11, 2024, https://www.defenceweb.co.za/featured/south-african-navy-calls-for-regional-maritime-security-cooperation/.
132. See, for example, Dean Wingrin, "SA Navy Struggles to Counter Maritime Threats amid Severe Underfunding," *defenceWeb*, October 7, 2024, https://www.defenceweb.co.za/editors-pick/sa-navy-struggles-to-counter-maritime-threats-amid-severe-underfunding; Africa Defense Forum, "Years of Budget Cuts Leave South Africa's Navy Struggling to Stay Afloat," October 31, 2024, https://adf-magazine.com/2024/10/years-of-budget-cuts-leave-south-africas-navy-struggling-to-stay-afloat/; and Timothy Walker and Denys Reva, *South Africa's Maritime Domain Awareness: A Capability Baseline Assessment*, Institute for Security Studies, August 2020.
133. PricewaterhouseCoopers, SA Mining 2023: *Adapt to Thrive*, October, https://www.pwc.co.za/en/assets/pdf/sa-mine-2023-v3.pdf.
134. Mining Technology, "TechMet Receives $50m Critical Minerals Investment Commitment from DFC," December 4, 2023, https://www.mining-technology.com/news/techmet-50m-dfc/.
135. Cecilia Jamasmie, "Rainbow Rare Earths Reaches Deal for 100% of Phalaborwa," *Mining.com*, June 28, 2023, https://www.mining.com/rainbow-rare-earths-reaches-deal-for-100-of-phalaborwa/.

Fighting in the information and maritime domains

From late May to early August 2024, the Rwanda Defence Force (RDF) and the Mouvement du 23 Mars (M23), its ally in the ongoing conflict with the DRC, deployed electronic warfare systems to disrupt and spoof GPS signals in eastern Congo. One system targeted areas over Goma, the North Kivu capital and main base of the Armed Forces of the DRC (FARDC), while another was deployed approximately sixty miles (ninety-eight kilometers) south of Rwanda's Kamembe Airport,[136] reportedly disrupting humanitarian and civilian flights entering eastern DRC.[137] Elsewhere, during the Second Libyan Civil War (2014–2020), the interim Government of National Accord deployed Turkish Koral EW systems to counter Chinese Wing Loong II drones provided to the Libyan National Army by the United Arab Emirates.[138] Nigeria has also used EW capabilities in its fight against Boko Haram, while the conflict between the Sudanese Armed Forces and the paramilitary Rapid Support Force has been largely fueled by disinformation operations.

Electronic warfare and the contest for EMS superiority are growing in importance, not only in great power rivalries but also within Africa's strategic landscape. In response, countries including Nigeria, Angola, Ethiopia, South Africa, and Ghana have increasingly begun to focus on acquiring or developing EW capabilities to safeguard their infrastructures and boost national security. For example, in September 2023, the Ghana Armed Forces (GAF) announced plans to form a Directorate of Cyber and Electronic Warfare Operations within its organizational framework, with the aim of securing the country's critical information systems and military assets. Ghana is one of sixteen African countries to have ratified the African Union Convention on Cyber Security and Personal Data Protection (referred to as the Malabo Convention), as of August 2024. The directorate's formation is part of Ghana's wider National Cybersecurity Policy and Strategy (2023–2027), which builds upon the Cybersecurity Act of 2020 to define the technological, legal, organizational, and global partnership measures necessary to counter cyber threats. Reflecting the aim of self-reliance set forth in Ghana's National Security Strategy, the policy calls for the "development of national capabilities in defensive cybersecurity towards self-reliance" and a "local cybersecurity industry."[139]

While Ghana's cyber and EW capabilities remain less advanced than those of regional leaders like Nigeria and South Africa—the latter of which has been developing indigenous EW technologies since the 1970s through companies such as Hensoldt South Africa, Denel, Paramount Group, Sysdel, and CSIR—Ghana has been making significant strides in acquiring capabilities in signals intelligence (SIGINT), EA systems for spoofing and jamming, and EMS control technologies. For example, the GAF has secured nineteen Guarani 6x6 armored personnel carriers from Israel's Elbit Systems, equipped with Remax remote weapon systems for enhanced night and thermal vision and E-LynX communication systems.[140] The E-LynX system offers dynamic frequency hopping and adaptable communication frequencies, both critical for effective EMS control in complex operational environments. Ghana has also sourced SIGNT and EW technologies from Germany and elsewhere in the European Union, the United Arab Emirates (UAE), as well as China, reflecting a diversified approach to strengthening its security and defense. While much of Ghana's recent acquisitions have primarily focused on land-based warfare, the country has also emphasized the integration of EW technologies for maritime security, as outlined in its latest National Integrated Maritime Strategy.[141]

136. Jeremy Binnie, "Rwanda Using Electronic Warfare Systems in DRC," *Janes*, January 9, 2025, https://www.janes.com/osint-insights/defence-news/rwanda-using-electronic-warfare-systems-in-drc.

137. Basillioh Rukanga, "DR Congo Accuses Rwanda of Jamming Flights," BBC News, July 30, 2024, https://www.bbc.com/news/articles/c19kxg3vz8eo.

138. See, for example, Lee Jeong-ho, "Chinese-Made Missiles and Drones Used in Libya Conflict, UN Experts Find," *South China Morning Post*, May 7, 2019, https://www.scmp.com/news/china/military/article/3009199/chinese-made-missiles-and-drones-used-libya-conflict-un-experts; Matt Herbert, "Libya's War Becomes a Tech Battleground," Institute for Security Studies, October 8, 2019, https://issafrica.org/iss-today/libyas-war-becomes-a-tech-battleground; and Jason Pack and Wolfgang Pusztai, "Turning the Tide: How Turkey Won the War for Tripoli," Middle East Institute, November 10, 2020, https://www.mei.edu/publications/turning-tide-how-turkey-won-war-tripoli.

139. Republic of Ghana, *National Cybersecurity Policy & Strategy: A Secure and Resilient Ghana, 2023–2027*, https://csa.gov.gh/resources/National%20Cybersecurity%20Policy%20and%20Strategy.pdf.

140. Eyal Boguslavsky, "Elbit Starts Delivering Guarani APCs to Ghana," *Israel Defense*, July 15, 2021, https://www.israeldefense.co.il/en /node/50909.

141. Republic of Ghana, *National Integrated Maritime Strategy (NIMS) of the Republic of Ghana*, August 2023, https://www.gogmi.org.gh/post/the-role-of-artificial-intelligence-in-ghana-s-national-integrated-maritime-strategy-nims-1.

Other coastal African nations are similarly advancing their EW capabilities to strengthen maritime security. For example, the Angolan Navy's BR71 MKII corvettes—advanced vessels supplied by the UAE and equipped with cutting-edge mission systems, including 3D radar, EW suites, secure communications, and surface-to-surface and surface-to-air missile systems—integrate EW solutions provided by Italy's Elettronica[142] designed to bolster ISR, EP, and EA operations. Maritime security remains a core defense priority for Luanda given Angola's strategic location on the Gulf of Guinea and the recently heightened importance of its ports, particularly in relation to the Lobito Corridor. To this end, Luanda has committed to enhancing its EW and cyber capabilities. While Angola has traditionally sourced such defense solutions from Russia, recent military modernization efforts under President João Lourenço reflect a deliberate shift toward diversifying defense partnerships, with an increasing focus on the United States.[143] For fiscal year 2025, Washington has committed to advancing "new opportunities to expand capacity building efforts for cyber security and Angola's Navy,"[144] which are likely to include support for the development of Angola's domestic DEW and broader EW capabilities. Such support aligns with the FY 2025 NDAA's emphasis on advancing the DOD's EMS and EW capabilities, including through targeted partnerships with developing nations. It also supplements US International Military Education and Training support for Angola, as well as Angola's periodic participation in US-led regional military exercises and security initiatives, particularly since its removal from the International Trade in Arms Regulations (ITAR) list in 2003. ITAR governs the manufacture, sale, and distribution of defense- and space-related articles and services to foreign partners.[145]

As of January 2025, nine African countries, including Ethiopia, Zimbabwe, and the DRC—all strategically important to the United States for defense and critical minerals—remain proscribed under ITAR. Exceptions exist for the DRC on a case-by-case basis, and primarily for humanitarian purposes.[146] Such designations complicate US efforts to support the development of domestic defense capabilities in these nations—when it is sought—or to provide defense articles, services, or funding through programs like Foreign Military Sales (FMS) and Foreign Military Financing (FMF). For African countries not under ITAR but that deal with prohibited states, including China, Iran, and North Korea,[147] or that source technological components from them, cooperation is similarly constrained. Such a scenario is problematic in a global strategic environment where axis-of-authoritarian nations are rapidly expanding their military capabilities and increasingly exporting them to Africa. For the US DIB, too, defense technology orders from partner nations such as Angola and Ghana could help support more predictable and efficient production rates and defray the cost of weapon systems—especially when demand for technologies is shared, as with DEWs.

Angola's mining sector has long been dominated by diamond production, contributing nearly 8 percent of global production.[148] Yet the country also possesses significant untapped reserves of REEs such as neodymium, praseodymium, and niobium, as well as

142. "Elettronica to Supply Electronic Warfare Systems for Angola's New Corvettes," *defenceWeb*, February 23, 2023, https://www.defenceweb.co.za/sea/sea-sea/eletrronica-to-supply-electronic-warfare-systems-for-angolas-new-corvettes/.

143. See, for example, Guy Martin, "Angola Looking to Acquire Military Hardware from the United States," *defenceWeb*, June 6, 2024, https://www.defenceweb.co.za/land/land-land/angolan-looking-to-acquire-military-hardware-from-the-united-states/; US Africa Command Public Affairs, United States Africa Command, "U.S. and Angola Co-Host Intelligence Conference," May 2, 2023, https://www.africom.mil/pressrelease/35187/us-and-angola-co-host-intelligence-conference; Lenin Ndebele "Why Angola Is Looking to Dump Russia as Its Arms Supplier and Opt for the U.S.," *News24*, December 21, 2022, https://www.news24.com/news24/africa/ news/why-angola-is-looking-to-dump-russia-as-its-arms-supplier-and-opt-for-the-us-20221221; and Maj. Joe Legros, "US, Ghana Armed Forces Strengthen Civil-Military Operations," US Army, September 9, 2024, https://www.army.mil/article/279510/us_ ghana_armed_forces_strengthen_civil_military_operations.

144. Nicholas Cook, "Angola: Key Developments and U.S. Relations," Congressional Research Service, October 18, 2024, https://crsreports.congress.gov/product/pdf/R/R48208#:~:text=U.S.%20bilateral%20assistance%20for%20Angola,%2C%20conservation%2C%20and%20local%20development.&text=Strategic%20Partnership%20Dialogue%20was%20established.

145. Regarding ITAR, see, for example, Directorate of Defense Trade Controls, "ITAR and Export Controls," US Department of State, n.d., https:// www.pmddtc.state.gov/ddtc_public?id=ddtc_public_portal_itar_ landing.

146. International Traffic in Arms Regulations (ITAR), § 126.1 (d)(2) and § 126.1 (d)(2)(i), updated January 22, 2025, https://www.ecfr. gov/current/title-22/chapter-I/subchapter-M/part-126/section-126.1.

147. Under ITAR, Russia is a proscribed, not prohibited, nation with access to US defense and space-related articles and services limited to space-related government cooperation and on a case-by-case basis. See ITAR, §126.1 (d)(2)(l).

148. Heidi Vella, "Untapped Mineral Riches: Angola Looks Beyond Diamond Mining," *Mining Technology*, April 19, 2024, https://www.mining-technology.com /features/angola-mining-resources-critical-minerals-rare-earths/.

critical minerals including copper, cobalt, manganese, and lithium.[149] In total, Angola holds thirty-six of the fifty-one minerals essential for global supply chains. As part of its recent military modernization efforts, its government has signaled a desire to shift away from such overreliance on diamond production—as well as that on oil and gas—and toward expanded critical mineral exploration and extraction. Minerals such as cobalt, for instance, are essential for producing shielding materials that protect military communication systems from EA operations, while manganese is key for direction-finding antennas used in cybersecurity and EW operations like signal interception, jamming, and EP. These capabilities are integral to the maritime security and broader defense capabilities Angola seeks to attain.

149. Vella, "Untapped Mineral Riches."

Section 3

Harnessing Africa's critical minerals

In November 2023, the USGS signed a memorandum of understanding with Angola's Geological Institute to collaborate on mapping potential resources of copper, lithium, cobalt, and manganese. In 2024, the DFC also extended a $3.4 million grant to British rare earth miner Pensana to support its Longonjo mine project along the Lobito Corridor. Pensana aims to double the mine's production capacity to forty thousand tons per year of mixed rare earth carbonate, including an estimated four thousand two hundred tons of praseodymium and neodymium—approximately 5 percent of the global supply.[150] The DFC grant also supports Pensana's Coola exploration project, located one hundred miles east of the Port of Lobito, where reserves of additional REEs have been identified. It also advances plans to establish Angola's domestic downstream infrastructure[151]—a critical step for the country to realize the value of its mineral wealth. Over time, such infrastructure could position Angola to harness its critical minerals to boost indigenous EW and broader defense capabilities. This could, for example, allow Angola to ensure the kind of secure port operations that projects like the Lobito demand.

Yet, Angola's progress remains nascent, and the country faces numerous challenges shared by other African countries striving to expand their upstream, and notably downstream, capabilities. Decades of underinvestment in mineral exploration have left large areas of the continent geologically unmapped—and while initiatives like the USGS partnership with Angola's Geological Institute have begun to fill these gaps, progress so far remains slow. Even in regions where mineral reserves are well-documented, political instability and infrastructure shortfalls undermine development. Needed, for instance, are reliable energy supplies to support refining and smelting operations, as well as integrated logistics networks—railways, roadways, and storage facilities linked with efficient port systems—to transport raw materials for processing and finished products to global markets. Addressing these challenges will require substantial infrastructure investment and sustained effort over time, not only in Angola but across Africa.

For the United States, which increasingly needs Africa's critical minerals for its DIB, and which would likely benefit from a broader network of strategic partners to navigate the challenges of the current global strategic environment, this presents a compelling opportunity. By partnering with African governments to develop domestic mineral mining infrastructure—particularly downstream capabilities that would allow the value of mineral resources to be retained within Africa rather than exported for processing—the United States could secure a reliable supply of refined, high-value materials directly for its DIB. Such an approach could also enable African nations to ultimately leverage their own mineral wealth for their domestic defense needs, fostering greater self-reliance. It could also likely help mitigate the economic risks often associated with raw material exports, including export restrictions, which some African governments—Nigeria, Zimbabwe, Ghana, Tanzania, and Namibia[152]—have pursued in recent years in a shift toward local beneficiation.

Yet while such policies are understandable given the history of natural resource exploitation in Africa, they risk deterring the very foreign investment Africa needs. A more mutually beneficial path forward lies in US investment aimed at building Africa's local processing capacities. No doubt, such a strategy is not without its challenges. Infrastructure financing in Africa remains complex, and China's entrenched role in the continent's mining sectors

150. Marleny Arnoldi, "US Institution Backs Pensana's Expansion Studies in Angola," *Mining Weekly*, September 26, 2024, https://www.miningweekly.com/article/us-institution-backs-pensanas-expansion-studies-in-angola-2024-09-26.

151. "Pensana Confirms Rare Earth Mineralization at Angola Project," *Mining.com*, September 15, 2023, https://www.mining.com/pensana-confirms-rare-earth-mineralization-at-coola-project/.

152. See, for example, "Namibia Bans Export of Unprocessed Critical Minerals," Reuters, June 8, 2023, https://www.reuters.com/markets/commodities/namibia-bans-export-unprocessed-critical-minerals-2023-06-08/; Ruth Olurounbi and Nduka Orjinmo, "Nigeria Seeks to Tighten Rules to Curb Raw Mineral Exports," Bloomberg, October 24, 2023, https://www.bloomberg.com/news/ articles/2023-10-24/nigeria-to-tighten-rules-to-curb-raw-mineral-exports; "Zimbabwe Bans All Lithium Exports," *Africanews*, August 13, 2022, https://www.africanews.com/2022/12/29/zimbabwe-bans-all-lithium-exports/; and "Ghana Set to Restrict Raw Bauxite Exports," *African Mining Market*, June 7, 2024, https://africanminingmarket.com/ghana-set-to-restrict-raw-bauxite-exports/18680/.

poses significant challenges. Yet, as in defense, a growing number of African nations have begun to signal a desire to diversify away from China. Viable financing models also exist, as do opportunities for engagement. The African Development Bank estimates Africa's infrastructure gap requires up to $170 billion annually to close, with 10 to 20 percent tied to mining-related infrastructure.[153]

The Lobito Corridor—a 1,300-kilometer railway line that connects the mineral-rich Copperbelt regions of northern Zambia and southern DRC to the Angolan Port of Lobito—offers valuable lessons for how such collaborations could unfold. As of September 2024 the United States, largely through the DFC, has mobilized more than four billion dollars in support of the project.[154] While the Lobito is not explicitly intended to foster the development of Africa's downstream mining capabilities, it holds potential to do so through its promotion of regional cooperation across mineral value chains; moreover, as a multilateral initiative involving the United States, African Finance Cooperation, European Union, African Development Bank, Angola, the DRC, and Zambia, it has attracted additional public and private stakeholders that not only contribute to its commercial viability but invest in parallel projects that offer opportunities for downstream development.

For example, in Angola, significant investments continue to be made in digital connectivity, including telecommunications and geospatial intelligence. A key area of focus is the country's space industry which, along with maritime security, has emerged as a strategic priority for the government—including for its significance for EW and as a future warfare domain.[155] Angola launched its first telecommunications satellite, AngoSat-1, in 2017 (though it ultimately failed), followed by AngoSat-2 in 2022, both developed in partnership with Russia's Energia. Reflecting Luanda's more recent desire to expand its foreign defense relations, in 2023 the government announced a collaboration with France's Airbus to produce Angeo-1, its first high-performance earth observation satellite. This satellite is expected to enhance Angola's maritime surveillance and security, provide real-time monitoring of infrastructure, and aid in the identification and management of critical mineral deposits. Angola plans to develop additional satellites tailored to similar objectives.[156] For the mining sector, such capabilities could provide key data for exploration, assist in tracking shipments, including those along the Lobito, and support site selection for downstream facilities.

Unlike extractive operations, where mining sites are geographically fixed—the underlying assets are immutable—downstream operations offer more flexibility as they can be established in areas that benefit from improved infrastructure and greater stability, mitigating the political risks that often hinder financing for mining and mining-adjacent infrastructure projects. For example, the DRC consistently ranks near the bottom of the World Bank's Political Stability/Absence of Violence indicator, which captures "perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism,"[157] due to persistent instability in its eastern provinces of Ituri, North and South Kivu, and Tanganyika, areas rich in tantalum and tungsten. The DRC's cobalt reserves are in the more stable southeastern provinces of Lualaba and Haut-Kantanga, though even there, illicit cobalt smuggling networks tied to North Korean operatives have fueled local armed groups that trade in violence and human rights abuses.[158] Advanced geospatial intelligence could help to disrupt such networks and mitigate similar security vulnerabilities.

Beyond the Lobito Corridor, several other critical mineral projects are underway across Africa, which offer additional insights into how the continent's critical mining capabilities could be developed in ways that both align with African objectives and support the US DIB. One such example is the Balama Graphite Mine in Mozambique, developed by an Australian graphite producer, Syrah Resources. Syrah has secured approximately $470 million in grants and

153. Teniola T. Tayo, "Trade Infrastructure Financing in Africa: An Exploration of Geopolitical Funds for Private Sector Participation," Africa Policy Research Institute, November 6, 2024, https://afripoli.org/trade-infrastructure-financing-in-africa-an-exploration-of-geopolitical-funds-for-private-sector-participation.

154. Adva Saldinger, "The Lobito Corridor: A Flagship: Biden Project's Progress and Future," *Devex*, December 5, 2024, https://www.devex.com/news/the-lobito-corridor-a-flagship-biden-project-s-progress-and-future-108869.

155. Along with Nigeria and Rwanda, Angola is one of three African nations to have joined the Artemis Accords.

156. Mustapha Iderawumi, "Airbus Defence and Space: Shaping Africa's Space Landscape through Collaboration and Innovation," Space in Africa, April 22, 2024, https://spaceinafrica.com/2024/04/22/airbus-defence-and-space-shaping-africas-space-landscape-through-collaboration-and-innovation/.

157. World Bank, *Worldwide Governance Indicators*, 2024, https://www.worldbank.org/en/publication/worldwide-governance-indicators, accessed January 6, 2025.

158. See, for example, Amnesty International, *DRC: Powering Change or Business as Usual?*, September 11, 2023, https://www.amnesty.org/ en/documents/afr62/7009/2023/en/; and United Nations Security Council S/2021/211, Final Report of the Panel of Experts Submitted Pursuant to Resolution 2515 (2020), https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2021_211.pdf .

loans from the DFC and the US Department of Energy (DOE), with graphite mined at its site in Mozambique linked to DOE-backed processing facilities in Vidalia, Louisiana.[159] This venture is the DFC's first major investment in graphite production, and among the largest US financial commitments in the context of US-Africa policy.[160] Although Syrah declared force majeure in December 2024 due to ongoing regional unrest, its model of vertically linking extraction in Africa with processing in the United States is a promising example of how African producers could be integrated into US critical mineral supply chains. To capture greater value from such extractive enterprises, too, African producers might consider investing in US-based processing facilities, as those in Vidalia, to more fully integrate their operations. Such investments could be facilitated through the US Export-Import Bank's Make More in America Initiative (MMIA), which finances US export-oriented manufacturing projects with a particular focus on critical minerals.[161] This approach could allow both Africa and the United States to diversify from Chinese processors, provide the United States with access to critical minerals, and enable African nations to capture a greater share of the value chain—also supplying the inputs needed to support Africa's domestic defense capabilities. While the development of local processing is, indeed, the ultimate aim, such a model could serve as a valuable starting point for further collaboration.

159. See "Syrah Secures $150m US Loan for Mozambique Graphite Operation," *Mining.com*, November 1, 2024, https://www. mining.com/syrah-secures-150m-us-loan-for-mozambique-graphite-operation/; "Australia's Syrah Resources Signs Graphite Supply Deals with US Firms," Reuters, August 3, 2023, https://www.reuters.com/article/idUSKBN2ZE024/; and The White House, "Fact Sheet: Delivering on the Next Generation of Innovation and Partnership with Australia," Press Release, October 25, 2023, https:// www.whitehouse.gov/briefing-room/statements-releases/2023/10/25/fact-sheet-delivering-on-the-next-generation-of-innovation-and-partnership-with-australia/.

160. For context, the United States allocated approximately $58.5 million in 2022 for its Prevention and Stabilization Fund, intended to assist seven African countries combat instability. See "Fact Sheet: U.S.-Africa Partnership in Promoting Peace, Security, and Democratic Governance," White House Press Release, December 15, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/12/15/fact-sheet-u-s-africa-partnership-in-promoting-peace-security-and-democratic-governance.

161. On MMIA, see Export-Import Bank of the United States, "Make More in America Initiative," n.d., https://www.exim.gov/about/special-initiatives/make-more-in-america-initiative.

Section 4

Getting ahead: Recommendations for ways forward

The challenges of the global strategic environment and the United State's depleted defense stockpiles have no quick or easy solutions. Yet the clock is ticking—as these issues are likely to compound before they improve. This makes it imperative for the United States to prioritize its defense capabilities now and establish a more certain future its manufacturing base.. The overarching objective should be to ensure the production of critical systems needed for the United States and its allies to credibly deter near-peer adversaries, such as China, and to demonstrate the capacity for sustained military campaigns, both now and in the future, if required. Central to this effort are critical minerals. The United States, however, remains heavily reliant on imports for many of these minerals, often from adversarial states—a vulnerability that is neither sustainable nor acceptable. Africa, with its vast critical mineral reserves, offers a unique opportunity to mitigate this risk.

This opportunity is further amplified by the growing ambitions of many African states to capture greater value from their mineral wealth—much of which currently flows to foreign markets—not only to drive economic development, but also to support broader efforts to build domestic industrial and defense capabilities. If approached with strategic intent, the United States has an opportunity to align its objectives with these aspirations, helping African nations realize their industrial and security goals while advancing its own interests and forging more durable, mutually beneficial partnerships. Doing so requires that the United States elevate critical minerals as a core pillar of its Africa policy. Needed, too, is a sense of urgency and tangible action.

Recommendations

A. Prioritize US national security and critical minerals in US-Africa policy. While the Biden administration took steps to align US national security interests with Africa's critical mineral development, most notably through its support for the Lobito Corridor, critical minerals remain peripheral to the broader framework of US-Africa policy.[162] Historically, US engagement with Africa has been heavily rooted in an aid-donor-recipient model, focused on values promotion and developmental initiatives. While such efforts have their merits, many African leaders have increasingly called for partnership-based approaches, particularly in natural resource extraction where shared economic and security benefits can be realized. To date, US attention on critical minerals has disproportionately focused on the DRC, Zambia, and to a lesser extent Angola—even though many other African nations possess significant potential for critical minerals that are essential to the US DIB (see Table 1). Such a narrow focus risks undermining opportunities to secure diversified supply chains, especially given China's entrenched position in African mining, along with increased activity from other axis-of-authoritarian states, including Russia and North Korea, as well as emerging competitors like the UAE and India. Given that, the United States should:

1. Reassess DIB requirements. A comprehensive reassessment of the US DIB is urgently needed to address evolving strategic challenges. Important questions must be asked—and answered. What are the United States' most pressing defense priorities? To what extent is the DIB able to deliver the required systems? What is the status of critical mineral reserves for these systems and their supply chains? What is the developmental status of these supply chains in Africa? The capabilities addressed in this report represent just one component of a broader, increasingly complex challenge. Congress could be useful in holding hearings, as well as requiring the DoD to conduct a classified study on the requirements needed to ensure US competitiveness in the current global strategic environment. Such findings should directly inform US-Africa policy.

2. Prioritize African countries with critical minerals vital to the US DIB and that pose the greatest vulnerability for US national security. Given limited resources and a more strategic, less interventionist, foreign policy under the Trump administration, the United States should prioritize establishing or deepening partnerships with African countries that possess minerals where it is most import-dependent, especially from China. It might additionally target relations with those nations actively seeking to strengthen their defense capabilities—for example, Ghana, Nigeria, and Angola under Lourenço—and likely to be receptive to increased US cooperation.

3. Establish an interagency task force to guide implementation of a comprehensive strategy. Such a task force would ideally be led by the National Security Council (NSC) and chaired by the NSC director(s) for African affairs, allowing for strengthened interagency coordination on all initiatives pertaining to African critical minerals and the revitalization of the US DIB. Such a task force could: (1) help ensure all US African critical mineral initiatives align with the requirements of the DIB and are implemented in a coordinated, strategic manner; (2) improve communication and information sharing across federal agencies to avoid duplication and inefficiencies; (3) bring more urgent attention to the relationship between African minerals and US national security, both within government and among the public through greater press engagement. While divergent in scope, the Australia-US Taskforce on Critical Minerals might offer some lessons.[163]

B. Shift from a developmental to a strategic focus in US trade and investment. US-Africa policy remains undermined by its treatment of issues such as critical minerals, defense, and China as isolated when in fact they are intricately linked. Its continued reliance on an outdated aid framework—one that often even extends to industrial and commercial initiatives—further undermines US effectiveness and disadvantages it in its competition with China in Africa. While aid has its place, it fails to address the core strategic concerns of many African governments:

162. The US Department of State's currently stated US-Africa policy objectives are: advancing trade and commercial ties with key African states to increase US and African prosperity; protecting the United States from cross-border health and security threats; and supporting key African states' progress toward stability, citizen-responsive governance, and self-reliance. "Our Mission," Bureau of African Affairs, US Department of State, accessed February 17, 2025, https://www.state.gov/bureaus-offices/under-secretary-for-political-affairs/bureau-of-african-affairs/.

163. "Australia-United States Climate, Critical Minerals and Clean Energy Transformation Compact," White House Press Release, May 20, 2023, https://www.whitehouse.gov/briefing-room/statements releases/2023/05/20/australia-united-states-climate-critical-minerals-and-clean-energy-transformation-compact/.

security, defense, and industrial development. US policy must be recalibrated to align with these priorities. Specifically, the United States should:

1. Strengthen and expand the DFC. Since its establishment under the Better Utilization of Investment Leading to Development (BUILD) Act in 2018, the DFC has been a critical tool for advancing US economic engagement with developing nations. Through loans, guarantees, and political risk insurance, it has continued to support private-sector-led projects, including strategic initiatives like the Lobito Corridor. Yet the agency's approach remains rooted in a development-focused framework that limits its ability to address the broader strategic imperatives that confront US national security. The DFC's upcoming reauthorization in September 2025 presents a key opportunity to reform and realign the agency to leverage its tools in the African critical minerals sector and advance the priorities of the US DIB.

2. Incorporate national security objectives into DFC project selection and expand authorities for strategic investments. When the DFC was established, its mandate emphasized a strictly "developmental" focus, with priority on traditional foreign aid activities such as small-business lending, poverty alleviation, and support for low- and lower-income countries. Yet such a narrow framework undermines critical projects—such as mining, infrastructure, and security-related initiatives—that could advance African development and defense self-reliance. Such projects should be more aggressively supported, if not favored. Greater flexibility is also needed within the DFC's mandate to support projects that directly contribute to the revitalization of the US DIB. This could include granting the DFC "notwithstanding authority"[164] from Congress to allow for exceptions for projects tied to compelling US national security needs. While development finance rules are necessary, they should advance rather than impede US national security objectives.

3. Include the DFC in the NSC-led task force on African critical minerals and the US DIB. Perspectives on what constitute "strategic" investments or national security priorities likely diverge between the DFC, DoD, and Congress. Including the DFC in the proposed NSC-led task force could help align priorities and provide crucial guidance on projects that may not meet every DFC financing criterion but would carry significant implications for US national security. Effectively leveraging Africa's critical minerals in service of the US DIB while delivering local impact in Africa demands a US whole-of-government approach. Coordinating defense efforts with private-sector capital through such a task force could be a promising step in this direction.

4. Reframe the US-Africa trade partnership as a strategic economic partnership tailored to the current global strategic environment. The African Growth and Opportunity Act (AGOA), set for reauthorization in 2025, presents a similar opportunity to reorient the US-Africa trade partnership within a strategic economic framework aligned with the current geopolitical landscape. Like the DFC, AGOA's scope should be revised and expanded beyond its traditional focus on textile and apparel to include provisions that directly support US-Africa trade in critical mineral supply chains essential to the United States DIB. Such revisions would also incentivize the integration of upstream African producers into US manufacturing supply chains. Equally important is to ensure AGOA does not disadvantage US companies from sourcing from African producers, which the Inflation Reduction Act (IRA) of 2022 currently does.[165] Unless the IRA is rescinded, policymakers must urgently assess the extent to which it undercuts US strategic engagement in African mining and disincentivizes mineral exports to the United States—particularly those critical to the US DIB—on which US processing and manufacturing will depend until domestic production is scaled.

164. Andrew Herscowitz, "Ten Recommendations to Help DFC Better Execute on its Development Mandate," ODI Global, February 21, 2024, https://odi.org/en/insights/ten-recommendations-to-help-dfc-better-execute-on-its-development-mandate/.

165. Section 30D of the 2022 Inflation Reduction Act (IRA) provides a $7,500 consumer tax credit for electric vehicles (EVs) to incentivize the use of critical minerals extracted or processed in the United States or in free trade agreement (FTA) partner countries. However, the AGOA partnership is not an FTA, and Morocco remains the only African country with FTA status. As a result, all other African nations are excluded from these incentives, making their critical minerals less attractive to US EV and battery manufacturers.

C. Pursue more comprehensive policies that recognize linkages between African issues. US-Africa relations have largely been characterized by a siloed approach to policy issues, where matters of natural resources, security, trade and development are addressed as distinct and unconnected priorities. Yet, as this report illustrates, such issues are deeply intertwined, and US policy should be adapted to better reflect these linkages. A more integrated approach would not only strengthen US engagement but could also bolster the United States' ability to compete with China, which routinely employs a more bundled approach to its African partnerships. For example, a 2023 deal between China and Zimbabwe included $28 million in military equipment, training on its use, and funding for Zimbabwe's National Defense University alongside journalist training initiatives.[166] The United States should pursue a similarly multifaceted approach that addresses the priorities of African nations while aligning with US strategic objectives. This requires, in part, that offices and departments that have traditionally not collaborated on US-Africa policy begin to do so. Also:

1. Consider future warfare domains. Angola is among a growing number of African nations advancing space programs to address domestic challenges in communications, agriculture, security, and resource monitoring, while seeking to drive economic growth. Countries such as South Africa, Nigeria, Ethiopia, Ghana, Kenya, and Rwanda are pursuing similar objectives, often in partnership with axis-of-authoritarian states. Yet the United States remains a clear leader in space capabilities, even as China continues to make notable strides. This presents a unique opportunity to deepen US-Africa space cooperation, assisting African nations in developing satellite and related technologies. Such advancements could help identify critical mineral reserves across the continent: reserves vital to the US DIB and, over time, instrumental in enabling Africa states to bolster their own industrial and defense capabilities. A potential strategy could involve the State Department, DoD, NASA, and the USGS, which could provide technical training in mineral exploration and safe recovery practices. Such an approach could also encourage more African states to join the Artemis Accords,[167] allowing the United States to expand its space influence and compete with China in this strategic domain.

2. Support African ambitions for greater self-reliance in defense through technology training centers, exchange programs, and private-sector partnerships. While helping African nations develop domestic processing capabilities to harness their mineral wealth is a critical step, it does not immediately translate into advanced industrial or defense systems. The development of UASs, EW solutions, and other modern defense capabilities requires significant technological inputs, technical expertise, and infrastructure—areas where many African countries face critical gaps. For example, UASs rely on advanced AI to enable key functions such as navigation, target recognition and tracking, and swarming. Yet, outside of Kenya, Nigeria, Ghana, South Africa and Ethiopia, AI is not being deployed at scale across the continent.[168] Addressing this challenge requires a culture of innovation and research, supported by universities, technology hubs, and partnerships with international academic institutions, private-sector firms, and governments.[169] Such initiatives could help African nations build the technical foundations needed to fully leverage their mineral wealth.

3. Fight in the information domain. China's focus on information and intelligentized warfare extends beyond technological advancements. Central to this strategy is what the CCP terms "discourse power," or narrative control, aimed at shaping global perceptions to support its aim of national rejuvenation. What is key to this effort are "people-to-people exchanges," which China has prioritized since 2017.[170] Such exchanges take various forms. In Africa, every

166. Jevans Nyabiage, "China Gives Zimbabwe Military Equipment Worth US$28 Million to Boost Security and Modernise Defence Forces," *South China Morning Post*, December 17, 2023, https://www.scmp.com/news/china/diplomacy/article/3245374/china-gives-zimbabwe-military-equipment-worth-us28-million-boost-security-and-modernise-defence.

167. As of this writing, fifty-three nations have signed the accords, which NASA, in coordination with the State Department, established in 2020. The accords provide "a common set of principles to enhance the governance of the civil exploration and use of outer space." See "The Artemis Accords," NASA, n.d., https://www.nasa.gov/artemis-accords/.

168. Gadzala Tirziu, "Coming to Life: Artificial Intelligence in Africa," Issue Brief, Atlantic Council, November 14, 2018, https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/coming-to-life-artificial-intelligence-in-africa/.

169. Gadzala Tirziu, "Coming to Life."

170. Gadzala Tirziu, "Global Reach: Information Is a Weapon," *Democracy: A Journal of Ideas*, no. 52 (2019), https://democracyjournal.org/ magazine/52/global-reach-information-is-a-weapon/; and John Garrick, "Understanding Xi Jinping Thought: The Clear and Present Implications for Democratic Nations," *Strategist* (commentary and analysis site), Australian Policy Strategy Institute, June 3, 2024, https://www.aspistrategist.org.au/about-the-strategist/.

CCP-affiliated news agency has a presence. For example, China Global Television Network (CGTN) operates thirty-five bureaus across Africa's fifty-four countries. Thousands of African journalists are trained annually at CCP-aligned institutions like the Communications University of China, under the Ministry of Education and the School of Journalism and Communication at Renmin University.[171] Further, an estimated ten thousand African government officials participate each year in CCP-sponsored programs on topics ranging from agricultural policy and media control strategies to Xi Jinping Thought.[172] China has also become a top destination for higher education among African studies, outpacing the United States.[173]

The United States has largely neglected this critical domain. This must change. Specifically, in the context of critical minerals, the US government should consider initiatives such as specialized mining scholarships and training programs to cultivate the next generation of African mining engineers. Such programs could be codeveloped with leading US mining institutions such as the Colorado School of Mines and the New Mexico Institute of Mining and Technology and implemented either bilaterally or through regional African organizations like the African Union's African Minerals Development Center. The US National Guard's State Partnership Program also offers a valuable avenue for deeper engagement. While the SPP's core focus is on military-to-military cooperation, it also has facilitated broader collaborations in economic development and social sectors. For example, the West Virginia National Guard's partnership with Gabon supports efforts in education, public health, and military-civil engineering.[174] Expanding the SPP to include US states with advanced mining industries could reinforce US-Africa ties, build technical expertise, and foster people-to-people relations. As of December 2024, the program has partnerships with twenty-five African nations.[175]

D. Explore opportunities for defense coproduction and "ally shoring," and address regulatory hurdles. Most African nations will encounter significant obstacles in scaling advanced defense capabilities to meet the technical demands of the current global strategic environment. Coproduction offers a strategic solution. For the United States, too, coproduction facilities could strengthen strategic alliances, boost economies of scale, support the US DIB, and counter China's joint military production efforts across the continent. For example, in 2016, China's Poly Technologies and Denel formed a partnership to coproduce three South African naval vessels.[176] Similarly, in January 2025, China and Nigeria agreed to jointly manufacture arms, leveraging Nigeria's mineral resources.[177] US and broader Western defense coproduction efforts with Africa present various regulatory, governance, labor, and infrastructure challenges. Yet there are several recent examples worth exploring in greater detail including Denel's codevelopment of A-Darter[178] missiles with Brazil—with the first batch delivered to the South African Air Force in late 2024—as well as its collaboration with Thales Group on above-armor panoramic gunnery sights, and with Northrup Grumman on LRF ammunition technology.[179] As African countries increasingly pursue their own defense capabilities, new coproduction opportunities are likely to emerge. To seize this potential, the United States should:

1. Streamline Foreign Military Financing (FMF) and Foreign Military Sales (FMS) programs for key allies and partners. The FMS and FMF programs, which facilitate

171. Gadzala Tirziu, "Inside China's Cognitive Warfare Strategy."
172. Gadzala Tirziu, "Global Reach: Information Is a Weapon."
173. Jevans Nyabiage, "Will African Students' Embrace of China Opportunities Build Support for Beijing?," *South China Morning Post*, August 15, 2024, https://www.scmp.com/news/china/diplomacy/article/3274392/will-african-students-embrace-china-opportunities-build-support-beijing.
174. Edwin Wriston, "West Virginia, Gabon Begin State Partnership," West Virginia National Guard, November 18, 2024, https://www.nationalguard.mil/News/State-Partnership-Program/Article/3968106/west-virginia-gabon-begin-state-partnership/.
175. On the US National Guard's SPPs, see, for example, United States National Guard, "State Partnership Program," n.d., https://www.nationalguard.mil/Leadership/Joint-Staff/J-5/International-Affairs-Division/State-Partnership-Program/.
176. Jonathan Katzenellenbogen, "China's Poly Defence Partners with Denel," *defenceWeb*, September 19, 2016, https://www.defenceweb. co.za/sea/sea-sea/chinas-poly-defence-partners-with-denel/.
177. Ekene Lionel, "Nigeria and China Enhance Military Partnership," Military Africa, January 12, 2025, https://www.military.africa/2025/01/nigeria-and-china-enhances-military-partnership/.
178. Sarah Lesedi, "First A-Darter Delivery Set for December," *Military Africa*, February 27, 2024, https://www.military.africa/2024 /02/first-a-darter-delivery-set-for-december/.
179. See, for example, "Denel and Thales Reveal New Armoured Vehicle Sight," *defenceWeb*, September 22, 2016, https://www.defenceweb. co.za/joint/science-a-defence-technology/denel-and-thales-reveal-new-armoured-vehicle-sight/; and "RDM and Northrop Grumman Collaborate on Precision-Guided Long Range Artillery Ammunition," *defenceWeb*, April 19, 2021, https:// www.defenceweb.co.za/featured/rdm-and-northrop-grumman-collaborate-on-precision-guided-long-range-artillery-ammunition/.

the transfer of US defense articles, training, funding, and services to foreign partners while indirectly supporting the US DIB, are largely misaligned with US-Africa policy and the broader demands of the current global strategic environment. These programs are in urgent need of reform, including an expansion of their scope. For instance, FMF could be directed to support defense coproduction initiatives, particularly in critical technologies like UASs and EW capabilities, and with a focus on African countries rich in critical minerals essential to the US DIB and demonstrating growing industrial potential. Similarly, FMS cases could be structured to allow African nations to acquire US-African coproduced defense systems, particularly those incorporating local critical mineral components. Such reforms would not only boost US-Africa defense cooperation but also help secure US and African supply chains and counter China's growing influence in African security and defense.

2. Modernize International Trade in Arms Regulations (ITAR) to facilitate coproduction. The proposed FMF and FMS reforms would likely require amendments to ITAR, which poses challenges for US engagement with African states that are either directly proscribed or that engage with prohibited states, such as the axis of authoritarians.[180] While such restrictions are crucial for protecting U.S. technologies, the current regulatory framework should evolve to better reflect the global strategic landscape—particularly acknowledging the near-term challenges African countries face in reducing dependence on China, where that is their goal.seek to do so. A possible solution could be to introduce a "case-by-case" exception for African countries with critical minerals vital to the US DIB and with demonstrated interest in codeveloping critical defense technologies of mutual benefit. Such an approach would require strict oversight criteria and compliance mechanisms to ensure US articles and services are protected.

3. Pursue regional defense production hubs and solutions. The Lobito Corridor has highlighted the advantages of regionally coordinated strategies, a concept that can be extended to defense cooperation. With the growing potential for regional mineral processing centers in countries like Kenya and Namibia, which largely possess the necessary infrastructure,[181] the United States should explore supporting the establishment of regional defense coproduction hubs in African countries with more advanced defense industries, such as South Africa, Ghana, and Kenya, that could be further developed with US partnership. Collaborative efforts could be further streamlined through regional defense-oriented organizations like the Southern African Development Community and the Gulf of Guinea Commission. Such regional frameworks could enable large-scale coproduction agreements, allowing African nations to leverage economies of scale while strengthening US strategic engagement. Where fitting, such hubs could be colocated or linked to regional mineral processing centers, creating efficient ecosystems that integrate defense and resource development.

180. Potential shifts in United States relations with Russia under the Trump administration could prompt revisions to the list of states prohibited under ITAR. However, no such changes have been enacted as of this writing.

181. United States Institute of Peace, "Critical Minerals in Africa: Strengthening Security, Supporting Development, and Reducing Conflict amid Geopolitical Competition," USIP Senior Study Group on Critical Minerals in Africa, April 9, 2024, https://www.usip.org/publications/2024/04/critical-minerals-africa-strengthening-security-supporting-development-and.

Conclusion

Such measures would be an important first step in addressing the United States' lack of preparedness for both the immediate and evolving global strategic environment through a more deliberate and refined Africa policy. Yet they remain just that—a beginning. Crafting a US-Africa policy that effectively aligns the continent's expanding resource development and defense needs with the imperatives of the US DIB and broader national security priorities will be neither swift nor easy, and success is far from guaranteed. Long-standing challenges, including those detailed in this analysis, as well as persistent governance failures and human rights concerns, have long impeded efforts to bolster African defense capabilities and self-sufficiency. Any US engagement aimed at strengthening African security and defense capacities must therefore be carefully calibrated to avoid inadvertently reinforcing repressive regimes. Instead, it must prioritize equipping key African nations to address regional security challenges independently, reinforcing their ability to serve as credible long-term US security partners—particularly as the axis of authoritarians, led by China, accelerates its drive to reorder the global system to its advantage.

At the center of this strategic dynamic are Africa's critical minerals, indispensable to both US and African policy. These resources are vital to the production of advanced weapons systems such as long-range fires, unmanned aerial systems, and directed energy weapons needed to sustain defense readiness, lethality, and technological superiority—particularly in the information and maritime domains, which are poised to become increasingly central to future warfare. Yet the United States remains heavily, if not entirely, reliant on imports for many of these minerals, with a significant portion sourced from adversarial states. At the same time, Africa lacks the necessary downstream industrial capacity to capture the full value of these resources, limiting its ability to refine and export value-added materials or leverage them for its own defense and broader developmental needs. This convergence of factors presents a unique opportunity for the United States to recalibrate its engagement with Africa and establish resilient, mutually beneficial critical mineral supply chains matched to the demands of the evolving global strategic environment.

Such an effort will require a holistic approach that extends beyond traditional aid-driven models and focuses on mutually shared interests. It will require sustained US commercial diplomacy, greater backing for US companies invested in Africa's domestic mining infrastructure, and targeted exchanges in technology and security. It will also necessitate US policy adjustments to facilitate closer supply chain cooperation and, critically, strategic patience. This is a long-term endeavor. Much like the axis states play the long game, it is time the United States adopted a similar long-term approach. The geopolitical stakes demand nothing less.

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Aleksandra Gadzala Tirziu is a nonresident senior fellow with the Atlantic Council's Africa Center and GeoStrategy Initiative in the Scowcroft Center for Strategy and Security. She is a globally recognized leader in foreign policy and geopolitics with a sharp focus on the soft power dynamics of great power competition, notably China's growing ideological global influence. With a background that spans the private and public sectors, as well as media, Tirziu has provided counsel to corporations and governments worldwide.

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