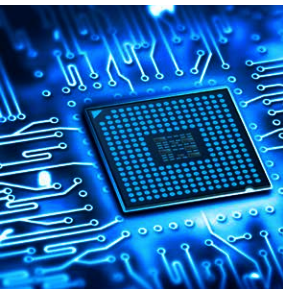
ENERGY SECURITY LEADERSHIP COUNCIL

A PROJECT OF SAFE

# The Pillars of Power

## A Strategy for Energy Security and Industrial Resiliency



SAFE is an action-oriented, nonpartisan organization committed to transportation, energy, and supply chain policies that advance the economic and national security of the United States, its partners, and allies. Since 2005, SAFE has worked with its Energy Security Leadership Council—a peerless coalition of current and former Fortune 500 CEOs and retired 4-star admirals and generals—to support secure, resilient, and responsible energy solutions. Learn more at SecureEnergy.org

ENERGY SECURITY LEADERSHIP COUNCIL

**The United States has reached an inflection point.** The foundation of America's power—its industrial capacity, technological leadership, and economic resilience—has been eroded by decades of offshoring, strategic foreign competition, and short-term policymaking. The result is a country that is increasingly reliant on foreign adversaries for the minerals, technologies, and supply chains that will drive economic growth, enhance energy security, and strengthen the national defense.

The United States must respond with a calibrated and coordinated plan. This moment must serve as a clarion call for bold policy changes and strategic investments in infrastructure, research, and technologies to ensure America reclaims and secures its competitive edge. Fulfilling that charge will not be easy and requires a national strategy that aligns government policy with private-sector investment. Success demands a sustained, long-term commitment to reshoring production, fostering domestic innovation, and developing a skilled workforce capable of driving an industrial resurgence.

This report marks a milestone in SAFE's 20-year commitment to strengthening America's economic and national security. Founded with a comprehensive focus on reducing U.S. dependence on oil from countries that share neither our values nor interests, SAFE remains committed to advancing policy solutions that secure America's economic future and global leadership.

Over the past two decades, reports such as *The Commanding Heights of Global Transportation* and iterations of *The National Strategy for Energy Security* have documented this shifting landscape, identifying strategic vulnerabilities in the economy and proposing pragmatic and nonpartisan policy solutions that balance the need to secure conventional energy and mineral resources with supporting development and deployment of advanced energy technologies. This latest report builds on that legacy, drawing on the expertise of SAFE's Centers to chart a path forward to revitalize American industry and innovate to create new ones.

The stakes could not be higher. The decisions made today will determine whether the United States reasserts and secures its position as the world's leading economic and technological power or continues to cede ground in industries critical to its future. This report provides a clear set of policy recommendations designed to strengthen America's industrial base, enhance energy security, and rebuild critical supply chains. Let us begin the hard work of bringing Americans together to support actionable, pragmatic solutions that are rooted in a shared commitment to economic strength and national security. With bold leadership and decisive action, the United States can secure its competitive edge and shape the future of its security and industry.

Sincerely,

SAFE's Energy Security Leadership Council

# Contents

# Introduction

**Not since World War II** has the American consciousness been forced to question its position in the global order. Today, however, the United States is waking up to the fact that it faces profound challenges to its power and influence from peer adversaries.

The United States must take swift and decisive action to sustain its primacy and safeguard its national security or else adapt to a new era defined by great power competition. At the same time, technology and innovation are proliferating at an accelerated pace, changing the priorities for economic competition. But the backbone of American economic and military power—its industrial base—while still robust, has shown signs of erosion and fracture, and in some key sectors no longer exists. The United States and its allies can no longer afford to remain complacent with the status quo. America needs a comprehensive strategy that reinforces its pillars of power for enduring prosperity and security.

For roughly 75 years, the United States has been the dominant world power, shaping international institutions, military alliances, and global markets. Its influence endured through shifting geopolitical eras—from the bipolar Cold War era to the unrivaled unipolarity of the post-Cold War period, and now into an increasingly multipolar world. Moving forward, however, that dominance is no longer assured.

The rise of China as a global economic and military competitor presents one of the most existential challenges the United States has faced in its history. China has rapidly expanded its technological capabilities, modernized its military, and established global economic initiatives that reach far beyond its borders. Russia has asserted itself militarily, challenging Western influence in Ukraine, the Middle East, and other regions. Emerging powers such as India and Brazil are taking more active roles in shaping global affairs, leading to a more distributed balance of power. Beyond military and economic competition, the United States must maintain its technological edge to ensure the security of critical supply chains and adapt to new threats in cyberspace and artificial intelligence. The shifting global landscape demands that the United States reexamine the foundations of

For roughly 75 years, the United States has been the dominant world power, shaping international institutions, military alliances, and global markets. Moving forward, however, that dominance is no longer assured.

its global power and consider how it will evolve to meet the challenges of the 21st century.

America's position as a global superpower has long been rooted in its industrial base and the economic strength it generates. It also has a legal system based on the rule of law and an economic system that promotes the capital formation necessary to build the industrial base. The ability to manufacture everything from critical infrastructure to durable consumer goods, advanced semiconductors, and cutting-edge military equipment has given the United States a strategic edge in national defense and global economic competition, but decades of globalization have contributed to the loss of U.S. industrial capacity. A strong industrial base drives job creation, technological innovation, and economic growth. In the past, it also ensured supply chain security, reducing reliance on foreign adversaries for essential goods.

Over recent decades, America's military power has been shaped to support the traditional Two-War Doctrine, which called for the United States to be able to sustain two major regional conflicts at once, "with emphasis on fighters, warships, armor, and other 'traditional' combat systems." Changes in warfare and the experience in Ukraine and Israel's multifront war, however, suggest the need for a more flexible supply-driven strategy that prioritizes the availability of sufficient manufacturing capacity to replace lost consumables, primarily ammunition, missiles, bombs, and other supplies, with the understanding that the time required to replace larger weapon systems, including, but not limited to, aircraft, ships, and satellites, will extend far beyond the reasonable length of any sustainable conflict.

This shift in the character of conflict also reflects a broader evolution in the strategic role of supply chains. During World War II, supply chains served primarily to equip the warfighter. In the Cold War, they became tools of ideological competition and strategic influence. Today, supply chains themselves have become instruments of power projection. They can be used to constrain adversaries, apply economic pressure, and even cripple a nation's warfighting capacity without firing a shot. In modern geopolitical competition, whoever controls the most resilient and strategically aligned supply chains holds a decisive economic and security advantage.

A new supply-driven strategy that emphasizes scaling industrial capacity to sustain multiple simultaneous conflicts, in which the United States is fighting or aligned with its allies, is desperately needed. The U.S. defense industrial base is currently not scaled to handle more than one major war at a time, let alone two or more. Such a strategy would focus on building long-term manufacturing and logistical capacity to ensure that U.S. forces and allies are never constrained by supply shortages of those items consumed most quickly in war. In short, the United States must ensure that we have large-scale production capacity for military equipment, munitions, energy, and technology to prevent adversaries from gaining an advantage.

As geopolitical competition evolves, rebuilding and modernizing the U.S. economy—especially in strategic sectors like energy, semiconductors, and transportation—will be crucial for maintaining American strength. Industrial power has long been a foundation of global influence, and its renewal is essential for securing future economic and national security. To achieve this, the United States must address the key pillars of power that underpin its security and industrial resilience. It is imperative to:

1. **Expand and secure supplies of minerals and materials** necessary to support our manufacturing sector and advanced technologies—from the mine, through the processing, to the final product;
2. **Ensure we have reliable and affordable energy sources** to power our industrial base and our economy;
3. **Increase our advanced manufacturing capacity** with a focus on the automotive sector and the defense industrial base; and
4. **Prepare for a digital and increasingly electrified economy** supported by artificial intelligence and big data, where electrification offers pathways to achieve total energy dominance and enhances our nation's energy security and global competitiveness.

The United States' position as a global power is not guaranteed. Sustaining it will require a clear understanding of how American strength was built—and the transformation that we must undertake to be prepared for the remainder of the 21st century. To maintain its position, the United States must reinforce its pillars of power by rebuilding its manufacturing and energy sectors, securing supply chains, fostering innovation, and adapting to the realities of a competitive multipolar world. The question is not whether the United States can remain influential but whether it will choose to evolve and lead in an era where power is more widely distributed than ever before.

# The Pillars of Power

# 1

# The Emergence of a Peer Adversary and Return of Great Power Politics

**Over the last decade,** the world has witnessed a slow but accelerating emergence of a new bloc of adversaries, representing a multifaceted threat that challenges U.S. economic interests and national security, and the global order the United States has championed for nearly a century.

Perhaps none are more concerning than the threats represented by the Chinese Communist Party (CCP). Notably, Beijing has grown its economy—from less than $10 trillion in 2013 to roughly $18 trillion in 2023—significantly closing the gap with the United States, whose gross domestic product (GDP) stood at nearly $28 trillion in 2023.[1] While many U.S., European, and other corporations in allied countries profited from greater access to a colossal new market following China's accession to the World Trade Organization (WTO) in 2001, and consumers enjoyed the savings from less expensive imported Chinese goods, China has disproportionately benefited from massive investments by its western counterparts and steadily wrested control over significant and strategic portions of the global economy.

However, China's sheer size is not what is concerning. Instead, it is the CCP's systematic efforts to distort free market competition through massive industrial subsidies and overcapacity, to steal intellectual property (IP) or coerce technology transfer, and to undermine free and fair trade. These systematic efforts strengthened China and weakened the United States and other western economies in several key industrial and technology areas. By now, its ambitions and methods to lead the world in economic, diplomatic, and military influence are not a secret, but neutralizing these threats will require a serious and sustained effort by U.S. policymakers and their allies.

[1] World Bank, "GDP (current US$) - China, United States," Webpage.

Leadership in automotive and related technologies has important implications for future global economic and military competitiveness.

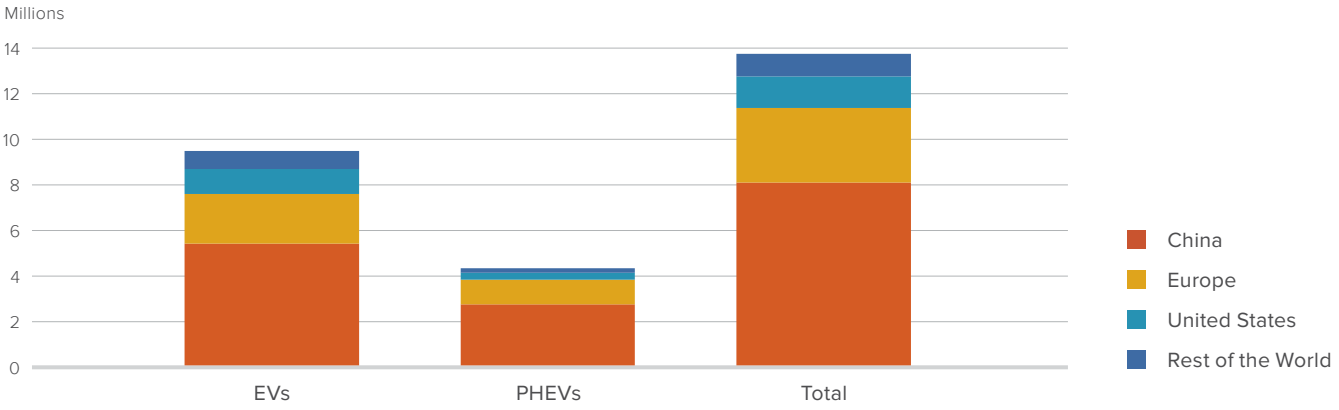
## MADE IN CHINA 2025

China's ascent accelerated in 2013 with the launch of the Belt and Road Initiative, and again in 2015 with the introduction of "Made in China 2025," a sweeping update to its state-led industrial policy. These plans were designed to guide and expedite China's evolution into a high-technology manufacturing superpower and global innovation hub. Now, roughly ten years later, in 2025, it is clear that Beijing will not execute and achieve all of the plan's specific goals (e.g., domination of world markets and complete self-sufficiency in all high-technology industries by 2049). But what is clear is the real and meaningful progress Beijing has made toward creating national champion firms in the most important industries of the future global economy, including vehicles powered by batteries, strategic materials and critical minerals, power generation and aerospace equipment, supercomputing, and artificial intelligence (AI).[2] Such a strategy has led to China accounting for more than a third of global manufacturing output in terms of value, while at the same time reducing reliance on foreign technology, oftentimes to the detriment of long-entrenched global leaders.[3]

Perhaps the most prominent example of China's industrial policy success is exemplified by Beijing's whole-of-nation strategy in the automotive sector. The progress China is making should be of particular concern to U.S. and allied policymakers because the automotive sector is a foundational industrial sector of the global economy, and it has been at the cutting edge of innovation in materials, engineering, digital design, and computing. The automobile industry increasingly drives high-tech innovation, maintains extensive supply chains, and leadership in automotive and related technologies have important implications for future global economic and military competitiveness.

Last year, China sold more than 30 million vehicles while exporting roughly six million—of which roughly 80 percent were internal combustion engine vehicles (ICEVs).[4] China's total vehicle sales also included 11.5 million electric vehicles

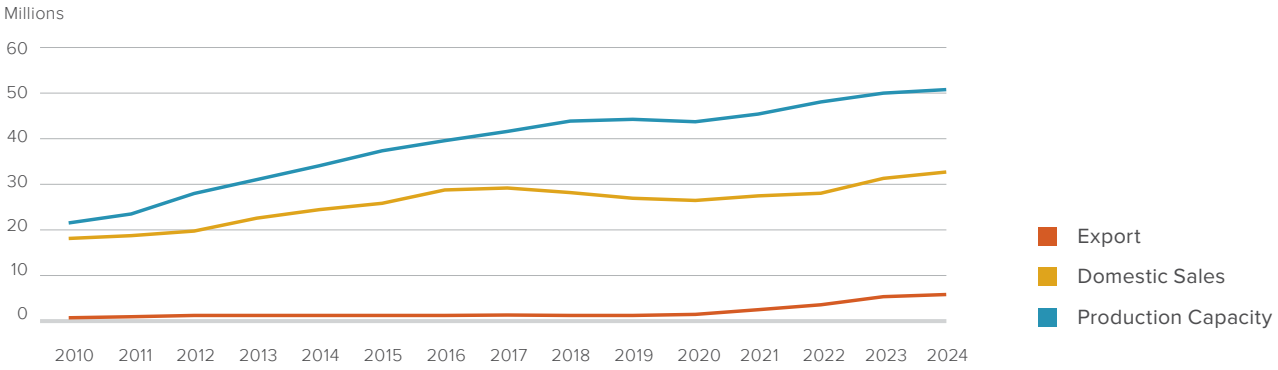
### Figure 1. **2023 Sales and Registrations of EVs and PHEVs by Country**




Source: IEA

[2] Stella Yifan Xie and Grace Li, "For Xi Jinping, 'Made in China 2025' has been worth every penny," *Nikkei Asia,* December 20, 2024.
[3] Ibid.
[4] China Association of Automobile Manufacturers, "Brief analysis of the production and sales of the automobile industry in December 2024," January 20, 2025; and China Association of Automobile Manufacturers, "A brief analysis of vehicle exports in December 2024," January 20, 2025.

## Figure 2. **Chinese Vehicle Sales, Export, and Production Capacity**




Source: GlobalData and China Association of Automobile Manufacturers

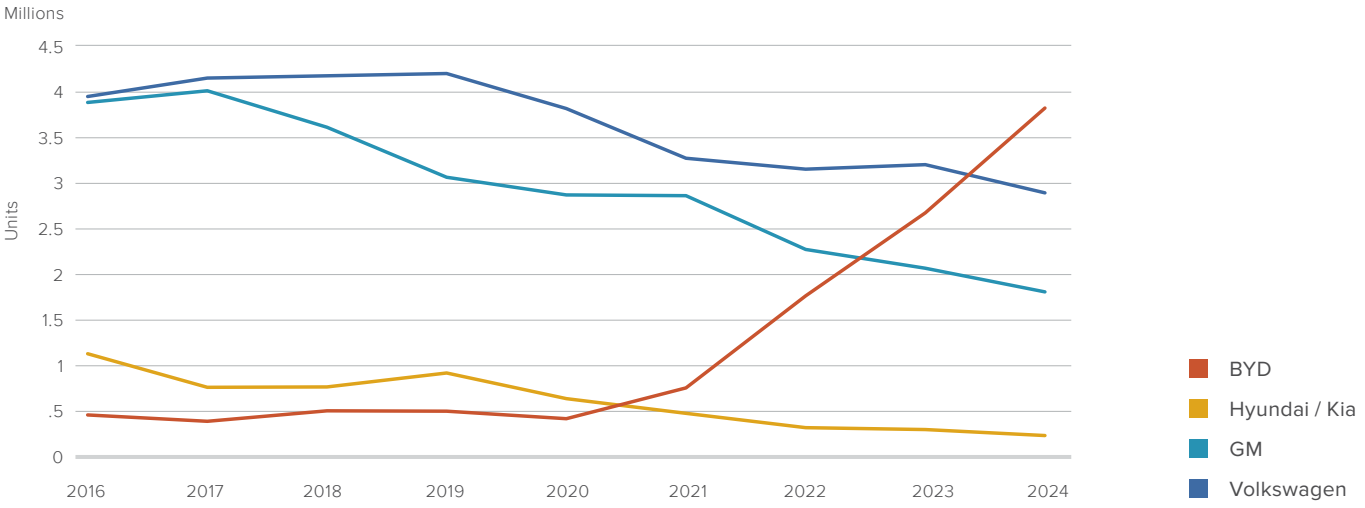
(EVs), which were sold both domestically and exported abroad, far surpassing its EV target of 20 percent of annual automotive sales by 2025.[5] Such success in EVs did not happen by chance, as Beijing invested more than $230 billion directly in the sector between 2009 and 2023.[6] These investments included a range of support, including consumer rebates, sales tax exemptions, research and development, infrastructure upgrades, direct government purchasing, and other substantial provincial and local incentives.

The scale of these investments—which do not include other investments in mining, metals, or the battery supply chain—has led to roughly 200 EV companies operating in China.[7] The most popular EVs in China now sell for around $12,000.[8] Although the vast majority of those companies are likely to eventually fail, as only a select few have reached profitability, the intense competition has resulted in rapid price decreases due to excess capacity far beyond what the market demands, creating both local and global distortions in the automotive market. In fact, China's overcapacity problem in the auto market is so vast—and notably extends into the internal combustion engine vehicle market as well—that experts believe China has the capacity to produce more than 40 million ICEVs and 20 million EVs, representing well over half of the global market demand and twice its domestic demand.[9] While China may not be efficient in its deployment of resources, the outcomes from its subsidies are an intentional feature of their approach to prop up key industries and drive global competitors into distress and bankruptcy.

In China, western auto companies' market shares have plummeted in what was once the most promising market for global automakers. General Motors (GM), for example, sold more vehicles in China than in the United States every year between 2010–2022. With more than four million vehicles sold in 2017, GM was selling more than a million more vehicles in the Chinese market than in the American market, providing the company with a substantial boost to its global revenue. The profitability of GM's Chinese operations has declined significantly, with the company losing $350 million through the third quarter of 2024, leading industry observers to question the continuation of operations in the Chinese market as sales dropped to under two million vehicles in 2024.[10] This erosion of global

[5] China Association of Automobile Manufacturers, "Brief analysis of the production and sales of the automobile industry in December 2024," January 20, 2025; China Association of Automobile Manufacturers, "A brief analysis of the production and sales of new energy vehicles in December 2024," January 20, 2025; and General Office of the State Council, "Development Plan for the New Energy Vehicle Industry (2021-2035)," November 2, 2020.
[6] Scott Kennedy, "The Chinese EV Dilemma: Subsidized Yet Striking," Center for Strategic & International Studies, June 20, 2024.
[7] Laura He, "A brutal elimination round is reshaping the world's biggest market for electric cars," *CNN,* April 24, 2024.
[8] Nicolás Rivero, "Why Chinese EVs are displacing Teslas," *The Washington Post,* January 18, 2025.
[9] Brad Sester, "Will China Take Over the Global Auto Industry?," Council on Foreign Relations, December 8, 2024.
[10] Nora Eckret, "GM to take more than $5 billion in charges on China operations," *Reuters,* December 4, 2024.

## Figure 3. **Foreign Brand Sales Plummet in China as National Champion BYD Soars**




Source: Company Reports

sales was a major focus of quarterly earnings calls and an important backdrop as GM looked for opportunities to cut costs, including shuttering its autonomous vehicle (AV) division, Cruise, citing costs as a driving factor. At the same time China has bet big on AVs as a key technology for 21st century competitiveness, with Chinese companies now beginning to expand operations overseas, perhaps positioning China as the global leader in this next generation of transportation technology.[11]

The same story is true for European automakers who have similarly lost market share to China and simply cannot compete on price. The rise of Chinese automakers has raised concerns from European policymakers, given the automotive industry comprises roughly seven percent of the European Union's economic output.[12] The squeeze from Chinese brands has not only hampered European exports to China but European automakers are now also seeing declining market share in their domestic market as well, as China now accounts for twelve percent of all EVs sold in Europe—a number that is expected to continue to rise in the years ahead.[13] In Japan, talks of a merger between Nissan and Honda earlier this year were held in large part due to the increased competition these automakers are seeing in emerging markets from Chinese brands.[14] Even South Korea, a global leader in the production of EV battery manufacturing and lower-cost EVs, is being threatened by EV imports.

China's recent momentum, while now garnering significant media and industry attention, was in fact seeded much earlier. Since the 1990s, Beijing has restricted market access to most foreign automakers unless they entered a joint venture (JV) with a Chinese manufacturer—and foreign automakers could own no more than 50 percent of the partnership.[15] Beijing was also an early user of tariffs to restrict imports, implementing 100 percent tariffs on automobiles in the early 1990s.[16] It used these JVs to coerce technology transfer, and nearly every leading

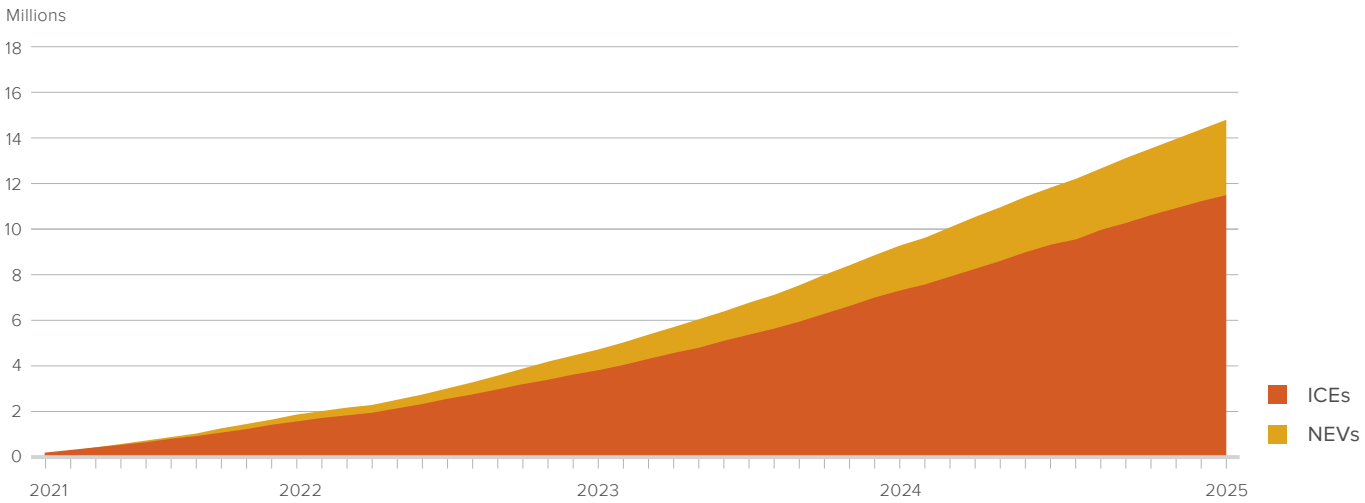
[11] Lora Kolodny and Micheal Wayland, "GM exits robotaxi market, will bring Cruise operations in house," *CNBC,* December 10, 2024.
[12] European Commission, "Automotive Industry," Webpage.
[13] BloombergNEF.
[14] See, e.g., Tom Carter, "Japanese carmakers are losing ground as China surges ahead in the EV race," *Business Insider,* November 12, 2024.
[15] See, e.g., Norihiko Shirouzu and Adam Jourdan, "China to Open Auto Market as Trade Tensions Simmer," *Reuters,* April 17, 2018.
[16] See, e.g., Michael Dunne, "China: The Forever King of Tariffs," The Dunne Insights Newsletter, March 15, 2025.

Chinese automaker has benefited greatly from this policy. In 2018, in an agreement negotiated by President Trump, China's National Development and Reform Commission (NDRC) announced that it would phase out foreign ownership restrictions.[17] But by then, the goal of partnerships and theft of intellectual property was already accomplished.

Since the phaseout was largely completed in 2022, China and its companies have pivoted to a new type of JV that targets production outside of China in order to enable access to new global markets.[18] Examples of this new approach include Stellantis partnering with China's Leapmotor to initially manufacture vehicles in Poland before shifting elsewhere in Europe, and Spain's EBRO-EV has teamed up with Chery to develop EVs in Barcelona.[19] China's companies, likely with the assistance of low-cost government loans, have continued to purchase Western companies to use their brands, a trend that began during the 2008 Financial Crisis when the auto industry was in deep distress. This dynamic means that western consumers might be buying a Chinese-made car without even knowing it.

The United States is not immune either, having adopted protectionist measures in the form of 100 percent tariffs on electric vehicles and increases on EV batteries and key minerals. It has also taken steps to severely restrict the import of Chinese vehicle hardware and software due to national security concerns, which could result in an effective ban on China's vehicles entering the U.S. market.[20] But even despite these actions, China exported $13.25 billion worth of lithium-ion batteries to the United States in 2024, accounting for 71 percent of all U.S. battery imports.[21] Although U.S. policymaker decisions may well

## Figure 4. **China: Export of Vehicles; Cumulative, March 2021–February 2025**




Source: China Association of Automobile Manufacturers

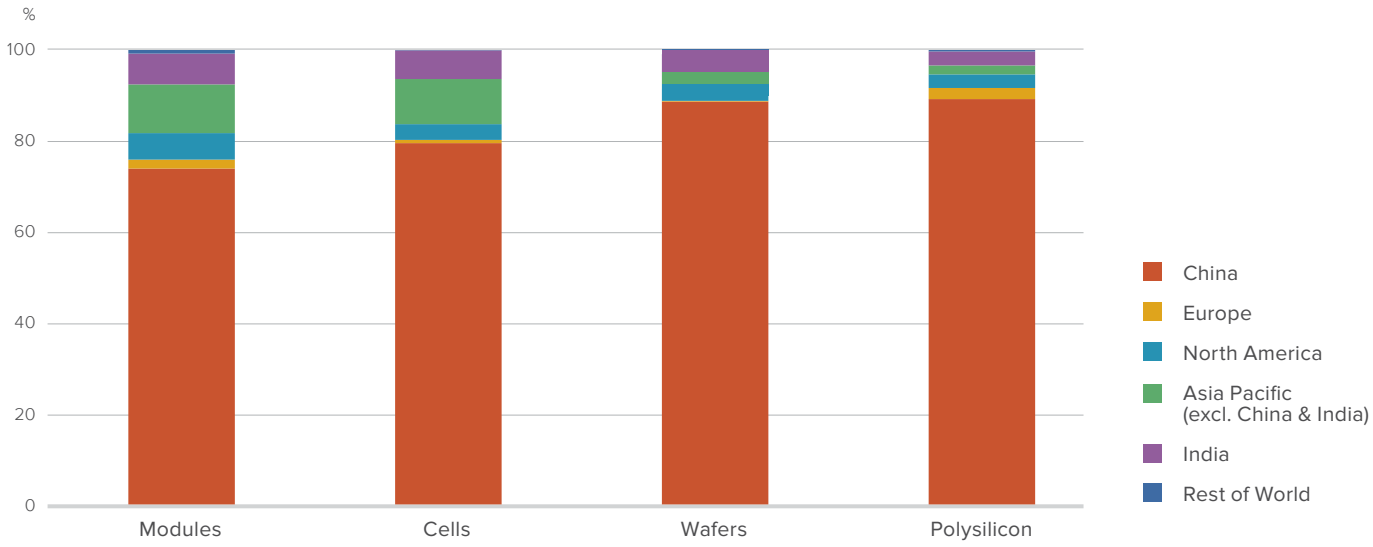
[17] Yueyuan Selina Xue et al., "China's automotive odyssey: From joint ventures to global EV dominance," *Innovation,* January 26, 2024.
[18] Hu Weijia, "Is the era of JVs in China's vehicle sector coming to an end?," *Global Times,* October 26, 2023.
[19] Jakob Hanke Vela and Jordyn Dahl, "Europe gives China a taste of its own trade medicine," *POLITICO,* June 18, 2024; and *Reuters,* "Stellantis stops making Leapmotor EV in Poland, eyes other options," April 8, 2025.
[20] See, e.g., David Shepardson, "Biden proposes banning Chinese vehicles, 'connected car' technology from US roads," *Reuters,* September 23, 2024.
[21] SAFE analysis based on United States International Trade Commission data.

The annual cost to the U.S. economy from stolen IP and theft of trade secrets, for example, is estimated to be between $225 billion and $600 billion per year.

slow Beijing's momentum, China's commanding lead in the global battery industry—which stood at 85 percent of global production capacity last year—means the People's Republic of China (PRC) will likely maintain its position for the foreseeable future.[22]

Beijing often goes to even more extreme lengths to put western firms at a disadvantage across a wide array of industries. The annual cost to the U.S. economy from stolen IP and theft of trade secrets, for example, is estimated to be between $225 billion and $600 billion per year, according to the Federal Bureau of Investigation.[23] In the automotive space, last year, a Chinese national was convicted for stealing Tesla's battery assembly line technology. In 2019, Akhan Semiconductors, based out of Illinois, sent a prototype to Chinese technology conglomerate Huawei, which then reverse engineered the technology, violating export control laws.[24] More recently, the Department of Commerce found that Huawei Ascend chips were likely developed or produced in violation of U.S. export controls.[25] The list of these types of actions is long, and former FBI Director Christopher Wray, has stated that there are 2,000 active investigations focused on the PRC's efforts to steal information across a wide range of high-technology sectors.[26] These are not isolated incidents from single bad actors but a concerted

## Figure 5. **Projected 2027 capacity for Solar PV manufacturing by country and region**




Source: IEA

[22] IEA, "Batteries and Secure Energy Transition," April 2024, at 113.
[23] FBI, "China: The Risk to Corporate America," 2019, at 1.
[24] House Committee on Foreign Affairs, "Egregious Cases of Chinese Theft of American Intellectual Property," February 2020, at 1.
[25] Office of Congressional and Public Affairs, "Department of Commerce Rescinds Biden-Era Artificial Intelligence Diffusion Rule, Strengthens Chip-Related Export Controls," Bureau of Industry & Security, May 13, 2025.
[26] Scott Pelley et al., "Global intelligence leaders warn against China's technology theft," *CBS News,* October 22, 2023.

campaign that starts from the top of the PRC to infiltrate everything from major corporations, small startups, university-level research labs, and even the U.S. government.

These incidents have impacted another growing industry in which the United States once maintained the lead. In a high-profile case dating back to 2012, Chinese hackers obtained access to Solar World executives' email, which included significant information about the company's operations and technology.[27] Not coincidently, the solar industry was also a prized strategic sector for Beijing, and now, more than a decade later, China holds more than 80 percent of the world's manufacturing capacity.[28]

Even if one is not a big supporter of solar energy, China's lead in the solar industry is particularly concerning given one of the primary materials needed to manufacture a solar panel is polysilicon. Polysilicon is widely used in the semiconductor industry for chips and integrated circuits, and the material is embedded in nearly every piece of modern electronic equipment. Though American and allied companies currently dominate the supply chain, China has again built excess capacity in the solar and polysilicon markets, which has rapidly driven down prices for solar panels over the last several years. This provides the country with the opportunity to make their way up the supply chain and push companies out of business by undercutting prices. China's dominance means the world is reliant on concentrated production for critical minerals and new energy technology within an adversarial nation, which raises longer-term concerns.

China has also focused heavily on creating self-sufficiency in the semiconductor industry, a sector that many advanced economies require to keep the industrial base churning. Nearly every modern convenience or invention requires chips—including vehicles, medical equipment, appliances, consumer electronics, and military weapons platforms. In the semiconductor industry, China again spent massively, beginning with a campaign in 2014 to acquire leading western firms backed with an initial investment of $21 billion, which was followed by another $29 billion in 2019.[29] Last year, Beijing initiated a third tranche of funding that amounted to an additional $47.5 billion.[30] These investments have led to China accounting for half of all new global capacity in older legacy semiconductors coming online through 2029.[31]

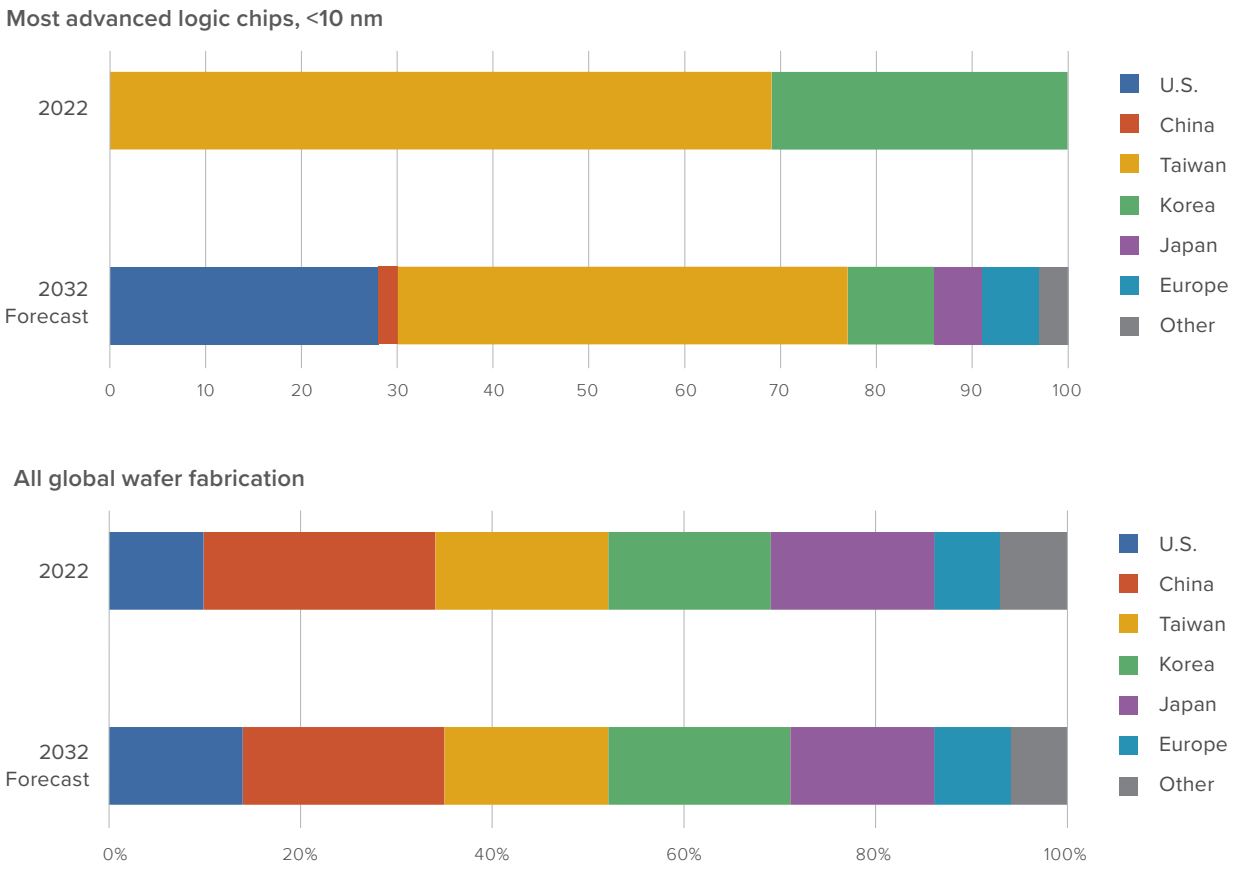
The United States and other western countries may possess the technology to produce the most advanced chips—those needed for AI, data centers, and supercomputing, among other things—but consolidation of older chip production has begun to shift the entire global economy toward reliance on Beijing. Given the pervasiveness of legacy chips in so many products, Beijing's efforts and success in the semiconductor industry have significant implications for the U.S. and western manufacturing industries, even if China is never able to achieve cutting edge production of the most advanced chips. In fact, if Beijing were to eventually use its position in the industry for geopolitical or trade purposes, the economic impacts would be significant. During the pandemic, for example, temporary chip disruption in the auto industry was estimated to cost $210 billion in lost revenues globally.[32] Western automakers were hit the hardest by this disruption—often because production was stalled by a shortage of just *one chip out of the three thousand* required for a finished vehicle.[33]

In recognition of the need to counter China's ascendance in the chip industry, the United States spent roughly $53 billion on the CHIPS and Science Act in 2022 in an effort to

Beijing's efforts and success in the semiconductor industry has significant implications for the U.S. and western manufacturing industries.

[27] Sam Frizell, "Here's What Chinese Hackers Actually Stole From U.S. Companies," *TIME,* May 20, 2024.
[28] Isabel Hilton, "How China Became the World's Leader on Renewable Energy," Yale Environment 360, March 13, 2024.
[29] Jimmy Goodrich, "China's Evolving Semiconductor Strategy," University of California Institute on Global Conflict and Cooperation, May 29, 2024; and Yoyo Kubota, "China Sets Up New $29 Billion Semiconductor Fund," *The Wall Street Journal,* October 25, 2019.
[30] Jimmy Goodrich, "China's Evolving Semiconductor Strategy," University of California Institute on Global Conflict and Cooperation, May 29, 2024.
[31] Karen Sutter and Micheal Sutherland, "China's Economy: Current Trends and Issues," Congressional Research Service, December 20, 2024, at 2.
[32] Timothy Yost, "Shortages related to semiconductors to cost the auto industry $210 billion in revenues this year, says new AlixPartners forecast," AlixPartners, September 23, 2021.
[33] Jack Ewing and Neal Boudette, "A Tiny Part's Big Ripple: Global Chip Shortage Hobbles the Auto Industry," *The New York Times,* April 23, 2021.

## Figure 6. **Global Wafer Fabrication Capacity by Region, 2022 and 2032 Forecast**




Source: Boston Consulting Group Analysis based on Department of Commerce and SEMI data.

keep pace. It also placed export controls and worked with allies to encourage them to place their own export controls on advanced semiconductor production equipment to China, with the intention of slowing China's progress toward producing more advanced chips. However, Beijing has made enough progress in the production of legacy chips to ensure that other advanced economies' manufacturing sectors and their integrated supply chains for a wide range of products will be reliant on China for the foreseeable future. For instance, China's share of logic chips over 28nm, chips that are not state-of-the-art but are widely used in applications where high performance is not the primary concern, including vehicles, will increase from 33 percent in 2022 to 37 percent in 2032 and their share of logic chips between 10nm and 22nm will triple its share from 6 percent in 2022 to 19 percent in 2032.[34]

[34] Raj Varadarajan et al., "Emerging Resilience in the Semiconductor Supply Chain," Boston Consulting Group and Semiconductor Industry Association, May 2024, at 14.

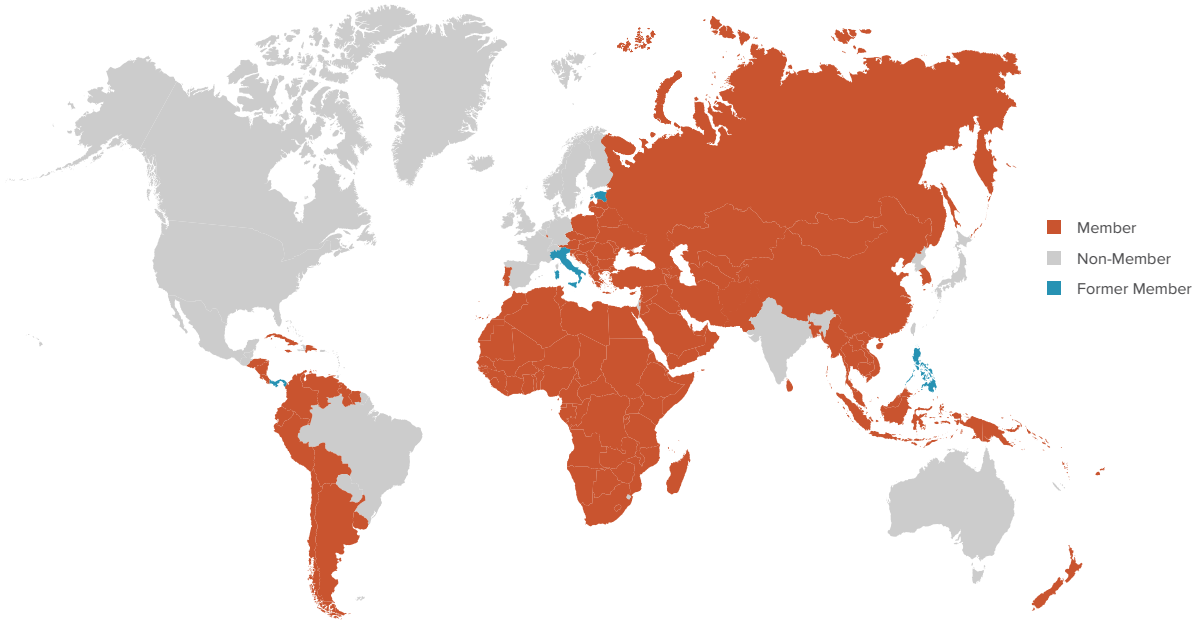
## CRACKS EMERGE

While the automotive, battery, solar, and semiconductor industries are often recognized as the largest industries China has subsidized and disrupted, there are dozens of others that play critical roles in the global economy that should be cause for concern amongst policymakers. In industrial robotics, which are increasingly used in a variety of sectors and hold the potential to provide meaningful increases in economic productivity, China is again leading the world—accounting for more than 50 percent of industrial robotic installations worldwide in 2022.[35] More significantly, China's use of robots in factories is greater on a per worker basis than in American factories.[36]

China is also the world's leading supplier of advanced grid components for ultrahigh-voltage systems, such as transformers, circuit breakers, and inverters, according to a U.S. National Intelligence Council report.[37] China's advances in grid components are particularly concerning given that the United States has imported roughly 450 transformers from China since 2006—which presents significant cyber vulnerability and domestic grid security risks, including the ability to turn off parts of the grid, if not addressed.[38]

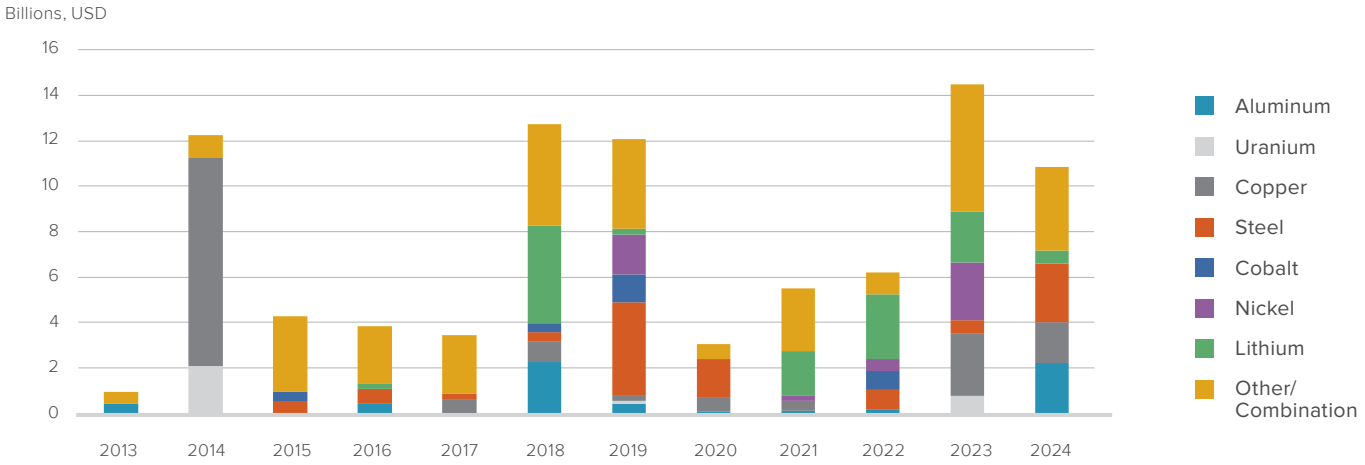
Taken as a whole, China's rapid ascent into increasingly complex manufacturing sectors—over just 25 years—was undoubtedly due in large part to its centrally directed economy. Beijing's industrial policy is designed to develop overcapacity of production and manufacturing while caring little about optimizing economic efficiency. Instead, in the strategic sectors it has identified, Beijing is focused on growth at any cost, and the power and national security

### Figure 7. **China's BRI Members and Global Influence**




[35] Robert Atkinson, "How Innovative Is China in the Robotics Industry?," Information Technology & Innovation Foundation, March 2024, at 6.
[36] See, e.g., Jon Emont, Daniel Michaels, Ming Li, and Jason French, "America Let Its Military-Industrial Might Wither. China's Is Booming," *Wall Street Journal,* May 29, 2025.
[37] National Intelligence Council, "Climate Change and International Responses Increasing Challenges to US National Security Through 2040," Office of the Director of National Intelligence, October 21, 2021, at 6.
[38] Joe Weiss, "The U.S. electric industry is not responding to cyber-vulnerable Chinese equipment," Security Info Watch, March 4, 2024.

## Figure 8. **Chinese Investment into Critical Raw Materials through the Belt & Road Initiative, 2013–2024**




Source: China Global Investment Tracker | American Enterprise Institute and SAFE analysis

that growth conveys, as evidenced by its massive subsidy programs and the measures it will take to acquire technology it deems desirable. Furthermore, its blatant disregard for human rights and the treatment of the eleven million Uyghurs in Xinjiang province have been described as genocide by the United States and others.[39] Beijing is estimated to have placed nearly two million Uyghurs in internment camps, which are often used as a source of forced labor to manufacture a range of products that are used to support global integrated supply chains that continue to feed the CCP's economic ambitions while at the same time quelling any perceived dissent.[40]

While nearly all western economies and their leading companies are locked into profit-maximizing and quarter-to-quarter thinking, China has used the market-based international system to its advantage. At least in the short-to-medium term, the CCP's five-year plans and long-term programs have outdueled free market capitalism, but longer-term success could very well prove elusive.

China, for example, is often thought to perform poorly on measures of innovation, as Beijing has often prioritized taking shortcuts or iterated on others' inventions. China's President, Xi Jinping, acknowledged last year in a speech that China's innovation was "still relatively weak" and currently lacked the elite technology talent necessary to compete over the long term.[41] However, the recent emergence of Chinese startup DeepSeek, and its powerful and low-cost AI system, was a reminder that China may be starting to close the gap with its western competitors. China is rapidly cementing its place as a research and science powerhouse, moving from a lead in only three critical technologies in 2007 to 57 out of 64 today.[42]

There are other signs, however, that China's system is beginning to crack, including the fact that China's share

[39] See, e.g., Michael Pompeo, "Determination of the Secretary of State on Atrocities in Xinjiang," Department of State, January 19, 2021; and European Parliament, "The cases of unjustly imprisoned Uyghurs in China, notably Ilham Tohti and Gulshan Abbas," October 10, 2024

[40] Lindsay Maizland, "China's Repression of Uyghurs in Xinjiang," Council on Foreign Relations, September 22, 2022.

[41] Katherine Tangalakis-Lippert and Matthew Loh, "Xi Jinping admits China is 'relatively weak' on innovation and needs more talent to dominate the tech 'battlefield'," *Business Insider,* June 26, 2024.

[42] Jennifer Wong Leung et al., ASPI's two-decade Critical Technology Tracker: The rewards of long-term research investment," Australian Strategic Policy Institute, August 2024, at 7.

of the world's GDP has likely peaked in 2022.[43] Much of China's economic slowdown has been attributed to a slowdown in the real estate and infrastructure development sectors.[44] But structurally speaking, China's economy may continue to face headwinds as it remains so heavily reliant on manufacturing and investment—capturing roughly 28 percent of global investment on an annual basis—while its domestic consumption only accounts for 12 percent of the world's total consumption.[45] How well Beijing will navigate some of these challenges remains to be seen, but given the structural imbalances in its economy, it is clear that looking outward will be one of its top priorities.

Given the recent economic stagnation China has faced, Beijing is likely to remain focused on expanding its alliances and partnerships around the world to first enhance its geopolitical standing, but perhaps more importantly, to offload its domestic overcapacity, which will become a crucial component of its economic engine to propel the next phase of its growth. Beijing, for its part, is well positioned due to the use of its banking and finance system over the last decade to build the largest global development, infrastructure, and trade initiative in the history of the world—its Belt and Road Initiative (BRI). China's BRI, which began in 2013, currently names roughly 150 countries as partners and is estimated to have invested more than $1 trillion to date, with up to an additional $7 trillion to be spent in the coming years.[46] Meanwhile, the United States International Development Finance Corporation (DFC), which has been viewed by many as a response to China's BRI—has an investment cap of only $60 billion.[47]

## BEIJING'S MINERAL DIPLOMACY

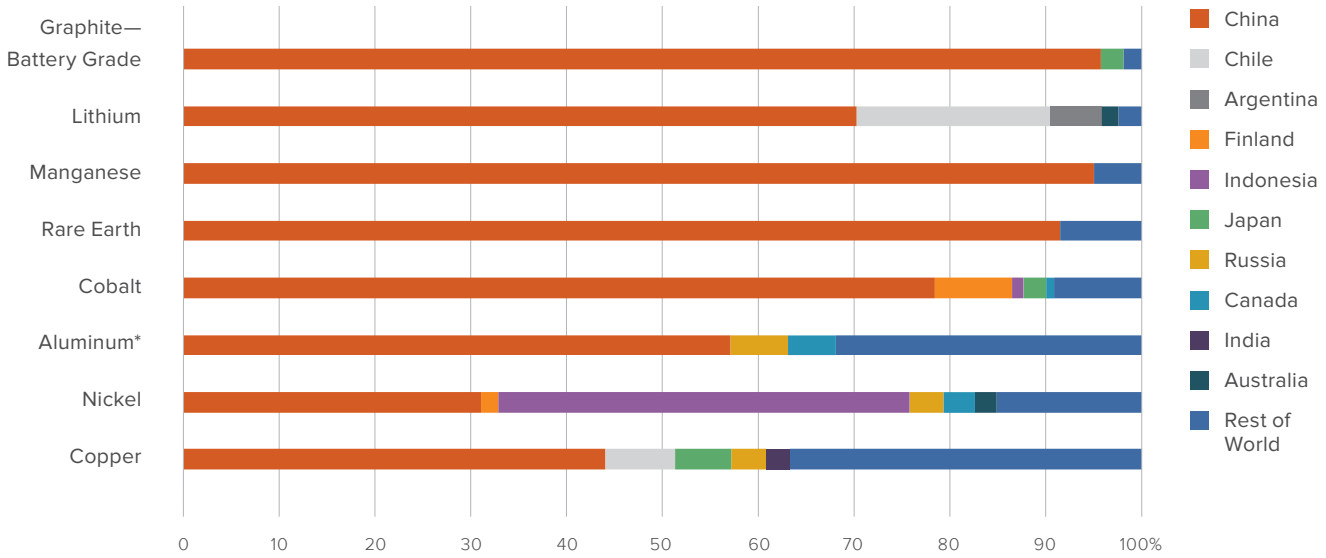
The BRI—which has led to China being the world's largest creditor—has primarily focused on building energy, transportation, and telecommunications networks—with projects such as power plants, railways, highways, ports, and telecommunications infrastructure being the primary areas of focus.[48] Countries have often welcomed the investments from Beijing—particularly because private sector capital often does not prioritize infrastructure investments in riskier emerging markets—but these deals are often described as "debt-trap" diplomacy. When countries cannot afford to meet financial obligations, repayment terms are often backed by collateral commitments (e.g., lease rights, minerals, or commodities), that help Beijing offset commercial risk.[49]

Given the recent economic stagnation China has faced, Beijing is likely to remain focused on expanding its alliances and partnerships around the world to first enhance its geopolitical standing, but perhaps more importantly, to offload its domestic overcapacity, which will become a crucial component of its economic engine to propel the next phase of its growth.

China's BRI success is particularly notable in the mining sector, as it has increasingly synced foreign investments in raw materials extraction to support its domestic manufacturing build-up. Beijing invested nearly $22 billion in 2024 alone to support foreign projects related to strategic materials and critical minerals.[50] Particular focus areas for these investments have included a number of African countries, Bolivia and Chile in Latin America, and Indonesia. Indonesia currently accounts for more than half of the world's nickel output. Since 2010, China is estimated to have spent more than $60 billion to develop its nickel supply chain, a commodity for which the vast majority of the output is either controlled by PRC entities or shipped to China for

[43] Daniel Rosen et al., "China's Slowdown Has Changed the Trade War," *Foreign Affairs,* December 17, 2024; and SAFE analysis based on World Bank data.
[44] Ning Leng, "Global Implications of China's Economic Expansion," Department of State, September 18, 2024.
[45] Daniel Rosen, "China's Slowdown Has Changed the Trade War," *Foreign Affairs,* December 17, 2024.
[46] James McBride et al., "China's Massive Belt and Road Initiative," Council on Foreign Relations, February 2, 2023; and Christoph Nedopil, "China Belt and Road Initiative (BRI) Investment Report 2024," Griffith Asia Institute, February 27, 2025, at 1.
[47] Erin Murphy et al., "The Next Five Years of the DFC," Center for Strategic & International Studies, September 27, 2023, at 3.
[48] GAO, "International Infrastructure Projects: China's Investments Significantly Outpace the U.S., and Experts Suggest Potential Improvements to the U.S. Approach," September 12, 2024, at 1.
[49] Karen Sutter et al., "China's "One Belt, One Road" Initiative: Economic Issues," Congressional Research Service, May 16, 2024.
[50] Christoph Nedopil, "China Belt and Road Initiative (BRI) Investment Report 2024," Griffith Asia Institute, February 27, 2025, at 7.

## Figure 9. **Share of Top Mineral Processing Countries in the World for Selected Minerals, 2024**




*Aluminum: 2023 data

Source: IEA, UNCTAD

processing.[51] A similar dynamic has emerged with lithium in South America and cobalt in the Democratic Republic of Congo, where significant Chinese investment has secured substantial influence over parts of the supply chain—raising concerns about Beijing's sway over global access to critical raw materials.

China has used these deals to establish a steady and secure feedstock of minerals to support the world's most robust materials and minerals processing industry. China currently holds the global processing/refining capacity for 70 to 80 percent of lithium and cobalt, roughly 60 percent of nickel, and more than 90 percent of graphite and rare earth elements.[52] By supporting its supply chain dominance with subsidies, stockpiling, and export quotas, China has positioned itself to dominate much of the world's advanced technology production, just as Saudi Arabia long dominated the oil sector, posing supply chain risks to the United States and its allies, which remain heavily import-dependent.

Dependence on China for critical minerals is likely a greater risk than dependence on the global oil market. China dominates the global supply chain for critical minerals, with highly concentrated production and refining capabilities in China, leaving few, if any, alternatives. Unlike critical minerals, there is a global market for oil on which supplies are available, even if at a high cost. Moreover, members of the Organization of the Petroleum Exporting Countries (OPEC) cannot easily target specific countries without affecting the broader oil market, which is a limiting factor. It can take years, if not decades, to develop new mines, establish mineral refining capacity, and build secure integrated supply chains. Although once minerals are integrated into batteries or other technologies located within U.S. borders, the ability to infinitely recycle the materials drastically reduces the

[51] IEA, "The Role of Critical Minerals in Clean Energy Transitions," May 5, 2021, at 145; and Ker liang Chan, "The Promise And Pitfalls Of Indonesia's Nickel Boom," S&P Global, March 13, 2023.

[52] See, e.g., Joseph Majkut et al., "Building Larger and More Diverse Supply Chains for Energy Minerals," Center for Strategic & International Studies, July 19, 2023, at 4; and IEA, "Global Critical Minerals Outlook 2025," May 21, 2025, at 252.

long-term risk. In contrast, oil supply shocks can be mitigated to some extent by increasing production elsewhere or tapping into strategic reserves. In short, dependence on China for critical minerals is a more systemic and long-term risk than oil dependence. China's dominance in extraction, refining, and processing, combined with the importance of these minerals in defense and energy, makes any disruption a serious threat to economic and national security.

## Figure 10. **Chinese Restrictions on Critical Mineral Exports**

| MINERAL | USES | STATUS |
|---|---|---|
| **Graphite** | Semiconductor Manufacturing, Steelmaking, Auto Manufacturing, Aerospace Manufacturing, Battery Manufacturing | Restricted |
| **Germanium** | Aerospace Manufacturing, Fiber-optic Technology | Banned for U.S. use |
| **Gallium** | Semiconductor Manufacturing, Electronics, Solar Panels | Banned for U.S. use |
| **Antimony** | Alloys, Battery Manufacturing, Night Vision Goggles, Nuclear Weapons | Banned for U.S. use |
| **Tungsten** | Metalworking, Oil and Gas Drilling, Electronics | Restricted |
| **Indium** | Electronic Screens, Fiber-optic Technology | Restricted |
| **Bismuth** | Alloys, Metallurgical Additives, Atomic Research | Restricted |
| **Tellurium** | Metallurgy, Solar Panels, Memory Chips | Restricted |
| **Molybdenum** | Steel Alloys, Petroleum Industry | Restricted |
| **Samarium** | Optical Lasers, Powerful Magnets, Nuclear Reactors | Restricted |
| **Gadolinium** | MRIs, Nuclear Reactors | Restricted |
| **Terbium** | Electronic Devices such as Sensors and Digital Displays | Restricted |
| **Dysprosium** | Permanent Magnets, Energy Storage | Restricted |
| **Lutetium** | Oil Refining | Restricted |
| **Scandium** | Aerospace Manufacturing | Restricted |
| **Yttrium** | Radar Technology, Lasers, Cancer Treatments | Restricted |

Source: USGS, "Mineral Commodity Summaries 2025"; Amy Lv and Lewis Jackson, "China's curbs on exports of strategic minerals," *Reuters,* February 4, 2025; Amy LV and Tony Munrow, "China bans export of critical minerals to US as trade tensions escalate," *Reuters,* December 3, 2024; Josh Xiao and James Mayger, "China Hits Back at Trump With Tariffs, Limits on Key Exports," *Bloomberg,* April 4, 2025; and Royal Society of Chemistry.

Given the dominant position that China has achieved in the production and processing of supply of a wide range of strategic materials and critical minerals, it is clear why the United States and its trading partners share the concern that their collective economic and national security are at risk. Moreover, the risk is not merely theoretical. China has a long, if slowly escalating, history of using its dominant position in the supply chain to its advantage for both commercial and geopolitical purposes, a particularly concerning trend.

As early as the 1990s, for example, China developed rare earth processing capacity and began flooding the rare earth minerals market with low-priced minerals to drive its competition out of business. Although the United States, Canada, and Australia have untapped rare earth deposits, their mines could not compete with China's low prices, which it achieved largely through poor environmental and labor practices, especially given the expense of mining the radioactive ore from which rare earth minerals are extracted.

Rare earths were an early indicator of Beijing's willingness to use its domination in critical materials as an instrument of foreign policy. The rare earth element mine at Mountain Pass, California—owned by Unocal until 2005, Chevron until 2008, and then Molycorp Minerals, until its bankruptcy in 2015—is the only stand-alone rare earth mine in the United States that is currently operating.[53] Once mining at volumes that made the United States the world's largest producer of rare earth minerals, mining operations ceased at Mountain Pass in 2002 in large part due to competition from China.[54]

[53] Keith Bradsher, "Challenging China in Rare Earth Mining," *New York Times,* April 21, 2010; Marc Humphries, "Critical Minerals and U.S. Public Policy," Congressional Research Service, June 28, 2019, at 3; and NS Energy "Mountain Pass Rare Earth Mine," Webpage, March 6, 2020.

[54] Marc Humphries, "Critical Minerals and U.S. Public Policy," Congressional Research Service, June 28, 2019, at 2-3.

In 2008, a group of investors formed Molycorp and bought the Mountain Pass mine from Chevron, planning to reopen the mine and produce rare earth minerals.

In 2010, a Chinese fishing trawler collided with a Japanese Coast Guard patrol boat in disputed waters near the Senkaku Islands, and Japan detained the trawler's captain and crew.[55] As the diplomatic dispute grew, Japan released the crew, trawler, and captain within 10 days. Still, the incident significantly increased tensions between Japan and China. Although the incident was entirely unrelated to minerals, China issued a de facto ban on rare earth mineral exports in response. It reduced Japan's imports from China by 52 percent and sent the price of rare earths soaring.[56] In response to that experience, Japan has diversified its sources of rare earth minerals in partnership with Australia and is now not critically dependent on Chinese imports.

Molycorp appeared to have a significant market opportunity after China restricted rare earth mineral exports, causing rare earth prices—and Molycorp's stock price—to rise sharply. To rebuild a domestic supply chain, Molycorp Minerals broke ground on a new processing facility in 2011, and restarted mining operations in 2012.[57] However, mining ceased again in October 2015, months after Molycorp filed for bankruptcy, largely due to competition from China and a global oversupply of its main products—cerium and lanthanum—which accounted for more than 80 percent of what Molycorp produced.[58] The mine was purchased by MP Materials in 2017 and reopened later that year.[59] Mountain Pass is now the world's second largest rare earth mine, yielding over 45,000 metric tons of rare earth oxides contained in concentrate in 2024, or around 12 percent of global supply.

China demonstrated its dominant position in the rare earth mineral market yet again in 2019. In 2019 Chinese Premier Xi Jinping visited a rare earth magnet-maker. Afterwards, Chinese state-run media published articles emphasizing that rare earths could become a "counter-weapon" in trade negotiations.[60] This veiled threat underscored China's willingness to use its minerals monopoly to pressure the United States. It prompted the U.S. government to start funding domestic rare earth mining and processing projects. Since 2020, the U.S. Department of Defense (DoD) has granted more than $439 million to establish domestic rare earth element supply chains, underscoring these materials key role in supporting the defense industrial base.[61]

The United States does not currently produce the full slate of refined rare earth materials, with no production of some heavy minerals that have several critical uses in defense and other applications.

Since 2021, MP Materials has produced at least 40,000 metric tons annually of rare earth oxides, and it is expanding that capacity.[62] In late 2023, MP Materials recommissioned the separations facility at Mountain Pass which is currently producing refined NdPr oxide, cerium chloride, lanthanum carbonate, and SEG+ (a mixed heavy rare earth concentrate). A heavy rare earth separation facility in development is expected to begin production in 2026. MP Materials also has opened a facility in Fort Worth, Texas, that produces NdPr metal as of December 2024 and anticipates manufacturing neodymium-iron-boron permanent magnets by the end of 2025.[63] It has also entered into an agreement with GM to supply finished magnets for use in electric vehicle motors, for which it has received $100 million in prepayments, reflecting GM's commitment to MP Materials' success.[64] Even with the progress from MP Materials' success, the United States does not currently produce the full slate of refined rare earth materials, with no production

[55] James Pamment et al., "Hybrid Threats: The 2010 Senkaku crisis," NATO Strategic Communications Centre of Excellence, June 6, 2019, at 173.
[56] See, e.g., Chikako Mogi, "Japan rare earths imports from China jump in Dec," *Reuters,* January 31, 2011.
[57] Marc Humphries, "Critical Minerals and U.S. Public Policy," Congressional Research Service, June 28, 2019, at 4.
[58] See, e.g., John Miller and Anjie Zheng, "Molycorp Files for Bankruptcy Protection, *Wall Street Journal,* June 25, 2015; and Melody M. Bomgardner, "The Struggle To Mine Rare Earths," Chemical and Engineering News, July 27, 2015; and "Securities and Exchange Commission Form 10-K," Molycorp Inc., March 16, 2015, at 42.
[59] Fortress Value Acquisition Corp., "424(b)(3) Prospectus," Securities and Exchange Commission, November 13, 2020, at 291.
[60] See, e.g., Srinivas Mazumdaru, "Can China stop rare earths exports to the US?," *Deutsche Welle,* June 5, 2019.
[61] Todd Lopez, "DOD Looks to Establish 'Mine-to-Magnet' Supply Chain for Rare Earth Materials," Department of Defense, March 11, 2024.
[62] MP Materials Corp., "SEC Form 10-K for the Year Ended December 31, 2024," February 28, 2025, at 41.
[63] Id., at 1.
[64] Id., at 67.

China has expended significant resources in building up its domestic stockpiles—for both commercial and military purposes.

of some heavy minerals that have several critical uses in defense and other applications.[65] Economically, it is difficult for a domestic processor to make the large capital investment without guaranteed offtake agreements, particularly with China's history of manipulating prices to undercut foreign processors, and there are not yet a sufficiently large number of domestic companies willing to pay higher prices for a more reliable domestic supply of critical mineral inputs.

More recently, Beijing instituted a slew of new measures regarding the export of minerals needed to manufacture advanced chips. In late 2024, in response to new U.S. restrictions on the export of equipment and software to manufacture advanced semiconductors, China implemented new restrictions on exporting certain "dual-use" technologies to the United States.[66] Tightening earlier restrictions, Beijing banned the export of gallium and germanium, minerals critical to the manufacture of high-performance chips with defense applications, and antimony, which is used to manufacture ammunition, electronics, specialty glass, and other products.[67] These were the first Chinese restrictions on the export of minerals directed solely at the United States.

In January 2025, China announced a proposed action that would place export controls on technology related to direct lithium extraction and the production of lithium-iron-phosphate (LFP) cathodes for batteries.[68] In February, China tightened export controls for tungsten, tellurium, bismuth, molybdenum and indium products, without singling out any particular country, a measure less severe than the December ban on the export of gallium and germanium.[69] Then, in April, in response to new U.S. tariffs on imports from China, China imposed export restrictions on seven rare earth elements and magnets used in the defense, energy, and automotive sectors, requiring companies to secure special export licenses to export the minerals and magnets.[70] Most recently, on June 11, the United States and China reportedly reached an agreement that will adjust tariffs between the two nations, and would continue to export rare earth minerals and rare earth magnets to the United States.[71] Again, while the United States certainly benefits from the conclusion of trade agreements with its trading partners, the high level of uncertainty about the future regulatory, economic, and business environment makes it difficult for investors to rely on trade mechanisms as tools supporting long-term capital investments, which require a higher degree of regulator and economic stability to create a positive investment climate.

These are just a few examples of the actions Beijing has taken to ensure their mineral producers and consumers remain leaders, but China has also expended significant resources in building up its domestic stockpiles—for both commercial and military purposes. For example, according to a study requested by the European Parliament, "Analysts believe…that China's stockpile is growing to secure reserves in the event of a conflict."[72] Perhaps not so coincidently, China's overall economic rise, combined with its near monopolistic position in many supply chains and technologies, has provided Beijing the confidence to become more emboldened on the global stage.

## CHINA'S GROWING MILITARY THREAT

While China's economic growth over the last 15 years is unquestioned, its armed forces have similarly advanced at a lightning pace, largely supported by its advanced industrial base. Beijing's publicly announced budget is currently in the range of $235 billion, though DoD estimates that China's

[65] Id., at 29; and Donald Bleiwas and Joseph Gambogi, "Preliminary Estimates of the Quantities of Rare-Earth Elements Contained in Selected Products and in Imports of Semimanufactured Products to the United States," U.S. Geological Survey, April 8, 2013, at 3.
[66] Amy Lv and Tony Munroe, "China bans export of critical minerals to US as trade tensions escalate," *Reuters,* December 3, 2024.
[67] Ibid.
[68] "China Flexes Lithium Dominance with Plans for Tech-Export Curbs," Bloomberg, January 2, 2025.
[69] TDi Sustainability, "Trade Laws and Restrictions | Timeline and Implications," March 12, 2025, Webpage.
[70] April Rubin, "What to know about rare earths in the China-U.S. trade dispute," *Axios*, June 4, 2025; and Institute for Energy Research, "China Imposes Export Controls on Rare Earth Minerals," April 16, 2025, Webpage.
[71] *Reuters,* "Trump says China will supply rare earths, US to allow students," June 11, 2025.
[72] Elmer Rietveld et al., "Strengthening the security of supply of products containing Critical Raw Materials for the green transition and decarbonisation," Policy Department for Economic, Scientific and Quality of Life Policies, December 2022, at 71.

actual budget could be up to 90 percent higher.[73] Beijing now possesses an advanced nuclear arsenal, a leading hypersonic missile development program, the world's largest navy with the capacity to develop a wide array of naval classes, counter-space capabilities, and more than three million active or reserve military personnel at the ready.[74] Yet China's ability to project power is not just a function of its military budget or technological advances, it is underpinned by an industrial base that far outstrips the United States.

A key factor in China's military rise has been its ability to rapidly expand its naval forces. China's navy currently surpasses the U.S. Navy in total battle force ships, with 370 warships compared to 292 for the United States.[75] Projections show this gap widening to 435 Chinese ships by 2030, while the U.S. fleet is expected to stagnate or shrink before recovering.[76] China's advantage is reinforced by its ability to build, maintain, and repair ships at a scale the United States cannot currently match. China's shipbuilding capacity is more than 200 times greater than that of the United States, with its shipyards producing more than 1,700 large vessels annually compared to a mere five for the United States.[77]

The consequences of this disparity extend beyond fleet size. China's shipbuilding infrastructure is dual-use, allowing Beijing to rapidly convert commercial shipbuilding capacity to naval production when it is needed. China's dual-use model has not only expanded its navy but accounts for 40 percent of the world's commercial ships.[78] Meanwhile, the U.S. industrial base is at a historic low. Only two U.S. shipyards—Philly Shipyard in Pennsylvania and NASSCO in San Diego—actively produce commercial vessels. However, Philly Shipyard operates at a loss, and NASSCO relies almost entirely on Navy contracts for survival.[79] As a result of production from these two shipyards, the United States accounts for just 0.2 percent of global shipbuilding tonnage.[80]

The decline in American shipbuilding capacity has crippled America's ability to sustain its own naval force. The U.S. Navy is struggling with ship retirements outpacing new construction and maintenance backlogs that have sidelined a large proportion of the fleet—including 16 of the Navy's 48 attack submarines awaiting maintenance.[81] The aging sealift and logistics support fleet further compound this problem, raising long-term concerns over whether the United States could sustain prolonged operations in the Pacific in the event of ongoing conflicts. While China's military build-up is concerning, it has long foreshadowed its territorial ambitions by first building up islands in the South China Sea in 2013. Between 2013 and 2015, Beijing created approximately five square miles of artificial land along the disputed Spratly Island chain, on which it then built military infrastructure and deployed advanced anti-ship and anti-aircraft missile systems and other military equipment in an effort to support its claim in the area.[82] Beijing also cracked down on freedoms in Hong Kong in 2019, sending more than 12,000 troops, which was followed by the implementation of a national security law in 2020 that gave Beijing sweeping power over the special administrative region and curtailed any autonomy and rights the entity previously enjoyed.[83]

While many remain concerned about these direct territorial encroachments that have complemented Beijing's commercial influence in other areas around the world, none rise to the level of concern related to China's ambitions of unifying with Taiwan. Over the years, China has increased its military exercises and "grey zone" operations around Taiwan, as well as increased threatening rhetoric. Beijing has set a goal of being able to invade Taiwan by 2027.[84] Such an act could draw the United States into a dangerous conflict with Beijing.

[73] The International Institute for Strategic Studies, "The Military Balance 2025," February 2025, at 239; and "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China," Department of Defense, December 18, 2024, at 147.
[74] Andrew Erickson, "What the Pentagon's New Report on Chinese Military Power Reveals About Capabilities, Context, and Consequences," *War on the Rocks,* December 19, 2024.
[75] Niharika Mandhana, "China's Shipyards Are Ready for a Protracted War. America's Aren't.," *The Wall Street Journal,* February 13, 2024.
[76] Ibid.
[77] Joseph Trevithick, "Alarming Navy Intel Slide Warns Of China's 200 Times Greater Shipbuilding Capacity," *The War Zone,* July 11, 2023; and John Grady, "Bipartisan 'Ships for America Act' Building Support in Congress, Say Sponsors," *USNI News,* September 25, 2024.
[78] Joseph Trevithick, "Alarming Navy Intel Slide Warns Of China's 200 Times Greater Shipbuilding Capacity," The War Zone, July 11, 2023.
[79] John Frittelli, "U.S. Commercial Shipbuilding in a Global Context," Congressional Research Service, November 14, 2023, at 2.
[80] Id., 1.
[81] Ronald O'Rourke, "Navy Virginia-Class Submarine Program and AUKUS Submarine (Pillar 1) Project: Background and Issues for Congress," Congressional Research Service, February 11, 2025, at 7.
[82] Ben Dolven et al., "China Primer: South China Sea Disputes," Congressional Research Service, August 21, 2023, at 2.
[83] "Hong Kong national security law: What is it and is it worrying?," BBC, March 18, 2024.
[84] Sorcha Bradley, "Will China invade Taiwan?," *The Week,* January 17, 2025.

# 2

# Leading with Strength: From Industrial Decline to America's Golden Age

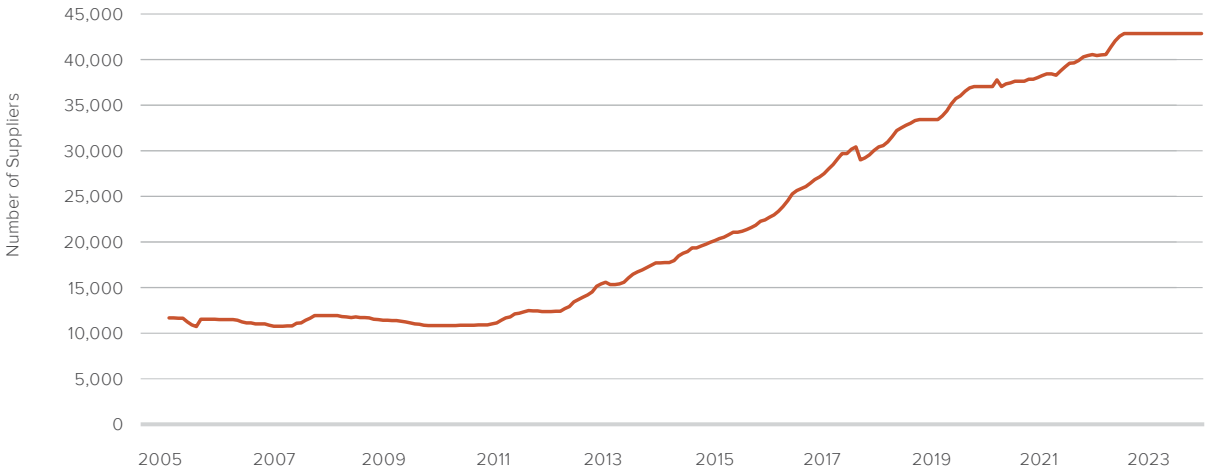
**Beijing's rise has led to a much more dangerous global security environment,** which requires careful planning in coordination with U.S. allies, prudent diplomacy, maintenance of a robust industrial base tied to the defense sector to maintain deterrence, and correspondingly secure and diverse supply chains.

China is no longer the world's factory floor with an abundance of goods labeled with "Made in China," but a peer adversary of the United States that has taken over strategic sectors of the global economy and shown a willingness to test the boundaries of its newfound power. Beijing remains a unique threat, and the United States and allied countries around the world must respond accordingly.

Following the end of the Cold War, the United States was the world's unquestioned superpower with the most powerful military and economy. Despite slashing defense spending in favor of a peace dividend in 1993, America maintained a robust industrial base with leading innovation and manufacturing capabilities, and the ability to ensure global security and a rules-based international trading system. While U.S. leadership came at a significant monetary cost—particularly for military interventions in the Middle East—the rapid globalization that followed saw America's trade share of GDP double from around 15 percent to 30 percent by the 2010s.[85] The 2010s also saw the U.S. economy add more than 22 million jobs, making it the longest expansion in U.S. history.[86] The corresponding economic growth was underpinned by a U.S. energy renaissance in oil and gas production and a technological revolution that saw the development of everything

[85] World Bank, "Trade (% of GDP) - United States," Webpage.
[86] Bureau of Labor Statistics, "Employment, Hours, and Earnings from the Current Employment Statistics survey (National)."

## Figure 11. **Chinese Suppliers in U.S. Defense Supply Chains, 2005–2023**




Source: Govini, "Numbers Matter: Defense Acquisition, U.S. Production Capacity, and Deterring China"

from smartphones to the proliferation of e-commerce, among other important innovations across the energy, transportation, and technology spheres. Although the United States continued to face challenges to its leadership, such as Russia's annexing of Crimea in 2014 and Iran's relentless pursuit of nuclear weapons, there was a perception of relative peace and prosperity—and it appeared America's plan of leading with strength and deterrence was working.

Over the last few years that perception has been shattered. It has become clear that a meaningful proportion of the U.S. industrial base—first in basic consumer staples, then in more advanced and higher-value products—has disappeared and been offshored to China or other emerging countries. Despite substantial increases in domestic productivity in the manufacturing sector, the issues associated with relying so heavily on foreign sources for commonly used goods and materials became apparent throughout the COVID-19 pandemic. For U.S. and allied policymakers, these disruptions served as a wake-up call for the need to secure supply chains and strengthen domestic production of key materials vital to economic stability and national defense.

At the same time, the U.S. and allied security environment has become increasingly complex. As China's economic and military ambitions expanded, so did its global influence. Russia's full-scale assault on Ukraine has seen the United States commit more than $66.5 billion in military assistance while drawing down more than $31.5 billion in military equipment from DoD stockpiles, which has strained financial resources and left the United States less prepared if new conflicts arise.[87] Similarly, Iran's nuclear enrichment has increased, as has activity from its regional proxies—including from Hamas, Yemen's Houthis, Lebanon's Hezbollah, and several Iraqi militias.[88] The United States is being challenged on several fronts, and at levels not seen since the Cold War. If America is to retain its position atop the global order, it must first reverse the long-term weakening across the U.S. and allied industrial base. The industrial base is not only foundational to economic success, but it is inexorably intertwined with the defense industrial base—and the defense industrial base cannot thrive unless there is a healthy economic and advanced manufacturing foundation to support it.

If the United States is to achieve an enduring American Golden Age, it must critically evaluate its strengths and

[87] Department of State, "U.S. Security Cooperation with Ukraine," March 12, 2025, Webpage.

[88] See, e.g., Jon Alterman "Middle East Challenges Will Vex Not Only the First 100 Days, but the First 1,000," in "The Global Impact of the 2024 U.S. Presidential Election," Center for Strategic and International Studies, September 2024, at 54.

weaknesses and formulate a strategy that is durable, agile, and provides the building blocks for both security and industrial resilience. A fundamental shift is occurring across three key dynamics that will drive the next several decades of U.S. and allied policy related to the economy, foreign policy, and national security. **First,** a U.S. strategy must account for those shifts to ensure that America remains dominant across the energy spheres—to support technological advancements, reindustrialization efforts, and an efficient economy. **Second,** the global economy is transitioning to a minerals-based economy, which requires new materials for both commercial innovations and defense applications that foreign adversaries currently dominate. America must lead this transition. **Finally,** the United States must ensure that it rebuilds and maintains a strong and resilient industrial base.

The U.S. automotive sector, which served as the Arsenal of Democracy during World War II by producing tanks, bombers, and trucks at an unprecedented scale, remains the backbone of the U.S. economy and conveys significant strategic benefits. If the United States loses its capacity to manufacture complex products or remains deficient across any of these key dynamics, it inevitably will be challenged during times of crisis and conflict.

## AMERICAN ENERGY DOMINANCE & OIL DEPENDENCE

The past decade has been one of meaningful positive change and growing dominance for the American energy economy. Following decades of decline and stagnation, the American oil industry invented and engineered a historic turnaround. Driven by the rapid expansion of the domestic shale industry from advances in hydraulic fracturing and horizontal drilling beginning in 2005, U.S. field production of liquid fuels surged by 72 percent from 2013 to 2023, making the United States the leading crude oil producer in the world at more than 13 million barrels per day.[89] Similarly, the United States has solidified its position as the global leader in natural gas production over the last two decades. From 19 trillion cubic feet (Tcf) in 2003, American production doubled,

A fundamental shift is occurring across three key dynamics that will drive the next several decades of U.S. and allied policy related to the economy, foreign policy, and national security.

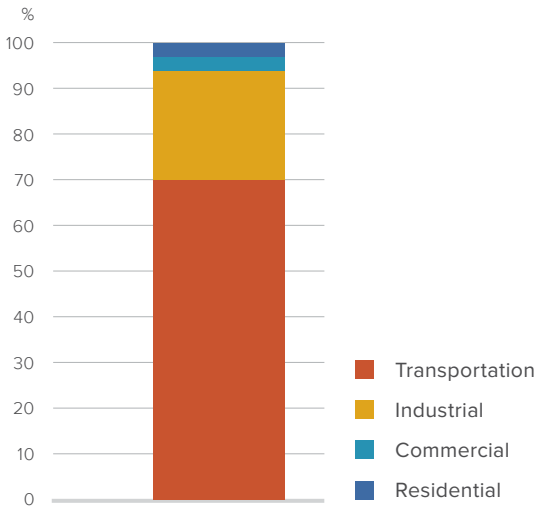
reaching a record of nearly 38 Tcf in 2023.[90] The shale industry now serves as a cornerstone for the U.S. economy, supporting hundreds of thousands of American jobs across states like Pennsylvania, Ohio, North Dakota, and Texas. It also remains a vital driver of employment, economic growth, and tax revenues. Between 2012 and 2025, the oil and gas industries were projected to cumulatively provide $1.6 trillion in federal and state tax revenue.[91]

As the United States continues to expand energy production by utilizing its vast natural resources and increasingly utilizes a comprehensive energy playbook, it has transitioned from being a major oil and gas importer to a global force in international energy markets. Despite the emerging shale boom, the United States remained a net importer of petroleum products as recently as 2019. However, it has become a net petroleum exporter in recent years, reaching 1.64 million barrels per day in 2023.[92] Since 2017, the United States has also become a net exporter of natural gas and continued to grow its exports by roughly 10 percent per year—contributing positively to its balance of trade.[93]

Importantly, the United States has been able to use its production capacity as a geopolitical tool, replacing Russia's oil and gas supply to the European Union following its invasion of Ukraine. In 2024, the United States supplied more than $13 billion in liquid natural gas (LNG) to the European Union and around 2.2 million barrels of oil per day to Europe.[94] Moreover, the Trump Administration has urged Saudi Arabia to lower oil prices, which combined with increasing U.S. production, could exert downward pressure on global oil prices.[95] Given that Russia's fiscal

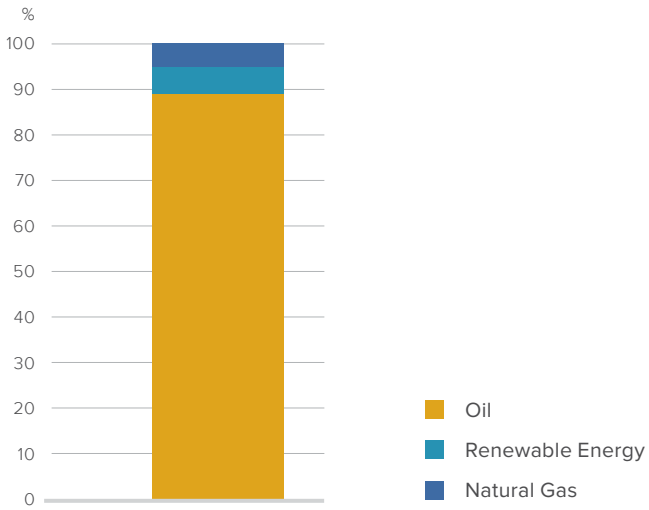
[89] EIA, "U.S. Field Production of Crude Oil," May 30, 2025.
[90] EIA, "Natural gas annual," Webpage, October 31, 2024.
[91] Department of Energy, "The Economic Benefits of Oil & Gas," Webpage.
[92] EIA, "Frequently Asked Questions (FAQs)," March 29, 2024.
[93] EIA, "U.S. energy facts explained," Webpage, July 15, 2024.
[94] See, e.g., Anne-Sophie Corbeau, "Bridging the US-EU Trade Gap with US LNG Is More Complex than It Sounds," Center on Global Energy Policy, February 20, 2025; and Paul Wightman, "U.S. Crude Oil Influence Grows with More Exports to Europe," *OpenMarkets,* August 22, 2024.
[95] See, e.g., Vishala Sri-Pathma and Oliver Smith, "Trump urges OPEC countries to slash oil prices," BBC, January 23, 2025.

## Figure 12. **Oil Usage by Sector, 2023**




Source: EIA

## Figure 13. **Energy Usage in Transportation, 2023**




Source: EIA

breakeven oil price sits around $77 per barrel, sustained U.S. output—where new drilling requires an average of $64 per barrel—would seriously weaken an adversary by cutting an important source of revenue that is used to finance its war efforts.[96] Maintaining these long-term production trends is clearly a significant benefit for American consumers and businesses, as robust production can lower energy costs, mitigate inflation, and enhance U.S. global influence. Since oil prices are driven by both supply and demand, increasing U.S. production alongside measures that reduce demand lowers prices and benefits American consumers and businesses. However, the continued expansion of LNG exports introduces a competing pressure: by redirecting domestic supply to overseas markets, these exports can raise natural gas prices at home, increasing energy costs for U.S. households and manufacturers.

Regardless of the sustained increases in U.S. energy production, state-run enterprises in Russia, the Middle East, and North Africa still control much of the world's oil reserves. These governments, which manage some of the world's lowest-cost resources globally, make upstream investment decisions based on a complex and opaque mix of factors, including competing social and military spending priorities. As a result, production from national oil companies often lags behind their available resources by a wide margin. For example, at the end of 2023, the national oil companies within OPEC controlled nearly 80 percent of global proved oil reserves yet accounted for only around 30 percent of global liquid fuels production.[97] If resources within OPEC were among the world's most expensive to produce, this dynamic would be unremarkable from an economic perspective. Instead, the opposite is true: OPEC members benefit from some of the lowest extraction costs in the world yet continue to underproduce relative to their reserves. The decades-long, persistent disconnect between these low-cost resources and their actual production reflects anti-competitive behavior—posing an ongoing threat to American energy dominance and national security.

At its core, however, American energy security is shaped by both the opportunities and risks of relying on oil. Access

[96] See, e.g., Federal Reserve Bank of Dallas, "Outlook improves even as oil and gas activity little changed; breakeven prices increase," Webpage, March 27, 2024; and bne IntelliNews, "Russia's budget oil breakeven price world's second lowest as oil revenues recover," September 13, 2024.

[97] See, e.g., "OPEC Share of World Crude Oil Reserves, 2023," Organization of the Petroleum Exporting Countries, Webpage; and EIA, "Short-Term Energy Outlook," February 2025, at 37.

to reliable, affordable supplies continues to be an urgent priority of supreme national interest because oil remains America's most vital fuel, accounting for 38 percent of total primary energy consumption, the largest share of any energy source.[98] Its significance is even greater in transportation, where petroleum fuels account for 89 percent of the energy consumed.[99] While U.S. reliance presents vulnerabilities, it also underscores the strategic advantage of maintaining strong domestic production and continuing to leverage U.S. energy leadership to shape global markets.

While oil has facilitated the rise of the modern era, the United States' overreliance on it creates energy security vulnerabilities because the price of this critical commodity is subject to manipulations by OPEC, which actively hinders the kind of regular, transparent price discovery needed for markets to function properly. As long as oil is priced on a global market and oil maintains its importance to both the United States and the global economy, America will remain susceptible to price volatility rather than physical supply disruption. For example, more than 50 percent of daily oil supplies transit through seven major chokepoints in often unstable regions, most notably the Middle East.[100] The U.S. military has borne the burden of protecting these maritime supply routes and vulnerable energy infrastructure across the globe at a cost of tens of billions of dollars per year.[101] Moreover, because of the importance of Middle East oil, the United States has participated in numerous conflicts in the Middle East, in particular, while also being confronted with terrorism—often funded by oil revenues. Similarly, Russia's war in Ukraine has largely been funded by oil and gas revenues, which were estimated at $254 billion last year and exceeded its war expenditures.[102]

Rapid fluctuations in oil prices—both upwards and downwards—due to natural market factors such as those that occurred during the COVID-19 pandemic or OPEC market manipulation, are an ever-present condition of oil markets that wreak havoc on the U.S. economy. These market

As long as oil is priced on a global market and oil maintains its importance to both the United States and the global economy, America will remain susceptible to price volatility rather than physical supply distribution.

gyrations have historically contributed to deep recessions and distorted investment decisions, causing severe supply and demand imbalances and damaging U.S. economic interests. Between 2007 and 2008, for example, oil prices increased to $145 per barrel, when volatility—a measure of how much prices have moved up and down—grew to an astonishing 120 percent.[103] The record-high prices at the pump were a contributing factor to the Great Recession.[104] Volatility has been such a long-term and persistent problem that nearly every U.S. recession has been preceded by an oil price spike.

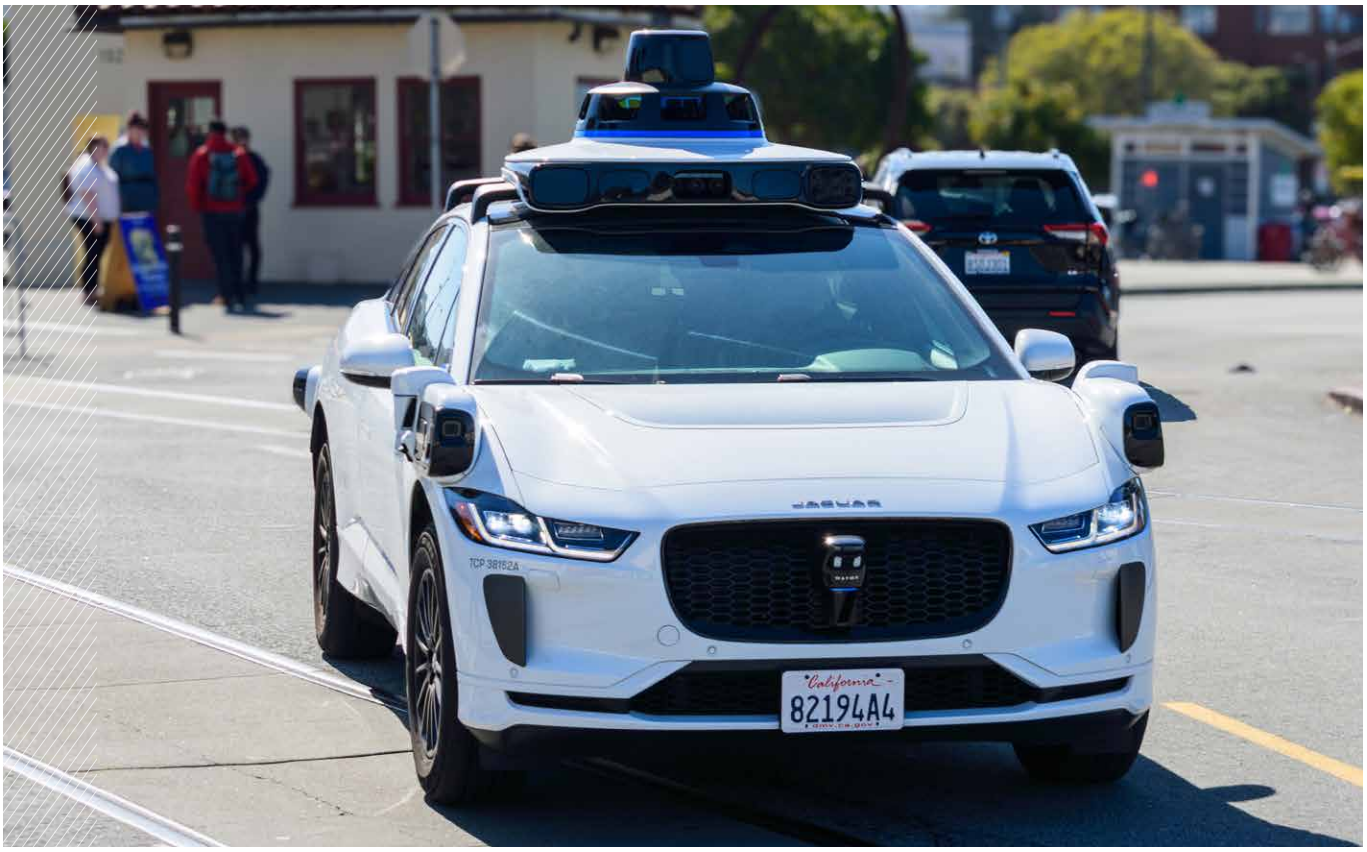
Price volatility also creates a highly uncertain investment climate, particularly for U.S. producers that do not sit on the lower end of the production cost curve. When Saudi Arabia increased production in the mid-1980s, sending oil prices plummeting to $10 per barrel, global upstream oil spending declined approximately 30 percent between 1985 and 1986 and did not return to 1985 levels again until the early 1990s.[105] Likewise, spending declined by approximately 17 percent between 2014 and 2015, resulting in more than 40 oil industry bankruptcies and 140,000 lost U.S. jobs as oil prices fell from nearly $108 a barrel in June 2014 to under $35 in December 2015.[106] Although the industry has since recovered, annual upstream investment globally must

[98] EIA, "U.S. primary energy consumption by energy source, 2023," Webpage.
[99] Ibid.
[100] EIA, "Country Analysis Brief: World Oil Transit Chokepoints," June 25, 2024, at 1.
[101] See, e.g., Jonathan Chanis and Paul Ruiz, "The Military Cost of Defending the Global Oil Supply," Securing America's Future Energy, September 21, 2018, at 8.
[102] B4Ukraine, "How Western Business and Policy Gaps Fuel Russia's War Machine and What Must Change," February 24, 2025, at 6; and David Vergun, "Official Says Without U.S. Funding, Ukraine's Defense Will Likely Collapse," Department of Defense, February 16, 2024.
[103] SAFE calculations based on EIA data.
[104] James Hamilton, "Causes and Consequences of the Oil Shock of 2007–08," Brookings Papers on Economic Activity, 2009, at 255.
[105] EIA, "Spot Prices (Crude Oil in Dollars per Barrel, Products in Dollars per Gallon)," Webpage.
[106] Chico Harlan, "The big bust in the oil fields," *The Washington Post,* March 25, 2016; and EIA, "Spot Prices (Crude Oil in Dollars per Barrel, Products in Dollars per Gallon)," Webpage.

increase $135 billion by 2030 to ensure adequate supplies.[107] The United States holds great potential to fill this gap and continue to grow its energy production, but sustained dependence on the global market, its volatile prices, and a singular fuel to power the transportation sector will continue to threaten both the economic and national security interests of the United States, regardless of the price of oil or America's level of energy dominance.[108]

Fortunately, energy security is primarily a function of consumption, not production. Numerous pathways exist to reshape consumption patterns to ensure positive economic and national security outcomes, insulate the American economy from oil market volatility, and strengthen U.S. foreign policy and military strategy. Achieving these outcomes requires a focused effort to reduce oil dependence in the transportation sector, given oil's central role in the economy, particularly transportation. This is not an argument for the United States to shy away from maximizing its domestic production with the highest environmental standards. Reducing oil dependence does not require oppressive mandates, a lack of consumer choice, or burdensome regulations; rather, it requires policies that support the development and deployment of new technologies capable of strengthening the U.S. military, industrial base, and economy.

Currently, and for the first time in more than 100 years, the transportation and automotive industries are undergoing a significant evolution, driven by advancements in connectivity, automation, batteries, and emerging technologies such as artificial intelligence, robotics, and advanced data analytics. These innovations provide opportunities to enhance transportation networks by improving efficiency—provided they are given room to develop and backed by an appropriately




[107] Allyson Cutright et al., "Upstream Oil and Gas Investment Outlook," International Energy Forum and S&P Global Commodity Insights, June 2024, at 74.
[108] Ibid.

calibrated regulatory environment. Yet, despite technological progress, scaling has been limited in the United States, and, in some cases, progress has stalled. An honest evaluation of the current mobility landscape is long overdue. Meanwhile, in other parts of the world, particularly in China, these technologies are advancing rapidly, underscoring the urgency for the United States to accelerate adoption and innovation.

EVs powered by domestic energy sources such as coal, natural gas, nuclear, and renewables are commonplace today. In 2024 alone, Americans purchased more than one million EVs. This rapid adoption is perhaps the quickest way to reduce reliance on oil as the near singular fuel powering transportation. Unfortunately, EV adoption is often caught in partisan debates between climate change and free markets. Regardless of one's views on climate change, EVs will likely play a major role in the future of the automotive industry—and the United States must lead the transition for both national and economic security reasons. If the U.S. vehicle manufacturing base is meaningfully eroded, the entire ecosystem that evolves around the automotive industry could deteriorate. Furthermore, if China successfully transitions away from oil, while the United States does not, America will be at an economic disadvantage economically when the global oil market inevitably experiences a severe price spike.[109] Continued dependence on oil increases the economic burden of securing oil supplies and leaves America vulnerable to global conflicts and market disruptions—further hampering its ability to compete in the global economy.

AVs are another example of an emerging technology, capable of fundamentally changing the way people and goods move—creating a safer, more efficient, and accessible transportation system. The transformative potential of AVs has driven more than $100 billion in investment since 2010, supporting substantial research, development, and testing efforts to date.[110] Since 2020, operational AV testing and deployment has been underway in limited commercial markets for public use including in Phoenix, San Francisco, and Los Angeles, with data showing steady progress toward expansion in other cities.[111] But despite these advancements, significant barriers remain before AVs can scale and realize their potential. One challenge is policy-related, particularly the absence of federal leadership to provide regulatory certainty through a national policy framework for AV testing and deployment across the country. Another critical obstacle is insufficient investments in essential enabling technologies—such as sensors, connectivity infrastructure, and advanced computing—that are essential to support full-scale AV deployment.[112]

In addition, software-defined vehicles are advancing in tandem with robust communications infrastructure, significantly enhancing vehicle connectivity. From telematics platforms that link vehicles to the outside world to cellular vehicle-to-everything (C-V2X) technologies designed to improve safety, connected vehicle systems continue to evolve rapidly. While vehicle connectivity has enabled new consumer experiences, improved roadway safety, and created revenue opportunities for original equipment manufacturers (OEMs), suppliers, and other stakeholders, substantial barriers remain. Chief among them is the challenge of turning the vast volumes of vehicle-generated data into actionable insights and scalable business models, whether through predictive maintenance, usage-based insurance, or enhanced traffic management. This barrier will persist without meaningful public-private partnerships and a mix of policy and market incentives to support data sharing, interoperability, and collaborative innovation.

While much of the focus has been on the types of vehicles and technologies that will transform the transportation sector, data and analytics can be a force multiplier for these changes. Leveraging the explosion of new data and insights from increasingly connected vehicles and digital infrastructure can enable split-second analyses of real-time and historical information, allowing for more effective planning, more efficient operation, and more transparency for users, businesses, policymakers, and public entities. Despite the vast amount of data being generated, several factors have limited the system-wide impact. These include a lack of coordination and standardization in data usage and structure, inadequate public funding to collect and apply public data, and challenges in monetizing vehicle data and analytics. This evolving landscape around data, analytics, and security complicates efforts to use these insights for decision making but could lead to a much safer and more efficient transportation system.

The final piece of the energy puzzle is the electric power system. Given electricity's central role in powering the digital

[109] Note: China, accounted for roughly 60 percent of global oil demand growth from 2013-2023, but it fell to under 20 percent last year; See, e.g., Ben Geman, "China's oil slowdown is a global wild card," Axios, March 18, 2025.
[110] Chris Bradley et al., "The next big arenas of competition," McKinsey Global Institute, October 2024, at 119.
[111] See, e.g., Stephanie Brinley, "Self-Driving Cars Gain Momentum in US," S&P Global, September 9, 2024.
[112] Coalition for Reimagined Mobility, "Unlocking a 21st Century Mobility System," January 8, 2024, at 11.

economy and revolutionary technologies—including AI, EVs, bitcoin, and advanced manufacturing—the resilience and reliability of the U.S. electric power system is a national imperative. AI, which requires immense compute, is expected to require at least 160 GW of new electrical power by 2030—the equivalent of tripling Texas's consumption—placing strain on the existing grid.[113] Additionally, the Department of Energy (DOE) estimates cryptocurrency mining already accounts for 2.3 percent of total U.S. electricity consumption annually.[114] As manufacturing processes become increasingly electrified through robotics and advanced computing, reliable electricity generation, distribution, and storage will become even more critical. The accelerating pace of change in the electric power sector underscores its growing importance; as Chinese battery company Contemporary Amperex Technology Co., Limited's (CATL) founder, Robert Zheng, noted, the business of developing and managing electric grids with battery storage could be ten times larger than CATL's EV battery business.[115]

Concerns about generation adequacy—the ability to generate enough electricity to meet peak demand with a margin of safety—have grown significantly in recent years. This is not surprising as electricity demand has been flat for decades and is now predicted to rise dramatically. Recent assessments by the North American Electric Reliability Corporation (NERC) have identified several areas in the United States facing heightened reliability risks. The Midcontinent Independent System Operator (MISO), which manages dispatchable power across a broad region of the country, projects insufficient reserve margins, with the situation worsening as more fossil fuel plants retire and are replaced by intermittent power sources.

Since 2015, nearly 41,000 megawatts (MW) of dispatchable generation capacity has been retired in the MISO region primarily from fossil fuel and nuclear, while only about 11,400 MW of new dispatchable generation has been added.[116] Meanwhile, more than 31,000 MW of new generation has come from wind and solar, which, while valuable, cannot be relied on for consistent output without a dispatchable source of power generation in reserve.[117] The shift toward intermittent energy, combined with growing interconnection costs and delays in connecting new projects online, undermines reliability and increases the risks of power shortages. However, renewables can be added to the grid much more quickly if new emphasis on longer-term natural gas takes focus.

California faces a similar challenge. Over the past 20 years, it has recorded more power outages than any other state. Its major utilities—Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric—have frequently resorted to rolling blackouts to maintain grid stability during peak demand periods. Additionally, utilities have implemented intentional shutoffs to prevent wildfires. These reliability issues, combined with intermittent energy integration, highlight California's vulnerability in maintaining a consistent electricity supply.

Texas faces a year-round risk of outages, and in 2021 suffered a particularly catastrophic failure during Winter Storm Uri. In the summers of 2023 and 2024, peak electricity demand exceeded 85,000 MW, surpassing historical averages.[118] With an estimated 103,000 MW of total available capacity, even minor outages could trigger rolling blackouts.[119] Moreover, the system operator in Texas, Electric Reliability Council of Texas (ERCOT), is forecasting substantial load growth in coming years with demand coming largely from population growth, data centers, industrial/oil & gas production facilities, and cryptocurrency mining operations, with some forecasts estimating shortages of power as soon as the summer of 2026.[120] These growing power shortages underscore the need for improved system planning in both generation and transmission. Baseload power is foundational, but a fully modernized grid will require flexible

[113] Note: RAND's estimate is more aggressive than other forecasts – for example, one Goldman Sachs analysis projected only ~24 GW global AI data center demand by 2030, and another study ~90 GW. Konstantin Pilz et al., "AI's Power Requirements Under Exponential Growth: Extrapolating AI Data Center Power Demand and Assessing Its Potential Impact on U.S. Competitiveness," RAND, January 28, 2025, at 2-3; and Karl Smith, Joseph Majkut, Cy McGeady, and Barath Harithas, "The AI Power Surge: Growth Scenarios for GenAI Datacenters Through 2030," Center for Strategic and International Studies, March 3, 2025.

[114] EIA, "Tracking electricity consumption from U.S. cryptocurrency mining operations," February 1, 2024, Webpage.

[115] Kevin Krolicki and Zhang Yan in Ningde, "China's CATL pushes beyond batteries into power grids, EV platforms," *Reuters,* November 13, 2024.

[116] EIA, "Inventory of Operating Generators," December 2024.

[117] Ibid.

[118] ERCOT, "Item 7: Summer 2024 Operational and Market Review," October 10, 2024, at 23.

[119] ERCOT, "Report on the Capacity, Demand and Reserves (CDR) in the ERCOT Region, 2025-2029," February 13, 2025, at 8.

[120] Id., at 4-6.

generation and energy management solutions to maintain stability and reduce consumer costs.

Small modular nuclear reactors (SMRs) are a promising technology that could significantly enhance the reliability of the United States electric power system. Unlike traditional large-scale nuclear plants, SMRs are compact, scalable, and can be deployed in a variety of locations, including areas with limited grid infrastructure. Their modular design will allow for rapid cost-effective deployment and flexible integration into existing energy systems, providing a stable and fully dispatchable source of power. SMRs improve grid reliability by offering consistent baseload generation, reducing dependence on intermittent sources. Additionally, they can operate independently of weather conditions, ensuring power availability during extreme heat, cold, or natural disasters. With advanced safety features and passive cooling systems, SMRs reduce the risk of catastrophic failures while maintaining efficient operation. By decentralizing power generation and generating continuous energy, SMRs can complement energy storage solutions to balance supply and demand, strengthen grid resilience, and help meet future electricity demand.

To keep the lights on, generation adequacy must be complemented by a robust and resilient electric power grid. Our increasing dependence on the electric power system makes grid modernization a national imperative. At the same time, the grid faces growing risks from natural disasters, cyber threats, geopolitical conflicts, and shifting generation sources. Addressing these challenges requires a comprehensive approach to upgrading transmission infrastructure, deploying smart grid technologies, and integrating diverse energy resources.

A more robust transmission system will enhance reliability by improving connectivity between power generation sources and consumption centers. Smart grid technologies, including real-time monitoring, automated controls, and advanced energy storage, will be key to this transformation. These innovations improve efficiency, reduce energy waste, and minimize outages by dynamically adjusting electricity flow based on demand and supply conditions. Investing in grid modernization is not just a matter of convenience but is a strategic necessity. Strengthening the power grid will enhance energy security, support economic growth, and enable the United

## Grid Stability as a National Security Imperative

A well-connected grid allows for flexible power distribution, minimizing the risk that disruptions in one area would lead to widespread outages. Just as supply chain diversification improves economic resilience, a diversified and interconnected grid prevents over-reliance on any single source of electric power. This is particularly crucial as the energy generation portfolio evolves, incorporating more diverse technologies, including some that are intermittent.

Modernizing the grid will also help meet surging electricity demand, particularly from energy-intensive technologies like AI. The Department of Defense, the nation's largest energy consumer, depends on a stable power supply to support military operations, intelligence systems, and national defense capabilities. Military bases, command centers, communication networks, missile defense systems, and other critical infrastructure all depend on reliable power to function effectively. Any disruption in electricity supply can compromise mission readiness, delay operations, and jeopardize national security.

One of the most critical aspects of modern military operations is the ability to coordinate forces, gather intelligence, and execute missions with precision. The DoD relies on sophisticated Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems that require uninterrupted power. Without a stable electric grid, these systems could experience outages or slowdowns, disrupting real-time decision-making and battlefield awareness. This is particularly concerning in an era when adversaries increasingly leverage cyberattacks and electronic warfare to disrupt U.S. military capabilities. The U.S. missile defense network relies on highly sensitive radar installations and tracking systems that must always remain operational. These systems provide early warning of incoming threats, such as intercontinental ballistic missiles, and are crucial for national defense. Any power disruption could leave gaps in coverage, increasing the vulnerability of U.S. defenses. Many of these installations rely on the commercial power grid, meaning a failure in civilian infrastructure can directly affect the DoD's ability to detect and respond to threats.

Finally, military bases across the United States function as key operational hubs, housing troops, maintaining equipment, and supporting training exercises, but are also crucial to supporting or sending U.S. forces forward in crisis or conflict. Many of these installations are also powered by the civilian power grid, making them susceptible to widespread outages. In recent years, extreme weather events such as hurricanes, wildfires, and winter storms have led to prolonged power failures at military bases, highlighting the urgent need for a more resilient grid. Additionally, power disruptions can interfere with domestic emergency response operations, as the military plays a critical role in disaster relief and humanitarian aid.

States to remain a global leader in technology and innovation. Without these upgrades, the country risks falling behind in the digital age, jeopardizing both economic prosperity and national security.

A well-connected grid allows for flexible power distribution, minimizing the risk that disruptions in one would lead to widespread outages. Just as supply chain diversification improves economic resilience, a diversified and interconnected North American grid prevents over-reliance on any single source of electric power. This is particularly crucial as the energy generation portfolio evolves, incorporating more diverse technologies, including some that are intermittent.

Modernizing the grid will also help meet surging electricity demand from AI, which has already doubled data center energy consumption since 2018 and could triple it again by 2028, reaching nearly 12 percent of total U.S. electricity use.[121] Additionally, the Department of Defense, the nation's largest energy consumer, increasingly depends on grid stability for military operations and national security, underscoring the need for continuing investments

[121] DOE, "DOE releases new report evaluating increase in electricity demand from data centers," December 20, 2024.

in cybersecurity related to critical national infrastructure. China's Volt Typhoon group, for example, had managed to install malware and take over hundreds of old and outdated routers connected to critical U.S. infrastructure such as grid control systems.[122] If left unaddressed, the consequences could be catastrophic to U.S. communications systems in the event of a conflict. Currently, 99 percent of military installations rely on civilian power grids, making the military vulnerable to disruptions.[123] Enhancing grid resilience is essential for safeguarding both America's economic and national security interests.

## THE IMPORTANCE OF DUAL-USE MATERIALS AND MINERALS: TRANSITIONING TO A MINERALS-BASED ECONOMY

For decades, authoritarian regimes enjoyed certain leverage over the United States and Europe due to their control over natural resources. For example, in the transportation sector, countries on both sides of the Atlantic have been overly reliant on a single fuel source, oil, which is traded on a manipulated global market. Regardless of the significant growth in domestic oil production in the United States over the last decade, oil markets continue to be manipulated by adversaries or countries that do not share our values and strategic interests, from Russia to OPEC members.

The ongoing war in Ukraine, for example, has led Europe to accelerate transportation electrification and adoption of renewables, both of which require mineral-intensive technologies. Despite these recent efforts to reduce supply dependencies on authoritarian governments, developing the capacity to reliably manufacture much of the new technology, including both materials and final products, means western economies will be dependent on autocracies for the foreseeable future. Ultimately, the United States and Europe risk trading reliance on oil for dependence on critical minerals sourced from autocracies like China unless they act swiftly. In a worst-case scenario, the United States would become vulnerable to both oil prices swings and mineral market manipulation.

The OPEC cartel's leverage over global oil markets is significant, but pales in comparison to China's dominance over the critical mineral markets—an advantage that undermines the United States and its partners ability to solve both its dependence on oil while modernizing its overall economy. The lack of diversity across critical raw material producers holds the potential to hinder energy security improvements but also poses new challenges to the defense and civil industrial base. The same minerals used in EV manufacturing and some renewable power generation, for example, are also required for the development of a modernized resilient power grid, the full range of future IT equipment, artificial intelligence, AVs, and military technologies. Lithium, a key component used in batteries, is found in nearly every weapon system including the guidance systems for missiles. Cobalt, another battery input, is used in the production of jet engine parts, armor plating, paints that make airplanes stealth, and other military equipment. Nickel is used in both batteries and the manufacture of armor plating and jet engines.[124] While the majority of mine production of these minerals does not take place in China, Beijing has direct control over their processing.[125]

China is also the largest producer of another set of dual-use minerals: 42 percent of molybdenum mining, around 70 percent of germanium and titanium mining, 70 percent of rare earths mining, and more than 98 percent of gallium mining today takes place in China.[126] Wind turbines, electrolyzers, and certain types of solar technologies require molybdenum, a superalloy material that is also suitable for applications that require high heat resistance, like jet engines.[127] Titanium, which is used in hydrogen electrolysis technologies, also has a wide range of military applications from helicopter rotors to structural components of fighter jets.[128] Germanium and gallium are used to produce solar PVs, as well as advanced chips that power advanced

[122] See, e.g., Frances Mao and Will Vernon, "FBI says Chinese state hacker group targeted US infrastructure," BBC, January 31, 2024.
[123] Constantine Samaras and Henry Willis, "Capabilities-Based Planning for Energy Security at Department of Defense Installations," RAND, February 20, 2013, at 1.
[124] Dynamic Industrial, "Materials," Website; and Defense Logistics Agency, "Materials of Interest," Webpage.
[125] SAFE analysis using data from U.S. Geological Survey and Benchmark Mineral Intelligence.
[126] IEA, "Global Critical Minerals Outlook 2025," May 21, 2025, at 252.
[127] See e.g., S. Carrara et al., "Supply Chain Analysis and Material Demand Forecast in Strategic Technologies and Sectors in the EU – A Foresight Study," European Commission, 2023, at 145; and Defense Logistics Agency, "Materials of Interest," Webpage.
[128] See e.g., U.S. Department of Energy, "Critical Materials Assessment 2023," July 2023, at 28; and Defense Logistics Agency, "Materials of Interest," Webpage.

weapons, radar, and communications systems.[129] Finally, rare earth elements are the building blocks of permanent magnets in wind turbines and electric motors, and they are also key components of precision-guided munitions, radar systems, and other military equipment.[130]

The demand growth from both new innovations and military technologies is intensifying the strain on critical mineral and material supply chains and increasing the risk of potential bottlenecks in their availability.[131] Russia's ongoing invasion of Ukraine has highlighted the importance of a robust defense industrial base, particularly because members of the North Atlantic Treaty Organization (NATO), on top of their own military modernization efforts, have found it difficult to restock weapons and munitions sent to Ukraine. The energy crisis ensuing from the invasion also led some to call for an accelerated energy transition.[132] The current Israel-Hamas and Israel-Iran conflicts are far from resolution and more significant conflicts could erupt in the Middle East and further strain the U.S. defense industrial base as it attempts to restock supplies and equipment.[133]

If there is ever an active war with China, the industrial base may well reach a breaking point. The United States and its allies would require the ability to supply their forces with weapons, repair damage to their major weapons platforms, and quickly rebuild their force structures at an unprecedented rate—meaning reliable and secure supplies of small quantities of minerals and materials would become an urgent priority. It is widely agreed that World War II was won, in large part, because of U.S. capacity to supply oil and military equipment to both its military and its allies, while Germany and Japan were unable to keep pace. The erosion of the allied industrial base presents significant threats to U.S. economic and national security today.

## The Military's Reliance on Civilian Critical Mineral Supply Chains

The shift from a fossil-based economy to a materials-based economy will demand significantly greater quantities of minerals. The sheer scale of this shift is only now being understood, particularly as new energy technologies become more mineral-intensive. One of the largest drivers of critical mineral demand is battery production, which, while historically limited to electronic applications, is now expanding into transportation and the stationary storage market. The material needs vary based on vehicle size and battery chemistry, but, on average, an EV manufactured in the United States contains: 1,600 pounds of aluminum; 500 pounds of steel; 115 pounds of copper; 19 pounds of lithium; 85 pounds of nickel; 50 pounds of manganese; 19 pounds of cobalt; 145 pounds of graphite; and 1 pound of rare earth minerals.[134] By comparison, a conventional internal combustion engine vehicle contains less than half the copper and manganese relative to an EV and nearly no lithium, nickel, cobalt, or graphite.[135] Importantly, because of advances in battery recycling technology, to reach circular battery self-sufficiency, the world only needs to mine a cumulative 125 million tons of battery minerals—an amount that is 17 times smaller than the volume of oil extracted and processed each year for road transport.[136]

Many of these materials are also critical for manufacturing military equipment, though specific details regarding the types and quantities of materials used in most military systems are classified. Nevertheless, it is clear from most available data that military requirements for these minerals significantly overlap with civilian supply chains. For example:

**F-35 Fighter Jets:** An F-35 reportedly contains about 920 pounds of rare earth minerals.[137] With approximately 630 operational in Spring 2024 and plans to purchase an

[129] See e.g., S. Carrara et al., "Supply Chain Analysis and Material Demand Forecast in Strategic Technologies and Sectors in the EU – A Foresight Study," European Commission, 2023, at page 144; and Eric Lee, "How Taiwan Underwrites the U.S. Defense Industrial Complex," *The Diplomat,* November 9, 2021.

[130] See e.g., Defense Logistics Agency, "Materials of Interest," Webpage; and Defense Advanced Research Projects Agency, "Developing Cohesive, Domestic Rare Earth Element (REE) Technologies," July 13, 2021, Webpage.

[131] Note: The military technologies listed in this paragraph with the exception of fighter jets are weapons allies are providing Ukraine to strengthen the nation's defense. Source: Gerry Doyle, Anurang Rao, and Vihdan Mohammad Kawoosa, "Shaping the Battlefield: How Weapons from Western Allies are Strengthening Ukraine's Defence," *Reuters,* March 10, 2023.

[132] IEA, "Russia's War on Ukraine," Webpage.

[133] See, e.g., Connor O'Brien, Joe Gould, Paul Mcleary, and Lara Seligman, "'Planes have already taken off': U.S. sends Israel air defense, munitions after Hamas attack," *POLITICO,* October 9, 2023.

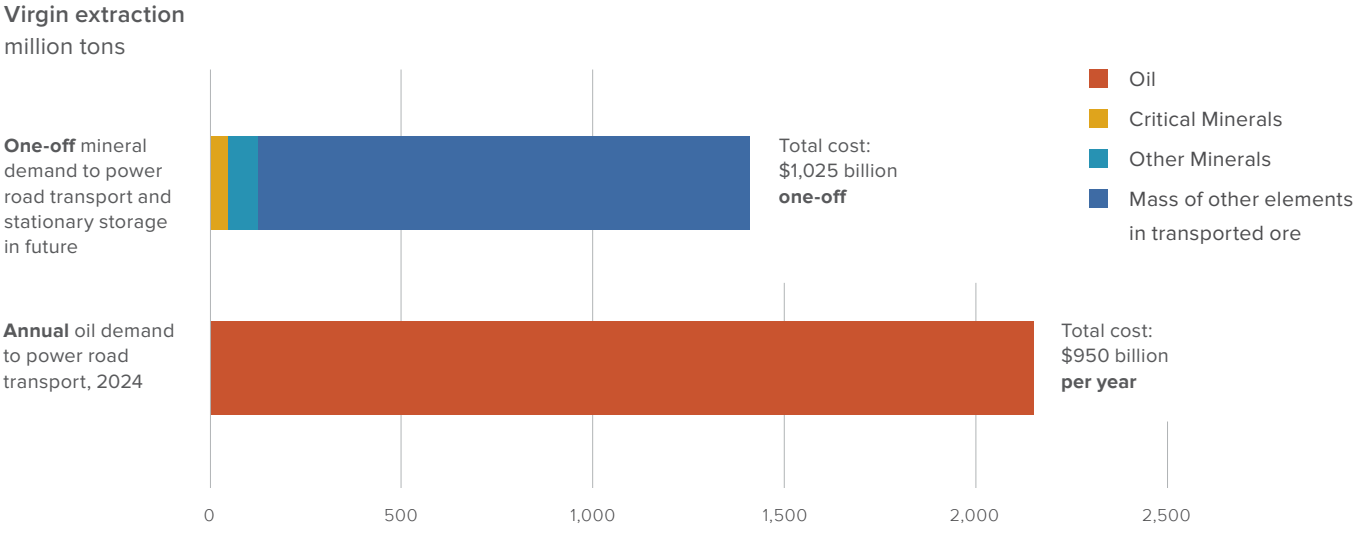
[134] IEA, "The Role of Critical Minerals in Clean Energy Transitions," May 2021, at 26.

[135] Ibid.

[136] Daan Walter et al., "The Battery Mineral Loop: The path from extraction to circularity," Rocky Mountain Institute, July 24, 2024, at 24.

[137] Russell Parman, "An Elemental Issue," Army AL&T, Fall 2019, at 89.

## Figure 14. **One-Off Battery Mineral Demand in Context**




Source: RMI analysis based on IEA and USGS data

additional 1,800 aircraft through the mid-2040s, this equates to approximately 2.2 million pounds—the equivalent amount in only approximately 2 million EVs.[138] Annual procurement averages 53,000 pounds of rare earth minerals a year, about the same as in about 48,000 EVs.

**Arleigh Burke DDG-51 Destroyers:** The entire fleet of 94 destroyers will contain about 489,000 pounds of rare earth elements, equivalent to the amount needed for 444,000 EVs.[139] Over the production lifecycle, the manufacture of the ships would require an average of 12,200 pounds of rare earth minerals each year, similar to 11,100 EVs.

**Virginia-Class Submarines**: The fleet of 59 submarines, projected for completion in the 2030s, will require 543,000 pounds of rare earth elements, equivalent to the volume of around 493,000 EVs.[140] This represents an annual average usage of 13,500 pounds of rare earth minerals a year, equivalent to 12,000 EVs.

**F-22 Raptors**: The total fleet of 186 aircraft uses 1.26 million pounds of graphite, equivalent to that used by just 8,650 EVs.[141] Annual graphite consumption during manufacturing averaged 84,000 pounds per year, the equivalent of 575 EV batteries. The requirements for the F-47 Next Generation Air Dominance (NGAD) successor to the F-22 are not publicly known but will no doubt be substantial.

Across all applications, the military's annual consumption of rare earth elements totals approximately 725,000 pounds–just about five percent of total demand in the United States.[142]

[138] SAFE analysis based on Department of Defense, "Modernized Selected Acquisition Report (MSAR): F-35 Lightning II Joint Strike Fighter (JSF) Program (F-35)," December 31, 2023, at 54; and IEA, "The Role of Critical Minerals in Clean Energy Transitions," May 2021, at 26.

[139] SAFE analysis based on Ronald O'Rourke, "Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress," Congressional Research Service, December 16, 2024 at 2; and Todd Lopez, "DOD Looks to Establish 'Mine-to-Magnet' Supply Chain for Rare Earth Materials," Department of Defense, March 11, 2024.

[140] Eric Labs, "An Analysis of the Navy's 2025 Shipbuilding Plan," Congressional Budget Office, January 2025, at 9; and Todd Lopez, "DOD Looks to Establish 'Mine-to-Magnet' Supply Chain for Rare Earth Materials," Department of Defense, March 11, 2024.

[141] SAFE calculations based on "F-22 Raptor," United States Air Force, Webpage and "F22 Air Dominance for the 21st Century," ALLSTAR Network, February 23, 1999, Webpage; and "F-22 Raptor Fast Facts," Lockheed Martin, October 2023.

[142] Note: SAFE calculations based on U.S. Geological Survey data and Mikayla Easley, "Special Report: U.S. Begins Forging Rare Earth Supply Chain," National Defense, February 10, 2023.

## Figure 15. **Critical Mineral Quantities in Select Military Platforms**

| MILITARY PLANNED INVENTORY | MATERIAL AMOUNT | ELECTRIC VEHICLE EQUIVALENT | ELECTRIC VEHICLES PER YEAR |
|---|---|---|---|
| **2,470 F-35s** | 2.2 million pounds of rare earth elements | 2 million EVs | 48,000 EVs per year |
| **94 Arleigh Burke DDG-51 destroyers** | 489,000 pounds of rare earth elements | 444,000 EVs | 11,100 EVs per year |
| **59 Virginia class submarines** | 543,000 pounds of rare earth elements | 493,000 EVs | 12,000 EVs per year |
| **186 F-22s** | 1.26 million pounds of graphite | 8,650 EVs | 575 EVs per year |

Source: SAFE calculations based on IEA, USGS, DoD, and Congressional Research Service Data

Although these metals and minerals are indispensable to manufacturing critical military equipment, the volumes required are small relative to the volumes consumed in the civilian economy. For instance, each F-22 Raptor contains about 8,650 pounds of aluminum and steel, although the exact proportions of each metal are not publicly disclosed.[143] Across the entire fleet of F-22s, this totals approximately the amount in a few thousand cars. Overall, total military aluminum consumption represents just a fraction—around three percent—of total United States demand.[144] Ford alone used nearly double that amount to manufacture its F-150s in 2024.[145]

### Scaling Civilian Supply Chains to Support Military and Economic Security

While the broader U.S. industry certainly faces challenges in developing the supply chains required to ensure that the civilian economy has secure and adequate supplies of these materials, the cost of developing parallel supply chains using significantly smaller volumes to meet the military's requirements would be far more expensive than relying on the civilian supply chains. In addition, the continued growth and scaling of the commercial sector undoubtedly reduces the potential for economic coercion from U.S. adversaries, coercion that increases the risk of military conflict. Without robust domestic supply chains, the defense industrial base risks becoming increasingly dependent on China as the default supplier, creating strategic vulnerabilities that could imperil long-term security and military readiness. It also has the potential to become more expensive if DoD seeks to build more of the integrated supply chain domestically.

Ensuring sufficient supply to meet growing demand will require a rapid increase in mineral extraction, processing, and manufacturing capabilities. Electrifying the transportation sector and building new supply chains for both transportation and other new energy technologies like transmission, generation, and pipelines is one of the most effective ways to drive this scaling. For example, cobalt demand for use in EVs is expected to triple, while demand for nickel, graphite, and

[143] SAFE calculations based on "F-22 Raptor," United States Air Force, Webpage and "F22 Air Dominance for the 21st Century," ALLSTAR Network, February 23, 1999, Webpage.

[144] Michaela Platzer et al., "U.S. Aluminum Manufacturing: National Security and Tariffs," Congressional Research Service, March 11, 2021, at 1; and SAFE calculations based on annual consumption data from U.S. Geological Survey, "Mineral Commodity Summaries 2025," January 2025, at 32.

[145] SAFE calculations based on Chris Chilton, "Ford's F-150 Relies On Aluminum That Might Be Making People Sick In The Amazon," *Carscoops,* February 28, 2023; and Mircea Panait, "2024 Sales Report: Ford F-Series Dominates Full-Size Truck Segment," *Autoevolution,* January 7, 2025.

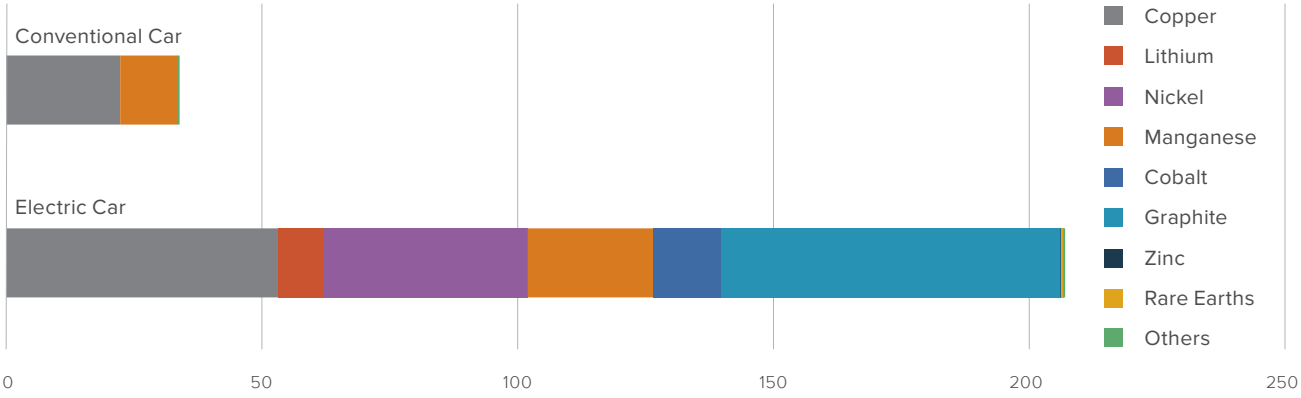
manganese will increase by about tenfold.[146] Lithium demand will grow by as much as 14 times by 2035.[147] Benchmark Mineral Intelligence estimates that more than 300 new mines will need to come online under the same timeline to meet rising demand.[148] Some of this gap could be filled by the United States with a supportive regulatory environment, as it has substantial reserves of some minerals.

A similar story will likely repeat across numerous other critical minerals, driven by emerging technologies and military applications. Copper, titanium, and molybdenum demand is expected to more than triple by 2035, primarily driven by expanding energy infrastructure.[149] Similarly, the demand for rare earths, particularly neodymium and dysprosium, will grow fivefold from current levels, driven by the increased production of wind turbines and electric motors.[150]

While policymakers are increasingly focused on addressing the immediate supply-side concerns related to minerals and materials, more focus is needed to support a long-term strategy. Robust recycling infrastructure should be a primary focus because recycling uniquely minimizes U.S. critical minerals imports from foreign adversaries. Several startup companies in the United States and Canada are focused on deploying advanced battery-recycling technology, which would enable the reuse of more than 90 percent of the minerals in used batteries.[151] Redwood Materials, which has recycling operations in Nevada and South Carolina, plans to produce 100 gigawatt-hours of battery materials annually, enough to produce more than one million EVs.[152] If the supply chain continues to expand domestically and commercial demand continues to grow, there would be a broad base of materials already integrated into the U.S. car parc and technosphere, for which recycling technology could begin

While policymakers are increasingly focused on addressing the immediate supply-side concerns related to minerals and materials, more focus is needed to support a long-term strategy.

## Figure 16. **Minerals Used in Electric Cars Compared to Conventional Cars**




Source: IEA

[146] SAFE analysis based on IEA mineral demand for clean energy technologies data.
[147] Ibid.
[148] Benchmark Mineral Intelligence, "How many mines are needed for the energy transition?," January 30, 2025, Webpage.
[149] SAFE analysis based on IEA mineral demand for clean energy technologies data.
[150] Ibid.
[151] See, e.g., Kirsten Korosec, "Why Amazon and Panasonic Are Betting on This Battery Recycling Startup," *Forbes,* October 9, 2020.
[152] See, e.g., Redwood Materials, "About," Webpage.

to replace the need to mine virgin materials from unreliable partners. However, analysts have assessed that, as of the end of 2023, there was only enough capacity to recycle roughly 210,000 end-of-life EV batteries annually.[153]

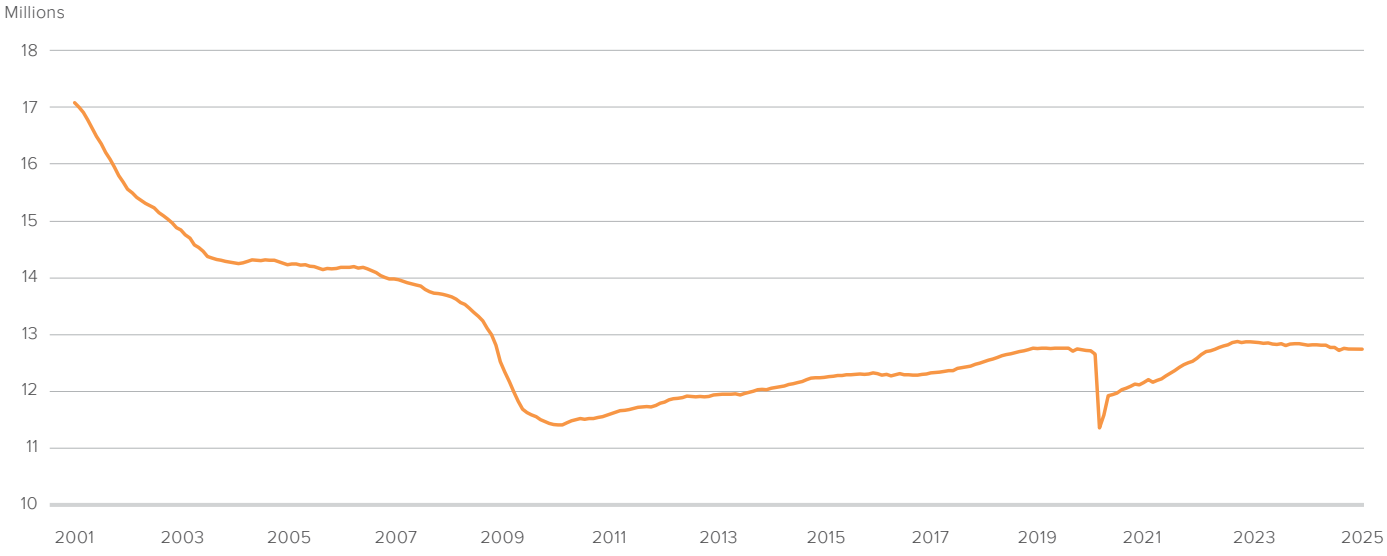
Although recycling should not be viewed as a panacea, as new materials and mining will likely always be needed, stabilizing critical mineral supply chains offers significant benefits. Expanding domestic recycling capacity should, therefore, be viewed as a national security imperative, as it allows reusing minerals and materials already within U.S. borders.

However, several barriers must be overcome to enable this new advanced recycling industry to flourish. For example, the lack of transparency in vehicle battery chemistries, design, and other data from vehicle manufacturers complicates recycling processes and planning. In addition, significant complexities exist regarding the transportation of used lithium-ion batteries, which are classified as hazardous waste by the U.S. Environmental Protection Agency (EPA), complicating their collection and safe transport to recyclers. Finally, securing the necessary environmental permits under statutes like the Resources Conservation and Recovery Act can take years, undermining efforts to build a robust recycling industry.

Failure to keep pace with rising demand and secure a critical mineral supply chain could create severe bottlenecks and pose significant repercussions for long-term economic growth and competitiveness. Equally important to achieving volume requirements will be locating future production capacity. This rapid shift in the global economy provides a unique, once-in-a-generation opportunity to establish secure and reliable critical mineral supply chains at scale. Seizing this moment would ensure the United States, Europe, and their allies can ramp up and sustain defense production in the future, preserving deterrence capabilities.

[153] See, e.g., Alexander Tankou and Dale Hall, "Will the U.S. EV battery recycling industry be ready for millions of end-of-life batteries?," ICCT, September 29, 2023.

Figure 17. **Americans Employed in the Manufacturing Sector, January 2001–March 2025**



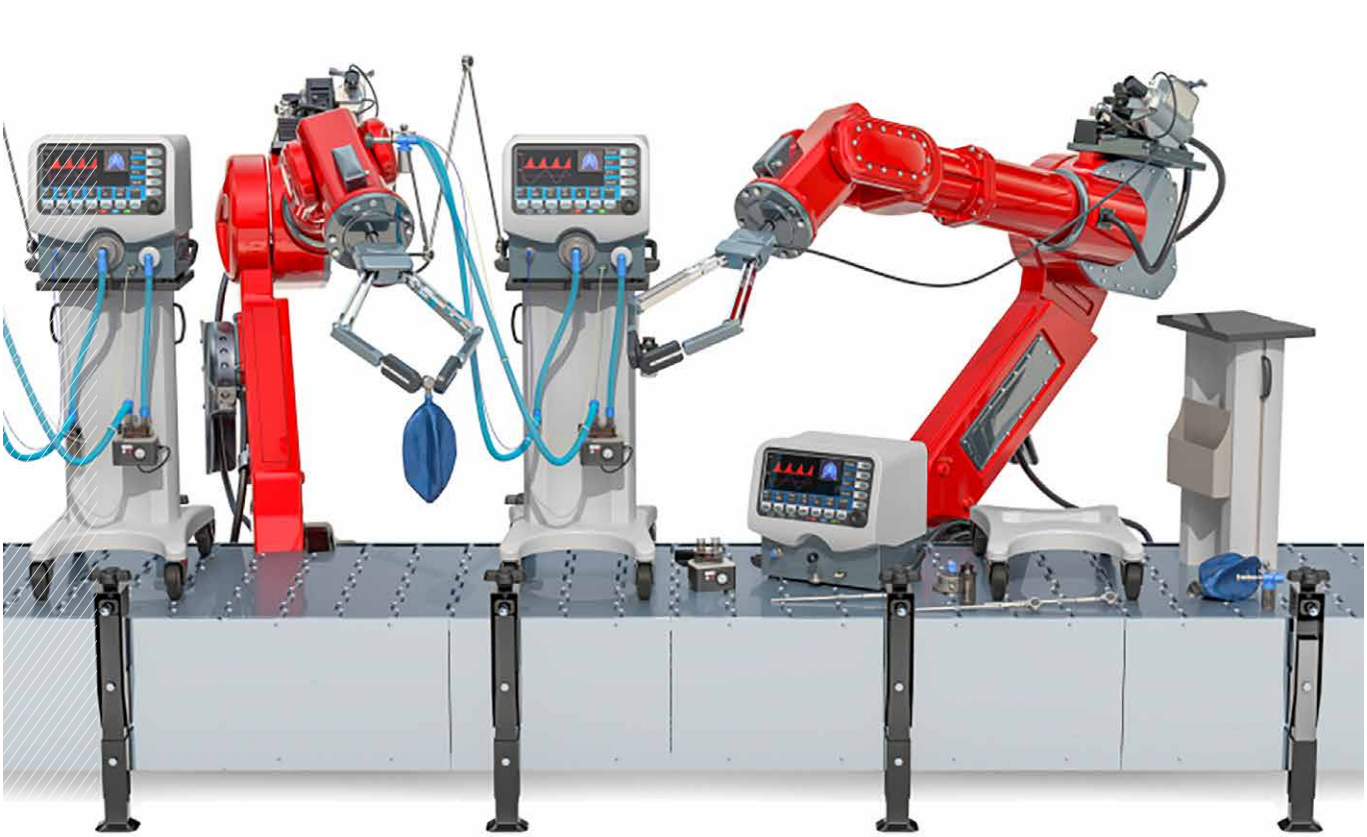

Source: Bureau of Labor Statistics

## RE-INDUSTRIALIZATION, AN ECONOMIC AND DEFENSE IMPERATIVE

The United States has undergone several waves of de-industrialization over the last few decades, which have altered both America's economic landscape and national security posture. In parallel, the DoD has shifted its focus and planning efforts toward high-intensity conflicts and invested meaningfully in developing advanced high-technology platforms increasingly reliant on critical minerals and strategic materials. These trends have left the United States vulnerable to failure by limiting its ability to supply its forces if prolonged conflict occurs. A fundamental issue exacerbating this vulnerability is that DoD's demand for critical minerals and strategic materials is small compared to private sector demand, making the defense industrial base reliant on global supply chains that are neither secure nor reliable. To mitigate these risks, the United States must maintain robust industrial and manufacturing capabilities in key sectors—such as automotive manufacturing, new energy technologies, and other heavy industrial segments—where demand for critical resources and components is highest. A robust domestic and allied industrial base, anchored in strong commercial demand, will be essential to preserving economic security and military readiness.

Spurred by the Second Industrial Revolution, the manufacturing sector's substantial growth transformed America's agricultural-based economy into a factory-based one, creating new jobs and opportunities, and contributing substantially to national income. This transformation also provided the industrial foundation the United States turned to in times of crisis. As the nation confronted the challenges posed by World War II, American companies repurposed employees' skills, plants, and manufacturing processes into a formidable machine of war that built tanks, bombers, and trucks—all serving as its bulwark "Arsenal of Democracy." In the Post-War Era, those factories and plants were again retooled for peacetime industries, facilitating the United States' rise to a global economic superpower.

At its peak, the stability and availability of manufacturing jobs brought prosperity to the American worker. Between 1965 and the early 2000s, the domestic manufacturing sector consistently employed around 17 million Americans, initially accounting for a quarter of jobs in the United States and



shrinking to 15 percent as the economy grew.[154] With such a significant share of human capital devoted to manufacturing, Detroit became the nation's hub for producing cars. Additionally, American workers constructed bridges, buildings, and other critical infrastructure throughout the country with domestically produced steel. As manufacturing employment declined in the early 21st century, many segments of the U.S. economy shifted toward services, including finance, healthcare, and technology. While these sectors created new types of jobs, they did not always offer the same wages, benefits, or geographic distribution as traditional industrial employment. However, as the nation flourished, its middle class grew, holding the largest share of aggregate national household income.[155] Clearly, America's might and global influence were fueled by a prosperous middle class, which thrived on the jobs and economic opportunities created by robust domestic manufacturing and industrial sectors.

Since then, U.S. policymakers have debated how to best navigate the shift toward offshoring and reliance on global supply chains and what it means for the future economy. Throughout the early 2000s, China's rise coincided with a rapid decline of the U.S. manufacturing sector, including the loss of approximately six million jobs across industries such as steel, chemicals, plastics, and cement.[156] Many industries faced significant decline, with some nearly disappearing from the domestic market. Industries like forging and foundries saw the number of businesses operating domestically cut in half, while machine tools declined from 28 percent of global market share in 1968 to five percent by 2019.[157] In the early 1990s, the U.S. aluminum industry operated nearly 40 smelters, making the United States the world's leading producer of primary aluminum.[158] Today,

[154] Bureau of Labor Statistics, "Employment, Hours, and Earnings from the Current Employment Statistics survey (National)"; and Bureau of Labor Statistics, "Labor Force Statistics from the Current Population Survey."
[155] Rakesh Kochhar, "The State of the American Middle Class," Pew Research Center, May 23, 2024.
[156] Bureau of Labor Statistics, "Employment, Hours, and Earnings from the Current Employment Statistics survey (National)."
[157] John Barret, "You Go to War with the Industrial Base You Have, Not the Industrial Base You Want," *War on the Rocks,* August 16, 2023.
[158] Christopher Watson, "U.S. Aluminum Manufacturing: Industry Trends and Sustainability," Congressional Research Service, October 26, 2022, at 2.

only four remain, producing less than two percent of the global output.[159]

By 2010, U.S. manufacturing employment had fallen below 12 million, and while manufacturing has modestly recovered, the sector accounts for roughly 10 percent of the U.S. workforce today.[160] While some of the reasons for this decline directly result from Beijing's predatory trade practices, these industries often have extremely high capital requirements and long-term production cycles, and operate on relatively low-profit margins. Capital markets have shifted their interest accordingly, and have rewarded the higher returns found in other segments of the service economy—in software, finance, or healthcare.[161] Still, the United States remains one of the world's premier manufacturing leaders, ranking only behind China in global output share.[162] Even with a relatively small industrial workforce, the United States leads the world in manufacturing productivity, as measured by value-added per worker.[163]

Nevertheless, even as U.S. industry remains globally competitive in certain sectors, the decline in domestic production has left critical vulnerabilities in supply chains that are essential for economic and national security. While the erosion of America's manufacturing base has affected industries across the economy, its consequences have been particularly acute in the defense sector, where a lack of sustained investment has left critical supply chains fragile and dependent on foreign sources. This decline has particularly damaged the defense-industrial base, where offshoring and shifting procurement priorities have weakened the domestic production of essential munitions and their chemical precursors.

Western nations, including the United States, have neglected the manufacturing of essential munitions like 155mm artillery shells in favor of more sophisticated platforms, allowing supply chains to atrophy.[164] The production of trinitrotoluene (TNT), for example, shifted overseas,

Even as U.S. industry remains globally competitive in certain sectors, the decline in domestic production has left critical vulnerabilities in supply chains that are essential for economic and national security.

making the United States dependent on imports from Poland, India, and—until its seizure by Russia—a facility in Ukraine.[165] As global demand for munitions surges, the lack of investment in production increases TNT scarcity, extending timelines for 155mm shells, which require 23.8 pounds of TNT each.[166] While United States shell production has nearly tripled since the start of the Russian invasion of Ukraine, it remains far below NATO's estimate of Russia's 100,000 artillery shell monthly output and even further below than EUCOM Commander General Christopher Cavoli's estimate of 250,000 a month.[167]

Other key chemical components have disappeared from domestic supply chains. Dechlorane Plus 25, a flame-resistant chemical used in weapon insulation, is no longer produced in the United States after its Chinese precursor supplier shut down, wiping out global availability.[168] Similarly, key missile propellant ingredients are increasingly sourced from China and India, leaving the U.S. military with limited alternatives and growing supply chain risks.[169] In 2018, a Pentagon report identified more than 300 weak spots in the U.S. defense-industrial base, many involving sole suppliers and foreign dependencies.[170] The report further confirms the U.S. military's growing dependence on

[159] Ibid.
[160] Bureau of Labor Statistics, "Employment, Hours, and Earnings from the Current Employment Statistics survey (National)"; and Bureau of Labor Statistics, "Labor Force Statistics from the Current Population Survey."
[161] François Rousseau and Luca Caruso, "Improving Returns in Capital-Intensive Industries," Bain & Company, October 2015.
[162] "World Manufacturing Production – Quarterly Report (Q3 2024)," United Nations Industrial Development Organization, December 18, 2024, at 3.
[163] Note: Calculations by SAFE based on United Nations Industrial Development Organization and International Labour Organization data.
[164] Richard Thomas, "U.S. to re-establish TNT production with new Kentucky-based factory," *Army Technology,* November 11, 2024.
[165] Stephen Grey, John Shiffman, and Allison Martell, "Years of miscalculations by U.S., NATO led to dire shell shortage in Ukraine," *Reuters,* July 19, 2024.
[166] Ibid.
[167] Ibid.; and General Christopher G. Cavoli, "Statement of General Christopher G. Cavoli, United States Army United States European Command," United States Senate Armed Services Committee, April 3, 2025.
[168] Aaron Mehta, "The US is running out of bombs – and it may soon struggle to make more," *DefenseNews,* May 22, 2018.
[169] Ibid.
[170] Interagency Task Force in Fulfillment of Executive Order 13806, "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," DoD, September 2018, at 46.

The American people should ask themselves whether the United States could ever summon the Arsenal of Democracy again. In its current state, the answer is no.

China for critical chemicals, raising concerns that Beijing could restrict access in a future conflict.[171] Even with new investment, ramping up production will take years due to limited expertise, outdated facilities, and entrenched foreign dependencies.

Despite an erosion of some core industrial capabilities, the U.S. economy has not faltered and has grown significantly. Businesses continue to gravitate toward lower-cost inputs and components made overseas, and American and allied consumers have ultimately benefited from globalized consumerism. While the economy may have balanced growth and productivity, the nation's industrial decline should concern Americans over the long term. In particular, the American people should ask themselves whether the United States could ever summon the Arsenal of Democracy again. In its current state, the answer is no. Unlike in past wars, repurposing existing industries for defense production is far more challenging today, as modern weapons platforms require highly specialized technology and manufacturing capabilities. In addition, there is no option to move a vast amount of human capital to backfill servicemember deployments, as Rosie the Riveter did in World War II, nor ramp up industrial capacity for advanced weapons at scale. Today, the United States relies almost entirely on global supply chains dominated by its likeliest foe, Beijing.

Amid broader industrial decline, the U.S. automotive sector has remained a pillar of domestic manufacturing, demonstrating resilience in times of crisis. When called upon during the pandemic, U.S. automakers answered and transformed vehicle assembly plants into an Arsenal for Health to combat the COVID-19 pandemic, making ventilators and other medical equipment. Ford, in collaboration with GE Healthcare, produced 50,000 ventilators within 100 days at its Michigan plant.[172] With 17 automakers operating 56 light-duty vehicle assembly plants across 16 states, vehicle production is the country's largest manufacturing sector.[173] The industry accounts for between $50 and $100 billion in exports of vehicles and parts per year, making it one of the largest exporting industries alongside oil and gas.[174] The industry's ability to pivot during the pandemic underscores the strategic importance of the U.S. auto sector—not only as a manufacturing powerhouse but as a critical driver of supply chains that extend far beyond automobiles.

For each job the auto industry supports, more than ten indirect jobs are created across other sectors because the industry requires large-scale component manufacturing facilities, utilization of a wide array of raw materials and other services, and investment in research and development. For example, automakers are among the largest purchasers of commodities and components supporting other industries, including aluminum and alumina, copper, plastics, rubber, steel, permanent magnets, and semiconductor chips. Today's vehicles rely on roughly 2,000 different compounds comprising 76 different elements, all of which present different risk levels in their global supply chains.[175]

The global automotive industry is also undergoing a generational change in technology. New vehicles are rapidly shifting to become electric (e.g., hybrid, plug-in hybrid, or full battery powered), connected, and autonomous—with advances in batteries, software, wireless communication, and AI all marking critical shifts in how vehicles interact with humans and each other. The United States is a clear leader in developing many of the advanced mobility technologies the industry plans to bring to market and spends more than $250 billion every year on research and development (R&D) and capital expenditures for that purpose.[176] GM, for example, has spent more than $10 billion on AV

[171] Id., at 49.
[172] Keith Naughton and Shira Stein, "Ford Ends Ventilator Production After Making 50,000 for U.S.," *Bloomberg,* August 31, 2020.
[173] American Automotive Policy Council, "State of the U.S. Automotive Industry 2025: Investment, Innovation, Jobs, Exports, and America's Economic Competitiveness," 2025, at 6.
[174] Bureau of Economic Analysis, "U.S. International Trade in Goods and Services, December 2024," at 3, 7.
[175] Karan Bhuwalka, "Assessing socio-economic risks in the supply chain of materials required for vehicle electrification," Massachusetts Institute of Technology Master's Thesis, 2021, at 18.
[176] See, e.g., Michael Wayland, "The auto industry is pulling back on its 'capital junkie' tendencies after unprecedented spending on EVs, self-driving," *CNBC,* November 25, 2024.

technologies since 2016, while several other automakers and technology companies have spent similar amounts.[177] Automakers' development of these technologies have other applications, particularly in the defense sector. Radar & Light Detection and Ranging (LiDAR) systems, for example, were originally used for reconnaissance and missile guidance systems to enhance target acquisition, terrain analysis, and navigation in hostile environments, and the auto sector's innovation has expanded its use to autonomous driving technologies.[178]

The U.S. auto industry is not without its challenges. Massive levels of investment must be spread across numerous areas to have any meaningful impact on product development timelines. Today's vehicles have more than 100 million lines of code requiring ongoing software development and cyber risk assessments before a package comes to market. The advent of EVs has added further complexity, forcing automakers to reconfigure both new and existing manufacturing plants while building entirely new supply chains for increasingly advanced products.[179] It is not uncommon for vehicles to undergo a product development cycle greater than five years—a timeline that underscores the challenges of bringing new technologies to market. Over the past decade, automakers have navigated a politically volatile regulatory environment, carefully balancing long-term R&D and capital investments to meet stricter ICEV fuel efficiency standards while scaling a diverse lineup of cost-competitive EVs.

Mitigating industry risks is complex, particularly in the context of ongoing technological advancements and substantial recent investments. Rapid changes in regulation or policy can have far-reaching consequences, potentially destabilizing sectors undergoing transformation. The U.S. automotive sector has emerged as a driver of critical innovations while supporting a broad industrial ecosystem that includes manufacturing capacity, a skilled workforce, specialized equipment, R&D infrastructure, and organizational expertise. A significant decline in this sector could disrupt economic stability, affect millions of jobs, and weaken the domestic supply chains that have long been built around the auto industry.

The automotive sector and other manufacturing industries in the United States could consider other advanced production technologies, like additive manufacturing (AM), to build industrial resilience and maintain a competitive edge. Unlike traditional manufacturing methods with long lead times and rigid supply chains, AM enables on-demand production, reduced industrial waste, and the creation of highly specialized components. During the COVID-19 pandemic, GM and Ford used AM in their existing production facilities to cut costs and supply ventilators for the U.S. government.[180] Especially in the aerospace, automotive, and defense industries, AM provides the capacity to rapidly adjust supply chains—enabling high levels of precision, customization, and security.

AM is also increasingly vital to national security. Across military departments, the Pentagon is integrating advanced manufacturing into logistics operations to streamline maintenance processes and extend the lifespan of mission-critical assets. The U.S. Air Force has turned to AM, for example, to address legacy aircraft part shortages like the turbofan engine of the aging B-52 Stratofortress—recreating components like anti-icing gaskets to replace obsolete parts.[181] The Navy is 3D-printing submarine parts such as pump housings and valve assemblies to cut reliance on foreign suppliers.[182] Meanwhile, the space industry is leveraging AM to lower costs and speed up rocket production, with startups 3D-printing major subsystems in the small launch market.[183]

The automotive sector and other manufacturing industries in the United States could consider other advanced production technologies, like additive manufacturing (AM), to build industrial resilience and maintain a competitive edge.

[177] Ibid.
[178] Craig Singleton and RADM (Ret.) Mark Montgomery, "Laser Focus: Countering China's LiDAR Threat to U.S. Critical Infrastructure and Military Systems," Foundation for Defense of Democracies, December 2, 2024, at 3.
[179] Geert De Lombaerde, "Ford CEO on Clearer EV Priorities, Supplier Changes and a 'New Global Standard of Fitness'," *Industry Week,* June 19, 2024.
[180] Evan Lam and Brennan Taylor, "The Use of Additive Manufacturing During the COVID-19 Pandemic," Office of Industry and Competitiveness Analysis, October 2024, at 2.
[181] Kyle Mizokami, "The Old-School Engine That Powers the B-52 Gets a 3D-Printed Upgrade," *Popular Mechanics,* August 10, 2020.
[182] Megan Eckstein, "Manufacturing woes could sink US sub fleet. Can 3D printing save it?," *DefenseNews,* November 6, 2023.
[183] Curt Hall, "3D Printing & the Future of Space Exploration," *Amplify* 37:2, at 55.

However, advanced manufacturing alone cannot fully address the broader vulnerabilities in U.S. defense manufacturing. While it enhances supply chain flexibility, a robust industrial base is essential to sustain military readiness. The U.S. military benefits greatly from scaled domestic commercial supply chains, as the defense industrial base alone lacks sufficient demand for most critical minerals and components to support an independent supply chain.[184]

While DoD continues to prioritize investments that will enhance national security, private-sector supply chains can develop and scale much more quickly. In 2023, Vacuumschmelze (VAC), a leading German producer of rare earth magnets, signed a long-term supply agreement with GM to produce EV components and subsequently invested in a manufacturing plant in South Carolina, expected to produce permanent magnets by 2025.[185] The production surplus is expected to be sold to DoD, which is a near-immediate security improvement relative to relying on supply chains running through China.[186]

Commercial partnerships like these are key to strengthening supply chains for commercial and defense applications. MP Materials, a U.S.-based company producing rare earth elements domestically for commercial applications, is now supplying DoD with strategic materials including NdPr oxide and lanthanum carbonate—critical resources for which the United States was nearly completely reliant on imports. Without the EV industry anchoring the market, companies throughout the mineral and magnet supply chains could face significant headwinds with fewer customers, to the detriment of U.S. national security.

While private-sector partnerships are helping to strengthen supply chains, the National Defense Stockpile (NDS) itself has faced significant underfunding since at least 2016, hindering its capacity to acquire the essential materials and components needed for sustained conflict. In its 2021 assessment, the NDS identified shortfalls in 53 materials, with 18 lacking any domestic production.[187] China is the primary global producer and main U.S. supplier of 20 or more shortfall materials.[188] By 2023, the situation had worsened, with the NDS reporting net shortfalls in 88 materials valued at $14.8 billion.[189] While stockpile requirements for materials and components may work in peacetime, accurately calibrating reserve sizes to meet the demand for military equipment, ammunition, and other technologies in wartime is much more challenging. If miscalculated, the intensity and duration of warfare can quickly deplete stockpiles, necessitating the continued production of new equipment to sustain military operations—all of which may take time and provide adversaries an advantage.

The strain on Western military stockpiles is evident in the ongoing high-intensity wars in Ukraine and Israel. The ability of the United States and individual European countries' capacity to deliver military support is a key aspect of defense and deterrence. Yet, arsenals are increasingly depleted—particularly in critical munitions. Arms manufacturers are already finding it hard to keep up with Ukraine's demand for military equipment, limiting the United States and Europe's ability to support Ukraine's defense against Russian aggression.[190] For example, it takes the United States a month to produce the volume of 155-millimeter artillery rounds that Ukrainian forces need to use in four days to keep up with Russian usage of shells.[191] In the future, it will be important to consider how to resolve chokepoints from both production capacity and material availability.

This experience points to challenges the United States could face in a future conflict, such as one concerning Taiwan. Manufacturing major weapon platforms, such as ships, aircraft, or missile batteries, takes years, and it would be difficult to replace them in the midst of a conflict. But better planning could reduce the time required to replace the consumable items that the military uses in a conflict, such as ammunition and missiles. Weapons requirements are typically calculated based on conflict assumptions, but the DoD often chooses not to fully fund those requirements when assembling its budgets. Recent studies suggest that U.S. forces could exhaust

[184] Note: Table 17 shows that for select critical minerals and strategic materials, U.S. DoD demand is less than 10 percent of domestic consumption.
[185] Vacuumschmelze, "On the road to an electric future," January 30, 2023.
[186] Todd Lopez, "DOD Looks to Establish 'Mine-to-Magnet' Supply Chain for Rare Earth Materials," Department of Defense, March 11, 2024.
[187] Cameron Keys, "Emergency Access to Strategic and Critical Materials: The National Defense Stockpile," Congressional Research Service, November 14, 2023, at 8.
[188] Id., at 9.
[189] Ibid.
[190] Giedrimas Jeglinskas and Viltaute Zarembaite, "Restocking US and Allies' Arsenals Starts with Getting Industry Involved at NATO Summit," Atlantic Council, June 8, 2023; and Vikram Mittal, "Ukraine Is Now Able To Produce 155mm Artillery Shells And Howitzers," *Forbes,* September 22, 2024.
[191] Nick Schifrin and Dan Sagalyn, "Arms Manufacturers Struggle to Supply Ukraine with Enough Ammunition," *PBS,* March 10, 2023.

Global power is now defined by those who produce the most advanced, efficient, and resilient systems—and have the resources and integrated supply chains to produce them quickly at scale when needed.

their inventory of long-range missiles within weeks during an intense conflict, but replacing these missiles could take up to two years—far exceeding the likely duration of any such conflict. Multinational war games have demonstrated that this problem is not unique to the United States, but that our allies would likely face the same situation.

Given the high costs of manufactured goods and uncertain demand, this shortfall reflects the defense industry's reluctance to increase weapons production without long-term contracts. In the past, DoD has had inconsistent procurement patterns, leading to shutdowns in production lines. Workforce shortages, supply chain vulnerabilities, and reliance on foreign sources—particularly China—for critical materials such as rare-earth metals and semiconductors—further exacerbate the problem. Moreover, it can be difficult to supply foreign allies with U.S. military stocks because DoD often manufactures versions for use by U.S. armed forces with enhanced capabilities that it is unwilling to export to maintain a technological edge over our adversaries.

These production shortfalls not only threaten the ability to defeat a belligerent Russia but also have implications for other countries that rely on stocks of Western military equipment for deterrence or warfighting. These dynamics will all be exacerbated when the geopolitical tension involves China, which maintains a dominant position through its vertically integrated supply chain and powerful manufacturing industry. Countries in North America, Europe, and elsewhere could be starved of the materials and supply chains they will need or do not have the industrial capacity to replace systems in a conflict with China. While the U.S. industrial base has weakened, there is still an opportunity to reverse course.

The "Arsenal of Democracy" was a defining moment in American history, but the world has changed. The challenges of the 21st century demand a more forward-looking approach. The ability to produce at scale remains essential for American consumers, technology manufacturers, and the defense industrial base; however, in scaling, the United States can no longer rely on its past industrial might. Instead, the United States must focus on its capabilities to manufacture and pioneer the next generation of transportation and industrial technologies that will shape the future of its economic and military power. Global power is now defined by those who produce the most advanced, efficient, and resilient systems—and have the resources and integrated supply chains to produce them quickly at scale when needed.

The United States cannot afford to be complacent while China aggressively expands its industrial dominance. For too long, policymakers have allowed strategic industries to erode while Beijing systematically builds up its manufacturing and technology sectors with government-backed subsidies and industrial espionage. Reversing this decline requires a bold national commitment to rebuilding domestic industrial capacity—not just through research or tax incentives, but by reshoring critical production, securing American and allied supply chains, and eliminating the nation's dangerous dependence on its adversaries. It is time for private industry to step up and reinvest in American manufacturing even when margins are low, and for the federal government to create the conditions necessary to make those investments viable.

America has always been a nation of builders. Today, that spirit is needed more than ever to scale quickly and ensure America reindustrializes. This shift is already reshaping the U.S. auto industry, which is struggling with these changes but is trying to leverage existing industrial capacity while investing billions in R&D—not just to lead technological change, but to transform manufacturing itself. A similar approach must extend beyond transportation and other high-technology sectors where private investment holds the potential to scale the commercial sector which in turn secures and lowers the cost of supply chains for the defense industrial base. Both of which can then be harnessed to support America's prosperity and security. If the United States can rally around an industrial strategy that dominates key sectors and critical supply chains in the coming decades, the nation will not only be more prosperous but will recapture its historic, strategic superiority.

# 3

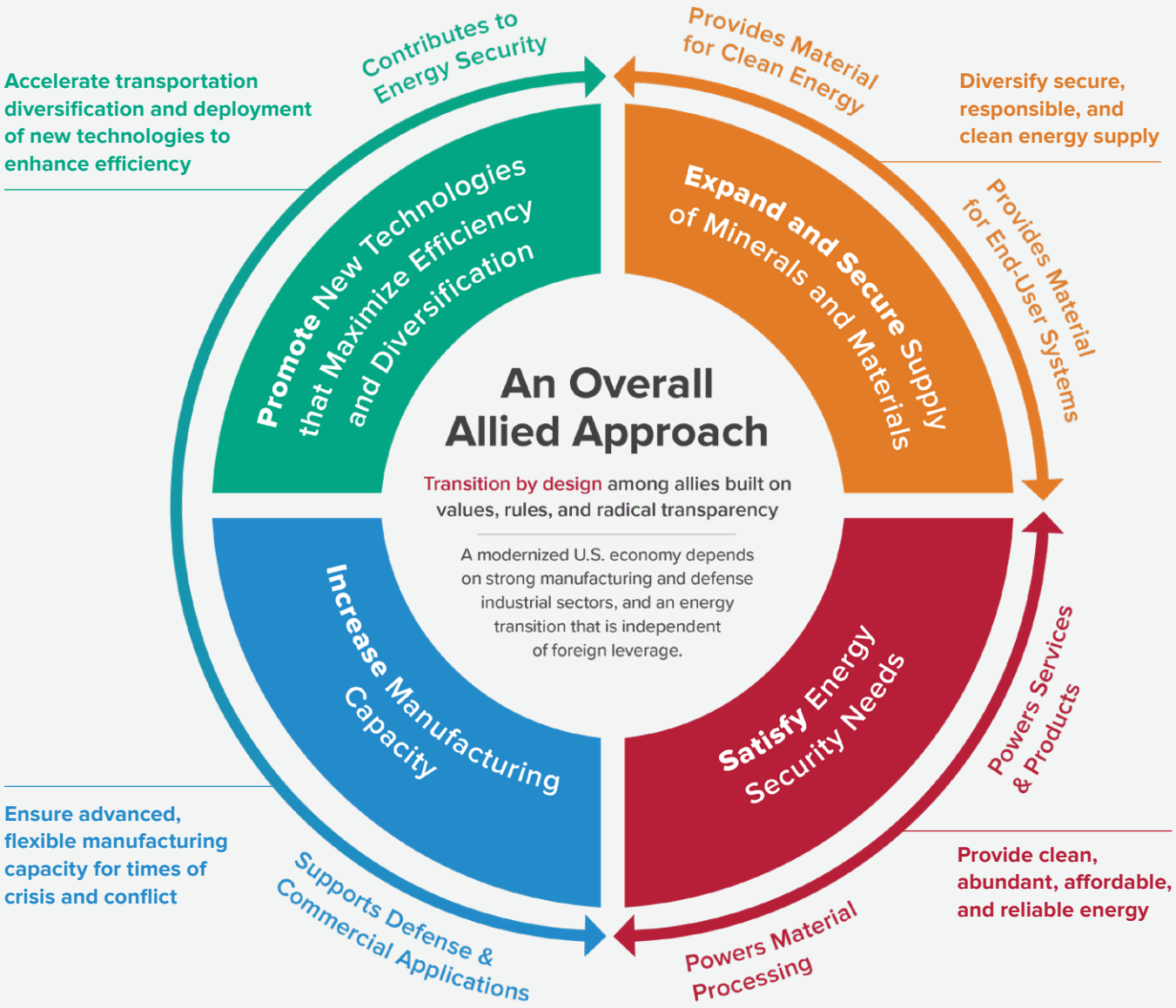
# The Pillars of Power

**The United States stands at an inflection point** in the evolution of its energy systems and industrial base, and how they will shape the nation's economic and national security. As new global flashpoints have emerged and the energy landscape continues to shift, America must modernize and maximize its energy infrastructure and abundant resources while maintaining high standards, fortifying its industrial base, and securing the supply chains that power its economy and military.

The Pillars of Power are a foundation for a comprehensive strategy for addressing these priorities, ensuring that the United States remains resilient, competitive, and prepared for the challenges ahead. These four interconnected pillars—**Expand and Secure Supply of Minerals and Materials**, **Satisfy Energy Security Needs**, **Promote New Technologies that Maximize Efficiency and Diversification,** and **Increase Manufacturing Capacity**—form the basis of a modernized economy that reduces reliance on foreign adversaries, enhances energy security, strengthens domestic industries, and drives technological innovation in both the commercial and defense sectors.

Each pillar addresses a key challenge that the United States must overcome to achieve a period of sustained prosperity and to fortify its position as the leading global power in an increasingly multipolar world. **Expanding and Securing the Supply of Minerals and Materials** ensures that critical minerals essential for advanced technologies, defense systems, and all energy technologies remain accessible and independent from geo-political coercion. **Satisfying Energy Security Needs** prioritizes a diverse, reliable, and affordable energy mix for both transportation and the generation of electric power, protecting against market volatility and ensuring long-term resilience. **Promoting New Technologies that Maximize Efficiency and Diversification** advances the deployment of next-generation transportation and energy systems, reducing inefficiencies and waste, and improving grid reliability. **Increasing Manufacturing Capacity** strengthens the domestic industrial base, ensuring that the United States can produce the technologies needed during periods of both relative peace and conflict. Taken as a whole, these pillars create a framework to view how economic strength, energy independence, and industrial leadership will evolve together in the 21st century.

# The Pillars of Power



# Pillar 1 Expand and Secure Supply of Minerals and Materials

Fossil fuels have powered industries, fueled transportation, and shaped geopolitics for more than a century. Steady access to oil and natural gas has been central to U.S. economic growth, providing affordable, reliable energy while supporting a strong industrial base. However, the requirements for advanced weapons systems and the development of myriad new technologies are driving a fundamental shift toward electrification and digitization, thus the need for critical minerals. Diversifying the fuel used to power U.S. transportation would reduce the nation's reliance on oil as a singular transportation fuel and its volatile global market and further unleash the power of domestically generated resources for export, improving the nation's balance of trade. At the same time, the new demand arising from emergent sources, AI, reindustrialization, and transportation electrification will require a significant investment to modernize the electric power grid. Together, the electrification of the transportation system, the transformation of the power grid, and increased demand from the defense industrial base are ushering in a shift toward a new "Age of Minerals."

This new era will see a growing reliance on a broad portfolio of minerals and strategic materials, including lithium, cobalt, nickel, manganese, titanium, copper, aluminum, steel, and rare earth elements—all of which are key to the manufacture of batteries, transmission lines, semiconductors, energy systems including nuclear and solar, and other critical infrastructure from pipelines to bridges, military platforms, and other innovative technologies. The transition to a minerals-based energy and manufacturing economy, however, introduces a new set of vulnerabilities that replace those created by oil dependence. These resources are concentrated in different regions, with the power to reshape the global geopolitical landscape. Mineral-rich nations, or those with the capacity to refine minerals into usable materials, could gain influence like that held by major oil-producing countries in the early 1970s. However, unlike oil, which relies on well-established extraction and refining processes, critical minerals require more complex production technologies and specialized processing systems. While dominant oil producers like Saudi Arabia have historically aligned with the leading Western economic and military powers, Beijing offers no such compact—wielding strategic leverage over the United States and its allies and raising new energy and national security challenges.

The electrification of the transportation system, the transformation of the power grid, and increased demand from the defense industrial base are ushering in a shift toward a new "Age of Minerals."

## The Path to a Minerals-Based Economy

Over the past century, oil has been and still is the world's most important energy. Industries ranging from automotive to petrochemicals have thrived on oil's availability and affordability. Over time, oil-rich regions gained geopolitical significance, shaping power dynamics and influencing political and economic trends. By the late 2000s, however, declining battery costs enabled the first mass-market electric cars. EVs' market share grew steadily throughout the 2010s and, by the early 2020s, became a mainstream alternative to internal combustion engines for passenger vehicles.

Recognizing this shift, automakers have begun planning a large-scale transition to EVs, with some committing to electrify their entire fleet. Transitioning to EVs, however, raises new issues as these vehicles are far more mineral-intensive than conventional cars. At the same time, electronic components that are increasingly pervasive in all cars, require significantly larger volumes of copper, aluminum, and other conductive materials, and an increasing number of advanced semiconductor chips and permanent magnets. Government policy has supported this transition, but it is primarily driven by technological advances that enabled the manufacture of lower-cost, high-density energy storage. Without any expectation that all vehicles will be fully electric, trends in the advancement of EVs and the expectation of continually improving performance and decreasing costs, in addition to the benefits of improved energy and economic security, point in the direction of improvement and increased adoption over the years and decades to come. Furthermore, the continued adoption of EVs remains a national security imperative. Reducing the transportation sector's dependence on petroleum offers several strategic benefits, including easing the military's responsibility to protect maritime oil supply routes and

While oil remains one of the most critical fuels required to maintain combat operations, the U.S. defense sector heavily depends on minerals and materials for a wide range of advanced military technologies.

vulnerable energy infrastructure abroad. It also decreases reliance on a commodity whose revenues have historically funded conflict and terrorism by actors whose interests often oppose those of the United States.

Upgrading the transmission grid to ensure reliable power, especially with the growing demand from AI-driven computing and the need to reindustrialize, also requires critical minerals and other strategic materials. Aluminum, valued for its high conductivity and low weight, is a key input used in transmission lines, and rare earth elements are integral to high-voltage componentry such as transformers. These same materials are essential for renewable energy infrastructure: aluminum and rare earths play a role in wind turbine construction, while solar panels require a wider range of critical minerals, including arsenic, gallium, germanium, indium, and tellurium.

Moreover, critical minerals and strategic materials are needed beyond the civilian economy. While oil remains one of the most critical fuels required to maintain combat operations, the U.S. defense sector heavily depends on minerals and materials for a wide range of advanced military technologies. Although the exact quantities required to meet the Pentagon's supply chain needs are generally classified, those nonfuel minerals are indispensable to the U.S. defense industrial base. They are essential for manufacturing military platforms like jet engines, planes, satellites, missile guidance systems, tanks, communication equipment, energy storage solutions, munitions, and artillery shells. Reliable access to these minerals and materials strengthens military readiness, while shortages undermine the nation's security.

The defense and energy sectors not only rely on many of the same minerals and materials, but they also face similar challenges. Any disruption in their supply chains—whether from geopolitical tensions, trade restrictions, or natural

disasters—could jeopardize U.S. energy security, weaken industrial competitiveness, and undermine military readiness. In response, the U.S. government has taken steps to mitigate the risk. To ensure a stable and secure supply of critical minerals, the United States must further develop its domestic mining and processing capabilities, invest in advanced recycling and material substitution technologies—such as permanent magnets that require no rare earths or silicon anodes—and deepen strategic partnerships with allied nations to diversify access to foreign reserves. This effort must also include working with international allies to neutralize Beijing's control over mineral and materials markets and ensure that the United States retains access.

To counter these growing risks and reduce reliance on a concentrated supply chain, the United States must expand and diversify its sources of critical minerals. This approach must include increasing domestic production, forging global partnerships, and tapping into emerging resources beyond traditional land-based mining. The seabed, for example, contains vast deposits of nickel, manganese, copper, zinc, and cobalt—materials essential for energy storage, semiconductors, and defense applications. Without clear policies or permitting to support the development of new seabed resources, or a lack of will to forge bilateral agreements with partner nations with seabed mineral resources, the United States risks falling behind in this critical resource frontier.

To expand our domestic critical mineral industries, it is important to also support the development and growth of industries that consume critical minerals. Without strong domestic demand, such as for electric vehicles, wind turbines, semiconductors, and defense technologies, there is little incentive for companies to invest in the costly and complex process of extracting, refining, and processing critical minerals domestically. These downstream industries provide the market pull that justifies upstream investments, from exploration to production. If the demand is consistently met by domestic consumers, it stabilizes the market, encourages innovation, and reduces reliance on volatile international supply chains. Moreover, co-locating supply and demand reduces transportation costs, and increases national security by minimizing dependence on foreign-controlled processing facilities. By investing in industries that use critical minerals, we can develop a vertically integrated ecosystem—one that captures more of the economic value, creates jobs, and promotes domestic industry. In short, a critical minerals industry cannot exist in isolation but must be paired with robust domestic demand to become sustainable, resilient, and strategic in the long term.[192]

The shift to a minerals-based economy is reshaping global geopolitics in ways that parallel the rise of the fossil fuel economy. As oil-rich nations wielded significant influence in the 20th century, countries with abundant mineral resources are becoming central players in the new energy landscape. This concentration of power should raise concern in the United States and amongst its allies and drive efforts to diversify supply chains or accelerate responsible permitting of domestic projects. In response, the United States and its allies are investing in domestic mining and processing while forging partnerships with resource-rich nations to secure critical supplies. The success of these efforts will not only affect the energy and national security of the United States for decades to come but also determine whether it has the capacity for a manufacturing resurgence.

## Recommendations

To sustain U.S. leadership in advanced manufacturing, energy security, and defense, the federal government must take decisive action to secure critical mineral supply chains and expand domestic processing capabilities. The modern economy is increasingly dependent on minerals and other strategic materials, yet supply chains remain concentrated in or controlled by a handful of nations, particularly China. By expanding domestic mining and refining capacity,

As oil-rich nations wielded significant influence in the 20th century, countries with abundant mineral resources are becoming central players in the new energy landscape.

[192] See e.g., Keith Bradsher, "China's Chokehold on This Obscure Mineral Threatens the West's Militaries," *The New York Times,* June 9, 2025; Ieva Baršauskaitė et al., "International Trade and Investment Agreements and Sustainable Critical Minerals Supply," International Institute for Sustainable Development, April 2025, at 1; and Martin Stratte et al., "Executive Order Mandates Immediate Action to Accelerate Funding for Domestic Mineral Production and Processing," Hunton, March 24, 2025, Webpage.

strengthening international partnerships, creating a trading system that supports transparency and high standards for domestic and allied supply, and investing in recycling and alternative materials, the United States and its allies can reduce dependence on foreign-controlled supply chains and fortify economic and defense resilience.

The following recommendations outline key steps to secure critical minerals and strategic materials and ensure supply availability.

**The U.S. government should develop a standards-driven tariff fortress around low-standard critical minerals.** The United States Trade Representative (USTR) should first work with like-minded nations to establish a limited number of traceability, transparency, labor, and environmental standards for critical minerals that are clear and enforceable. In delivering on the G7's 2024 Critical Minerals Action Plan, the USTR should work with the U.S. International Trade Commission (USITC) to develop more granular harmonized tariff schedule (HTS) numbers to distinguish the critical minerals produced with high standards from critical minerals that do not meet minimum standards in U.S. regulations, which can be globally harmonized at the World Customs Organization. The President of the United States can then adjust tariffs on low-standard critical minerals while creating "portholes" to allow open and fair trade for needed minerals under a compliant marketplace or exchange, and can more easily take into account standards in foreign nations when establishing tariffs pursuant to Section 232 investigations. Such a policy is a strategic move to block materials controlled by the CCP from flooding U.S. supply chains while simultaneously redefining global competitiveness by establishing guardrails that block bad actors from exploiting market loopholes. Finally, to support the development of international deposits developed with high standards, the United States should establish a U.S.-backed funding pipeline for international deposits of strategic national importance through mechanisms such as the Export-Import Bank of the United States (EXIM) and U.S. International Development Finance Corporation (DFC).

To improve permitting efficiency, the U.S. government should update processes to enhance transparency, predictability, and coordination across federal, state, and tribal authorities.

**The U.S. government should implement permitting reform, and Congress should propose new mining legislation to accelerate responsible domestic mineral production and processing capacity.** The current U.S. federal permitting system requires comprehensive reform to enhance efficiency while maintaining stringent environmental standards. Modernization efforts should focus on establishing (1) clear and consistent rules and processes, (2) objective decision-making criteria, and (3) the capacity for timely execution, without weakening environmental standards that are an important competitive advantage to ensure long-term resiliency of projects. To support this, Congress should direct and fund the National Academies of Sciences (NAS) to build on the Department of the Interior's Interagency Working Group on Responsible Mining by conducting a comprehensive review of U.S. mining regulations. The NAS study should identify legislative and regulatory improvements, assess health, safety, environmental, and land use issues, and examine opportunities to streamline repetitive and redundant interagency reviews while preserving environmental rigor.

To improve permitting efficiency, the U.S. government should update processes to enhance transparency, predictability, and coordination across federal, state, and tribal authorities. SAFE applauds the administration's decision to add more critical mineral projects to the FAST-41 process and recommends applying FAST-41 principles—structured tracking, clear timelines, interagency coordination, and public dashboards—to all hard rock mining projects. While the administration is already taking important steps to modernize and digitize permitting, these efforts should be extended to enable greater information sharing not only across federal agencies, but also with state and local regulators, project proponents, and other stakeholders.

In addition to administrative inefficiencies, litigation is a major contributor to permitting delays. Early, meaningful stakeholder engagement—especially during the mineral exploration and pre-scoping phases—can reduce litigation risk by identifying and addressing concerns before permitting decisions are finalized. To reinforce these benefits, Congress should include statutory limits on late-stage legal challenges. Lawsuits should be filed within 120 days of the Record of Decision, and claims should only proceed if brought by parties who actively participated in

the permitting process. These measures would improve predictability, reduce uncertainty, and help accelerate the development of responsible domestic mineral projects.

**Strengthen critical mineral supply chains by partnering with allied nations to develop new mining and processing capacity.** The administration has already signaled its intent to use Defense Production Act (DPA) Title III authorities to support critical mineral projects and to work with the DFC in implementing this support, including through a new critical minerals fund seeded with DPA Title III and Office of Strategic Capital (OSC) funding. In addition to supporting greenfield development, eligible projects for support should include the reprocessing of mine waste by Good Samaritans—whether from abandoned mines, legacy assets, or tailings associated with existing operations—to enable the recovery of critical minerals and reduce environmental liabilities.

While advancing domestic production remains essential, the administration should also leverage DPA authorities as well as DFC and EXIM to strategically support high-standard projects in eligible countries such as Canada, the United Kingdom, and Australia, as well as other trusted allies and strategic partners for minerals where the United States has limited or no known domestic reserves. Moreover, U.S. purchasers and funding agencies should coordinate with partners in allied countries to aggregate demand and provide sufficient market certainty to justify private investment in new processing capacity. These efforts will help diversify supply chains, reduce geopolitical risk, and reinforce partnerships with like-minded nations. Congress should prioritize DPA, DFC, and EXIM reauthorization and earmark funding for critical minerals within it.

**Congress should extend and expand the U.S. Geological Survey (USGS) Earth Mapping Resource Initiative (EarthMRI).** While not providing immediate supply solutions due to long project development timelines, enhanced mapping of U.S. lands and mine waste will improve understanding of domestic resource potential and help direct exploration efforts to areas with a greater likelihood of success. Congressional action should extend EarthMRI's appropriations beyond FY2026 and expand EarthMRI's mine waste assessments beyond resource characterization and include an evaluation of nearby infrastructure that could provide opportunities to reprocess mine tailings, as well as evaluations of the economic viability of recovering critical minerals from mine waste.

By prioritizing the purchase of domestic aluminum, the DoD can enhance operational readiness, strengthen economic security, and the long-term sustainability of U.S. manufacturing.

**DOE and DoD should support expanded U.S. critical mineral processing capacity through public-private partnerships.** DOE and DoD should lead a cost-sharing initiative with battery manufacturers and other downstream industries. This initiative will help overcome financial barriers, increase the uptake of innovative refining technologies, and support the development of processing facilities for lithium-ion battery materials and other high-priority critical minerals, such as rare earth elements, cobalt, and nickel.

**The DoD should purchase aluminum and other critical materials or equipment from domestic sources when available and where doing so would strengthen critical supply chains.** To strengthen national security, support domestic industry, and ensure a reliable supply chain for the Pentagon, the DoD should source aluminum solely from domestic producers as is feasible. Aluminum is a critical material for military aircraft, armored vehicles, naval ships, and advanced weapons systems. Relying on foreign suppliers, especially from geopolitical rivals, poses supply chain risks during conflicts or economic disruptions. Investing in domestic aluminum production preserves U.S. manufacturing capabilities, protects American jobs, and reduces import dependence. A stable, U.S.-based supply ensures the availability of high-quality materials that meet defense standards while fostering technological advancements in aluminum smelting. Supporting domestic aluminum producers aligns with broader efforts to strengthen the U.S. manufacturing base and enhance its resilience, ensuring that the United States can rapidly scale production in emergencies. By prioritizing the purchase of domestic aluminum, the DoD can enhance operational readiness, economic security, and the long-term sustainability of U.S. manufacturing. Moreover, DoD should also consider working to reshore supply chains that support other key sectors already identified by DoD such as kinetic

capabilities (e.g., missiles), microelectronics, and castings and forgings.[193]

**Congress should expand support for research to improve mineral processing by establishing a research consortium and cost-sharing initiative between National Labs and industry partners.** This initiative will fund research, development, and demonstration projects to advance and scale cutting-edge technologies that are cleaner, faster, and more cost-competitive. It will prioritize the scaling of new methods to process and refine critical minerals from raw and spent materials and mine waste, reducing environmental impacts while strengthening domestic supply chains.

**The United States should out-compete China to be the first nation in the world to commercialize deep-seabed minerals.** Following President Trump's April 2024 executive order, *Unleashing America's Offshore Critical Minerals and Resources*, the United States should immediately begin seeking critical minerals agreements with nations with significant seabed mineral deposits within their Exclusive Economic Zones. Such agreements should support American companies developing minerals projects in those jurisdictions, particularly those that sponsor seabed minerals contracts. In parallel, Congress should pass legislation to create an enduring legislative framework that accelerates domestic and allied deep-sea mineral development to enable commercial recovery of polymetallic nodules, protect legacy U.S. claims from competition, and incentivize the processing of these minerals in the United States. These actions should be accompanied by an urgent program to develop industrial-scale domestic processing capabilities for deep-seabed minerals in the United States. Finally, the Pentagon should purchase and stockpile polymetallic nodules.

For the past fifty years, the United States has faced significant energy risks due to its reliance on oil to fuel its transportation system.

## Pillar 2 Satisfy Energy Security Needs

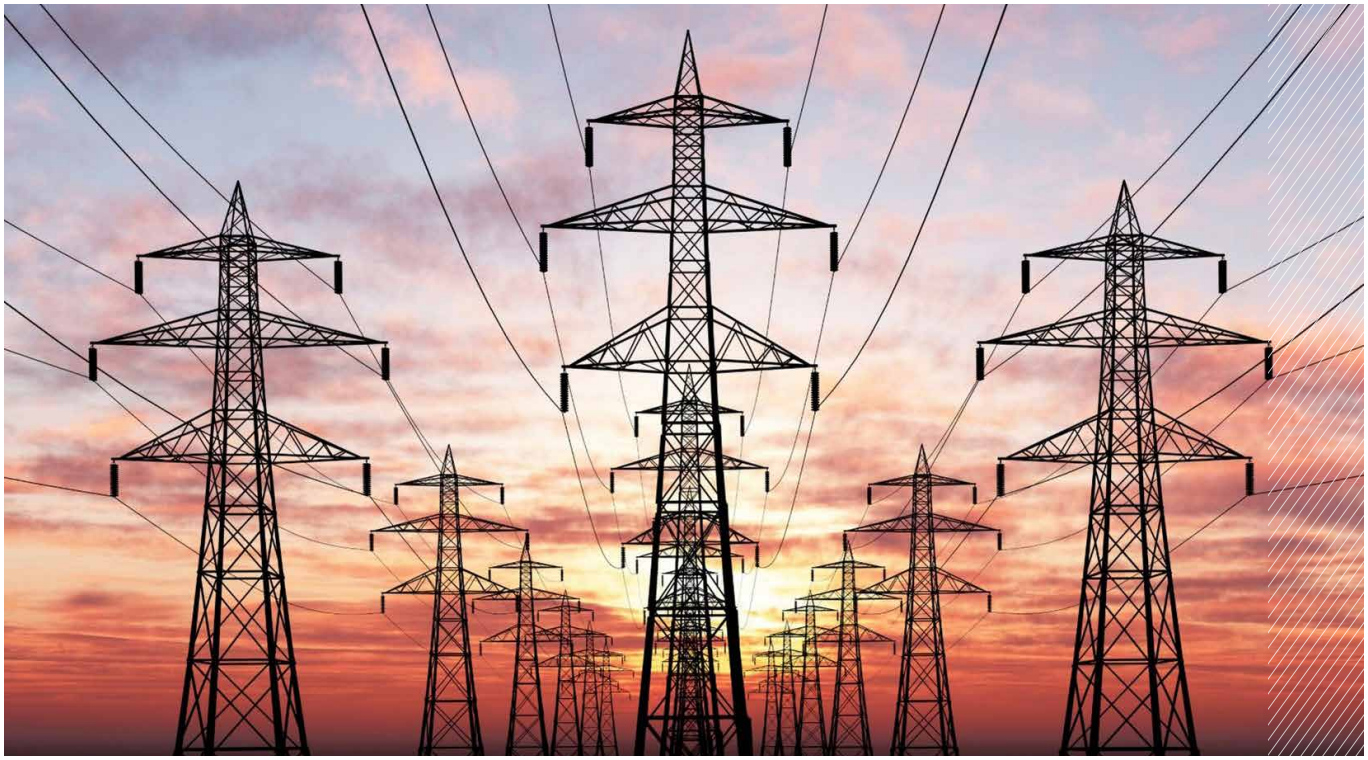
As the United States embarks on a new era of reindustrialization and rapid advancements in artificial intelligence, electricity demand is set to surge at an unprecedented pace. With well-established oil and natural gas resources, highly developed infrastructure, and a dynamic private sector, the United States remains an energy powerhouse—shaping global markets and influencing policy. However, building upon this leadership—and ensuring long-term economic growth—will require a sustained commitment to further harness the vast natural resources the United States possesses while also investing in robust generation and transmission capacity and streamlining the nation's permitting processes. Such actions would provide a strong foundation for continued industrial and technological leadership.

### Fossil Fuels: The Foundation of U.S. Energy Dominance

For the past fifty years, the United States has faced significant energy risks due to its reliance on oil to fuel its transportation system. With short-term demand for oil being highly inelastic, the United States was vulnerable to price volatility in the global oil market dominated by oil-rich nations. While increased domestic production has reduced the nation's dependence on foreign oil, that risk remains today. Because oil trades on the global market, foreign producers can strongly influence domestic prices at the pump. Although high levels of U.S. production help offset the economic impact of rising prices on national income, consumers and businesses remain exposed to price shocks, and U.S. oil and gas producers remain exposed to low prices.

Since the mid-2000s, the United States has become the world's largest oil and natural gas producer, driven by technological advancements in hydraulic fracturing and horizontal drilling techniques. The shale boom that started around 2005 and lasted for more than a decade unlocked vast oil and natural gas reserves, and drastically reduced the nation's reliance on imported fuel. Natural gas has also played a particularly crucial role in reshaping the U.S. energy landscape. It has provided a reliable and affordable source of electricity, as the expansion of natural gas production and liquefied natural

[193] See Department of Defense, "Securing Defense-Critical Supply Chains: An Action Plan Developed in Response to Executive Order 14017," February 2022.



gas infrastructure has strengthened U.S. energy security and reinforced its role in global energy diplomacy. In the wake of the Russia-Ukraine War, for example, U.S. LNG exports helped European allies reduce dependence on Russian gas. By the mid-2010s, the surge in shale production transformed the United States into a net energy exporter, and the Trump Administration has expressed that continuing this trend is an urgent national priority.

## Ensuring Global Leadership and Manufacturing Capability on Advanced Energy Technologies

While fossil fuels remain a cornerstone of the U.S. energy sector, the country has also emerged as a global leader in other forms of energy. The rapid expansion of wind and solar power, for example, has positioned the United States as a driving force in adding new energy sources and technology into the energy mix. Wind energy now generates more than 20 percent of all electricity in Texas, Wyoming, and Minnesota; 30 percent or more in Colorado, Nebraska, North Dakota, and New Mexico; 40 percent or more in Oklahoma; 50 percent more in Kansas, and nearly 60 percent in Iowa.[194] Similarly, solar power accounts for nearly 30 percent of California and Nevada's power generation, with a large proportion also generated in other western and southern states with abundant sunshine.[195] Geothermal power accounts for ten percent of power production in Nevada, five percent in California, and three percent in Hawaii.[196] But Texas leads the way in demonstrating the value of a comprehensive energy strategy, with the state the producing more oil, more natural gas, and more wind power, and more overall renewable energy than any other state, with its generation of renewable power more than twice the volume of renewable power generated in California.

[194] Data from EIA, Electricity Browser.
[195] Ibid.
[196] EIA, "Electric Power Monthly: February 2024," Tables 1.3.B and 1.16.B.

Renewable energy offers both security and economic advantages. Unlike fossil fuels, renewables do not require fuel inputs, making them immune to price volatility. The generation of wind and solar power is, however, inherently variable, requiring advances in energy storage or grid modernization to more widely distribute their benefits nationwide. Continued appropriate and calibrated federal support and private sector investment are crucial to ensure that there is a market and innovation in the United States—as opposed to ceding leadership and control to China and other countries. These projects will also likely be the quickest to bring online in the next one to five years. Given the growth in energy demand, the United States should ensure such projects are appropriately included in an All-of-the-Above strategy. It was once said that natural gas was a bridge to renewable energy, but the United States now finds itself flipping the script, asking if renewables are the bridge while it expands natural gas infrastructure, as it will take time to build pipelines and work through the rapidly growing equipment orders for gas turbines.

Likewise, nuclear energy remains a vital component of the U.S. energy portfolio. With more than 90 operating commercial nuclear reactors, the United States remains the largest nuclear power producer, providing 18 percent of the nation's energy in 2024.[197] Unlike other emission-free electricity sources, nuclear power provides consistent and reliable baseload power to the grid. Recent advances in nuclear technology, including the prospective development of small modular reactors and microreactors, offer the promise of several advantages, including lower costs, enhanced safety features, and the ability to be deployed in remote locations. Government funding and private investment are accelerating the development of next-generation nuclear technologies and may ensure nuclear energy remains a key part of the U.S. energy mix.

By accelerating permitting processes, strengthening domestic energy production, and investing in next-generation energy solutions, the United States can maintain its competitive edge.

Finally, fusion energy is generated by fusing light elements, typically isotopes of hydrogen, to release massive amounts of energy. The process mimics the reactions that power the sun and stars. The design of new fusion reactors and innovations in magnet technology could allow smaller, more efficient fusion reactors, potentially accelerating commercialization. In December 2022, the National Ignition Facility (NIF) achieved a key milestone when it achieved a net energy gain from fusion ignition, though it was a small-scale experiment and not a practical energy source. Meanwhile, China is spending at least $1.5 billion annually on fusion technology, though analysts estimate it could be double that figure, while the United States spends roughly half that amount.[198] Although the United States has most of the leading fusion companies—including Commonwealth Fusion Systems—further support for technology that could provide limitless energy is needed now, alongside technological innovations, government funding, and streamlined regulatory processes.

### Grid Modernization

A reliable, secure, and resilient grid is essential to modern life. However, today's grid faces mounting challenges from natural disasters, cyber threats, geopolitical tensions, rising demand, and an evolving energy mix. The grid must be modernized to ensure stable and uninterrupted service.

One major obstacle to grid modernization is the lengthy and complex permitting process. Regulatory hurdles, environmental assessments, and local opposition can delay critical projects for years, hindering progress and increasing costs. Streamlining the permitting process is essential to accelerate the deployment of new energy infrastructure. Regulators should implement policies that facilitate faster approval timelines. By expediting the permitting process, the United States can attract investment, create jobs, and enhance energy reliability.

At the same time, strengthening transmission capacity is critical to improving system reliability. A more robust and interconnected grid reduces vulnerabilities and improves resilience by increasing the pathways over which power can flow from generators to demand, reducing the risk of outages during periods of peak usage or supply disruptions. Like any supply chain, a grid that relies on only a few sources or connections is more prone to instability; increasing interconnectivity and diversification reduces the risks of service interruptions.

[197] EIA, "Net Generation by Energy Source: Total (All Sectors), 2015-March 2025," Electric Power Monthly, May 22, 2025; and Tom Clynes, "Is China Pulling Ahead in the Quest for Fusion Energy?," IEEE Spectrum, April 29, 2025.

[198] See, e.g., Katie Tarasov, "How the U.S. is losing ground to China in nuclear fusion, as AI power needs surge," CNBC, March 16, 2025.

Expanding and strengthening the grid is not only a matter of reliability—it is essential to meeting the nation's growing electricity demands. A modern transmission system will support the rapid expansion of artificial intelligence, the slow but growing need for electricity in transportation, the needs of major energy consumers—including industrial companies to crush, smelt, and process materials and minerals—and from DoD, the largest consumer of power in the nation.[199]

## Energy Security Challenges

Despite the United States' leadership in energy production and innovation, several challenges remain. The United States remains tied to the global oil market, and geopolitical tensions and price volatility can still impact consumers. In addition, demand for electricity is growing rapidly, and the United States must expand generation and transmission capacity to meet the needs for reindustrialization and AI-driven data centers, among other innovations.

Despite these risks, the United States is well-positioned to capitalize on the growing global demand for the entire portfolio of energy solutions and export U.S.-produced energy to the world, including manufactured solar panels and batteries—provided it continues to invest. Expanding exports of LNG, renewable energy technologies, and advanced nuclear reactors will strengthen economic competitiveness and enhance our nation's energy security. The United States is undeniably an energy powerhouse, with abundant natural resources, an advanced infrastructure, large capital markets, AI customers who need power, and a robust innovation ecosystem. By continuing to invest in innovation, infrastructure modernization, and regulatory and policy alignment with the needs of the private sector, the United States can continue to maintain and build its energy dominance.

## Recommendations

To ensure long-term energy security and sustain U.S. leadership in global energy markets, the federal government must expand all opportunities to generate more electric power, modernize infrastructure, and stop picking winners and losers of energy sources so that all can develop to diversify fuel sources. Rising electricity demand, supply chain vulnerabilities, and intensifying global competition require prudent policy action to protect economic resilience and national security. By accelerating permitting processes, strengthening domestic energy production, and investing in next-generation energy solutions, the United States can maintain its competitive edge.

The United States remains tied to the global oil market, and geopolitical tensions and price volatility can still impact consumers.

The following recommendations outline key actions to strengthen America's energy future and ensure long-term reliability.

**The nation should adopt a truly comprehensive energy strategy and end the war on specific energy sources.** The country has become divided on energy. Democrats have long been resistant to fossil fuel resources that are undoubtedly critical to the U.S. economy, while Republicans have attacked proven technologies such as renewable energy. The war must end and the nation must recognize and embrace the valuable contribution that all sources of energy make to the national economy, including the important role of oil in fueling transportation, of natural gas in generating power and heat, of wind and solar in generating ever-growing volumes of energy at a low marginal cost, and of batteries of providing energy storage to enhance systems' reliability.

**The federal government should accelerate transmission and pipeline approvals.** Lengthy permitting processes remain one of the barriers to constructing new electric power transmission lines and oil and gas pipelines. The government should streamline permitting procedures and reduce delays to expedite critical energy projects. Additionally, the threshold for energy projects to qualify as covered projects under the FAST-41 process—which coordinates the interagency review of federal permits—should be lowered to ensure more projects benefit from expedited approvals.

**DOE should accelerate approvals of LNG export facilities.** Expediting LNG export facility approvals would reinforce U.S. energy leadership, enhance global energy security, and support economic growth. On January 20, 2025, President Trump issued two separate Executive Orders that direct

[199] DOE, "About the Federal Energy Management Program," Webpage; and Heather Greenley, "Department of Defense Energy Management: Background and Issues for Congress," Congressional Research Service, July 25, 2019, at 1.

Faster approvals are important because they enable the United States to meet increasing natural gas demand from its trading partners, providing allies with reliable energy sources and reducing their dependence on geopolitical adversaries.

the government to accelerate the issuance of LNG export permits. Since then, the Department of Energy has issued three export permits, of which two are conditionally approved. As of June 22, 2025, at least seven applications for export permits remain under review at DOE. Faster approvals are important because they enable the United States to meet increasing natural gas demand from its trading partners, providing allies with reliable energy sources and reducing their dependence on geopolitical adversaries. The Department of Energy should establish strict timelines for approval of LNG export facilities and expedite all applications to the extent practical..

**DOI should expand drilling on public lands and offshore.** U.S. oil and gas production is at an all-time high, significantly enhancing the nation's energy security. However, there may be demand for increased access to federal lands and offshore areas for energy production. The Department of the Interior (DOI) should assess whether there is commercial interest in expanding offshore drilling opportunities and, if warranted, consider reopening the current five-year plan, which extends through 2029. Additionally, the DOI should evaluate whether there is demand for increased access to federal land and, if justified, establish an expedited process for offering additional oil and gas leases.

**Congress should direct DOE to refill the Strategic Petroleum Reserve.** Maintaining a full Strategic Petroleum Reserve (SPR) is crucial to national energy security, ensuring preparedness for potential supply disruptions. A well-stocked SPR acts as a critical buffer against geopolitical uncertainties and natural disasters, reinforcing economic stability and enhancing the nation's ability to respond to emergencies. A robust reserve signals strength to global markets. For these reasons, in January 2025, President Trump stated that he would refill the SPR "right to the top." The July 2025 reconciliation bill appropriated $171 million for crude oil purchases, enough to acquire about 3 million barrels at current prices. At the earliest possible time, Congress should direct the Department of Energy to refill the SPR and appropriate the necessary funds to do so. Oil from the SPR should not be sold to generate funds to pay for increased federal spending.

**DOE should fund next-generation nuclear deployment grants.** Advanced nuclear technologies, including small modular nuclear reactors (SMRs) and large, light-water reactors (LWRs) present a promising solution for clean, reliable, and scalable energy production. SMRs, in particular, hold the promise of enabling easier manufacturing, lowering initial capital costs, and improving siting flexibility compared to traditional nuclear reactors. Meanwhile, interest is growing in LWRs for meeting baseload residential and commercial demand, particularly for high-demand digital applications. DOE has received applications for $900 million in grants to support the development of Gen III+ small modular reactors. The July 2025 reconciliation bill made small modifications to the clean energy production tax credit which enhances the credit for facilities in selected communities, and other modifications to the nuclear power production tax credit limiting its availability to certain foreign entities, but otherwise left the applicable tax credits intact. DOE should award available grant funding as soon as possible and assess whether additional funding is warranted. If demand justifies the investment, DOE should seek additional appropriations from Congress.

**DoD should purchase small modular reactors.** DoD should support the development of a domestic SMR supply chain by committing to purchase a specified number of SMRs to provide clean, resilient, and reliable power to key military bases and installations. This commitment would help drive investment, accelerate deployment, and strengthen energy security for critical defense infrastructure. The July 2025 reconciliation bill appropriated $125 million to accelerate the development of SMRs. DoD should leverage this funding to initiate pilot projects and, if necessary, seek additional appropriations from Congress to fund the purchase of SMRs and ensure the successful integration of SMRs into military energy systems.

# Pillar 3 Promote New Technologies that Maximize Efficiency and Diversification

The U.S. transportation system is undergoing a transformation that will redefine how people and goods move. Throughout history, technological advancements—from the internal combustion engine to the interstate highway system—have reshaped transportation, driven economic growth, improved quality of life, and strengthened the nation's security.

Today, the United States stands at an inflection point, as electrification, automation, AI, and connectivity converge to shape the next generation of transportation. The global shift toward these transportation technologies is critical to improving energy security, optimizing system efficiency, and modernizing logistics on land, sea, and air. The shift to new technologies, such as EVs, is also critical to national security, as dependence on a volatile and manipulated oil market constrain U.S. foreign policymaking and affect the flexibility and activities of the military. However, this transition must be executed with care: U.S. supply chains for EVs and other emerging technologies must be resilient and secure, free from undue reliance on foreign adversaries like China, whose dominance in critical mineral processing presents long-term strategic risks. At the same time, outdated infrastructure, fragmented policies, overregulation and inconsistent regulation, and gaps in investment threaten to slow progress, while other nations rapidly accelerate the deployment of these technologies. The United States must align its infrastructure, regulatory framework, and national strategy to support an interoperable, scalable, and efficient mobility ecosystem to remain competitive.

## A Historic Transportation Transformation is Underway

For decades, the transportation system has been dependent on oil, leaving businesses and consumers vulnerable to price volatility, geopolitical instability, and supply chain disruptions. Oil dependence affects more than just prices at the pump. Logistics inefficiencies and aging infrastructure drive up delivery costs that are then passed on to consumers and weaken supply chain resilience, increasing costs throughout the economy. Many companies are

working to overcome these challenges, but critical technologies like autonomy and connectivity are not yet fully developed or integrated.

The United States must take bold action to scale automation, electrification, and digital connectivity to ensure these technologies deliver cost reductions, safety improvements, times savings for citizens, and efficiency enhancement benefits as soon as possible. Electrification is already lowering costs for households and businesses, while connected and automated vehicle technologies have the potential to optimize traffic management, reduce congestion, and improve road safety through AI-powered logistics.

Autonomous transportation, in particular, is advancing across multiple sectors. Waymo is expanding its AV deployments both domestically and internationally—in 2025, successfully adapting its technology to left-hand traffic in Japan.[200] Moreover, the transition to integrate AVs into the broader system can accelerate the adoption of EVs because as shared autonomous mobility services grow, they will create a network effect. Consumers will come to expect a service that offers convenience, reliability, and safety, regardless of which drivetrain it offers. And all indications from industry are that nearly all AVs being developed will be EVs, primarily to reduce fuel expenses. It will be important to ensure that the United States maintains a strong battery supply chain to ensure that AVs are not reliant on China.

Breakthroughs in the freight sector are equally promising. In December 2024, Kodiak Robotics launched a first-of-its-kind driverless delivery operation for a customer in the Permian Basin, transporting hydraulic fracturing sands along a 21-mile route from depot to well site.[201] Driverless delivery operations are expanding into the air, with major retailers and e-commerce companies like Amazon and Walmart investing in drone deliveries. Some are developing in-house programs while others are partnering with startups to scale deployment. The growing focus on advanced air mobility (AAM) extends beyond retail, as companies like Supernal test electric vertical take-off and landing (eVTOL) aircraft for future air taxi services.[202]

## The Power of Scale

Unlocking the full potential of connected, automated, electric, and shared mobility requires modern infrastructure that supports rapid technological adoption at scale. While expanding EV charging networks is critical to adoption, policymakers and industry leaders must strategically coordinate investments to ensure availability aligns with vehicle deployment. While local initiatives can deliver immediate benefits, scaling next-generation mobility solutions require a broader, cohesive strategy. Investments in C-V2X communication systems, multimodal mobility hubs, and interoperable data networks will be needed to improve overall system efficiency and connectivity.

Electrification is already lowering costs for households and businesses, while connected and automated vehicle technologies have the potential to optimize traffic management, reduce congestion, and improve road safety through AI-powered logistics

However, as nations across Europe and Asia aggressively modernize their transportation systems, the absence of a coordinated national strategy in the United States risks slowing the adoption of these mobility advancements. To maintain leadership, the United States must develop a comprehensive national policy framework of innovation and deployment that fosters advanced transportation technologies while ensuring safety and reliability. The challenge is not just about advancing technology—but aligning regulations, infrastructure, and investment strategies to create an interoperable, scalable, and resilient transportation system.

Addressing regulatory barriers is critical. Governments, state departments of transportation, and planning agencies must modernize Intelligent Transportation Systems (ITS) to incorporate AI-powered decision-making tools for real-time traffic management, better route planning for fleets, and predictive analytics to improve road safety and reduce crashes, while regulators need to update vehicle design and safety standards to accommodate electric, autonomous, and connected vehicles. However, a holistic, innovation-driven transportation ecosystem will only

[200] Graham Hope, "Waymo Self-Driving Taxis Hit the Road in Japan," *IOT World Today,* April 15, 2025.
[201] "Kodiak Delivers Customer-Owned Autonomous RoboTrucks to Atlas Energy Solutions, Completes 100 Loads of Proppant with First-Ever Driverless Commercial Semi-Truck Service," *Businesswire,* January 24, 2025.
[202] Elan Head, "Supernal prepares eVTOL technology demonstrator for first flight in Mojave," *The Air Current,* February 12, 2025.

materialize if industry and government work together to accelerate digital infrastructure deployment, modernize regulatory frameworks, and remove policy bottlenecks that could slow the next era of transportation.

## Recommendations

To maintain U.S. leadership in transportation innovation, the federal government must take decisive action to modernize regulations, strengthen supply chains, and accelerate the deployment of new technologies. Scaling new technologies requires a coordinated national strategy fostering regulatory consistency, physical and digital infrastructure investment, and supply chain resilience. Without clear policies, the United States risks falling behind as other nations advance in next-generation transportation solutions.

The following recommendations outline key steps to enhance transportation efficiency, strengthen domestic manufacturing, and remove policy barriers that could hinder progress.

**The U.S. Department of Transportation should preempt state regulation of AVs.** A uniform federal regulatory framework is essential to ensure safety, innovation, and regulatory efficiency as AV technology advances. As it exists today, a patchwork of state-by-state regulations creates uncertainty for manufacturers, developers, and consumers, making it difficult to deploy AVs at scale. Without federal preemption, states could impose conflicting safety, testing, and operational requirements, forcing manufacturers to navigate inconsistent standards that hinder nationwide adoption. Establishing a federal standard will enable seamless operation, reduce regulatory bottlenecks, and accelerate AV deployment. Congress should pass legislation affirming the National Highway Traffic Safety Administration's (NHTSA) authority over AV safety standards while ensuring that this does not preclude the Department of Commerce or other federal agencies from regulating the national security aspects of AV technology.

**EPA and NHTSA should reform greenhouse gas emission and Corporate Average Fuel Economy standards.** The Environmental Protection Agency (EPA) and NHTSA should identify policy options to recalibrate or replace existing fuel economy and greenhouse gas emission regulations. Instead of focusing solely on vehicle-specific standards, policymakers should adopt a system-wide approach that evaluates the broader transportation system, including infrastructure, fuel availability, and efficiency gains across various modes of transport. In addition, a revenue-neutral gasoline tax may provide a more economically efficient and market-driven alternative to the current regulatory structure. Such a system would replace complex compliance mechanisms with a transparent fuel pricing model, allowing consumers to choose vehicles based on clear market signals. By aligning incentives with market behavior, this approach could simplify regulations, expand consumer choice, and enhance economic efficiencies.

**The Department of Commerce should confirm and expand efforts to protect connected vehicles from foreign interference.** The Department of Commerce recently finalized its *Securing the Information and Communications Technology and Services Supply Chain: Connected Vehicles* rule to protect U.S. drivers and critical infrastructure from potential foreign exploitation and manipulation. While the rule establishes restrictions on the sale and import of connected vehicles and components linked to U.S. adversaries, it offers further clarification on what constitutes a "foreign adversary," how it defines a "connected vehicle," and the safeguards that protect vehicle-generated data as it is transmitted, stored, and processed beyond the vehicle. By addressing these issues it reduces the opportunity for adversaries to exploit these technologies to compromise vehicle operations or data security as connected vehicle adoption expands. Congress should pass legislation that provides more explicit statutory authority for the rule, strengthening protections against national security risks and ensuring more durable protection against Chinese connected vehicles and components. Over time, if Congress determines that the rule cannot effectively protect U.S. drivers and infrastructure from foreign exploitation and manipulation, it should ban the import of vehicles from foreign adversaries.

**The Federal Transit Administration (FTA) should expand Low- or Zero-Emission Vehicle Grant Program for American-manufactured vehicles.** The United States is home to a burgeoning electric bus industry that is beginning to strengthen the nation's supply chain for energy storage

A patchwork of state-by-state regulations creates uncertainty for manufacturers, developers, and consumers, making it difficult to deploy AVs at scale

technology. Government policies have spurred the growth of this vital industry, supporting American jobs at advanced manufacturing facilities operated by companies like Proterra, Navistar, and Blue Bird. The iconic yellow school buses carry 25 million American children to school every day, and a concentrated national effort to replace America's 480,000 school buses with electric versions would rapidly contribute to accelerating the development of the battery supply chain in the United States, as buses' batteries are significantly larger than those used for light-duty vehicles. Increased federal support through the FTA's Low-No program will not only improve school transportation and reduce operating costs but also create large-scale demand while the market for light-duty vehicles continues to mature.

**Congress should establish a tax credit for finished manufactured goods that incorporate batteries with a capacity greater than 20 kilowatt-hours.** As President Trump has recognized, critical minerals are essential to the digital economy because they power the technologies that drive communication, automation, and data processing. Minerals like lithium, cobalt, and rare earth elements are key components in batteries, smartphones, computers, advanced energy systems, and a wide range of military equipment. As industries transition towards an electric and digital economy, demand for these minerals are expected to rise sharply. To remain economically, energy, and militarily secure, it is critical that the United States develop secure supply chains for these minerals. Companies are ready and willing to invest in production and processing of these minerals. Those companies, however, need customers who are willing to sign off-take agreements to ensure that their investments are economically viable. This credit can play a critical role in the manufacture of critical minerals by creating the demand without which it will be difficult to develop a domestic critical mineral supply chain. To ensure this investment strengthens U.S. national and economic security, the Department of the Treasury should also implement stringent restrictions excluding companies controlled by prohibited foreign entities, including "foreign entities of concern," Chinese military companies, and those flagged under statutes like the Uyghur Forced Labor Prevention Act, from eligibility for the credit.

Additive manufacturing is a critical enabler of advanced manufacturing and national security, allowing for rapid prototyping and the manufacture of different products more easily in a single manufacturing facility, thereby enabling more rapid precision production of mission-critical components.

**State and local governments should safeguard open-access requirements for publicly funded vertiports by implementing FAA guidance and aligning local AAM initiatives with statewide planning efforts.** Publicly financed vertiport facilities must prioritize open access and serve the public interest, ensuring fair competition and preventing dominance by a single operator. By collaborating with the FAA to maintain consistency and transparency, governments can create an equitable framework that promotes innovation and broad industry participation. Public-private partnerships offer a proven approach. Combining public ownership with regulated private operations ensures a balance between flexibility and oversight, allowing these facilities to remain open and competitive. State and local governments should require contracts that keep vertiports open to all operators, while promoting private investment, fair competition, and a well-connected network that supports the AAM industry.

**Congress should authorize funding for Digital Infrastructure Investments and Programs.** As part of the 2026 surface transportation reauthorization bill, Congress should define digital infrastructure within transportation programs, appropriately considering it alongside traditional physical infrastructure and explicitly including the concept in transportation planning and law. Further it should encourage States, Metropolitan Planning Organizations, and local governments to consider digital infrastructure strategies and uses in their transportation plans. Further, Congress should expand eligibility under key transportation formula programs to include greater use of digital infrastructure technologies so that states and localities have even more opportunities and flexibility with the use of federal funds. Any reauthorized discretionary grant programs should include digital infrastructure technologies as eligible components of the program activities.

# Pillar 4 Increase Manufacturing Capacity

In an era of escalating global competition and geopolitical uncertainty, the imperative to rebuild manufacturing capacity in the United States has never been more critical. Manufacturing is not just the backbone of a nation's economic strength but also a vital pillar supporting its national security. The United States must reinvigorate its manufacturing sector to maintain its strategic advantage in energy, transportation, and defense applications, to ensure resilience against supply chain vulnerabilities, foster innovation, create good jobs, and bolster economic growth.

The automobile manufacturing sector is foundational to the U.S. economy. For decades, jobs created across auto manufacturing supply chains provided a key foundation for middle-class growth and prosperity.[203] As the largest manufacturing industry in the country, it supports millions of direct and indirect jobs, from assembly line workers to engineers, suppliers, and dealership employees. The depth and complexity of its supply chain are reflected in its high job multiplier effect, which supports other industries, including steel, aluminum, electronics, and energy, amplifying its economic impact.[204] The sector also drives technological innovation, with research and development investments in vehicles, automation, and safety innovations driving advancements that benefit the entire economy. Finally, it has a trained workforce for manufacturing centered on

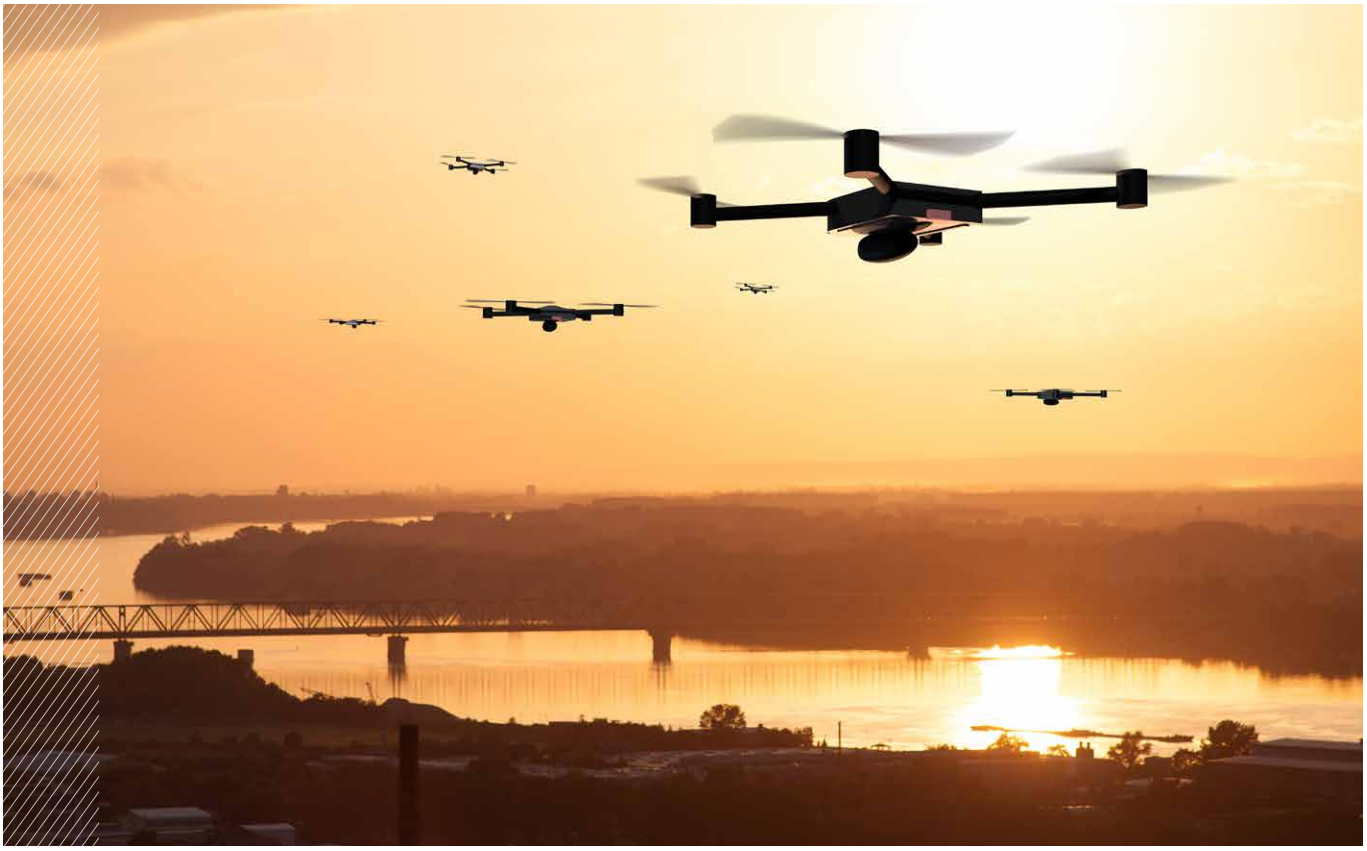
[203] Jim Barrett and Josh Bivens, "The stakes for workers in how policymakers manage the coming shift to all-electric vehicles," Economic Policy Institute, September 22, 2021.
[204] Josh Bivens, "Updated employment multipliers for the U.S. economy," Economic Policy Institute, January 23, 2019.

key skills like tooling. Continued presence of a strong auto manufacturing base is an indicator of industrial strength. It is critical to ensuring that the United States remains a leader in next-generation mobility, securing economic and national security advantages for the nation.

Just as the auto manufacturing sector is undergoing a critical transition, so is the electric power sector. As the nation seeks to upgrade its electric power sector to meet the ever-growing demands of a digital economy (including the explosive growth in power demand to support AI) and develop advanced nuclear technologies, a strong domestic supply chain is essential to meet growing energy demand. Strengthening the domestic production of key components, including generators, batteries, transformers, transmission lines, and nuclear components, requires sophisticated manufacturing processes that are currently dominated by foreign competitors, particularly in Asia. By rebuilding its manufacturing capacity, the United States can reduce its reliance on imported capital equipment, lower energy costs, and create high-paying jobs in the energy sector.

A supply-driven strategy would focus on building long-term manufacturing and logistical capacity to ensure shortages never constrain U.S. forces and allies.

A robust domestic manufacturing base is also indispensable for national defense. The modern battlefield relies on advanced weaponry, aerospace systems, and cybersecurity infrastructure that demand precision manufacturing capabilities. DoD should adopt a more focused supply-driven strategy that emphasizes scaling industrial capacity to ensure the United States could simultaneously fight and win two major regional conflicts. Two-War



Doctrine shaped U.S. defense policy and influenced military force structure, budget allocation, and global strategic planning for the last 50 years. The changing nature of global threats and the increasing complexity of modern warfare, however, suggest that today's geopolitical landscape demands a more resilient, flexible, and supply-driven approach to defense strategy.

Today, the United States faces strategic challenges from China in the Indo-Pacific, Russia in Eastern Europe, regional conflicts in the Middle East, and unpredictable threats from rogue states or terrorist groups. The Two-War Doctrine is no longer sufficient when threats could emerge simultaneously across multiple theaters. Moreover, as we have seen in Ukraine and Gaza, modern warfare is not just about troops and firepower but depends on sustained industrial production and supply chain security. Today's wars require semiconductors, advanced materials, rare earth elements, unmanned systems, and even resilient power grids. The U.S. defense industrial base is currently not scaled to handle more than one major war at a time, let alone two or more. A supply-driven strategy would focus on building long-term manufacturing and logistical capacity to ensure shortages never constrain U.S. forces and allies.

The United States must prepare for attacks beyond conventional warfare, including cyber-attacks, space-based conflicts, economic coercion, and supply chain disruptions. A supply-driven strategy acknowledges that conflicts today will not be limited to traditional battlefields. China and Russia have already conducted cyberattacks on critical infrastructure, so the U.S. military must be prepared to sustain operations even amid severe disruptions to power grids, communication networks, and financial systems. Stated simply, the United States requires long-term thinking and large-scale production capacity for military equipment, munitions, energy, and technology to prevent adversaries from gaining an advantage.

Over the past several decades, the offshoring of critical manufacturing processes has left the United States vulnerable to supply chain disruptions in China and other unreliable suppliers exercising leverage and a range of geopolitical tensions. The COVID-19 pandemic underscored the fragility of these supply chains, highlighting the need for secure domestic production capabilities for essential materials. To maintain technological superiority, the United States must ensure a steady supply of domestically produced defense components. By investing in domestic manufacturing infrastructure, the United States can safeguard critical defense technologies, enhance readiness, respond rapidly to emerging threats, and meet our obligations to our allies and partners, thereby maintaining rapid response capability and deterrence.

A resurgence in U.S. manufacturing would have far-reaching economic benefits. It would revitalize industrial regions, create skilled employment opportunities, and stimulate local economies. Moreover, manufacturing fosters innovation, which so often happens on the factory floor, by bringing together engineers, designers, and production experts, driving advancements in automation, AI, and materials science. In defense and energy applications, innovation is critical to maintaining a competitive edge. A thriving domestic manufacturing ecosystem encourages collaboration between private industry, government agencies, and academic institutions, leading to breakthroughs that enhance both national security and energy efficiency.

## Recommendations

To maintain U.S. industrial leadership and economic resilience and take steps toward establishing a more supply-driven strategy, the federal government must take the necessary steps to restore domestic manufacturing capacity, secure critical supply chains, and support industrial innovation. By leveraging strategic investments and public-private partnerships, the United States can revitalize its industrial base, enhance supply chain security, and sustain global competitiveness.

The following recommendations, while not comprehensive in nature, outline key first steps to rebuild manufacturing strength and protect national security in an increasingly competitive geopolitical environment:

**Congress should reprioritize existing loan guarantee programs to support advanced energy, manufacturing, and dual-use manufacturing capacity.** Federal government assistance for advanced manufacturing facilities is crucial for fostering economic growth, technological innovation,

By leveraging strategic investments and public-private partnerships, the United States can revitalize its industrial base, enhance supply chain security, and sustain global competitiveness.

and national security. Advanced manufacturing involves significant upfront costs, long development cycles, and substantial risks, which can deter private investment. Strategic government support can help mitigate these risks, ensuring domestic production of critical technologies such as semiconductors, energy components, and aerospace systems—sectors vital to economic growth, technological leadership, and national security. Congress should reprioritize existing and available loan programs within the Departments of Commerce and Defense to support advanced manufacturing and dual-use production.

**Congress should expand and reauthorize Section 48(c) tax credits to support advanced energy manufacturing.** Section 48(c) gives the Department of the Treasury the authority to allocate tax credits supporting the manufacture of new geothermal and biogas generation, microgrid infrastructure, and energy storage, and the credit was preserved in the July 2025 reconciliation bill. To further strengthen domestic energy security and reliability, Congress should expand the scope of eligible technologies to include nuclear generation and fusion, both sources of stable, baseload power, providing a new appropriation to fund this broader mission. Expanding eligibility and replenishing funding could catalyze investment in next-generation nuclear technologies, enhance grid resilience, and diversify the U.S. energy mix. Section 48(c) also incentivizes energy manufacturing within the United States strengthening domestic supply chains and creating high-quality, good-paying jobs for both new and incumbent workers. The program also promotes the processing, refining, and recycling of critical materials.

**DoD should update procurement programs for stability over time to promote the maintenance of manufacturing capacity.** Procurement patterns can significantly affect the health of the defense sector's manufacturing capacity. Weapons and other DoD purchases are often made in bulk and in cycles. Doing so can reduce costs, but weakens supply chains, as contractors and subcontractors cannot afford to maintain idle supply chains and workforces while waiting for the next order from the Pentagon. DoD should consider the effect that its purchasing patterns have on its supply chains. When negotiating a price for a weapon or a system, DoD needs to be willing to pay not only for the weapon but also for the contractor and its supply chain to operate in a manner that ensures security over the period for which the Pentagon might rely on the weapon or system.

**Congress should allow full expensing of additive manufacturing capital equipment, and the Department of Defense should prioritize the development of munitions that can be manufactured with additive manufacturing.** Additive manufacturing is a critical enabler of advanced manufacturing and national security, allowing for rapid prototyping and the manufacture of different products more easily in a single manufacturing facility, thereby enabling more rapid precision production of mission-critical components. Its ability to support on-demand production and customization enhances the defense and energy sectors' flexibility, agility, and resilience, reducing reliance on foreign suppliers and mitigating supply chain disruptions. To accelerate the adoption of this technology, Congress should allow for the full expensing of additive manufacturing capital equipment, enabling manufacturers to deduct the full investment cost in the year of purchase. This policy would encourage private sector investment, reduce barriers to deployment, and increase domestic production capacity in industries vital to the nation's economic and national security. Robotics can also play a transformative role in advanced manufacturing by enhancing the efficiency, precision, and flexibility of production processes. Robots can perform repetitive, high-volume tasks with speed and accuracy, reducing production time and labor costs, undertaking hazardous tasks, improving workplace safety, and reducing reliance on human labor. Congress should allow for the full expensing of robotic equipment used in advanced manufacturing facilities. Moreover, DoD should prioritize developing munitions using flexible additive manufacturing processes, which could significantly accelerate production, ensuring a steady supply of consumables during conflicts, and reducing the need to restart idle assembly lines or reassemble deconstructed ones.

**DoD should map military supply chains to identify critical material requirements and require new procurement contracts to include an obligation for suppliers to map materials and components used to manufacture purchased items or equipment.** Critical minerals and strategic

Robotics can play a transformative role in advanced manufacturing by enhancing the efficiency, precision, and flexibility of production processes

materials are essential for manufacturing advanced weaponry and other rapidly consumable materials needed in wartime. Mapping military supply chains can help pinpoint vulnerabilities, reduce dependence on foreign sources, and ensure stable supply during geopolitical crises. However, DoD and its key suppliers often lack visibility in the minerals and materials required to sustain its warfighting operations. To the extent that DoD or its contractors have gained insight into their supply chains, it has come from a top-down analysis that remains incomplete. DoD should close this gap, by working with its contractors to conduct a comprehensive assessment, identifying the materials and components most rapidly consumed during a conflict, determining their replenishment feasibility, and mapping their supply chains and critical material requirements. Moreover, in future procurement contracts, DoD should require their prime contractors to map their entire supply chains—using blockchain or other technologies as appropriate—to ensure a full understanding of the materials and suppliers that are required to manufacture the critical equipment and supplies on which the military relies.[205] This exercise should then be used to develop a strategy that ensures adequate stockpiles, secure sourcing, and sufficient domestic manufacturing capacity to maintain readiness during a prolonged conflict.

**DoD should explore opportunities to design weapons for the U.S. military that can be easily downgraded for export eligibility.** Weapons manufacturers often make different versions of weapons or platforms, with a more capable version manufactured for use by U.S. forces, and a less capable version available for export, thus maintaining a technological edge. However, if the United States seeks to supply an ally in a conflict, it is unable to draw from U.S. military stocks—despite their ability to be replenished—forcing it to rely on allies around the world who have export-eligible weapons in their own inventories. DoD should seek opportunities to design weapons and systems for U.S. forces that might be easily downgraded, perhaps removing or replacing key components, so that in the event of a crisis, we have more flexibility to resupply our allies quickly.

**DoD should stockpile critical weapons components and enter into standby manufacturing contracts with advanced manufacturers.** To enhance national defense preparedness,

If the United States seeks to supply an ally in a conflict, it is unable to draw from U.S. military stocks—despite their ability to be replenished—forcing it to rely on allies around the world who have export-eligible weapons in their own inventories.

DoD should proactively identify and stockpile long lead-time components of advanced weapons systems—especially specialized electronic components like guidance chips, RF modules, and secure communication units. These components often take months or years to manufacture due to their complexity and limited suppliers. A coordinated effort by the DoD, defense contractors, and technology partners could map supply chains to flag critical bottlenecks, such as single-source suppliers or overseas dependencies. Once identified, the government could stockpile these electronics in secure facilities, ensuring they are periodically tested and rotated to maintain functionality and relevance. DoD could then enter into standby contracts with major manufacturers, such as automakers and aerospace firms, whose advanced, automated assembly lines could be quickly repurposed to produce missile bodies or other weapon platforms during a conflict. These contracts would include pre-negotiated terms, technical transition plans, and periodic readiness assessments. During peacetime, manufacturers would continue regular operations, but in a crisis, they would shift to defense production using government-provided electronics and pre-approved designs. This dual-track approach—stockpiling high-tech components and tapping civilian manufacturing capacity—would enable the United States to surge weapons production rapidly without waiting for new components or building new factories. It also fosters industrial resilience and civilian-military collaboration, turning economic power into strategic readiness, modeling the World War II-era Arsenal of Democracy, modernized for the digital age, ensuring that the United States and our allies can meet the demands of high-intensity conflict with speed and scale.

[205] Note: Idea sourced from discussion with Dr. Christine Michienzi; and Dr. Christine Michienzi, "Finding Adversaries Hiding in the Defense Department's Supply Chains," *War on the Rocks,* March 12, 2025.

# Recommendations Summary

## Pillar 1 Expand and Secure Supply of Minerals and Materials

The U.S. government should develop a standards-driven tariff fortress around low-standard critical minerals.

The U.S. government should implement permitting reform, and Congress should propose new mining legislation to accelerate responsible domestic mineral production and processing capacity.

Strengthen critical mineral supply chains by partnering with allied nations to develop new mining and processing capacity.

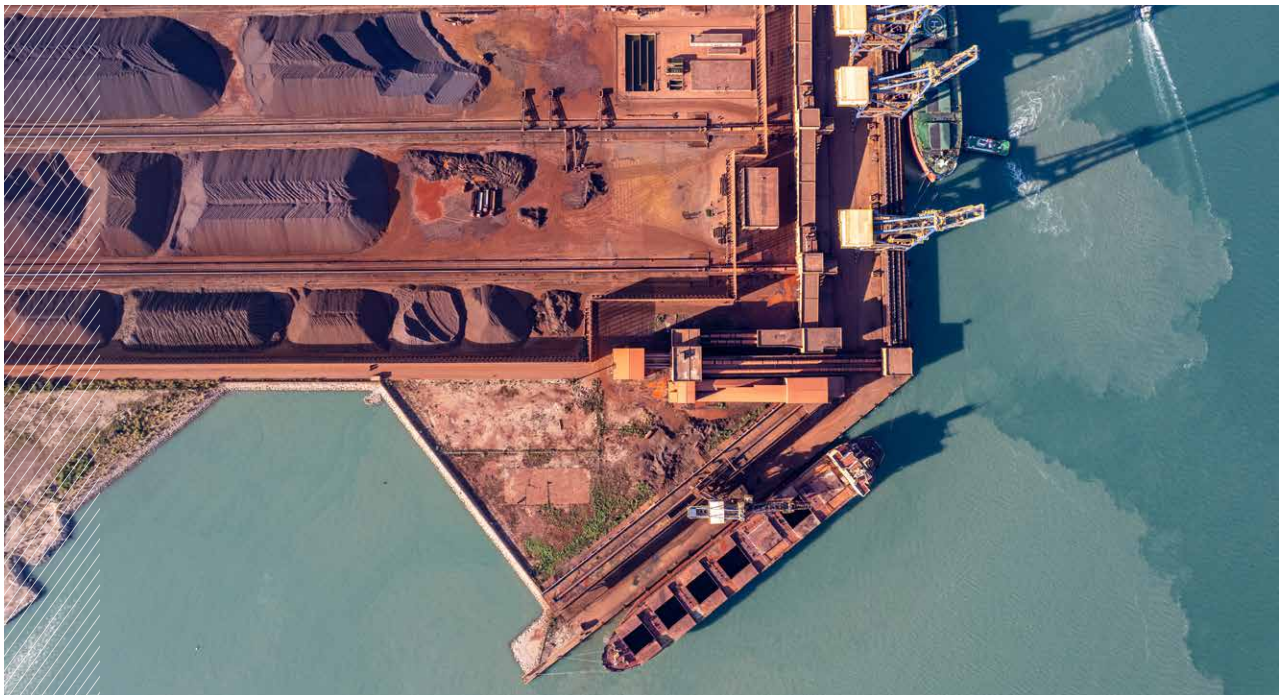
Congress should extend and expand the U.S. Geological Survey (USGS) Earth Mapping Resource Initiative (EarthMRI).

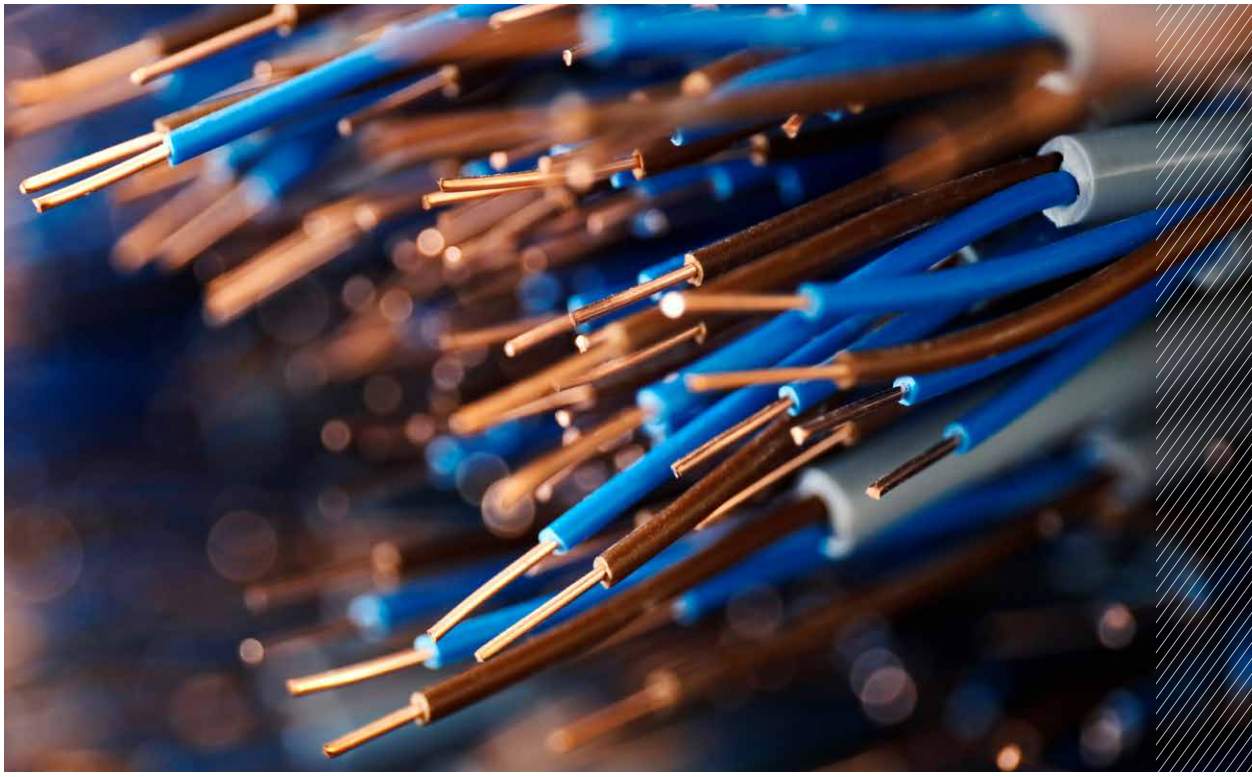
DOE and DoD should support expanded U.S. critical mineral processing capacity through public-private partnerships.

The DoD should purchase aluminum and other critical materials or equipment from domestic sources when available and where doing so would strengthen critical supply chains.

Congress should expand support for research to improve mineral processing by establishing a research consortium and cost-sharing initiative between National Labs and industry partners.

The United States should out-compete China to be the first nation in the world to commercialize deep-seabed minerals.





## Pillar 2 Satisfy Energy Security Needs

The nation should adopt a truly comprehensive energy strategy and end the war on specific energy sources.

The federal government should accelerate transmission and pipeline approvals.

DOE should accelerate approvals of LNG export facilities.

DOI should expand drilling on public lands and offshore.

Congress should direct DOE to refill the Strategic Petroleum Reserve.

DOE should fund next-generation nuclear deployment grants.

DoD should purchase small modular reactors.

## Pillar 3 Promote New Technologies that Maximize Efficiency and Diversification

The U.S. Department of Transportation should preempt state regulation of autonomous vehicles.

EPA and NHTSA should reform greenhouse gas emission and Corporate Average Fuel Economy standards.

The Department of Commerce should confirm and expand efforts to protect connected vehicles from foreign interference.

The Federal Transit Administration (FTA) should expand Low- or Zero-Emission Vehicle Grant Program for American-manufactured vehicles.

Congress should update electric vehicle and critical mineral manufacturing tax credit eligibilities.

State and local governments should safeguard open-access requirements for publicly funded vertiports by implementing FAA guidance and aligning local advanced air mobility initiatives with statewide planning efforts.

Congress should authorize funding for Digital Infrastructure Investments and Programs.

# Pillar 4 Increase Manufacturing Capacity

Congress should reprioritize existing loan guarantee programs to support advanced energy, manufacturing, and dual-use manufacturing capacity.

Congress should expand and reauthorize Section 48(c) tax credits to support advanced energy manufacturing.

DoD should update procurement programs for stability over time to promote the maintenance of manufacturing capacity.

Congress should allow full expensing of additive manufacturing capital equipment, and the Department of Defense should prioritize the development of munitions that can be manufactured with additive manufacturing.

DoD should map military supply chains to identify critical material requirements and require new procurement contracts to include an obligation for suppliers to map materials and components used to manufacture purchased items or equipment.

DoD should explore opportunities to design weapons for the U.S. military that can be easily downgraded for export eligibility.

DoD should stockpile critical weapons components and enter into standby manufacturing contracts with advanced manufacturers.

SAFE

1111 19TH STREET, NW #406 WASHINGTON, DC 20036 · 202.461.2360 · **SECUREENERGY.ORG**