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Minerals, Manufacturing, and Markets: Foreign Policy for U.S. Energy Technology and Minerals

Milo McBride and Daniel Helmeci

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The following paper is in support of the Carnegie Endowment for International Peace's U.S. Foreign Policy for Clean Energy Taskforce, a nonpartisan working group seeking to bolster U.S. clean industrial goals with cooperative decarbonization abroad.

Carnegie Endowment for International Peace
Publications Department
1779 Massachusetts Avenue NW
Washington, DC 20036
P: + 1 202 483 7600
F: + 1 202 483 1840
CarnegieEndowment.org

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Introduction

Revolutionary shifts are underway in energy and mineral geopolitics. Renewables are now the cheapest energy systems on most of the planet and the fastest growing sources of electricity in human history.[1] Cost improvements for battery storage are making renewables reliable and putting electric vehicles (EVs) at imminent-cost parity with gas cars.[2] Clean tech has become a central demand driver of critical minerals, which have dual use applications in the defense sector.[3] These technological transformations will influence the future of industrial power—and the United States is behind China in almost every sense.[4] Bipartisan goals of mineral autonomy and technological superiority can only be realized through collaboration with allies and partners given a lack of unilateral resources, know-how, and intellectual property.[5] Under the past two administrations, the United States accelerated a foreign policy to advance its interests in energy technology and related minerals—with mixed results.

Some formative new architectures were erected and strategic investments were finalized during these years, notably in the minerals and nuclear sectors. Yet in other moments, some diplomatic and financial capital was invested in low-return areas that were not crucial to developing U.S. energy technology and perhaps the result of low-hanging fruit or political expediency. All the while, potent and innovative government efforts have gone unnoticed by the public, like in wielding science diplomacy to help other nations solve technological challenges and market barriers. The following presents a detailed analysis of where and how such advances have been made, as well as lessons learned from their shortcomings. It takes stock of those decisions and offers input on how future U.S. policymakers, diplomats, and trade delegates can advance more pressing sectors and areas of cooperation.

Thus far, the United States has focused its diplomatic muscle primarily on a subset of key clean technology verticals—minerals, hydrogen, and nuclear—with a diversity of actors in both Western and nonaligned blocs. Alongside this relatively fragmented bilateral strategy, some key minilateral efforts have emerged like the Mineral Security Partnership (MSP) or sector-specific coordination like the Sapporo 5 partnership for nuclear supply chains.[6] Such frameworks are essential to building durable, multistakeholder buy-in and non-Chinese pipelines for technological buildout—but they remain nascent, and many are underfunded. Ultimately, these efforts have not resulted in a cohesive foreign industrial strategy or a united, all-of-government approach. Unlike traditional energy, technology and minerals are not legacy drivers of U.S. foreign policy—they are both unfamiliar and historically treated as a secondary issue.

Going forward, U.S. foreign policy for energy technology and minerals should build partnerships with countries that can abate supply chain vulnerability, yield exports for American technology, and mutually unlock next-generation systems through joint research and development (R&D) efforts. This will mean concentrating focus—across agencies—on specific opportunities and vulnerabilities based on genuine market size or the materiality of supply vulnerability, not political aspiration or ease. The diplomatic and financial efforts over the last eight years should not be abandoned. They set an important framework to build upon and outline valuable opportunities to improve. It is the new administration's role to refine the approach and accelerate meaningful international cooperation in areas of strategic importance and U.S. commercial advantage.

Lessons Learned from Traditional Energy

Today's U.S. energy dominance was no coincidence. America's present stature as the global hydrocarbon superpower is thanks to decades of concerted R&D at home and, over time, funding to stimulate demand abroad.[7] In some instances, such policies proved directly beneficial to U.S. production of unconventional energy resources, but in others success was less clear and, ultimately, not actualized. The historical example of developing a robust domestic base and leveraging those resources for geoeconomic gains can help inform how to develop prominence across new commodities and energy technologies.

For years, the United States has offered a foreign tax credit (FTC) that allows U.S. domiciled oil and gas producers to write off royalties paid when operating in foreign markets.[8] While this incentive today may not be as necessary given the revolutionary production of unconventional energy resources at home, it could be applied to minerals—an area of national vulnerability. U.S. mining companies operating abroad, many of which are small-scale, could use these mechanisms to balance financial and political risks that deter

foreign operations. Going forward, a minerals FTC could be explored by Congress and, if determined to be a sound strategy, applied to help incentivize these firms and relevant U.S. mining corporations to pursue strategic projects abroad, regardless of foreign royalty structures.

More recently, the State Department sought to export horizontal hydraulic fracturing (or "fracking") to Eastern Europe under the Global Shale Gas Initiative (GSGI).[9] The project failed due to political pushback from civil society and governments as well as a miscalculation of potential resources.[10] If the United States is to export its clean firm technologies like next-generation geothermal and nuclear power, there are lessons to be taken from the State Department's mishaps. First, shared findings from preliminary feasibility studies and rigorous resource identification are necessary before diplomats pursue ideas that have political but not yet scientific and social buy-in. Secondly, is to ensure that these operations have multistakeholder acceptance and will not trigger community backlash.

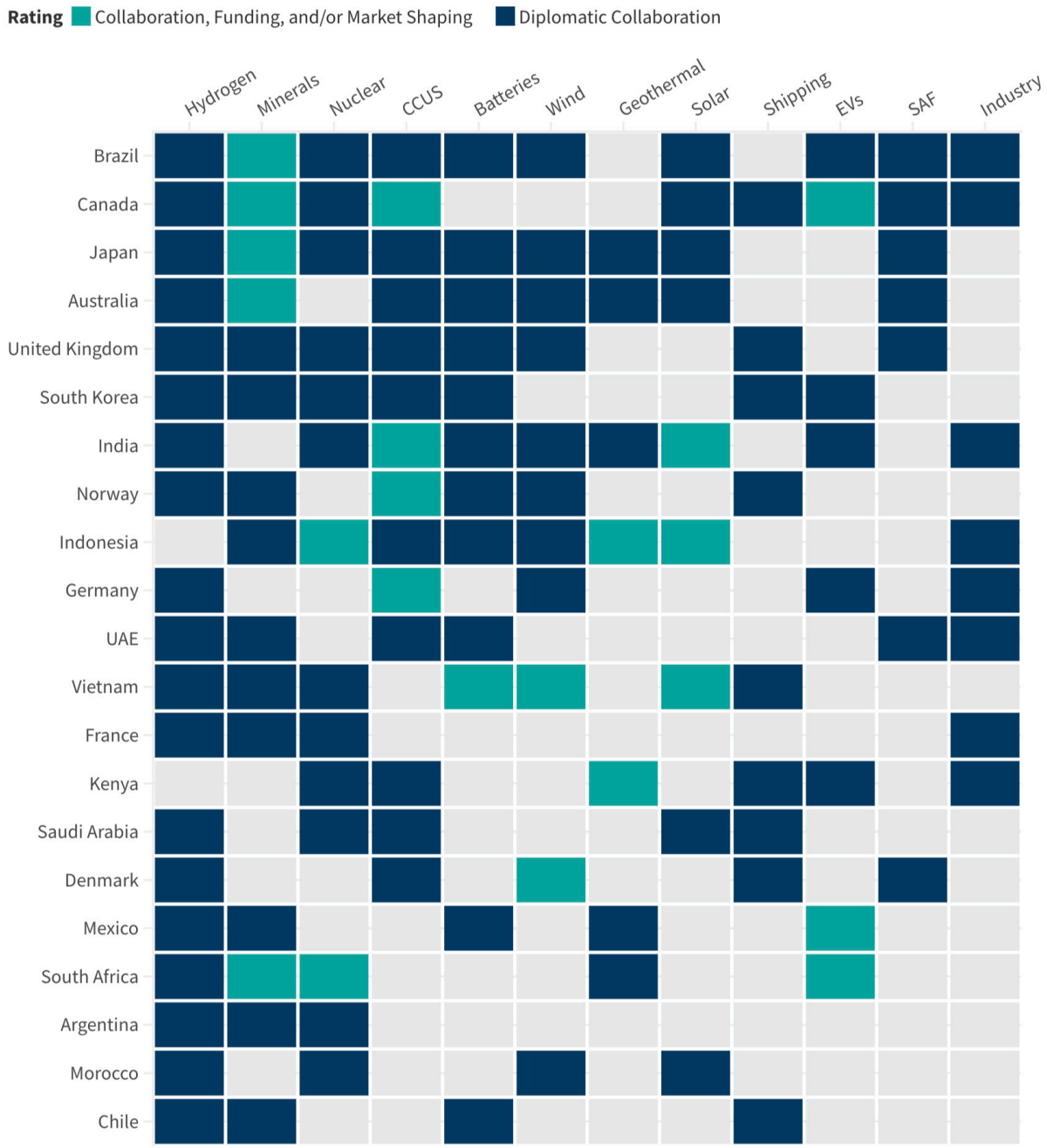
Conversely, U.S. foreign financing mechanisms have proven effective in efforts to develop liquefied natural gas (LNG) import terminals abroad that, in turn, create demand for U.S. gas production.[11] The U.S. Trade and Development Agency (USTDA) has provided pre-feasibility studies across Eastern Europe and Asia that help entice activity from American corporations and buy-in from respective governments.[12] From there, examples of project financing have come from the Export-Import Bank of the United States (EXIM) and the Overseas Private Investment Corporation (OPIC), the predecessor to the U.S. International Development Finance Corporation (DFC). Specifically, OPIC pledged financial support to LNG terminals from El Salvador to Poland, while EXIM has provided guarantees and loans to terminals and gas-fired power plants in Guyana, Bahrain, and the Bahamas—all in the past year.[13] Developing a multiagency approach for U.S. demand stimulation should be considered for American energy technologies with export potential.

Measuring U.S. Bilateral Engagement on Energy Technology

In recent years, this diplomatic muscle used for conventional energy has been applied to energy technology and minerals. To gauge and assess where U.S. foreign policy has been pursued, the following analysis tallies bilateral collaborations (dialogues, commitments, and memoranda of understanding, or MOUs) and market-shaping initiatives (trade deals, direct funding, loan guarantees, and so on) initiated in the past two administrations. This information has then been used to quantify where the United States has engaged in various energy technologies, their related supply chains, and to assess whether these engagements opened new markets. While these benchmarks alone cannot decipher the U.S. foreign policy process, they do offer an exclusive opportunity to reflect on what has been initiated thus far and what those efforts sought to accomplish.

Figure 1. Charting U.S. Clean Energy Foreign Policy

Diplomatic Efforts Across Twelve Clean Energy Supply Chains Span the World with Key Regional Anchors



Source: Compiled documents from the White House Briefing Room, U.S. Department of Energy, U.S. Department of State, U.S. Department of the Treasury, Office of the United States Trade Representative, U.S. Trade and Development Agency, U.S. Agency for International Development.

Notes: Sample size includes 40 of the world's largest economies relevant across clean energy supply chains. The table reflects data from surveyed partners with three or more collaboration agreements. To qualify for funding, partners must receive U.S. funds for manufacturing projects (for example, DFC's project finance for solar manufacturing facilities in India). Funding for solar, wind, or battery projects do not qualify without a corresponding manufacturing agreement. Geothermal and nuclear projects, however, qualify for "Collaboration and Funding" assuming the involvement of U.S. technology providers.

Countries with the most comprehensive clean energy pacts include Brazil, Canada, Japan, Australia, India, and the UK (see Figure 1). These agreements span nearly the entirety of this project's technology verticals as well as systems outside the scope of the analysis, as seen with R&D for nuclear fusion via both the UK and Japan. It is notable that Brazil and India—which are two key BRICs economies outside of most Western frameworks—are in the top five and privy to comprehensive frameworks that include industrial decarbonization. Many of the "usual suspects" of allied countries like France and Germany have about five to seven sectors covered in their MOUs, and, barring France's specific coordination goal for geologic hydrogen R&D, the agreements are broad and not inherently designed to unlock mutual strengths.[14] Nonaligned but important energy players like Kenya, Saudi Arabia, and the UAE all received similar pacts. Notable MOUs in the mineral sector were signed with commodity producers like Argentina, Chile, the Democratic Republic of the Congo, and Zambia.

Overall, many of these MOUs proved overly focused on broad technology verticals when the pressing area for collaboration was for specific parts of the supply chain or specific technology types. For example, there were multiple MOUs on solar or energy storage with countries like Australia or India, but no observed direction to address their core challenges of diversifying global production of inputs like crystalline silicon solar wafers or active cathode/anode material, let alone the relevant capital equipment or know-how needed to produce them. Similarly, several energy storage MOUs do not focus on long-duration storage, which is the only area where American battery storage in the grid sector has a chance at competing with China.[15] Such clarity could help ensure diplomatic efforts align with national interests. No foreign policies were observed to address these materials or products at the bilateral level. Of course, tone-setting at the leader level provides a sense of direction and value, but it must be followed by specificity to concentrate efforts.

MOUs alone do not develop markets. They are purely a signal of potential political ambition and not an indicator of transnational investment or industrial formation. In the next stage of analysis, bilateral market-shaping indicators were tallied regarding the relevant energy technology verticals (see Figure 2). These include foreign financing measures from the DFC, EXIM, and USTDA that range from feasibility funding to providing grants or debt for project finance.

The analysis also includes any trade measures that could stimulate markets. The prototypical example of which is the mineral-specific trade deal between the United States and Japan, to help grant Japanese nickel producers access to the U.S. EV subsidy known as 30D.[16] It should be noted that 30D—which mandates that a certain threshold of battery metals and materials are sourced from FTA-aligned countries—is a potent market shaping tool that could be expanded and subject to more diligent regulation. Going forward, policymakers could consider how to apply 30D's ethos to sectors beyond EV batteries to pull non-Chinese metals into the U.S. market: for example, similar subsidies for transmission lines that procure domestic and FTA-aligned copper and aluminum. Likewise, Mexico and Canada's inclusion of the U.S. EV subsidy—although building on preexisting trade architectures—signals a notable market shaping incentive across borders.[17]

Figure 2. Mapping U.S. Clean Energy Finance and Market Shaping Efforts

Includes Project Finance and Market Shaping Agreements

Country Name	Funding Type	Feasibility Study	Technical Assistance or R&D	Project Finance/ Insurance	Equity Investment	Market Access, Other
Indonesia	DFC financing for geothermal project and USTDA technical assistance for small modular reactor project		■	■		
India	DFC financing for two solar manufacturing facilities and USTDA feasibility study funding for carbon capture, utilization, and storage complex	■		■		
Ethiopia	USTDA feasibility study funding for geothermal project	■				
Kenya	DFC financing for a geothermal project and USTDA feasibility study funding for hydropower and geothermal projects	■		■		
Malawi	USTDA feasibility study funding for hydropower project	■				
Tanzania	DFC financing for nickel and other critical minerals mining project			■		
Brazil	DFC equity investment in two mining and processing facilities for cobalt and rare earth elements				■	
Germany	DOE R&D funding for advanced carbon sequestration and geologic storage		■			
Norway	DOE R&D funding for advanced carbon sequestration and geologic storage		■			
Vietnam	Proposed project financing for solar, wind, and battery supply chain development			■		
Türkiye	USTDA feasibility study funding for geothermal projects	■				
Denmark	DOE R&D funding for floating offshore wind technology		■			
Romania	DFC financing and USTDA feasibility study funding for small modular nuclear reactor	■	■	■		
Poland	DFC financing and USTDA feasibility study funding for conventional nuclear reactor	■		■		
Zambia	DFC technical assistance funding for green copper mine and USTDA feasibility study funding for hydropower and geothermal projects	■	■			
Sierra Leone	USTDA feasibility study funding for hydropower projects	■				
Guinea	DFC financing for bauxite mining and export facility			■		
Ivory Coast	USTDA feasibility study funding for hydropower project	■				

Country Name	Funding Type	Feasibility Study	Technical Assistance or R&D	Project Finance/ Insurance	Equity Investment	Market Access, Other
Angola	DFC financing for Lobito rail line and feasibility study funding for midstream rare earths processing	■				
Mozambique	DFC financing for graphite mining and processing expansion and technical assistance for carbon capture installation on a gas-fired power plant		■	■		
Rwanda	USTDA project assistance funding for hydropower project		■			
Uganda	DFC finance for hydropower project and feasibility study funding for flake graphite mine		■	■		
Honduras	DFC financing for geothermal project and USTDA feasibility study funding for geothermal project	■		■		
Gabon	DFC insurance for mineral export terminal			■		
Canada	DOE R&D funding for advanced carbon sequestration and geologic storage, 30D electric vehicle tax credit qualification, DPA funding qualification		■			■
Mexico	30D electric vehicle tax credit qualification					■
Panama	USTDA feasibility study funding for geothermal project	■				
Australia	DPA funding qualification and favorable Export-Import Bank single point of entry policies					■
Madagascar	DFC technical assistance funding for hydropower project		■			
Philippines	USTDA feasibility study funding for geothermal projects and mineral processing	■				
Japan	Critical Raw Materials Act tax incentives inclusion					■
South Africa	DFC equity investment in rare earths mining, processing, and separation hub for downstream use in permanent magnets and DFC letter of interest for nuclear reactor financing			■	■	

Source: Compiled documents from the White House Briefing Room, U.S. Department of Energy, U.S. Department of State, U.S. Department of the Treasury, Office of the United States Trade Representative, U.S. Trade and Development Agency, U.S. Agency for International Development.

Note: To qualify, a program must provide grants, loans, insurance, equity, or trade inclusions for clean energy manufacturing projects or geothermal, hydropower, or nuclear generation projects in partnership with U.S. firms.

The analysis only includes the production and manufacturing of energy technologies—not their procurement. For example, it omits foreign financing for solar, wind, or hydrogen projects because they procure equipment from third-party manufacturers. The analysis includes projects like the DFC's issuance of grants for Indian solar manufacturing, a notable area of clean tech supply chain financing abroad: $500 million was provided to construct an American thin-film solar factory and to develop solar cell and module production in India.[18] It is worth nothing that, although the latter promotes U.S. industry in a partner country, neither specifically helps the United States de-risk its silicon solar supply chain from China's control of upstream products like ingots and wafers.[19]

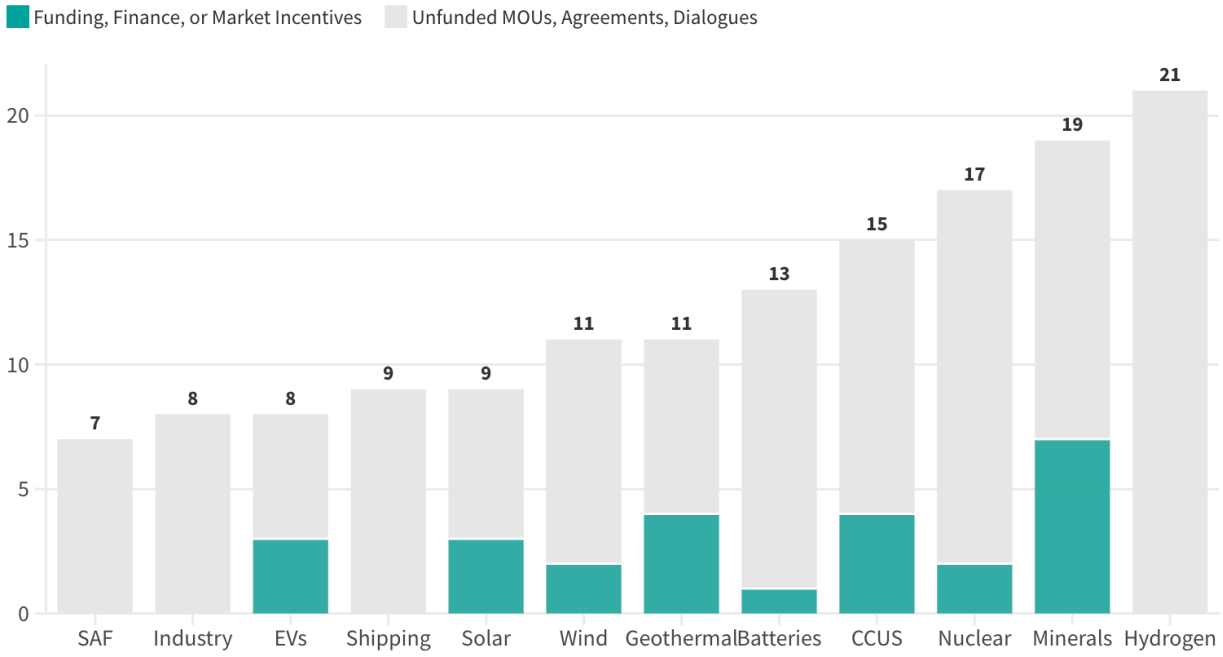
Nuclear, geothermal, and hydropower projects' finances are included in the analysis because the process of constructing these facilities is viewed as part of the supply chain (albeit, with the recognition that specialized equipment—such as organic rankine cycles or nuclear fuel rods—is needed, as well). DFC and EXIM have pledged funding for U.S. nuclear projects in Indonesia, Poland, Romania, and South Africa.[20] All the while, USTDA and DFC have backed geothermal projects in El Salvador, Honduras, Indonesia, Kenya, and the Philippines.[21] Both of these clean firm technologies—areas of unique bipartisan support—present opportunities where coordination can and should be continued, especially in scaling novel geothermal systems abroad that promote U.S. drilling interests.[22]

Mineral supply chains received the largest amount of financing and market-shaping engagement, underscoring the strategic importance of securing resilient supply of precursor elements. Funding has been deployed from DFC and EXIM for minerals of acute supply chain risk: rare earths, graphite, cobalt, and nickel. Some of these developments have coincided with strategic financing for domestic processing like a graphite project in Mozambique that received a government loan for its midstream facility in Louisiana.[23] The incentives also target stimulating non-Congolese and Indonesian sources of cobalt and nickel, like from copper tailings in Chile or a co-production in Brazil.[24] The Pentagon's Defense Production Act (DPA) has financed mineral production, namely for cobalt and graphite supply chains in Canada.[25] While the priority of DPA is to secure a defense industrial base, this mechanism also wields opportunities to de-risk dual use mining projects—especially in countries that are a part of the Five Eyes intelligence sharing alliance, like Australia which was recently included in the list of DPA eligible countries.[26]

When measuring bilateral MOUs by sectors, three verticals reign supreme: hydrogen, minerals, and nuclear (see Figure 3). From a security standpoint, focusing on minerals—a notable area of U.S. weakness—was a sound decision. Diplomatic mineral engagement should be maintained, if not accelerated, given the risks pervasive throughout energy, national security, and consumer technologies.[27] With limited reserves in some minerals at home, mineral diplomacy will be an essential facet of U.S. foreign policy in the twenty-first century.[28] But many of the observed mineral-related MOUs are not necessarily with commodity producers; some are designed to coordinate on supply de-risking with allies that face analogous risks. Going forward, the United States should be pragmatic and focus on forging stronger ties with resource-rich, emerging, and developing markets keen to incubate

Figure 3. U.S. Clean Energy Outreach

Bilateral Clean Energy Engagement in Select Countries since 2016



Source: Compiled documents from the White House Briefing Room, U.S. Department of Energy, U.S. Department of State, U.S. Department of the Treasury, Office of the United States Trade Representative, U.S. Trade and Development Agency, U.S. Agency for International Development

Note: Sample includes forty of the world's largest economies and relevant players in clean energy supply chains

value-added industry and diversify their FDI in the extractive sector. When engaging in minerals with other OECD countries, the United States should focus such efforts on joint R&D for advanced processing and metallurgy techniques, as it has done with Australia, and could expand Finland and Canada.

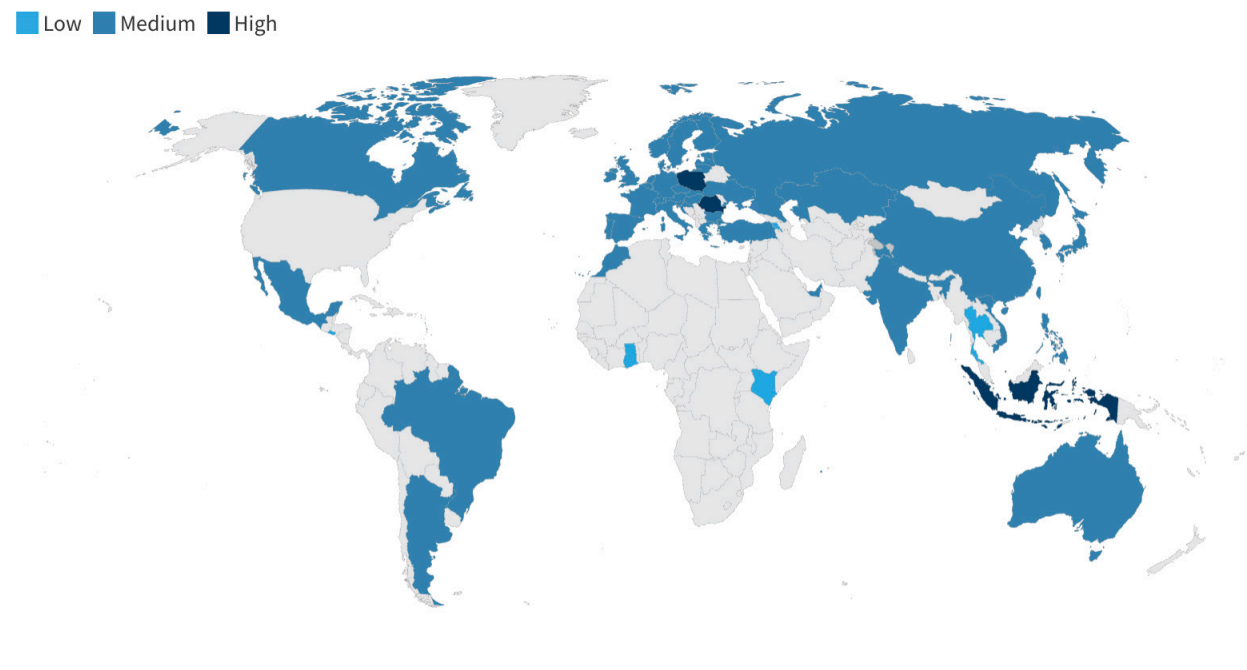
Conversely, the twenty-one hydrogen collaborations observed from the United States was not a strategic use of political capital. The analysis shows that despite winning on MOUs, hydrogen received zero market-shaping policies for its key challenges: supply chain choke points or advanced breakthroughs in producing cheap, clean hydrogen. And such criticism is not merely due to bearish sentiments plaguing clean hydrogen markets in 2025.[29] Opportunities for U.S. hydrogen exports—even for derivatives like ammonia and methanol—were likely to be modest and take years to materialize.[30] In most cases, hydrogen MOUs were likely designed to sway countries toward cleaner hydrogen demand, which did not trigger U.S. production nor solve national challenges in hydrogen technology, like production gaps in electrolyzers and correlated access to niche platinum and platinum group metals.[31] Hydrogen was likely an easy victory for the odd consortium of new guard climate diplomats and old guard energy security career service officials. Everyone could agree on cleaner molecules.

An area where diplomatic efforts could—eventually—yield exports is nuclear technology (see Figure 4). Nuclear power has unparalleled bipartisan support in the United States and is re-emerging as a key technology in great power competition, especially amid China and Russia's lead in these industries and supply chains.[32] However, the U.S. nuclear industry needs a jumpstart at home before expanding abroad. It is facing domestic challenges of a lagging labor force, supply chain gaps, and a stalled pipeline of new projects.[33] While domestic capabilities are rebuilt, U.S. foreign policy institutions could continue long-term outreach strategy to prepare the ground for future competition with Chinese and Russian reactor rollouts in emerging nuclear energy states.

Over thirty countries are developing nuclear power programs, but U.S. firms face export constraints in the absence of a mature industry and robust financing measures to match. To engage with new countries on joint nuclear development, bilateral Section 123 agreements help enforce nonproliferation and supply chain safety standards. While effective in managing proliferation, the stringent requirements of these agreements—such as prohibiting

Figure 4. Mapping U.S. Nuclear Engagement and Export Potential

U.S. Nuclear Engagement by Type of Cooperation



Source: Authors' analysis of U.S. Department of State, U.S. Department of Energy, U.S. Development Finance Corporation, U.S. Export-Import Bank documents and press releases.

Note: Low indicates a signed Nuclear Cooperation Memorandum of Understanding (NCMOU); Medium represents a Section 123 Agreement with or without an accompanying NCMOU or nuclear R&D MOU; High indicates U.S. project finance from DFC or EXIM, contingent on the status of a Section 123 Agreement. This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors. Dotted lines represent approximate disputed boundaries and contested territory and the gray areas represent contested territory between China, India, and Pakistan.

domestic uranium enrichment—can make U.S. offers less appealing than those from China or Russia, which come with fewer strings attached. To address this, the State Department introduced the more flexible Nuclear Cooperation MOU (NCMOU) framework, seeking gradual engagement and potentially laying the groundwork for future 123 agreements. While NCMOUs have targeted partnerships on next-generation small modular reactors and helped the Philippines transition to a full 123 agreement in 2024, their overall effectiveness remains unclear.[34]

Other notable areas for MOUs and market-shaping mechanisms include battery energy storage, geothermal, and heavy industry, including sustainable aviation fuels (SAF). While all of these sectors are viewed as potential opportunities of U.S. industrial strength, they have varying degrees of immediate importance. In recent years, the United States has begun elevating geothermal energy in diplomatic dialogues, notable in recent ministerial dialogues through the Partnership for Transatlantic Energy Cooperation.[35] Despite these discussions, Washington has likely missed an opportunity to promote its geothermal drilling interests abroad with a relatively low number of collaborations, especially given the technology's increasing global opportunity in next-generation systems.[36] Going forward, as novel U.S. energy storage systems come to market and innovative SAF technologies become sought after, U.S. foreign financing arms could advance exports and joint-ventures abroad. It should be noted that carbon capture, utilization, and storage (CCUS), which received the fourth-most MOUs of any vertical, is still relatively niche, ineffective, and uneconomic.[37] Technology diplomacy for carbon capture should adjust accordingly and focus on unlocking new, more effective techniques and developing secure, long-term means of storing carbon, potentially through existing frameworks like the Global Carbon Challenge.

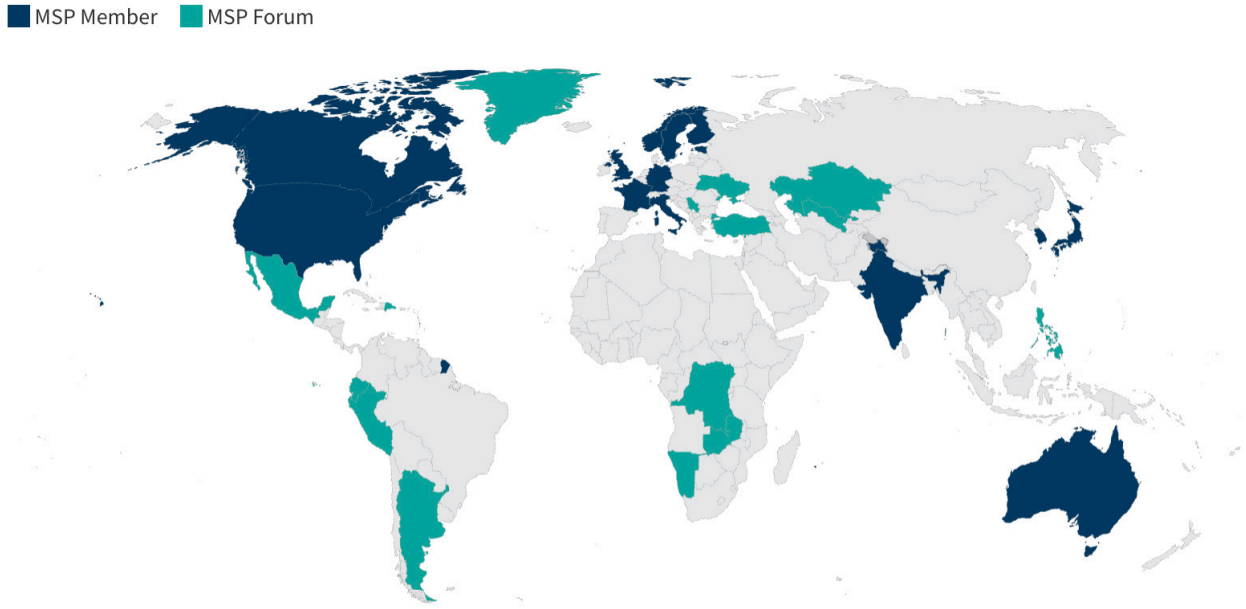
Multilateral Frameworks and Sector-Specific Initiatives

In addition to these bilateral engagements, the United States has pursued its energy technology and mineral agenda through mini- and multilateral architectures. These groupings have primarily sought to address minerals, nuclear, and industrial decarbonization—leaving opportunity for additional engagement with high-priority American industries like geothermal development and carbon removal R&D. While it remains difficult to gauge the impact of these arrangements, they are likely more effective than larger forums like the Clean Energy Ministerial and Mission Innovation, which, although helpful for agenda-setting, have proven unable to strengthen more targeted supply chain and industrial challenges due to large constituencies and weak enforcement mechanisms. This conclusion is not to dissuade the importance of larger-scale multilateralism, but to emphasize the more pragmatic potential of leveraging a smaller pool of actors with a higher gradient of shared interests and objectives.

Minerals, including their related infrastructure development and investment environment, have been a top priority thus far. Most notable is the State Department's MSP in collaboration with Australia, the EU (including individual members), India, Japan, Norway, South Korea, and the UK (see Figure 5). The consortium has worked to harmonize environmental and community standards, as well as de-risk investment in strategic mineral projects for the likes of rare earths, cobalt, nickel, and graphite, as well as recycling.[38] Although the MSP has been successful in developing a pipeline of new projects and creating a platform for non-Chinese mineral supply chains—beyond capacity building—is an ongoing challenge. In conjunction with the MSP, the United States has launched the Partner for Global Infrastructure Investment with G7 partners to counter China's Belt and Road Initiative.[39] This project has largely prioritized developing non-Chinese rail and port infrastructure for the Lobito Corridor, a high-opportunity commodity route between Angola, the Democratic Republic of the Congo, and Zambia.[40]

Figure 5. Mapping the Minerals Security Partnership

MSP Members Represent Demand Pull, While Forum Countries Offer Significant Reserves



Source: Mineral Security Partnership, U.S. Department of State, Accessed January 15, 2025, https://www.state.gov/minerals-security-partnership/; EU and U.S. Welcome New Members to the Minerals Security Partnership, European Commission, Accessed January 15, 2024, https://policy.trade.ec.europa.eu/news/eu-and-us-welcome-new-members-minerals-security-partnership-2024-09-27_en.

Note: This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors. Dotted lines represent approximate disputed boundaries and contested territory and the gray areas represent contested territory between China, India, and Pakistan.

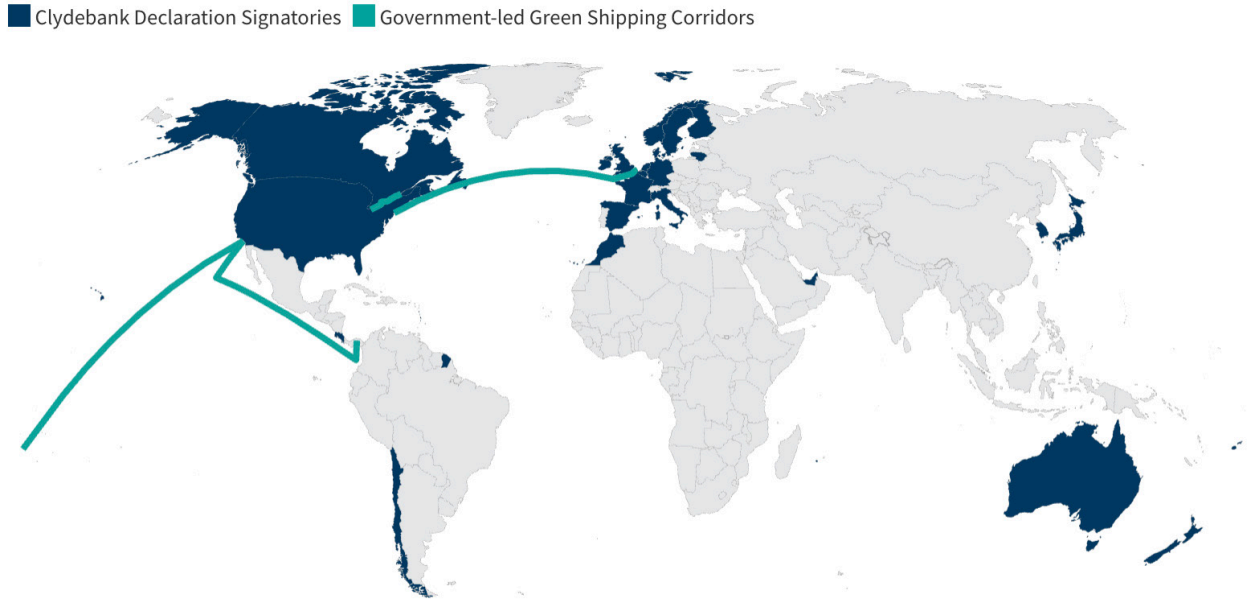
Other sector-specific, minilateral forums have been used for technology developments. For example, the Sapporo 5 initiative has been an important approach for non-Russian and non-Chinese nuclear development.[41] The group, consisting of Canada, France, Japan, the UK, and United States, sought over $4 billion in new, allied nuclear investment to help diversify supply chains. After making significant progress, most parties involved have experienced new and mutually beneficial developments ranging from increased enrichment capacity to facilities for new nuclear fuel production.[42] The United States should replicate this program with high-opportunity sectors, especially with geothermal, which, as mentioned, has so far received modest diplomatic engagement compared to its increasing domestic industrial potential.

Heavy industry—representing a significant challenge to climate goals—was the recipient of nonbinding private sector initiatives and a failed transatlantic clean trade agreement. The First Mover's Coalition acted as a platform to help match corporate offtakes for first-of-a-kind industrial products or technologies.[43] While private sector coordination is welcome, it should be accompanied by coherent government-to-government strategies focused on establishing aligned standards and paving the road for clean trade policy. The primary example of this was the Global Arrangement on Sustainable Steel and Aluminum, in which the United States and EU strove to carve a free trade deal that incorporated low-carbon standards for industrial goods. The deal failed, largely because of how politically difficult it is to pass a domestic price on carbon in the United States (let alone harmonizing one with Brussels).[44] Given Europe's commitment to green trade policies, the United States should not abandon these talks, but should continue to pursue such avenues, especially amid the national potential to efficiently produce novel, low-carbon goods.

U.S. diplomatic engagement on low-emissions industrial development could prioritize partnerships with other actors seeking to gain a foothold in hard-to-abate sectors. Gulf states, for example, are primed to ramp up significant primary steel capacity and also processing plays like in aluminum and copper production.[45] The United States should commit to coordinate with these newcomers before new, high-carbon capacity comes online and locks in emissions growth. With early intervention comes the potential to harmonize standards, laying a groundwork to negotiate subsequent market shaping initiatives including a reimagined and broader approach to the defunct Global Arrangement on Sustainable Steel and Aluminum. The United States can utilize existing industrial expertise through groups like the International Trade Administration's (ITA's) International Trade Advisory Committees (ITAC). ITACs 5 and 11—focusing on critical minerals and nonferrous metals and steel, respectively—offer forums to engage U.S. corporate leaders and labor representatives alike.[46]

Figure 6. Clydebank Declaration Signatories and Green Shipping Corridors

Green Shipping Corridors Operationalize Clydebank Commitments



Sources: COP26: Clydebank Declaration for Green Shipping Corridors, United Kingdom Department for Transport, December 6, 2023, https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors; Jonathan Whiting, "Green Shipping Corridor Route Tracker," Mission Innovtion, Accessed February 10, 2024, https://mission-innovation.net/missions/shipping/green-shipping-corridors/route-tracker/

Note: This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors. Dotted lines represent approximate disputed boundaries and contested territory.

Further participation in international green shipping corridors (see Figure 6) would benefit American infrastructure and expertise in legacy industrial applications—particularly storage terminals for ammonia, methanol, and liquid natural gas. Already, the United States has laid the groundwork for clean shipping routes, engaging relevant counterparts from key partners including Saudi Arabia, the UK, and Vietnam.[47] These public-private partnerships are enabled for low-emissions maritime shipping by rolling out bunkering infrastructure for alternative-fuel capable ships in ports along major sea lanes.[48] The United States is well positioned to support these infrastructure expansions, particularly in regions overlooked by existing green corridors like East Africa, Central America, and South Asia (especially notable given their importance as mineral suppliers). Targeted engagement with relevant port authorities and national governments to provide early-stage feasibility assessments and technical assistance will remain critical and could build on efforts from the Department of Transportation and ITA.

Some multilateral forums have remained largely untapped, and there is ample room for advancing new, sector-specific fora analogous to the Sapporo 5. Notably, the Quad—a group including Australia, India, Japan, and the United States—includes clean energy supply chains in its stated principles and has held discussions on these issues, but it has not yet offered any apparent market shaping decisions.[49] While seen as an ineffective platform, likely due to lack of alignment between stakeholders, these partnerships could be used to advance sectors like non-Chinese minerals extraction and processing, as well as solar photovoltaic manufacturing given the players involved. Similar architectures to the Sapporo 5 might be considered for other areas of American strength.

Science diplomacy for clean energy has been an unnoticed—and perhaps underappreciated—avenue in multilateral efforts.[50] Alongside existing bilateral initiatives and exchanges with research institutes, the U.S. Energy Department developed the Net-Zero World Initiative, which allowed the department's seventeen world-leading national labs (which study various facets of energy systems) to help emerging and developing markets wrangle their own technological and market barriers. The program included countries like Chile, Egypt, Indonesia, Nigeria, Singapore, and Ukraine and helped nations develop their own strategies and policies to advance new energy integration.[51] Ultimately, it set a new precedent for the scale of utilizing science diplomacy and sharing U.S. expertise, one that should be continued, especially in areas where U.S. technological strength is pronounced, like geothermal drilling, long-duration storage, or the implementation of virtual power plant software.

Figure 7. Other U.S. Multilateral Clean Energy or Industrial Partnerships

Sector-specific multilateral agreements expanded under the past two administrations

Source: Compiled documents from the White House Briefing Room, U.S. Department of Energy, U.S. Department of State, U.S. Department of the Treasury, Office of the United States Trade Representative, U.S. Trade and Development Agency, U.S. Agency for International Development.

Policy Recommendations

An ongoing observation of this analysis is that diplomatic engagement outpaced funding. Going forward, the United States should prioritize deploying capital and shaping markets. Alongside the myriad of sector-specific suggestions outlined in this analysis, expanding the U.S. government's ability to finance technology and mineral projects abroad is essential to develop durable new supply chains. Further, delivering on diplomatic pledges to trade partners is a necessity to preserving trust in U.S. development agendas and countering China's ability to finance projects abroad. Over the next two years, both DFC and EXIM will be up for congressional reauthorization, presenting new opportunities to expand foreign financing. These will present enormous potential changes in available funds to advance U.S. exports and de-risk supply chains abroad.

For DFC, policymakers could increase how much and where it can deploy funds. For example, Congress might increase its contingency liability cap and the spending cap on individual projects. Expanding funding to higher-income countries, while maintaining a baseline threshold for development, could help stimulate a wider array of opportunities in countries with critical materials or industrial capabilities. Other innovative financial frameworks could be considered, like how DFC accounts for equity investments, so it is not treated as direct spending, allowing more flexibility and reinvestment. And lastly, innovative measures could be deployed to mitigate political risk—by expanding its reinsurance funding—or technological risks—by easing repayment rules for early-stage projects. The latter two being especially important to priority areas like mineral production and next-generation clean firm power development.

In 2026, EXIM reauthorization will provide opportunities to enhance alignment with these technology verticals. Expanding the definition of renewable energy under the China Transformational Exports Program (CTEP, designed to counter China's exports) to a technology-agnostic approach that includes nuclear, energy storage, clean tech manufacturing, mineral processing, and grid infrastructure would improve EXIM's flexibility in supporting these critical industries. Raising the default rate cap could enable larger energy transactions, particularly relevant for capital intensive nuclear or grid projects. Similarly, a National Interest Account—aggregating existing strategic investment platforms like CTEP under a single account—could allocate funding specifically in service of strategic national goals with higher risks thresholds and a focus on international cooperation.[52] For example, it could be used to co-invest with other development finance institutions and sovereign wealth funds in areas of mutual strategic alignment.

While EXIM and DFC are both center stage and have incoming legislative opportunities, lesser-known agencies should not be forgotten. In particular, USTDA, which provides technical assistance and feasibility studies, should be viewed as a potent first-mover in developing projects abroad. Going forward, USTDA's staff and remit should be tailored to focus on specific technology verticals and supply chain vulnerabilities with foreign partners—particularly those in Africa and Southeast Asia where opportunities for mineral diversification, geothermal development, and low-cost clean tech manufacturing are notably high.[53]

Unlocking financing and creating more opportunities for market-shaping developments could specifically be used to strengthen existing frameworks and trade architectures. For example, the United States-Mexico-Canada Agreement reauthorization, slated for 2026, could be an opportunity to align North American mineral production and establish standards for regional, carbon-intensive products. The negotiations will face challenges with Mexico's recent statist push in its power market, which the United States might circumvent by helping Mexico's state-owned electric utility develop clean power plants with American and Canadian made products like wind turbines, solar panels, and especially, geothermal—all of which have near endless, untapped resources in the country.[54] A newly invigorated DFC and EXIM could help stimulate these types of projects.

New funding opportunities would be essential in bolstering progress of sector-specific multilateral architectures in key areas like minerals, carbon management, nuclear, and shipping. Despite developing a handful of mining and processing projects, the Mineral Security Partnership Finance Network—which provides catalytic funding to commodity rich countries—would benefit from new sources of capital to draw in investment from other actors. The Global Carbon Management Challenge—which focuses broadly on industrial decarbonization—could be used to promote America's arsenal of novel, breakthrough clean heavy industries like cement, fuels, and chemicals in partner countries.[55] The Clydebank Declaration and Green Shipping Challenge, which both aim to operationalize green shipping infrastructure by coordinating stakeholders, should focus on linking the existing network of disparate green shipping corridors—with a particular emphasis on establishing technical assistance programs for overlooked ports in Africa, South America, and South Asia.[56]

The United States should seriously consider its industrial advantage in geothermal and long-duration storage technologies and build analogous forums to promote its technologies. A next-generation geothermal consortium could bring in high-opportunity players across continents including Chile, Hungary, India, Italy, Japan, Kenya, Mexico, Nigeria, the Philippines, and Tanzania, to build an early project pipeline for novel geothermal techniques abroad, which USTDA could support.[57] A similar group for long-duration energy storage could help stimulate demand for U.S. storage technologies abroad in markets with high-penetration of intermittent renewables.

Lastly, recent efforts in science diplomacy should be maintained and focused on technologies that unlock future U.S. industries or help a foreign partner de-risk a supply chain Washington deems important. Key examples include focusing international R&D on technologies like supercritical geothermal resources, geologic hydrogen, and nuclear fusion, which all have the potential to unleash varying degrees of energy abundance, and which the United States is well positioned to unlock.[58] Other areas to target could be collaborating on developing perovskite solar cell supply chains with Japan, a leader in perovskite R&D, and other Quad members, which, eventually, could supplant the polysilicon supply chain that China has cornered.[59] Above all else, initiating a multipartner initiative akin to the

Manhattan Project to remove carbon from the atmosphere will be essential to pooling the world's best resources in building multiple technological pathways to preserve the stability of the climate. U.S. expertise is well positioned to lead in this research, and the fate of the planet is at stake.

Conclusion

To best optimize U.S. foreign policy for energy technology and minerals, diplomats and trade delegates should learn from these past experiences. In some instances, greater levels of intra-ministerial coordination will be essential to ensuring coordination can achieve goals beyond agenda setting. In engaging bilaterally or multilaterally, U.S. delegations should extend beyond key diplomats at the Energy and State Departments, and should include delegates from lesser sought-after agencies like USTDA and ITA, which have an underappreciated potential to stimulate trade discussions and unveil new market opportunities. When working in such coordinated groups, policymakers might take a clear-eyed view of what national strengths and weaknesses are endemic to the American industrial base. They should focus on key choke points—not broad verticals—and promote sectors that can yield shorter-term export results—not long-term aspirations. This level of pragmatism will be necessary to meaningful sway these emerging, clean energy markets in favor of U.S. national interests.

About the Authors

Milo McBride is a fellow in the Sustainability, Climate, and Geopolitics Program at the Carnegie Endowment for International Peace in Washington, DC. His research focuses on the geopolitics of energy transition technologies, critical minerals, and role of next-generation advancements in decarbonization pathways. Alongside his work at Carnegie, Milo is a nonresident fellow at the Center on Global Energy Policy at Columbia University.

Daniel Helmeci is a research assistant in the Carnegie Sustainability, Climate, and Geopolitics Program. He was previously a James C. Gaither Junior Fellow in the Carnegie Sustainability, Climate, and Geopolitics Program. Before joining Carnegie, Dan studied Political Science and History at Rice University.

Notes

1 "Will solar PV and wind costs finally begin to fall again in 2023 and 2024?," International Energy Agency, June 2023, https://www.iea.org/reports/renewable-energy-market-update-june-2023; Malgorzata Wiatros-Motyka, Dave Jones, and Nicolas Fulghum, "Global Electricity Review 2024," Ember, May 8, 2024, https://ember-energy.org/latest-insights/global-electricity-review-2024/.

2 Robert Armstrong, et al., "The Future of Energy Storage," MIT Technology Review, 2022, https://energy.mit.edu/wp-content/uploads/2022/05/The-Future-of-Energy-Storage.pdf; Maha El Dahan, Federico Maccioni, "UAE's Masdar Announces $6 billion Project to Deliver Reliable Clean Power," Reuters, January 14, 2025, https://www.reuters.com/business/energy/uaes-masdar-launches-facility-produce-1gw-uninterrupted-renewable-energy-2025-01-14/; "Electric Vehicle Battery Prices are Expected to Fall Almost 50% by 2026," Goldman Sachs, October 7, 2024, https://www.goldmansachs.com/insights/articles/electric-vehicle-battery-prices-are-expected-to-fall-almost-50-percent-by-2025?.

3 Fabian Villalobos, "Implications of Dual-Use Technologies on Critical Minerals Policy and Strategy," Colorado School of Mines, September 21, 2023, https://www.strausscenter.org/wp-content/uploads/Villalobos-Dual-Use-Technologies.pdf; Kwasi Ampofo, et al., "Transition Metals Outlook 2024," BNEF, https://assets.bbhub.io/professional/sites/24/202410BNEFTransitionMetalsOutlook2024.pdf.

4 Jennifer Dlouhy, "China Extends Clean-Tech Dominance Over US Despite Biden's IRA," Bloomberg, April 16, 2024, https://www.bloomberg.com/news/newsletters/2024-04-16/china-extends-clean-tech-dominance-over-us-despite-biden-s-ira-blueprint; "Energy Technology Perspectives 2024," International Energy Agency, October 2024, https://www.iea.org/reports/energy-technology-perspectives-2024.

5 See other papers in this Carnegie series, "How the U.S. Can Stop Losing the Race for Clean Energy" and "Assessing Progress in Building Clean Energy Supply Chains: The Technical Paper of the U.S. Foreign Policy for Clean Energy Taskforce."

6 "Minerals Security Partnership," U.S. Department of State, 2024, https://www.state.gov/minerals-security-partnership; "Sapporo 5 Leaders Make Significant Progress in Securing a Reliable Nuclear Fuel Supply Chain," U.S. Department of Energy, April 18, 2024,https://www.energy.gov/ne/articles/sapporo-5-leaders-make-significant-progress-securing-reliable-nuclear-fuel-supply-chain.

7 Zhongmin Wang and Alan Krupnik, "U.S. Shale Gas Development: What Led to the Boom," Resources for the Future, May 2013, https://media.rff.org/documents/RFF-IB-13-04.pdf; "DOE›s Early Investment in Shale Gas Technology Producing Results Today," U.S. Department of Energy, February 2, 2011, https://www.energy.gov/fecm/articles/does-early-investment-shale-gas-technology-producing-results-today; Clayton Coleman and Emma Dietz, "Fact Sheet | Fossil Fuel Subsidies: A Closer Look at Tax Breaks and Societal Costs," Environmental and Energy Study Institute, July 29, 2019, https://www.eesi.org/papers/view/fact-sheet-fossil-fuel-subsidies-a-closer-look-at-tax-breaks-and-societal-costs.

8 "The Foreign Tax Credit and U.S. Energy Policy," U.S. Government Accountability Office, September 10, 1980, https://www.gao.gov/products/emd-80-86.

9 "Global Shale Gas Initiative," U.S. Department of State, August 20, 2010, https://2009-2017.state.gov/r/pa/prs/ps/2010/08/146161.htm.

10 Andreea Maierean, "What Went Wrong? Fracking in Eastern Europe," *Springer Nature*, Volume 1, Article 3, 2021, https://link.springer.com/article/10.1007/s43937-021-00003-5.

11 Nikos Tsafos, "Geoeconomics Without Fossil Fuels," Center for Strategic and International Studies, February 8, 2021, https://www.csis.org/analysis/geoeconomics-without-fossil-fuels.

12 "USTDA and Indonesia Partner to Develop Critical Gas Infrastructure," U.S. Trade and Development Agency, June 15, 2020, https://www.ustda.gov/ustda-and-indonesia-partner-to-develop-critical-gas-infrastructure/; "Lithuania: Securing Energy Independence in Eastern Europe," U.S. Trade and Development Agency, https://www.ustda.gov/success_story/lithuania-securing-energy-independence-in-eastern-europe/.

13 "Active Projects," U.S. Development Finance Corporation, Accessed 2024, https://www.dfc.gov/what-we-do/active-projects; "Transactions," U.S. Export-Import Bank, Accessed 2024, https://www.exim.gov/solutions/project-and-structured-finance/transactions.

14 "2024 U.S. - France Bilateral Clean Energy Partnership Joint Statement," U.S. Department of Energy, May 24, 2022, https://www.energy.gov/ia/articles/2024-us-france-bilateral-clean-energy-partnership-joint-statement-0.

15 Milo McBride, "Catching Up or Leaping Ahead? How Energy Innovation Can Secure U.S. Industrial Stature in a Net Zero World," Carnegie Endowment for International Peace, September 19, 2024, https://carnegieendowment.org/research/2024/09/energy-innovation-us-industrial-stature?lang=en.

16 "United States and Japan Sign Critical Minerals Agreement," Office of the United States Trade Representative, March 28, 2023, https://ustr.gov/about-us/policy-offices/press-office/press-releases/2023/march/united-states-and-japan-sign-critical-minerals-agreement.

17 "Electric Vehicles with Final Assembly in North America," U.S. Department of Energy, accessed February 11, 2025, https://afdc.energy.gov/laws/electric-vehicles-for-tax-credit.

18 "DFC Announces Approval to Provide up to $500 Million of Debt Financing for First Solar's Vertically-Integrated Thin Film Solar Manufacturing Facility in India," U.S. Development Finance Corporation, December 7, 2021, https://www.dfc.gov/media/press-releases/dfc-announces-approval-provide-500-million-debt-financing-first-solars.

19 See other papers in this Carnegie series, "How the U.S. Can Stop Losing the Race for Clean Energy" and "Assessing Progress in Building Clean Energy Supply Chains: The Technical Paper of the U.S. Foreign Policy for Clean Energy Taskforce."

20 "Export-Import Bank of the United States Announces Letters of Interest for U.S. Nuclear Exports to Romania Alongside Special Envoy for Climate John Kerry, Romanian President Iohannis and Minister of Energy Popescu at COP27," U.S. Export-Import Bank, November 9, 2022, https://www.exim.gov/news/export-import-bank-united-states-announces-letters-interest-for-nuclear-exports-romania; "EXIM Support for Nuclear Sector Transactions," U.S. Export-Import Bank, September 2023, https://www.exim.gov/policies/exim-support-for-nuclear-sector-transactions; "Export-Import Bank of the United States Issues a $3 Billion Letter of Interest for U.S. Nuclear Exports to Poland," U.S. Export-Import Bank, April 17, 2023, https://www.exim.gov/news/export-import-bank-united-states-issues-3b-letter-interest-for-nuclear-exports-poland; "Report on DFC's Financing Nuclear Energy Projects Overseas," U.S. Development Finance Corporation, March 2024, https://www.dfc.gov/sites/default/files/media/documents/DFC%20Report%20-%20Civilian%20Nuclear%20Energy%202024.pdf.

21 "USTDA, Indonesia Partner on Nuclear Power," U.S. Trade and Development Agency, March 20, 2023, https://www.ustda.gov/ustda-indonesia-partner-on-nuclear-power/; "United States Announces New $126 Million Commitment for Ambitious Indonesia Geothermal Project," U.S. Development Finance Corporation, May 22, 2024, https://www.dfc.gov/media/press-releases/united-states-announces-new-126-million-commitment-ambitious-indonesian; "USTDA Supports Innovative Geothermal Technology in the Philippines," U.S. Trade and Development Agency, November 13, 2023, https://www.ustda.gov/ustda-supports-innovative-geothermal-technology-in-the-philippines/; "Success in Honduras: Platanares Geothermal Power Plant," U.S. Trade and Development Agency, October 18, 2019, https://www.ustda.gov/success_story/success-in-honduras-platanares-geothermal-power-plant/; "DFC CCO Levine and DCCO Shrivastava Highlight Investment Opportunities in Electric Vehicle Value Chain, Reliable, Baseload Clean Energy, and Climate-Smart Agriculture in the DRC and Kenya," U.S. Development Finance Corporation, April 7, 2023, https://www.dfc.gov/media/press-releases/dfc-cco-levine-and-dcco-shrivastava-highlight-investment-opportunities.

22 "The Future of Geothermal Energy," International Energy Agency, December 2024, https://www.iea.org/reports/the-future-of-geothermal-energy.
23 "Syrah Received $150 Million DFC Loan for Balama," Syrah Resources, Accessed 2024, https://www.syrahresources.com.au/news/syrah-receives-us-150m-dfc-loan-for-balama; "DOE Announces First Advanced Technology Vehicles Manufacturing Loan in More than a Decade," U.S. Department of Energy, July 27, 2022, https://www.energy.gov/articles/doe-announces-first-advanced-technology-vehicles-manufacturing-loan-more-decade.
24 "Chilean Cobalt gets $317 million funding support from EXIM Bank," Mining.com, June 17, 2024, https://www.mining.com/chilean-cobalt-gets-317-million-funding-support-from-exim-bank/; "Brazilian Nickel advances project financing with LOI for $550m," Mining.com, December 9, 2024, https://www.mining.com/subscribe-login/?id=1167565.
25 "Department of Defense Awards $14.7 Million to Enhance North American Cobalt and Graphite Supply Chain," U.S. Department of Defense, May 16, 2024, https://www.defense.gov/News/Releases/Release/Article/3777044/department-of-defense-awards-147-million-to-enhance-north-american-cobalt-and-g/.
26 "US Congress progresses AUKUS," Government of Australia Defense Ministers, December 18, 2023, https://www.minister.defence.gov.au/statements/2023-12-18/us-congress-progresses-aukus.
27 Greg Wischer, "The U.S. Military and NATO Face Serious Risks of Mineral Shortages," Carnegie Endowment for International Peace, February 12, 2024, https://carnegieendowment.org/research/2024/02/the-us-military-and-nato-face-serious-risks-of-mineral-shortages?lang=en.
28 Bentley Allan, Noah Gordon, and Cathy Wang, "Friendshoring Critical Minerals: What Could the U.S. and Its Partners Produce?," Carnegie Endowment for International Peace, May 3, 2023, https://carnegieendowment.org/research/2023/05/friendshoring-critical-minerals-what-could-the-us-and-its-partners-produce?lang=en.
29 Dafni Papapolyzou and Anne-Sophie Corbeau, "The US has a Hydrogen Demand Problem – Despite Generous Incentives," Center on Global Energy Policy, November 7, 2024, https://www.energypolicy.columbia.edu/the-us-has-a-hydrogen-demand-problem-despite-generous-incentives/.
30 "Hydrogen Supply Outlook 2024: A Reality Check," BNEF, May 14, 2024, https://about.bnef.com/blog/hydrogen-supply-outlook-2024-a-reality-check/.
31 "Technology Targets for Proton Exchange Membrane Electrolysis," U.S. Department of Energy, accessed February 11, 2025, https://www.energy.gov/eere/fuelcells/technical-targets-proton-exchange-membrane-electrolysis#.
32 Cat Clifford, "China on Track to Dominate Nuclear Energy," Cipher News, February 5, 2025, https://www.ciphernews.com/articles/china-on-track-to-dominate-nuclear-energy/; "Plans for New Reactors Worldwide," World Nuclear Association, January 23, 2025, https://world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.
33 Robert Wright, "Can the Nuclear Industry Find a Better Way to Build," *Financial Times*, February 10, 2025, https://www.ft.com/content/5e563e3f-575d-4a90-bd46-4d0a3083f707.
34 Please see associated web archive for a complete database of cited documents.
35 "The Partnership for Transatlantic Energy and Climate Cooperation (P-TECC)," U.S. Department of Energy, 2024, https://www.energy.gov/ia/partnership-transatlantic-energy-and-climate-cooperation-p-tecc.
36 "The Future of Geothermal Energy," International Energy Agency, December 2024, https://www.iea.org/reports/the-future-of-geothermal-energy.
37 "Global Clean Energy Investment Jumps 17%, Hits $1.8 Trillion in 2023, According to BloombergNEF Report," BNEF, January 30, 2024, https://about.bnef.com/blog/global-clean-energy-investment-jumps-17-hits-1-8-trillion-in-2023-according-to-bloombergnef-report/; Katie Lebling, et al., "7 Things to Know About Carbon Capture, Utilization and Sequestration," World Resources Institute, November 13, 2023, https://www.wri.org/insights/carbon-capture-technology.
38 "Minerals Security Partnership," U.S. Department of State, 2024, https://www.state.gov/minerals-security-partnership.
39 "Face Sheet: Partnership for Global Infrastructure and Investment at the G7 Summit," press release, White House, June 13, 2024, https://bidenwhitehouse.archives.gov/briefing-room/statements-releases/2024/06/13/fact-sheet-partnership-for-global-infrastructure-and-investment-at-the-g7-summit-2/.
40 Anthony Carroll, "What is Africa's Lobito Corridor?," U.S. Institute of Peace, June 18, 2024, https://www.usip.org/blog/2024/06/what-africas-lobito-corridor.
41 "Sapporo 5 Release Joint Statement Calling for Like-Minded Nations to Join Commitment to Secure a Reliable Nuclear Fuel Supply Chain," U.S. Department of Energy, September 18, 2024, https://www.energy.gov/ne/articles/sapporo-5-release-joint-statement-calling-minded-nations-join-commitment-secure.

42 "Sapporo 5 Leaders Make Significant Progress in Securing a Reliable Nuclear Fuel Supply Chain," U.S. Department of Energy, April 18, 2024, https://www.energy.gov/ne/articles/sapporo-5-leaders-make-significant-progress-securing-reliable-nuclear-fuel-supply-chain.
43 "Commitments," First Movers Coalition, accessed February 14, 2025, https://initiatives.weforum.org/first-movers-coalition/commitments.
44 Herman K. Trabish, "Pricing carbon is vital to US climate goals and politically unlikely, but there is another way, analysts say," Utility Dive, November 24, 2021, https://www.utilitydive.com/news/pricing-carbon-is-vital-to-us-climate-goals-and-politically-unlikely-but-th/609618/.
45 Serife Durmus, "Middle Eastern steelmakers pave the way for green steel: LME Week," Fastmarkets, September 30, 2024,https://www.fastmarkets.com/insights/middle-eastern-steelmakers-pave-the-way-for-green-steel-lme-week/; Gracelin Baskaran, "Saudi Arabia Has a Strategic Advantage in Sourcing Critical Minerals from Africa," Center for Strategic and International Studies, December 5, 2023, https://www.csis.org/analysis/saudi-arabia-has-strategic-advantage-sourcing-critical-minerals-africa.
46 "Industry Trade Advisory Center," International Trade Administration, https://www.trade.gov/itac-committees.
47 Please see associated web archive for a complete database of cited documents
48 "Green Shipping Corridors: Leveraging Synergies," American Bureau of Shipping, 2022, https://ww2.eagle.org/content/dam/eagle/publications/whitepapers/02-green-shipping-corridors-22380.pdf.
49 "DOE Participates in First Ever Meeting of Quad Energy Ministers," U.S. Department of Energy, July 13, 2022, https://www.energy.gov/articles/doe-participates-first-ever-meeting-quad-energy-ministers.
50 Bridget M. Dolan, "Science and Technology Agreements as Tools for Science Diplomacy: A U.S. Case Study," *American Association for the Advancement of Science (AAAS), December 10, 2012,* https://www.sciencediplomacy.org/article/2012/science-and-technology-agreements-tools-for-science-diplomacy
51 "Multi-Laboratory Collaborations for Advanced Global Energy Systems," National Renewable Energy Laboratory, accessed February 11, 2025, https://www.nrel.gov/international/net-zero-world.html.
52 Adam Frost, "The Necessity of a National Interest Account," Center for Strategic and International Studies, October 29, 2024, https://www.csis.org/analysis/necessity-national-interest-account.
53 For further reading on early stage U.S. government project identification from USTDA and the Millennium Challenge Corporation, see Katie Auth, "Our Shared Energy Security: Why the U.S. and Its Energy-Poor Allies Must Coinvest in Solutions—and How," Carnegie Endowment for International Peace, January 13, 2025, https://carnegieendowment.org/research/2025/01/our-shared-energy-security-why-the-us-and-its-energy-poor-allies-must-coinvest-in-solutions?lang=en.
54 Francisco Flores-Espino, Sarah Booth, and Andrew Graves, "Mexico's Geothermal Market Assessment Report," National Renewable Energy Laboratory, March 2017, https://www.nrel.gov/docs/fy17osti/63722.pdf.
55 See other papers in this Carnegie series, "Catching up or Leaping Ahead: How Energy Innovation Can Secure U.S. Industrial Stature in a Net-Zero World."
56 "Clydebank Declaration for Green Shipping Corridors," UK Department for Transport, December 6, 2023, https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors; "The Green Shipping Challenge," Green Shipping Challenge, accessed February 11, 2025, https://greenshippingchallenge.org.
57 "The Future of Geothermal Energy," International Energy Agency, December 2024, https://www.iea.org/reports/the-future-of-geothermal-energy.
58 See other papers in this Carnegie series, "Catching up or Leaping Ahead: How Energy Innovation Can Secure U.S. Industrial Stature in a Net-Zero World."
59 See other papers in this Carnegie series, "How the U.S. Can Stop Losing the Race for Clean Energy" and "Assessing Progress in Building Clean Energy Supply Chains: The Technical Paper of the U.S. Foreign Policy for Clean Energy Taskforce."

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