

EXIM

EXPORT-IMPORT BANK
OF THE UNITED STATES



HELPING

AMERICAN BUSINESSES

WIN THE FUTURE



Export-Import Bank of the United States | Report to
Congress on the Transformational Export Areas (TEAs)

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Letter from the Chair

Since my confirmation as President and Chair of the Export-Import Bank of the United States, we have exceeded expectations through more than \$2.7 billion in transactions in our China and Transformational Exports Program (CTEP) mandate. Our authorizations in these sectors have increased exponentially in recent years, both in numbers as well as a share of EXIM's authorizations. That is a good news story, and there is more work to be done.

EXIM is indisputably a necessary tool to help U.S. businesses compete against companies that benefit from the well documented industrial policies of the PRC. As President Biden has said,

“We’re in a competition with China and other countries to win the 21st Century.” Under the Board’s purpose driven leadership, we are utilizing EXIM to help American workers and companies win.

Last fiscal year, EXIM recorded its strongest year since Congress reauthorized the agency in 2019, authorizing over \$8.7 billion in financing to support U.S. companies of all sizes exporting goods and services abroad. These transactions further the agency’s mission to support U.S. exporters and support American jobs. They also advance several of the agency’s congressional mandates, including our small business, renewable energy, and Sub-Saharan Africa mandates.

Of particular importance are the goods and services from industries that comprise the transformational exports areas. U.S. companies that produce these transformational goods and services define the future, and one way that EXIM adds to American job creation, prosperity, and security is by accelerating support to these critical exporters in industries ranging from telecommunications to semiconductors, to renewable energy, and many others. EXIM’s analytic framework and methodology to assess U.S. comparative leadership in these transformational export areas gives the agency an unparalleled understanding of the global market and helped identify where to target and prioritize EXIM outreach.

The statutorily defined transformational export areas are key to our economic and national security. *And EXIM is delivering.* The Bank has found ways to be creative to deliver for the American exporter. For example, EXIM’s first Make More in America (MMIA) transaction, a \$4.7 million direct loan to Aquatech, a minority-owned small business based in Pennsylvania, will support the purchase of services and laboratory equipment to modernize and expand Aquatech’s existing facilities at two locations in Pennsylvania and Wisconsin. The financing will lead to innovations in the extraction of lithium, a critical mineral, from brine. By considering certain critical minerals under the mandate, we can unlock flexibilities to support these critical minerals projects and strengthen our supply chains.



Reta Jo Lewis, Esq.
President and Chair of the Export-Import Bank Board of Directors

Similarly, the second MMIA transaction that EXIM financed was for BETA Technologies, a manufacturer of advanced air mobility (AAM) electric and conventional airplanes. This \$169 million transaction qualified as a transformational export because of BETA's innovative battery technology, while also advancing America's leadership in AAM airplanes.

Our staff have exercised flexibilities prudently and only when necessary. The CTEP mandate, however, does not overrule the requirements and limitations that govern all EXIM activities. For example, EXIM is still restricted to a two percent default rate cap. Congress should consider excluding CTEP transactions from the default rate cap, so that the agency can aggressively compete with the PRC without risking a potential shutdown of the Bank.

It is imperative that the United States prioritize transformational exports through critical technology sectors and for critical goods to meet our strategic goals to reduce dependence on the PRC. There has never been a more consequential time for EXIM to deploy financial support domestically and to international partners to compete with the PRC's Belt and Road Initiative. EXIM stands ready and open to continue our progress in coordination and engagement with the private sector and our interagency partners on all the financial tools EXIM provides both domestically and abroad.

Letter from EXIM's Council on China Competition

As members of the Export-Import Bank's (EXIM) Advisory Subcommittee on Strategic Competition with the People's Republic of China (PRC), or the Council on China Competition (the Council or C3), we are pleased to introduce this important report and comment on EXIM's efforts to support American workers and American exports in an increasingly challenging global environment.

Our Council advises EXIM on advancing the comparative leadership of the United States with respect to the PRC and supporting U.S. innovation and employment through competitive export finance.

The C3's public and private sector collective experience spans the military, government, diplomatic relations, multi-lateral banks, academic institutions, think tanks, private industries, banking and finance, technology, the intelligence community, and more. The breadth and depth of our experiences are focused on advising EXIM on its crucial China and Transformational Exports Program (CTEP) mandate.

We believe EXIM's CTEP is a critical tool in America's strategy to compete with the PRC. EXIM's record of creative problem solving and financing flexibility for vital markets and transformational export areas shows the Bank takes this responsibility seriously. In Fiscal Year 2023, EXIM authorized more than \$8.7 billion in financing, its best performance since reauthorization in 2019. Of those transactions, \$2.4 billion in financing supported the CTEP mandate. Accordingly, more than a quarter of EXIM's authorizations went to support U.S. exporters competing with the PRC and/or supporting U.S. exports in transformational export areas.

We commend EXIM for its tireless efforts in meeting the PRC challenge and delivering tangible results.

Since the Council on China Competition was established, EXIM's staff have taken our recommendations seriously, while being completely transparent about the limitations of the agency. CTEP exists and operates within those limitations, none of which were relaxed to help the agency deliver on its mandate. Some of these constraints prevent EXIM from being more aggressive and taking more risk.

Although EXIM is not typically viewed as a national security tool, the transformational export areas are critical to America's prosperity. C3 members have seen firsthand the wide reach of the PRC's financial levers, which are validated in this report. Our nation's future as a world leader is inextricably linked to American innovation and competing successfully in the transformational export areas. It is a matter of economic security and thus national security.

We cannot afford to underestimate the PRC, even as it faces critical domestic and international challenges. The tendency to find comfort or breathing room in the notion of "peak China" is a myth that must be rejected.

It is within this context that this four-year report addresses the successes of the program and the challenges the agency faces to fully deliver on the CTEP mandate. EXIM has not been idle these past four years, as this report details. EXIM has embraced the mandate. We encourage Congress to consider the challenges that restrict EXIM and contemplate the ways and means to best empower the agency to deliver greater gains in the years ahead for our country, U.S. businesses and the American worker.

Members of the Council on China Competition

Admiral Gary Roughead

(Chair)
USN (Ret.), Robert and Marion
Oster Distinguished Military
Fellow, Hoover Institution,
Stanford University

Ambassador Paula Dobriansky

Senior Fellow, Harvard University
Belfer Center for Science and
International Affairs; Vice Chair,
Scowcroft Center for Strategy
and Security, Atlantic Council

Pavneet Singh

CEO, Infobalize; Former Director
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National Security Council,
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Kirsten Bartok-Touw

Co-Founder and Managing
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Dr. Robert Atkinson

President, Information
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Joe Purcell

Former Vice Chairman, Financial
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Lars Hickey

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Partner
TD International LLC

Executive Summary

In EXIM's 2019 reauthorization, Congress called on the agency to create the China and Transformational Exports Program (CTEP) and use its tools and authorities to advance the comparative leadership of the United States with respect to the People's Republic of China, or support United States innovation, employment, and technological standards through direct exports in 10 transformational export areas. These are:

- AI • Biotech • Biomedical • Wireless Communications • Quantum Computing • Renewable Energy, Storage, & Energy Efficiency • Semiconductors • Fintech • Water Treatment & Sanitation • High Performance Computing • Associated services necessary for use of any of the foregoing exports

Congress also directed that the agency provide this report by December 2023 on both the capacity of U.S. entities to produce, and foreign demand for, the goods and services of the approximately 115 industries that comprise the above transformational export areas. Congress further directed EXIM to report on both the availability of private-sector financing for exports in the areas, and the advisability of sustaining the 20 percent reserve goal with respect to transformational export area mandate.

Advancing the comparative leadership of the U.S. through exports requires, first, an assessment of where that competition currently stands. This report finds a wide range in the capacity to produce, and foreign demand for, the U.S. goods and services of the 115 industries associated with the transformational export areas. In some, U.S. businesses lead their PRC competitors in production capacity and, consequently, foreign demand. However, in many industries, PRC entities clearly produce and export more than their U.S. competitors. Additionally, some of the transformational export area industries involve technologies that are too nascent to export or operate business models that do not necessarily leverage debt financing, further compounding this complex picture.

The capacity and demand analyses of this report shows EXIM is indisputably a necessary tool to help U.S. businesses compete against firms that benefit from the well documented industrial policies of the PRC. Where U.S. businesses lead their PRC competitors in their capacity to produce and supply to foreign demand, EXIM support helps defend that lead against PRC offers. And in those industries where PRC businesses lead, EXIM support is indispensable in absorbing prudent risks and making financing available to U.S. exporters.

Which leads to an important finding with respect to the availability of private sector finance. If transformational export area industries neither produce in, nor export from, the U.S., it is difficult to make available either EXIM or private sector finance to advance U.S. comparative leadership. So while official export finance is a necessary tool to advance U.S. comparative leadership, *alone* it is insufficient.

Additionally, this study found critical minerals are a crucial component of multiple transformational export areas - and the U.S. lags the PRC in the proven reserves, mining, and processing of many critical minerals. Thus, while not itself a transformational export area, EXIM has prioritized critical minerals that clearly align to the capacity to produce and foreign demand for U.S. goods and services in transformational export area industries.

This complexity has governed EXIM’s approach to seek durable results with a quiet, purposeful urgency that, as of September 2023, is showing results.

EXIM and its Board have authorized a cumulative total of approximately \$2.9 billion in CTEP-related transactions since 2019. To date, this includes \$1.7 billion in authorizations against transformational export area industries and \$1.2 billion for authorizations where the U.S. exporter faced PRC competition, but the industry did not align to a transformational export area. The agency increased CTEP-related authorizations from \$252.9 million in FY 2022 to \$2.4 billion in FY 2023. As a share of the agency’s authorizations in FY 2023, CTEP-related transactions made up approximately 28 percent of the agency’s overall authorizations for the fiscal year.

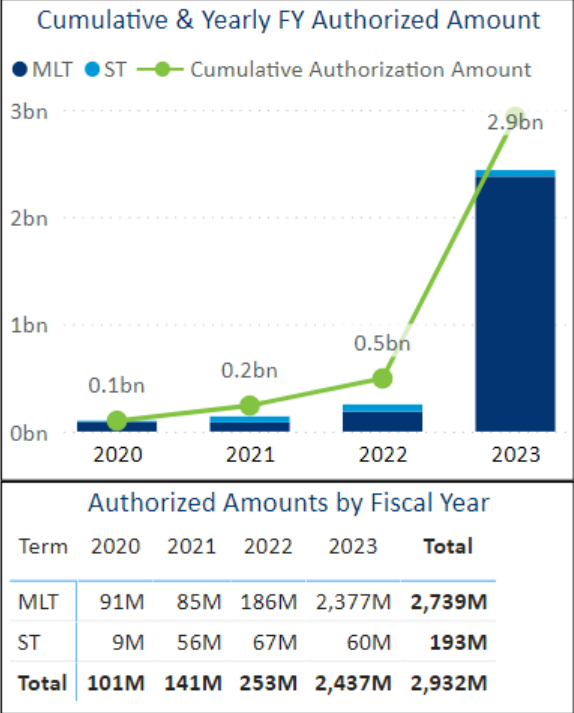
The CTEP mandate, however, does not overrule the requirements and limitations that govern all EXIM activities. Lending is inherently a risk-taking activity, but there are limits to the risks EXIM can take, which are defined by three major statutory features: underwriting standards, loan-loss reserve requirements, and the default rate cap.

First, Congress has mandated that the agency’s financing demonstrate a “reasonable assurance of repayment.” EXIM applies this standard to all its transactions.

Next, federal budgetary laws, such as the Federal Credit Reform Act, require the agency to set aside risk-rated loan-loss reserves for its financing. EXIM is then required to charge the borrower at least the minimum amount of fees needed to cover its loan-loss reserves unless the agency has appropriated funds, known as program budget, to offset the difference between fees collected and reserve requirements.

Finally, in 2012, Congress established a two percent default rate cap for the agency. In 2015 Congress revised the cap so that any breach would effectively bring nearly all financing activity by EXIM to a halt – including for small businesses, minority-owned businesses, transactions in direct competition with the PRC, and transformational export areas.

EXIM is therefore both an indispensable tool in the U.S.-PRC competition but also one that could do more. The agency has and will continue to aggressively push the boundaries within its span of control to counter PRC-backed export financing and support America’s comparative leadership in the transformational export areas. But EXIM’s ability to level the playing field against the PRC is limited by its statutory parameters. To better compete for America’s comparative leadership the agency would need statutory permission to accept more risk, such as creating a default cap carveout for CTEP-related deals and ensuring the agency has the funds and flexibility to offer competitive financing. And because CTEP sunsets on December 31, 2026, early reauthorization would signal the market and U.S. exporters that the agency is with them for duration of a competition American workers are sure to win.



Reporting Requirement

In its 2019 reauthorization of the Export-Import Bank of the United States (EXIM), Congress directed the agency to provide a report to Congress on the China and Transformational Exports Program by December 20, 2023 with an assessment of:

- i. The capacity and demand of United States entities to export goods and services in the transformational export areas;
- ii. The availability of private-sector financing for exports in the transformational export areas; and
- iii. The feasibility and advisability of continuing the goal of reserving not less than 20 percent of its financing authority for CTEP with respect to advancing the comparative leadership of the United States with respect to the People’s Republic of China, or supporting United States innovation, employment, and technological standards, through direct exports in any of the areas after December 31, 2026.¹

Background

Founded in 1934, the Export-Import Bank of the United States (EXIM) is an independent federal agency and the official export credit agency of the United States. EXIM's mission is to support American jobs by facilitating the purchase of American-made goods and services around the world. EXIM offers loan guarantees, direct loans, and insurance products that enable U.S. goods and services to compete in international markets. EXIM financing does not compete with private capital and all transactions are required by statute to demonstrate a reasonable assurance of repayment.

Exports grow American businesses, increase employment, and enhance economic prosperity. Exporting products overseas opens new markets, allows businesses to scale, and adds new revenue streams for U.S. industry, creating economic value for both businesses and their employees. Exports also advance U.S. comparative leadership in the industries that are most vital to America’s prosperity and security in the twenty-first century. Today, American industries produce goods, technologies, and services that compete and win in global markets based on quality, innovation, and price. EXIM helps ensure that financing does not stand in the way of American exporters closing a sale.

When the playing field is not level, however, U.S. exporters face barriers and challenges in foreign markets. The industrial policies of the People’s Republic of China (PRC) adversely impact the ability of American exporters to compete on fair terms in the global marketplace. And because the PRC combines both export finance and development finance to aid its exporters, it’s role as the largest official source of international development finance makes it a direct competitor to U.S. exporters.

Data on PRC overseas financial activity is opaque, difficult to assess for quality and often crosses Western definitional lines, for instance blending Overseas Development Assistance (ODA) with Other

¹ P.L. 116-94, Division I, Title IV, § 402, December 20, 2019.

Official Flows (OOF).² As reported in EXIM’s annual Competitiveness Reports,³ the PRC has two official export credit agencies, as well as multiple other government institutions that provide export and trade-related finance in support of the PRC’s policy and commercial goals. As noted by the U.S. China Security and Review Commission, these institutions are significantly less transparent about their lending products and volumes than the Participants to the Organization for Economic Cooperation and Development (OECD) Arrangement on Officially Supported Export Credits (“the Arrangement”).^{4,5} By using estimates, public-source data, and annual reports from the PRC, EXIM estimates that in 2018 and 2019, the PRC’s export financing activity was larger than all G7 export credit agencies combined.

More recent academic analyses contradict the conventional wisdom that PRC overseas lending is decreasing. William and Mary AidData finds that credit commitments to low- and middle-income countries alone hovering around \$80 billion a year.⁶ With regard to officially supported export credit financing, the PRC provided approximately \$11 billion in medium- and long-term financing in both 2021 and 2022. The PRC’s official support continues to be geographically dispersed, with the Caribbean and Oceania garnering more support than their bilateral trade relationships with the PRC would suggest.

Export financing, in conjunction with a multitude of other PRC industrial policy efforts, puts U.S. companies at a comparative disadvantage. These broad industrial policies include state-led investment into strategic industries through targeted funds, state ownership of companies, the Belt and Road Initiative, and other similar infrastructure spending, lending subsidies with banks, talent recruitment, government procurement, use of sovereign wealth funds, unfair trade practices, including illegal subsidies and forced technology transfer.

In this context, in December 2019, Congress directed the agency to establish a China and Transformational Exports Program (CTEP) with the goal of supporting, “to the extent practicable,” financing on terms and conditions that are fully competitive with the rates, terms, and other conditions established by the PRC. Congress gave the program two directives:

- To directly neutralize export subsidies for competing goods and services financed by official export credit, tied aid, or blended financing provided by the PRC (PRC Competition).
- To advance the comparative leadership of the United States with respect to the PRC, or support United States innovation, employment, and technological standards through direct exports in 10 transformational export areas. (Transformational Export Area)

Applications to EXIM can qualify as either PRC Competition, a Transformational Export Area, or both.

To implement this direction, in 2020 EXIM established its Office of the China and Transformational Exports Program, and immediately launched its Strengthening American Competitiveness initiative to learn directly from the market how EXIM should approach this challenge. The program hired full-time career staff in Q2 FY21 and began implementing the reforms outlined below in earnest.

² <https://www.aiddata.org/blog/negotiating-the-blurred-lines-between-official-development-assistance-and-other-official-flows>

³ Available online at <https://www.exim.gov/news/reports/competitiveness-reports>.

⁴ In addition to the PRC’s official export credit agencies and the China Development Bank, which is a development finance institution, there are at least 49 wholly or partially state-owned financial institutions that engage in export-related financing. While these banks are not official export credit agencies, they are not immune from the policy direction of the State and Party.

⁵ https://www.uscc.gov/sites/default/files/2023-11/2023_Annual_Report_to_Congress.pdf

⁶ “Belt and Road Reboot: Beijing Bid to De-Risk its Global Infrastructure Initiative,” https://docs.aiddata.org/reports/belt-and-road-reboot/Belt_and_Road_Reboot_Executive_Summary.pdf

EXIM Context

The statutory mandate establishing CTEP did not alter any other statutory provisions. Therefore, EXIM’s CTEP-related financing is governed by the same requirements and limitations that apply to all EXIM lending, which set the boundaries of what is “practicable” for the agency to offer in its effort to be “fully competitive.”

Additionally, demand for CTEP financing necessarily takes place within the broader context of demand for EXIM financing. After its financing authorization levels peaked in fiscal year 2012, with the agency authorizing nearly \$36 billion in the wake of the Global Financial Crisis and the European Debt Crisis, EXIM authorizations dropped to \$20.5 billion in FY 2014, before the agency experienced a six-month lapse in its authority beginning in June 2015. Despite Congress fully reauthorizing the agency in December 2015, EXIM’s Board of Directors lacked a quorum and was unable to approve medium- and long-term transactions greater than \$10 million until May 2019.

During this four-year period, as the PRC ramped up financing under its Belt and Road Initiative and foreign export credit agencies actively worked to increase its exporters’ global market share and competitiveness, EXIM was largely unable to meaningfully facilitate U.S. exports and support U.S. jobs.

Since May 2019, EXIM has worked hard to re-establish its image in the eyes of exporters, lenders, and borrowers as a reliable source of financing that is fully competitive with foreign export credit agencies.

By statute, any financing EXIM supports requires a reasonable assurance of repayment, but the processing and due diligence EXIM undertakes varies by product. EXIM’s short-term products, with a repayment tenor of up to one year, support a high volume of transactions that tend to feature lower amounts of financing. These types of transactions have relatively quick processing times, as do most medium-term transactions (those less than \$25 million and tenors between 2 and 7 years). Long-term financing applications, which are for transactions greater than \$25 million or over 7 years, generally require longer processing time as extensive due diligence and underwriting are necessary given their more complex nature and risks.

In practice, this means that for EXIM to rebuild its pipeline of long-term transactions, it must engage with applicants for weeks or months to support the completion of an application and to facilitate the due diligence necessary to underwrite the transaction. Since a quorum was restored to EXIM’s Board, agency staff have diligently worked to build up and strengthen the pipeline of long-term transactions. As with any deal pipeline, certain applications may fall out for reasons outside of the agency’s control, such as a failure by the buyer and seller to reach agreement on commercial terms or the availability of alternative financing options.

EXIM experienced further headwinds as the COVID pandemic roiled the global economy and significantly disrupted international trade across a wide range of sectors. After relatively modest authorization levels in FY 2020 – FY 2022, EXIM is now seeing an increase in demand for its financing, culminating in the agency authorizing more than \$8.7 billion in FY 2023.

And EXIM sees opportunities ahead. Historic investments in strengthening the domestic manufacturing base for semiconductors, renewable energy, energy storage, and other climate friendly technologies have the potential of moving U.S. companies up the maturity curve and increasing their ability to compete in both quality and cost. As these companies strengthen their global competitiveness, EXIM is

actively working to ensure that its financing, consistent with all applicable statutory requirements, can be effectively and expeditiously deployed to ensure these technologies can compete on a level playing field and that its financing can supplement gaps in available private sector financing.

Financing Authority for EXIM's CTEP

EXIM currently has a total financing authority of \$135 billion that can be deployed at any one time to facilitate U.S. exports. As of September 30, 2023, EXIM had approximately \$34 billion of outstanding exposure, leaving the agency with more than \$100 billion of available financing authority.

When Congress directed EXIM to establish CTEP as part of its 2019 reauthorization, it established a goal for the agency to reserve not less than 20 percent of its total available financing authority (e.g., \$27 billion) for CTEP transactions.

As discussed previously, with the lack of a quorum on EXIM's Board of Directors and the more modest authorization levels approved in recent years, the agency has not faced any challenges in having sufficient financing authority to meet the needs of U.S. exporters and their buyers under both CTEP and its standard financing programs.

EXIM recognizes that the 20 percent reserve provision for CTEP is a goal but notes that its financing authority is available to maximally support U.S. exports regardless of sector or region. Should EXIM require additional financing authority to execute its mission of facilitating U.S. exports and supporting American jobs, including financing authority to support CTEP transactions, it will communicate its request to Congress for such authority, consistent with standard procedures for legislative requests.

EXIM Progress to Date

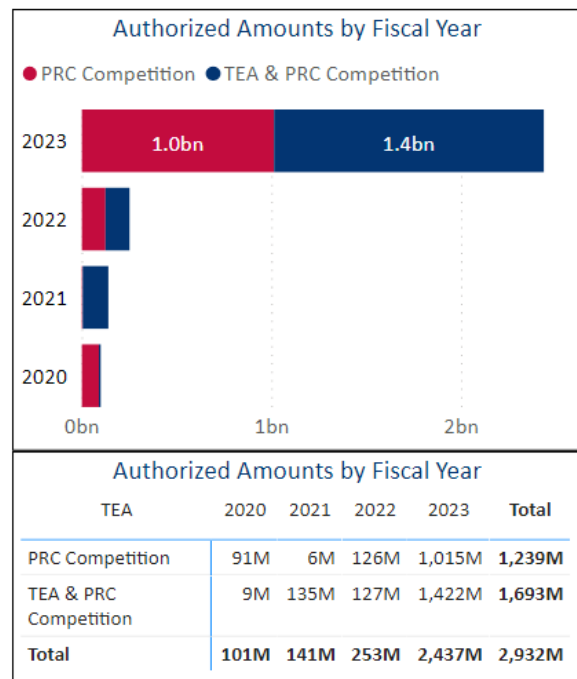
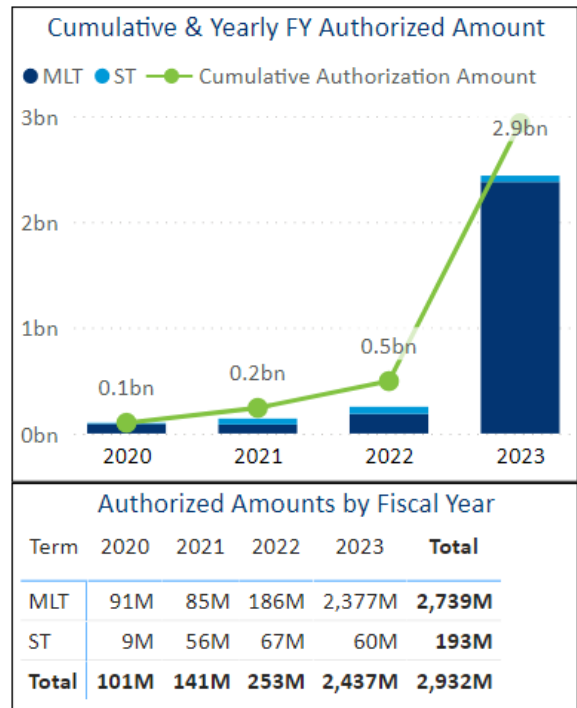
EXIM’s has pursued durable results with a quiet, purposeful urgency.

The CTEP mandate does not overrule the requirements and limitations that govern all EXIM activities, so for areas within its span of control the agency has aggressively pushed the boundaries to counter PRC-backed export financing and support America’s comparative leadership in the transformational export areas.

As of September 30, 2023, EXIM’s four years of concerted efforts are demonstrating progress. EXIM’s Board has authorized a cumulative total of approximately \$2.9 billion in CTEP-related transactions since 2019. This includes \$1.69 billion in authorizations against transformational export area industries and \$1.2 billion for authorizations where the U.S. exporter faced PRC competition, but the industry did not align to a transformational export area. And as the chart to the right shows, the value of CTEP-related authorizations has begun to significantly increase as large-value transactions mature through the due diligence process. The agency increased CTEP authorizations from \$252.9 million in FY 2022 to \$2.4 billion in FY 2023. As a share of the agency’s financing in FY 2023, CTEP transactions made up approximately 28 percent of the agency’s overall authorizations for the fiscal year.

EXIM has seen interest from a wide range of U.S. companies and prospective applicants, including many exporters that had not previously used EXIM. Entities engaging with EXIM for the first time often require more significant engagement to better understand the application process and programmatic requirements. EXIM has increased staff resources dedicated to engaging and supporting potential CTEP transactions, upgraded business processes and bank software, and innovated to improve the agency’s offerings.

For example, EXIM established a CTEP determination letter to complement its existing letters of interest, preliminary commitments, and memoranda of understanding to both demonstrate the



agency's willingness to actively compete as well as give buyers confidence that financing can be available for the purchase of high quality, trusted, and reliable American-made goods and services.⁷

In December 2020, EXIM's Board of Directors adopted policy flexibilities that allowed for qualifying transactions to receive maximum financing support so long as at least 51 percent of the net export value consisted of U.S. content. The flexibilities also laid out a path for transactions with lower U.S. content levels to receive maximum agency financing so long as additional criteria are met. EXIM further clarified its content policy specifically related to 5G in January 2023.⁸

In December 2021, EXIM implemented a methodology for evaluating exceptions to its policies for riskier markets – what EXIM refers to as its Country Limitation Schedule⁹ – against a broader framework. EXIM now measures the aggregate amount of exposure across all riskier markets as well as the exposure per country as a basis to responsibly balance the mandate to compete with the PRC against the risk of loss in those markets.

EXIM has further extended flexibility on the down payment requirement for long-term, transformational export area transactions with sovereign governments in non-high-income markets. Consistent with a temporary modification to the OECD Arrangement, qualifying transactions only require the buyer to meet a 5 percent down payment, rather than the standard 15 percent, to access maximum EXIM financing.

In April 2022, in response to challenges in domestic manufacturing and supply chains exposed by the COVID-19 pandemic, EXIM's Board of Directors approved the extension of its financing to encompass term financing for export-oriented domestic projects, known as the Make More in America Initiative. The Board recognized the potential for this financing to help advance America's comparative leadership in transformational export areas and adopted increased flexibilities on qualifications for these transactions.¹⁰

These efforts and others have resulted in a steady increase in opportunities, such as this sampling of notable transactions since 2020.

Weldy-Lamont Exports for Rural Electrification Project, Senegal

In March 2020, the EXIM Board unanimously authorized a \$91.5 million transaction in support of Weldy-Lamont Associates LLC, a U.S. small business exporter that won a contract to provide electricity to 330,000 Senegalese in 400 rural villages through extending Senegal's rural electricity grid and providing off-grid solar power. The EXIM credit will support an estimated 500 U.S. jobs in 14 states. In early 2021, EXIM became aware that a PRC-based consortium sought to replace Weldy-Lamont by offering a more favorable financial package with terms that were out of line with the OECD arrangement. To offset the terms offered by PRC entities, in

⁷ CTEP determination letters inform applicants that, based on the information provided to the agency, a proposed transaction appears to meet the requirements for CTEP flexibilities, should such an application be submitted, meet applicable underwriting and policy guidelines, and be approved. Letters of Interest are non-binding statements that the agency would generally be willing to consider a proposed application for its financing. A Preliminary Commitment is a non-binding commitment that the agency would be willing to provide a certain amount of financing in association with a given application. Memoranda of understanding referenced here are non-binding commitments to work with foreign governments to identify opportunities where EXIM financing may support the purchase of U.S. goods and services.

⁸ <https://www.exim.gov/about/special-initiatives/ctep/5g-content-policy>

⁹ <https://www.exim.gov/resources/country-limitation-schedule>

¹⁰ "Make More in America Initiative," EXIM website, available at: <https://www.exim.gov/about/special-initiatives/make-more-in-america-initiative>.

February 2021, EXIM's Board of Directors unanimously approved an additional amendment to the transaction, extending an option of an 18-year repayment term to cover the entire EXIM financing of the project and an option to convert the previously approved EXIM loan guarantee to a direct loan.

Hoffman International Exports for Construction Equipment Sale, Cameroon

On June 30, 2022, EXIM's Board approved a guarantee in support of a \$73.7 million seven-year loan with an 18-month drawdown to the Special Council Support Fund for Mutual Assistance (FEICOM) for the sale of 271 pieces of construction equipment and related goods and services by Hoffman International, Inc. (Hoffman). FEICOM will lease the construction equipment to municipalities for various civil works projects. As Hoffman competed against PRC-backed firms, EXIM used appropriated program budget funds to offset the fee difference between federal budgetary reserve requirements and OECD minimum fee requirements, making the agency's pricing more competitive. This is also an example of EXIM neutralizing a direct PRC competition for exporters that are not in transformational export areas.

5G for ICE, Costa Rica

As part of a whole of government approach to compete against Huawei 5G equipment, on June 9, 2023, EXIM's Board approved a preliminary commitment to the Government of Costa Rica's Instituto Costarricense de Electricidad & Subsidiaries (ICE). This action demonstrated EXIM's willingness to consider financing a \$300 million credit for procuring equipment and supporting materials and services from trusted vendors to deploy a 5G network across Costa Rica. Though more substantial than a Letter of Interest, a preliminary commitment is not an offer of EXIM financing. Such an offer is subject to the award of the export contract, EXIM's additional review of an application for a final commitment, satisfaction of various terms and conditions, and Board approval.

Renewable Energy for Sun Africa, Angola

On June 1, 2023, EXIM's Board approved a \$907 million direct loan to the Angolan Ministry of Energy and Water to support the construction of two photovoltaic solar energy power plants. The project will support exports of U.S. solar panel mounting systems, connectors, switches, sensors, and other equipment and help Angola meet its climate commitments by generating over 500 megawatts of renewable power and providing access to clean energy resources across Angola; and EXIM leveraged its flexibility for transformational export area transactions that qualify for lower down payment requirements.

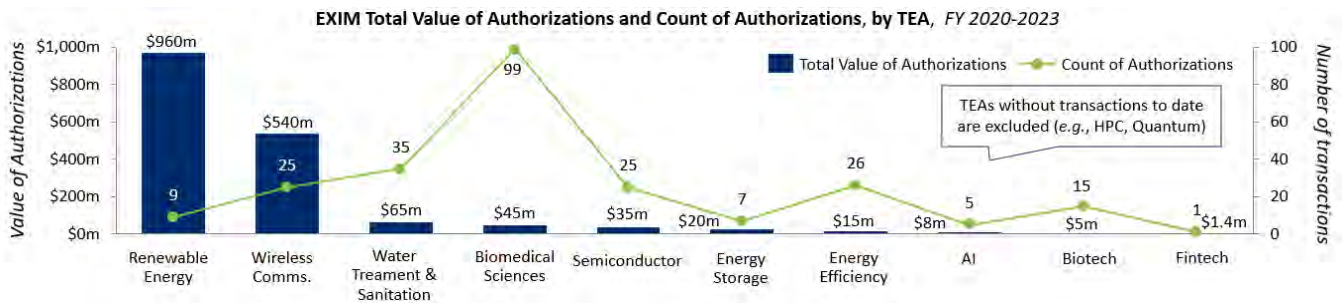
Aquatech Modernizations for Lithium, USA

On August 31, 2023, EXIM's Board approved a \$4.7 million direct loan to Aquatech International, a small, minority-owned business based in Canonsburg, Pennsylvania. This first transaction authorized under EXIM's Make More in America initiative will support the purchase of services and laboratory equipment to modernize and expand existing facilities at two locations in Pennsylvania and Wisconsin. This transaction enables Aquatech to better support the domestic lithium (a critical mineral) and electric vehicle supply chains. EXIM's designation

that critical mineral-related transactions were essential to transformational export area industries qualified the transaction for increased flexibility to access domestic term financing.

BETA Technologies Manufacturing for Advanced Air Mobility, USA

On November 16, 2023, EXIM’s Board approved a \$169 million direct loan under the Make More in America initiative to BETA Technologies, a small business in Burlington, Vermont, that manufactures all electric-powered aircraft (including vertical takeoff and landing aircraft, A250 aircraft, conventional takeoff and landing aircraft, and CX300 aircraft [collectively, the ALIA Aircraft]). The direct loan will finance the expansion of BETA’s South 40 Manufacturing Campus and help a U.S. manufacturer compete with the PRC for this emerging industry.



Note: due to rounding and a number of transactions categorized under more than one TEA, sums will not match totals.

Supporting a Whole of Government Approach

EXIM and export finance tools are necessary, but on their own are insufficient to effectively compete with the PRC. EXIM, therefore, closely collaborates with the interagency in this highly complex and dynamic landscape to lay the groundwork and identify opportunities where the agency’s financing tools can facilitate U.S exports in high priority, geostrategic markets and sectors. Over the last four years EXIM has deepened bilateral cooperation across the interagency and increased agency participation in National Security Council meetings, with a strong focus on competition with the PRC.

In one notable example from 2022, in support of the diplomatic efforts of the Undersecretary of State for Economic Growth, Energy, and the Environment, EXIM provided the cornerstone of a wider U.S. government effort to counter PRC economic coercion of NATO ally Lithuania with a \$600 million Memorandum of Understanding (MOU). The MOU supported efforts to identify opportunities to finance the sale of U.S. exports while providing ballast to the State Department’s diplomacy. Not only was this effort a strategic success for the U.S. government, but it has also served as a case study of a whole-of-government response to the economic coercion of a U.S. ally.¹¹

EXIM also helped lead the effort to modernize the OECD Arrangement so that the United States and its allies can better compete with financing from the PRC. Under the revised OECD Arrangement, which took effect in July 2023, participating countries agreed to increase the maximum repayment term for most projects up to 15 years, introduce additional repayment flexibilities, and adjust minimum premia for longer repayment terms in sub-investment grade markets. This effort ensures that the

¹¹ For background on the PRC economic coercion of Lithuania, please see: <https://www.csis.org/analysis/chinas-economic-coercion-lessons-lithuania>

Arrangement continues to support a disciplined, level playing field for export credit agencies, while ensuring U.S. exporters are positioned to fully compete against the PRC.

Additionally, in September 2022, EXIM's President and Chair joined Secretary of State Antony Blinken and Under Secretary of State Jose W. Fernandez in launching the Minerals Security Partnership, demonstrating the agency's strong commitment to identifying new opportunities related to critical minerals. At this Ministerial on the sides of the UN General Assembly, Chair Lewis announced that critical mineral projects important to the value chains of transformational export area industries would be considered under CTEP. As a result, EXIM now has a pipeline of critical minerals opportunities beginning the due diligence process.

As another example, in December 2022, an EXIM delegation participated in the inaugural Quad Investors Network meeting in Sydney, Australia to pursue co-financing opportunities with Indian, Japanese and Australian counterparts that align directly with the transformational export areas.¹²

In November 2023, Chair Lewis joined Secretary of Commerce Gina Raimondo, National Economic Council Director Lael Brainard, and Kurt Campbell, Deputy Assistant to the President and Coordinator for Indo-Pacific Affairs on the National Security Council at an official Asia Pacific Economic Cooperation (APEC) Leaders' week event to highlight the importance of U.S. exports to the Asia-Pacific and how fostering economic resilience through global infrastructure enables U.S. companies to expand and create new high paying U.S. jobs. As part of EXIM's participation at APEC, Chair Lewis also participated in a closed-door meeting organized by the White House focused on U.S. government partnerships with the Indo-Pacific to advance trusted vendors in 4G, 5G, and Open RAN.

¹² [Quad Investors Network](#)

Introduction: Transformational Export Area Capacity and Demand Analyses

In EXIM’s 2019 reauthorization, Congress called on the agency to use its tools and authorities to advance the comparative leadership of the United States with respect to the People’s Republic of China, or support United States innovation, employment, and technological standards through direct exports in 10 transformational export areas. These are:

- AI • Biotech • Biomedical • Wireless Communications • Quantum Computing • Renewable Energy, Storage, & Energy Efficiency • Semiconductors • Fintech • Water Treatment & Sanitation • High Performance Computing • Associated services necessary for use of any of the foregoing exports

The identified transformational export areas are open-ended terms, with each encompassing a variety of industries. For example, industries included within the Renewable Energy, Energy Storage, and Energy Efficiency area range from solar power to flywheels to energy-efficient buildings.

EXIM’s capacity and demand assessment, therefore, began by segmenting the transformational export areas into what became 115 distinct, non-overlapping segments and industries. Each of these discrete industries have their own highly varied domestic production capacity and foreign demand. EXIM’s understanding of the capacity and demand of United States businesses to export goods and services in the transformational export areas begins with a high-level overview of the agency’s definitions and experience to date. It then provides appropriate market research and uses “Spotlights” of individual industries to offer details that demonstrate larger overall trends.

Congressional direction for the program to “advance the comparative leadership of the United States *with respect to the PRC*” led EXIM to assess the capacity and demand in each transformational export area *relative* to that of the PRC.

Two additional factors also shape EXIM’s approach to implementing this mandate. First, the term transformational export “areas” is a broader term than transformational export products, industries or goods. Second, the list of transformational export areas includes the phrase, “Associated services necessary for use of any of the foregoing exports.” These factors led EXIM to study the transformational export areas as value chains. Value chains focus on how products are made, whereas supply chains focus on where input materials come from. EXIM considers both—using the term “value chain” throughout for consistency – and evaluates each transaction on whether *either* a) the value of the export largely consists of equipment or services that align to a TEA definition (products); *and/or* b) will the foreign buyer use the export for the purpose that aligns to a TEA definition (buyer use). For example, EXIM may consider an export of radios for a mobile network as a wireless communications product. But EXIM may also consider the export of fiber optic cables as a wireless communications transaction provided the offtake is a foreign mobile network operator seeking to improve their wireless communications service.

Observations on Availability of Private Sector Financing

With four years' experience implementing CTEP, combined with the capacity and demand analyses of this report, EXIM offers the following observations about the availability of private-sector financing for exports in the transformational export areas.

In its Charter, Congress has directed that EXIM “should supplement and encourage, but not compete with, private capital in its transactions.”¹³ EXIM refers to this concept as “additionality” and reviews applications to determine whether private sector financing is unavailable and EXIM financing is needed to facilitate the transaction.¹⁴

Within this guidance, two levels of analysis are necessary to understand availability of private sector export financing in the transformational export areas for the purpose of advancing the comparative leadership of the United States with respect to the People's Republic of China.

- 1) Comparative leadership by industry: In the existing global market, does private sector financing find U.S. or PRC industries possess relative advantage in the capacity to produce, and foreign demand for, the products in the value chain?
- 2) Acceptable risk by transaction: In each opportunity where a U.S. exporter is in demand, is private sector financing competitive with PRC lending and comfortable with risks such as a) new or newer technology; b) relatively riskier markets; or c) the potentially large and long-term transaction sizes?

First, at the industry level, where PRC industries lead those of the U.S. – where PRC firms have larger market share, already export more, receive government support and have larger firms – private-sector financing seeking to maximize returns is necessarily less available to U.S. exporters or foreign buyers.

Unlike riskier forms of investment like venture capital, private sector debt financing is conservative by nature. It operates on market-based principles and seeks to limit the probability of loan non-payment (by foreign buyers or exporters) and maximize return on its extensions of credit. By its nature, private sector debt financing institutions are not positioned, nor should they be expected, to adjust their financing terms or risk tolerance at the expense of profits and/or regulatory requirements to support U.S. exporters against competitors that benefit from PRC state support. Without some risk mitigant, such as an EXIM loan guarantee, it is difficult for private-sector financing to support U.S. industries when PRC firms are more globally competitive.

Importantly, absent a mitigating factor like EXIM, a divergence between the ability of U.S. exporters to compete with PRC exporters in third markets can be self-reinforcing. A lack of comparative leadership in an industry contributes to reduced private sector-financing interest—and a lack of private-sector financing interest drives a further reduction in U.S. comparative leadership.

¹³ Section 2(b)(1)(B) of the Export-Import Bank Act of 1945, as amended, referred to as EXIM's Charter. EXIM's Charter is available online at <https://www.exim.gov/leadership-governance/charter-and-bylaws> and is codified at 12 U.S.C. § 635 et seq.

¹⁴ “Additionality,” EXIM Website, available online at: <https://www.exim.gov/policies/additionality-checklist>

The chapters that follow analyze the comparative leadership of U.S. industries relative to the PRC in their capacity to produce, and foreign demand for, exports in the transformational export area industries.

When U.S. industries lead the PRC, EXIM support helps defend that lead by supporting exports additional to what the private capital market would otherwise provide. And when PRC industries lead those of the U.S.– which is not uncommon – EXIM cover is indispensable in absorbing prudent risks and crowding in private sector financing.

Second, at the transaction level, the largest gaps for private sector financing for transformational export areas include a) newer technologies; b) relatively riskier markets; c) potentially large transaction sizes; and d) repayment tenors.

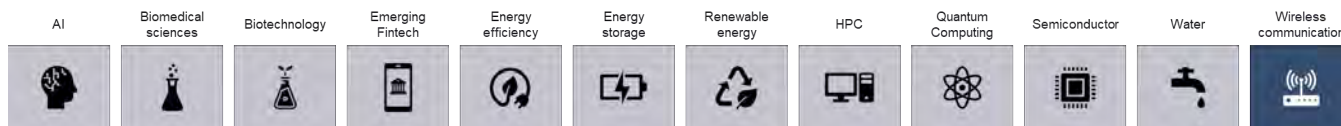
In general, well-established technologies (e.g., onshore wind) in investment grade markets do not tend to face challenges raising capital in private markets. Newer technologies (e.g., offshore wind) in more challenging markets face more commercial financing gaps and are more dependent on government-backed financing such as export credit agencies. EXIM has found that a typical commercial bank is willing to offer funding for creditworthy corporate transactions that have a repayment period of around five to seven years. Some commercial lenders are willing to authorize a project finance transaction with eight to ten-year repayment periods without requiring some kind of governmental backstop. When EXIM examined open-source data, most 12-year or longer loans without governmental backing happened only in markets with high investment grade ratings.

However, even when private sector lenders are comfortable with the technology or market risk, available financing still may not be competitive with the PRC (or other government) offer. With the Belt and Road Initiative, the PRC has been a major source of financing for foreign projects for the last decade. While identified international lending is down from peaks identified in 2018, official PRC medium- and long-term export support amounted to \$11 billion in both 2021 and 2022.¹⁵ This amount does not account for lending by the China Development Bank, state-owned banks, or support provided directly to PRC exporters that allows them to offer more generous credit terms than their global competitors, including U.S. exporters.

A key driver of EXIM’s additionality determination is the presence of competition from government financing. That means even in situations where private sector financing may be available – such as with established technologies in low-risk markets – EXIM financing may still be necessary to offset a financing offer from the PRC.

¹⁵ EXIM Competitiveness Report 2022

Transformational Export Area Capacity and Demand Analyses



Wireless Communications Equipment

Scope

EXIM defines the “Wireless communications equipment (including 5G or subsequent wireless technologies)” transformational export area as equipment or services intended for the distribution of information by means of digital electromagnetic transmission without the need for wires, optical fiber, or other synthesized materials.

EXIM segmented this definition into twelve industries: Satellite communications; Telecommunications equipment; Optical communications and networking equipment; Wi-fi devices; Near-field communications; TV & radio; Infrared detectors; GPS tracking devices; Radio frequency identification; Radar; Wireless audio devices; Sonar systems.

EXIM Activity

From January 2020 to September 2023, EXIM has authorized 25 transactions worth nearly \$540 million that qualify under the wireless communications equipment transformational export area; with approximately \$15 million of financing in short-term insurance or working capital products, and over \$520 million in EXIM’s medium- or long-term financing programs. Notably, EXIM authorized a \$407 million transaction for Viasat Technologies Limited’s purchase of United Launch Services’ satellite launch services. As noted below, given that the U.S. retains comparative leadership in this segment, EXIM support has helped defend America’s lead in the satellite sector.

Capacity and Demand Overview

For a range of reasons, foreign competitors – especially within the PRC – have secured significant global market share and U.S. companies are limited to niches where they can exploit their competitive advantages. For example, the Department of Commerce and Homeland Security assessment finds that the global supply chain for fiber optic cable and modules have shifted towards being centered in the PRC.¹⁶ PRC optical fiber, cable, and connector exports in aggregate from 2019-2021 were approximately 1.75 times higher than U.S. exports.¹⁷ The telecommunications equipment spotlight below helps to illustrate the capacity and demand of U.S. industries and the global market within which EXIM is trying to help U.S. businesses compete.

One key industry where the U.S. is demonstrating a strong capacity and is seeing strong foreign demand is within satellite communications, where U.S. businesses hold clear comparative leadership over the PRC. In the PRC, state-owned entities control almost all production, and the government is supporting domestic industry by encouraging private investment and targeting developing markets on

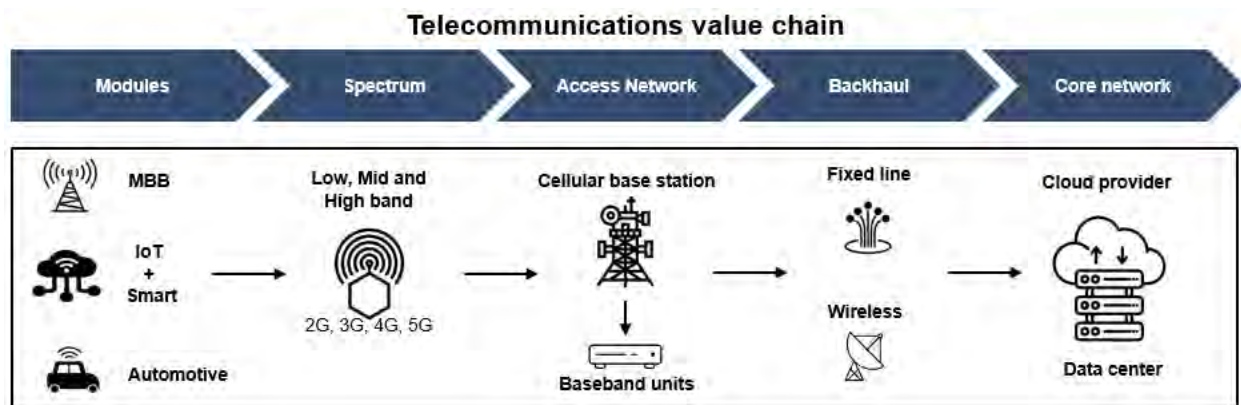
¹⁶ [Department of Commerce and Homeland Security](#)

¹⁷ [UN Comtrade Database](#)

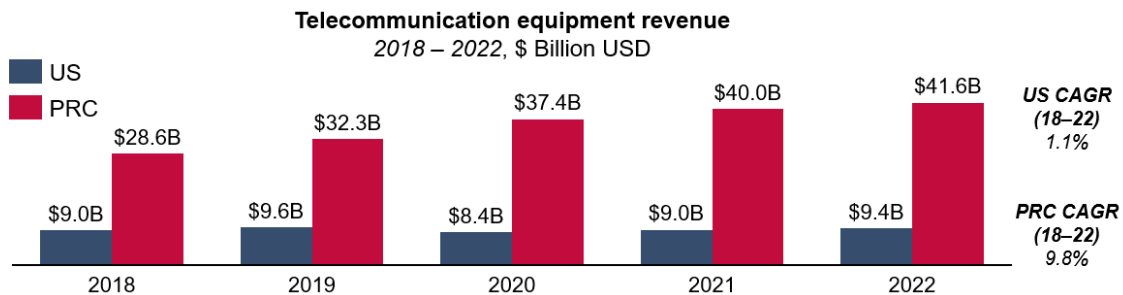
the Belt and Road and in Europe.¹⁸ And PRC firms are positioning to compete with U.S. companies in emerging markets and have exported communication satellites to Nigeria, Belarus, Algeria, Laos, and other countries.¹⁹ Nonetheless, as of 2020, the U.S. market for satellites was more than six times the size of the PRC market. For launch vehicles, the U.S. market was approximately four times the size of the PRC market.²⁰ And in 2021, U.S. aggregate communication satellite and launch vehicle exports from 2016-2020 were approximately 4.7 times higher than PRC exports.²¹

Spotlight: Telecommunications Equipment

Common examples of wireless telecommunications equipment include cell phones, mobile broadband, WiFi, and Bluetooth. Today, 5G—the fifth generation of mobile networks—is deploying worldwide, delivering higher bandwidth for users. The production and exports of the physical equipment used in wireless networks, especially 5G infrastructure, are areas of economic and geopolitical significance.



PRODUCTION (Capacity)²²



The U.S. has largely relied on the offshore production of equipment used in current wireless networks, primarily based in the PRC. In 2022, U.S. telecom equipment revenue—which includes the physical infrastructure used in wireless networks such as antennas, radio units, base stations, routers, and switches, among others—was nearly five times less than that of the PRC and represented only nine

¹⁸ [Observer Research Foundation](#)

¹⁹ [Observer Research Foundation](#)

²⁰ [Global Industry Analysts](#)

²¹ [United Nations Comtrade Database](#)

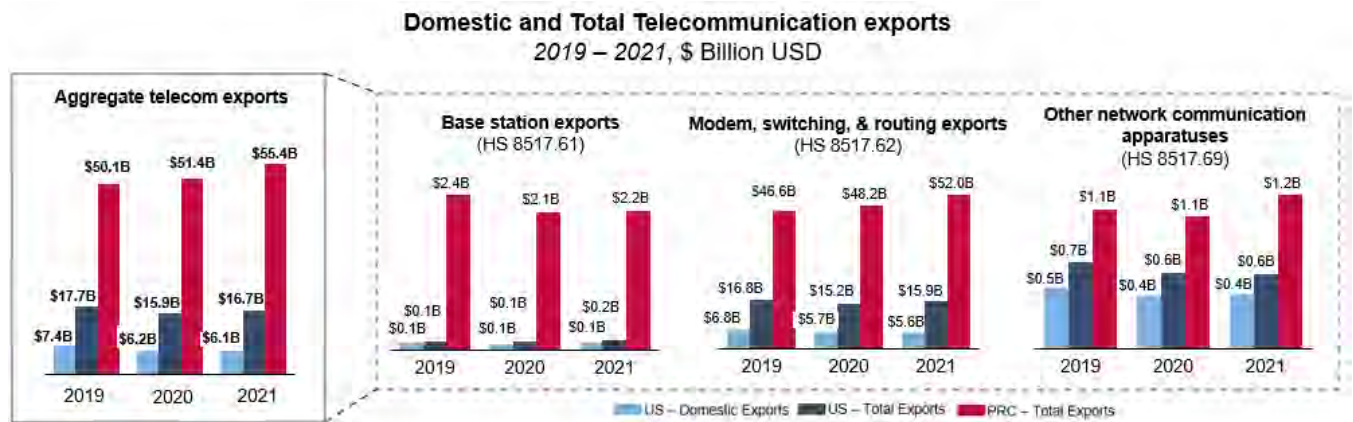
²² The compound annual growth rate (CAGR) is the rate of return that would be required for an investment to grow from its beginning balance to its ending balance, assuming the profits were reinvested at the end of each period of the investment’s life span.

percent of the global market.²³ U.S. production has also remained relatively flat in recent years, growing at one percent year-over-year since 2018.²⁴ Furthermore, in contrast to the PRC, the U.S. does not have a true end-to-end player across the wireless telecom equipment value chain. U.S.-based telecom equipment companies tend to focus largely on optical and switching equipment.²⁵

In recent years, U.S. companies have prioritized developing open radio access network (O-RAN) capabilities, rather than building the proprietary equipment used in traditional wireless networks.²⁶ While O-RAN remains a small segment of the overall wireless equipment market today, it is growing rapidly; by 2026, industry analysts project that wireless service providers will spend 21 percent of their RAN capital expenditures on O-RAN technologies.²⁷ U.S. companies are among the most advanced worldwide in O-RAN development and manufacturing.²⁸ Additionally, relative to traditional wireless infrastructure, O-RAN offers lower barriers to market entry, in theory allowing smaller U.S. companies to attempt to compete against larger PRC firms, such as Huawei and ZTE.²⁹

The U.S. government has recently taken several steps to boost domestic production of telecom equipment, largely targeted toward O-RAN development. In 2020, the Federal Communications Commission (FCC) requested \$2 billion from Congress to finance the removal of Huawei equipment from U.S. networks, and suggested replacing the Huawei gear with O-RAN technology.³⁰ Similarly, in 2022, the Chips and Science Act contained \$1.5 billion for O-RAN funding to bolster the competitiveness of U.S. manufacturing.³¹

EXPORTS (Demand)



EXIM shows Total U.S. Exports to ensure an “apples-to-apples” comparison with PRC Total Exports, but must also show Domestic U.S. Exports to highlight the subsegment EXIM can support.

Domestic Exports—Commodities grown, produced or manufactured in the U.S., including commodities imported from foreign countries that have been significantly changed or enhanced in value, in either the United States or a Foreign Trade Zone.

Total Exports—Domestic Exports plus Commodities of foreign origin that have entered the U.S. but are "re-exported" in substantially the same condition as when imported.

²³ [Dell’Oro Group](#)

²⁴ [Dell’Oro Group](#)

²⁵ [Information Technology & Innovation Foundation](#)

²⁶ [National Spectrum Consortium](#)

²⁷ [STL Partners](#)

²⁸ [Analysys Mason](#)

²⁹ [Light Reading](#)

³⁰ [MeriTalk](#)

³¹ P.L. 117-167, August 9, 2022. [National Telecommunications and Information Administration](#)

In 2021, the value of U.S. telecom equipment exports was 3.3 times *less* than that of the PRC.³² Over the past three years, U.S. exports in the wireless infrastructure space have declined slightly due to decreases in U.S. trade of modems, switches, and routers, as well as other network communication gear. The U.S. runs a significant trade deficit in telecom equipment; in aggregate, the U.S. imported \$44.6 billion in network gear in 2021, 2.7 times greater than the value of its exports. U.S. manufacturers who produce wireless infrastructure largely do so using overseas manufacturing.³³

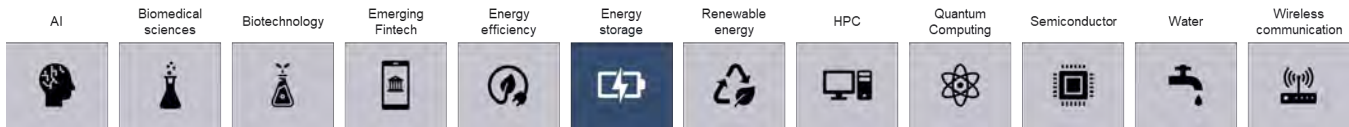
Despite the strategic importance of wireless equipment, the U.S. lacks a leading provider of mobile wireless infrastructure—a key source of global demand—which has limited the U.S. government’s ability to support domestic exports. To counter the PRC in the 5G space, U.S. officials have explored opportunities to leverage U.S. financing to support sales from companies based in partner or allied countries that have U.S.-based operations.

While the U.S. exports only a relatively modest amount of telecommunications hardware, however, U.S. technology companies are leaders in the development of network software and hardware. U.S. companies—which remain R&D players in the space—have pioneered advances in new technologies such as multiple-input and multiple-output antennas, mobile packet core software, RAN software, and software for Unified Communications as a Service.³⁴ While the telecom equipment market remains dominated by physical gear such as base stations, modems, switches, and routers, among others, the U.S. is better positioned to lead in the export of new software and more specialized hardware.

³² [United Nations Comtrade Database](#)

³³ For example, see: [Cisco](#)

³⁴ [Information Technology & Innovation Foundation](#)



Energy Storage

Scope

EXIM defines the Energy Storage transformational export area as equipment or services for storing energy with a capacity greater than 1 kWh.

EXIM segmented this definition into seven industries: battery; hydrogen; pumped hydro; electrical; thermal; compressed air; and flywheel.

EXIM Activity

From January 2020 to September 2023, EXIM has authorized seven transactions worth over \$20 million that qualify under Energy Storage, with the amount split between short- and medium-term transactions. One noteworthy transaction that demonstrates the connection between critical minerals and energy storage is financing for the expansion of Aquatech’s laboratory and equipment, which will be used to extract lithium from brine to 99.97 percent battery grade quality for electric vehicles.

Capacity and Demand Overview

As the spotlight below illuminates, U.S. businesses seeking to penetrate the global battery market significantly lag PRC companies in production capacity, exports, government support, and business performance. The production capacity of U.S. businesses is less those from the PRC in the battery industries – precisely the value chain where EXIM has seen interest in accessing financing for foreign borrowers looking to purchase U.S. goods and services and for domestic borrowers looking to develop U.S.-based projects with an export nexus.

It is worth noting that, at the time of this report, U.S. production and exports lead the PRC in hydrogen energy storage segment due to U.S. advantages in fossil fuel industries. In 2021, the U.S. share of the global hydrogen energy storage market was 1.4 times greater than that of the PRC.³⁵ U.S. production is projected grow 5.2 percent year-over-year through 2025, outpacing both the global growth rate (4.4 percent) and PRC growth rate (4.0 percent).³⁶ Thus, the U.S. hydrogen storage market is both larger than the corresponding PRC market and is growing faster. By the macro statistics, the U.S. leads in hydrogen production relative to the PRC due to several market dynamics. One factor is cost: because of the U.S. can produce hydrogen at a rate of \$1.00–1.50 per kilogram, while the PRC can produce hydrogen at a rate of \$1.75–\$2.50 per kilogram.³⁷ However, it is important to note that the cost of hydrogen is low due to efficiencies in so-called grey hydrogen, or hydrogen with unabated CO₂. Grey hydrogen is not used as a form of energy storage and is mostly a feedstock for the oil and gas refining sector, as well as ammonia and the chemicals industry. The value of U.S. exports in the hydrogen industry was more than 14 times the value of PRC hydrogen exports in 2022.³⁸ U.S. exports—worth

³⁵ [Grand View Research](#)

³⁶ [Grand View Research](#)

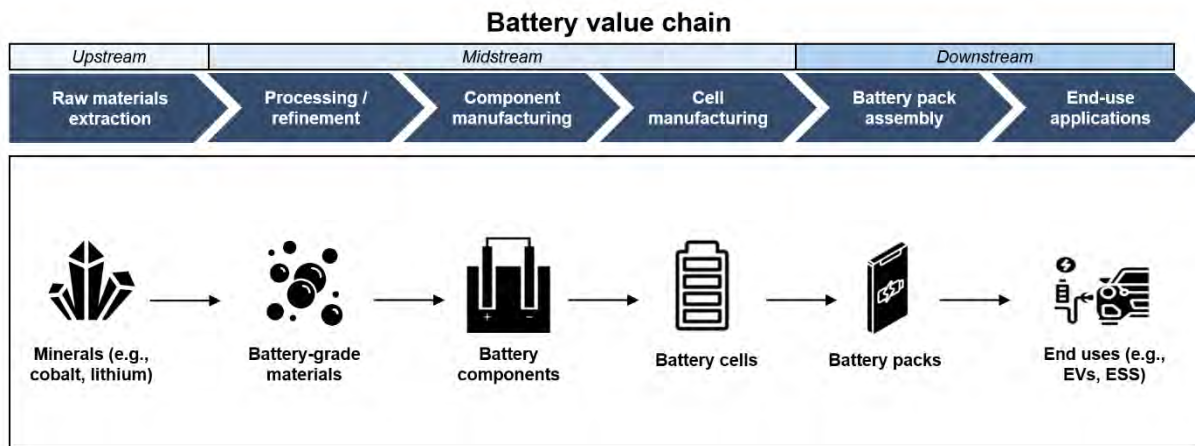
³⁷ [International Energy Agency](#)

³⁸ [United Nations Comtrade Database](#)

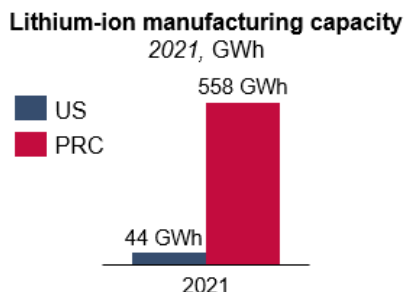
almost \$15 million in 2022—are relatively low simply because overall international trade of hydrogen is low, primarily due to the difficulty in transporting it.³⁹ While the U.S. has a lower hydrogen trade deficit relative to the PRC, it is still a net importer of hydrogen, importing approximately \$53 million in 2022.⁴⁰

Spotlight: Batteries

Batteries accept, store, and release chemical energy. Lithium-ion batteries (LiBs) are a particularly important enabler of the green energy transition and represent a key global economic and industrial policy focus area. As a result, this analysis focuses primarily on the lithium-ion battery market.



PRODUCTION (Capacity)



The U.S. lagged the PRC in lithium-ion battery manufacturing in 2021, producing just 44 gigawatt hours (GWh) of capacity versus 558 GWh for the PRC.⁴¹ This disparity results most directly from higher labor and material costs—additionally, factors such as lower U.S. government supply and demand-side support, declining U.S. control over key mineral resources over the last few decades, and the transfer of U.S. technological innovations all help drive the PRC’s position.^{42, 43} In terms of global share, the U.S. controlled only six percent of the world’s LiB manufacturing capacity in 2021—and even lower shares of components and key minerals. There is also not a single U.S.-based company among the

³⁹ [International Energy Agency](#)

⁴⁰ [United Nations Comtrade Database](#)

⁴¹ [Visual Capitalist](#)

⁴² [Li-Bridge](#)

⁴³ [Wood Mac](#)

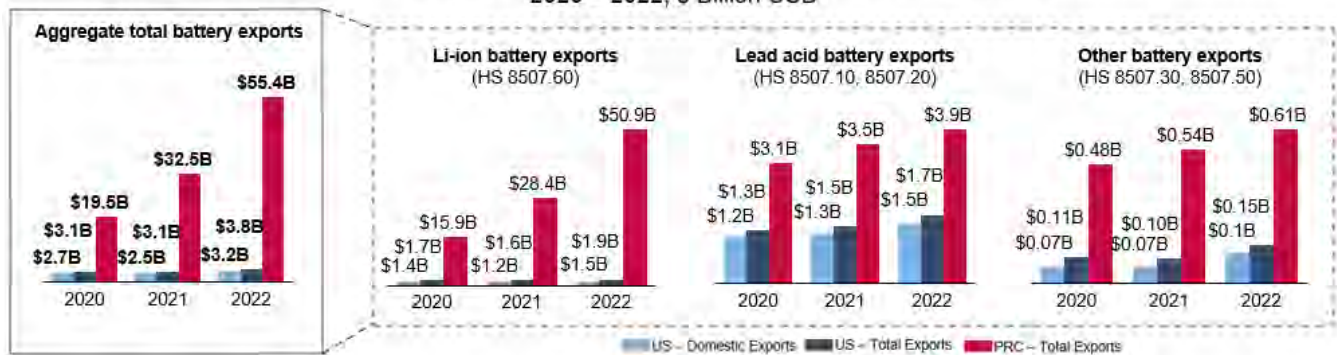
world’s top 10 LiB suppliers as of this report’s drafting.^{44, 45} The razor-thin margins and high capital costs associated with battery production decrease attractiveness to investors, exacerbating the PRC’s first-mover advantage and economies of scale.

This manufacturing shortfall has taken on increasing importance as the U.S. electric vehicle (EV) industry takes off, with EV registrations increasing 57 percent in 2022 and U.S. EV battery demand expected to rise 36 GWh between 2023 and 2032.^{46, 47} The Infrastructure Investment and Jobs Act and Inflation Reduction Act provide incentives for domestic manufacturing, such as the battery production tax credit, which has already resulted in announcements of more than 800 GWh of new U.S. battery production capacity.⁴⁸ Most existing U.S.-based battery manufacturing builds lower-density, lead-acid batteries, and U.S. auto-makers have, to date, low vertical integration for battery production. Therefore, the Inflation Reduction Act’s tax credits aim to help attract foreign investment and human capital to fill the current U.S. capacity gap for lithium-ion batteries.

Meanwhile, the PRC dominates the globe in LiB production capacity across the entire value chain. In 2022, the PRC refined 67 percent of the world’s lithium, 73 percent of cobalt, 95 percent of manganese, and 70 percent of graphite, reflecting the PRC’s positioning as the world’s key refining hub for critical minerals.⁴⁹ In terms of battery component production, the PRC manufactured 77 percent of cathodes, 92 percent of anodes, 74 percent of separators, and 82 percent of electrolytes as of 2021.⁵⁰ Finally, the PRC controls nearly 80 percent of the world’s LiB cell production—including 99 percent of lithium iron phosphate (LFP) LiB cells.⁵¹

EXPORTS (Demand)

Domestic and Total Battery (Li-ion, lead acid, and other) exports
2020 – 2022, \$ Billion USD



EXIM shows Total U.S. Exports to ensure an “apples-to-apples” comparison with PRC Total Exports but must also show Domestic U.S. Exports to highlight the subsegment EXIM can support.

Domestic Exports—Commodities grown, produced or manufactured in the U.S., including commodities imported from foreign countries that have been significantly changed or enhanced in value, in either the United States or a Foreign Trade Zone.

Total Exports—Domestic Exports plus Commodities of foreign origin that have entered the U.S. but are "re-exported" in substantially the same condition as when imported.

⁴⁴ [Visual Capitalist](#)

⁴⁵ [Visual Capitalist](#)

⁴⁶ [InsideEVs](#)

⁴⁷ [Columbia School of International and Public Affairs](#)

⁴⁸ [Forbes](#)

⁴⁹ [CRU Group](#)

⁵⁰ [CRU Group](#)

⁵¹ [Columbia School of International and Public Affairs](#)

In 2022, the U.S. exported nearly 14 times *less* in trade value than the PRC in Lithium ion, lead acid, and other batteries—with the PRC’s dominant edge in LiB exports over the U.S. (\$51 billion vs. \$2 billion) accounting for the bulk of its export leadership. Additionally, the U.S. is the world’s second largest importer of LiBs (after Germany) and ran a negative trade balance of around \$12 billion in 2022, the largest in the world. Around two-thirds of U.S. LiB imports came from the PRC, led by shipments from the PRC battery maker CATL, which helped propel the PRC from \$1.1 billion in annual LiB exports to the U.S. in 2017 to \$10.1 billion today. Q1 2023 figures suggested a further increasing concentration of imports on the PRC, which represented about 88 percent of U.S. LiB imports as of May 2023.^{52, 53}

In fact, the U.S. has seen 11 consecutive quarters of LiB import growth through Q1 2023 due to increasing demand for electric vehicles and energy storage stations. These record U.S. battery imports reflect how existing U.S. battery manufacturing capacity is struggling to keep pace with rising domestic demand, let alone whether U.S. manufacturers have the spare capacity to export their products to foreign buyers.⁵⁴ Further, while *final* battery assembly in the U.S. is expected to begin nearing self-sufficiency in the next five years—with production predicted to reach 12.2 million passenger vehicles, or 95 percent of 2022 sales, by 2027—domestic shortfalls are likely to continue in “midstream” value chain stages like cathode and anode production and the refinement of key minerals (e.g., cobalt). Cathode and anode shortages by 2032 are still estimated at 82 percent and 92 percent, respectively, implying continued import reliance on the PRC and other exporters for key battery components, even as U.S. battery manufacturing takes off.^{55, 56}

However, the Inflation Reduction Act aims to encourage the development of additional battery manufacturing capacity directly via the advanced manufacturing production credit and indirectly via subsidization for sales of electric vehicles that meet certain domestic content requirements—as well as support for residential battery storage technology.⁵⁷ These incentives set forth targets intended to transform the industry value chain from its highly PRC-centric existing state. An increase in U.S.-produced batteries will also increase opportunities for EXIM financing to support U.S. growth in this industry.

⁵² [S&P Global](#)

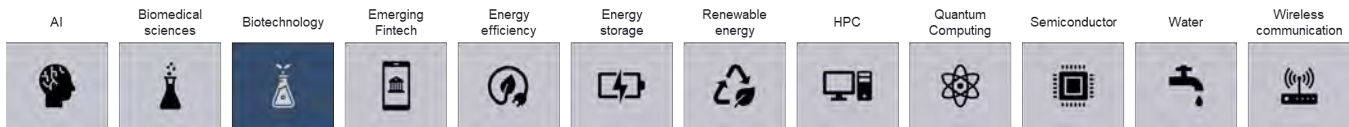
⁵³ [United Nations Comtrade Database](#)

⁵⁴ [S&P Global](#)

⁵⁵ [Columbia School of International and Public Affairs](#)

⁵⁶ [Environmental Defense Fund](#)

⁵⁷ [United States Congress](#)



Biotechnology

Scope

EXIM defines the Biotechnology transformational export area as equipment or services that utilize biological processes for industrial and other purposes.

EXIM segmented this definition into 18 industries: biofuels; synthetic biology; alternative proteins; bioplastics and biopolymers; bioengineered seeds; bioinformatic technology; animal genetics; fertilizers; pesticides; industrial enzymes; organic acids; amino acids; surfactants; aroma chemicals; fermented ingredients; flavor enhancers; vitamins; and natural sweeteners.

EXIM Activity

From January 2020 to September 2023, EXIM has authorized 15 transactions worth over \$5 million that qualify under Biotechnology, all of which have been short-term insurance policies.

Capacity and Demand Overview

EXIM activity in the Biotechnology industries has been small because, except for biofuels, most are in the nascent stages of commercialization and don't yet produce many exports. As the Synthetic Biology spotlight illuminates below, EXIM found that in many industries, at the time of this report, U.S. companies lead the PRC in R&D and early production, but the nascent markets do not yet support volume and Harmonized System (HS) codes don't necessarily exist yet, making export analysis insufficiently precise.

Biofuels – the industrial biotech industry that creates input materials for biomass renewable energy - is sufficiently mature, however. The U.S. produced 21 billion gallons of biofuels in 2021, of which 85 percent was ethanol and 11 percent was biodiesel.⁵⁸ The United States holds a commanding lead over the PRC in the production of ethanol, which stems from the country's strong corn farming infrastructure.⁵⁹ The U.S. produces 59 percent more ethanol than Brazil, the largest producer in the world, while the PRC is the fourth largest producer worldwide.⁶⁰ Finally, in aggregate, U.S exports in biofuels are 2.5 times higher than the corresponding PRC exports; more specifically, the U.S. leads the PRC in the exports of ethanol and biodiesel blends.

Spotlight: Synthetic Biology

Synthetic biology refers to the design and fabrication of biological systems that do not exist in nature—as well as the redesign of existing biological systems.^{61, 62} Applications of synthetic biology often include the design and engineering of enzymes, genetic circuits, cells, and microbes. Industry

⁵⁸ [Energy Information Administration](#)

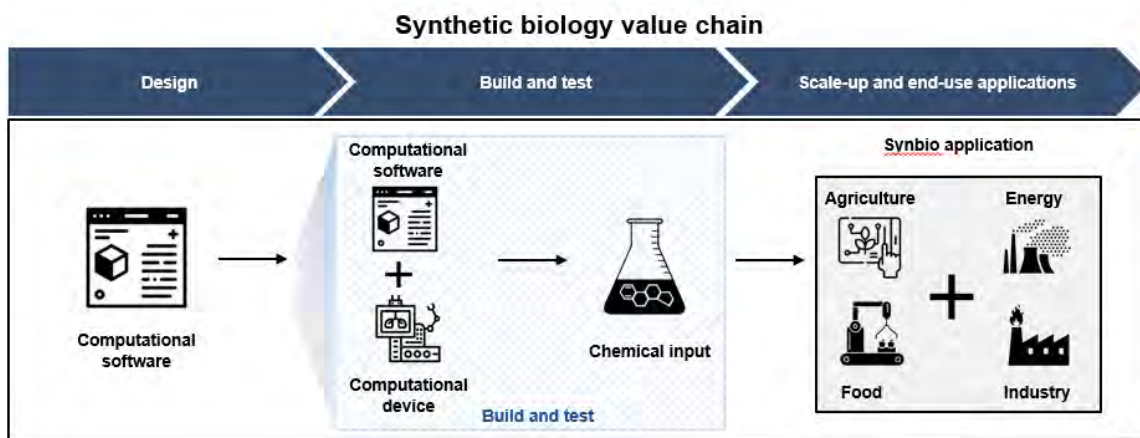
⁵⁹ [Department of Agriculture](#)

⁶⁰ [Department of Agriculture](#)

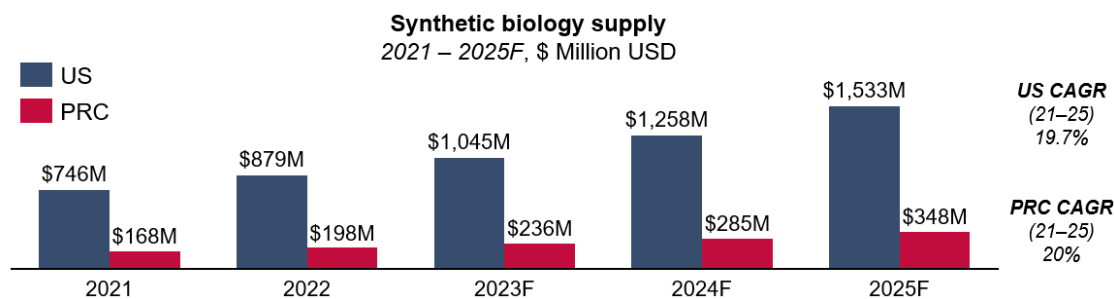
⁶¹ [National Institutes of Health](#)

⁶² [Massachusetts Institute of Technology](#)

participants typically divide the synthetic biology industry into two segments: healthcare and non-healthcare. For EXIM’s purposes, the healthcare segment is captured under the Biomedical Sciences transformational export area because it includes technologies used by medical and pharmaceutical institutions. The non-healthcare segment—which is the primary focus of this report spotlight—includes technologies used in agriculture and manufacturing, among other industries. Within the non-healthcare segment, synthetic biology products are key inputs in new food production, military, and biofuel technologies, among other goods.⁶³



PRODUCTION (Capacity)



U.S. production in the synthetic biology space is currently more than four times greater than PRC production and will grow by a projected nearly 20 percent year-over-year through 2025.⁶⁴ There are currently relatively few U.S. companies (e.g., Twist Bioscience (U.S.) and Illumina (U.S.)) that operate exclusively in synthetic biology, illustrating that the commercialization of new technologies in the space is in its early stages.⁶⁵ However, U.S. firms are investing in synthetic biology and expanding their portfolios abroad to gain manufacturing capacity. For example, in 2020, Integrated DNA Technologies (U.S.) established strategic partnerships in Japan and South Korea with the intent to help the company scale production.⁶⁶

⁶³ [Research and Development Europe](#)

⁶⁴ [Grand View Research](#)

⁶⁵ [S&P Capital IQ](#)

⁶⁶ [Grand View Research](#)

Multiple U.S. government agencies have identified synthetic biology as a key strategic focus and are investing in domestic production. The National Science Foundation, the National Institutes of Health, NASA, the Navy, the Air Force, and the Departments of Energy, Defense, Agriculture, and Health and Human Services, have each provided federal funding to companies in the synthetic biology space.⁶⁷ In addition to providing federal funding, the Department of Defense, through the Office of the Under Secretary of Defense, Research and Engineering (OUSD(R&E)), listed biotechnology—including synthetic biology—as one of its Critical Technology Areas.⁶⁸ With growing public support and private investment, U.S. production in the synthetic biology space will likely increase over the coming decade. While the PRC currently trails the United States in terms of synthetic biology production by a factor of four, production is expected to grow rapidly through 2025, with analysts estimating a 20 percent Compound Annual Growth Rate (CAGR).⁶⁹ And the PRC military has also labeled synthetic biology as a key warfighting domain.⁷⁰

EXPORTS (Demand)

The global synthetic biology industry is still in its infancy. Products specific to synthetic biology have not yet been included in the HS Classification Handbook, rendering precise export data unavailable. Therefore, this report does not evaluate U.S. and PRC synthetic biology export figures. Rather, it provides a description of early-stage investment and R&D efforts in each country—

U.S. companies are investing heavily in non-healthcare synthetic biology R&D. As of 2022, there were 74 investor-funded synthetic biology companies in the U.S., as opposed to 11 in the PRC.⁷¹ Furthermore, in 2020, combined public and private investment in U.S. synthetic biology companies totaled over \$15 billion – and the government provided less than \$1 billion in funding.⁷² Food is among the most active subfields of synthetic biology; two U.S. companies (Impossible Foods (U.S.) and New Age Meats (U.S.)) were top recipients of venture capital funding in this space, compared to zero PRC companies. Moreover, the average deal size (2017-2021) of private synthetic biology transactions in the U.S. was more than seven times greater than that of the PRC, illustrating the relative U.S. advantage of greater private investment in synthetic biology research.

The U.S. government has also invested in synthetic biology R&D. In 2021, the U.S. government provided \$220 million in synthetic biology funding, spread across multiple federal agencies. Notably, most of the Department of Defense’s funding came from the Defense Advanced Research Projects Agency (DARPA), emphasizing synthetic bio’s importance to national security.⁷³ U.S. investors have testified to government bodies regarding the strategic importance of the government prioritizing synthetic biology investment to a greater extent.⁷⁴ However, in contrast to the PRC, the U.S. government has not released a national roadmap for promoting innovation in the synthetic biology industry.⁷⁵ Overall, U.S. investment in synthetic biology R&D remains dominated by the private sector,

⁶⁷ [Grand View Research](#)

⁶⁸ [Department of Defense](#)

⁶⁹ [Grand View Research](#)

⁷⁰ [National Library of Medicine](#)

⁷¹ [Pitchbook](#)

⁷² [Grand View Research](#)

⁷³ [Defense Advanced Research Projects Agency](#)

⁷⁴ [United States-China Economic and Security Review Commission](#)

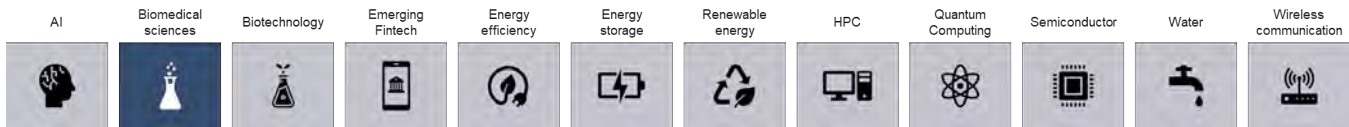
⁷⁵ [National Science Review](#)

with funding by life sciences incumbents and venture capital and private equity investors driving development.

Of note, the PRC has developed an advantage over the United States in access to genetic material, which underpins next-generation synthetic biology technologies such as high-yield crops and living camouflage, among others. Beijing Geonomics Institute (BGI) has gained access to an enormous amount of both human and non-human genetic data, sometimes surreptitiously.⁷⁶ The PRC's emerging advantage in genetics may provide the country with a competitive edge over the U.S. in future competition in this space.⁷⁷

⁷⁶[United States Sentencing Commission](#)

⁷⁷[National Academy of Sciences](#)



Biomedical Sciences

Scope

EXIM defines the Biomedical Sciences transformational export area as equipment or services related to advanced medical equipment and processes used for the diagnosis and treatment of medical conditions in humans.

EXIM segmented this definition into 31 industries associated with six scientific areas⁷⁸ associated with Biomedical Sciences: vaccines; monoclonal antibodies; pharmaceutical drugs; medical imaging equipment; surgical robotics; blood testing; blood banking; cell therapy; electron microscopy; radiotherapy; gene therapy; molecular diagnostics; genetic testing; allergy immunotherapies; respiratory care devices; contact lenses; elderly and disabled assistive devices; electric nerve stimulation machines; reading glasses; hearing aids; medical furniture; medical garments; medical tubing; orthopedic devices; sterilization equipment; surgical drapes; medical globes; dental equipment; advanced wound dressing; surgical instruments; and rapid diagnostic kits.

EXIM Activity

From January 2020 to September 2023, EXIM has authorized 99 transactions worth over \$45 million that qualify under Biomedical Sciences, the largest number of transactions within the transformational export areas. All transactions have been short-term insurance or working capital products. Exports include laboratory equipment, surgical and medical instruments, and innovative pharmaceuticals.

Capacity and Demand Overview

A summary assessment of capacity and demand across the sheer range of biomedical industries is difficult. The goods and services are highly varied and have very different profiles. Not to the exclusion of any opportunity, EXIM sees great export and job growth potential in the vaccines, monoclonal antibodies, pharmaceutical drugs, medical imaging equipment, and surgical robotics industries. Many of the Biomedical transformational export area industries produce non-durable goods or services that buyers purchase during the performance of normal business operations. EXIM can and does finance the sales of such products through its short-term export credit insurance program, which is typically used by smaller businesses to reduce the risk of buyer non-payment. Transactions are typically for smaller dollar amounts and are limited to those companies that have difficulty securing competitive and commercially viable export credit insurance policies from the private sector.

EXIM does see significant potential for more sizable debt financing transactions to facilitate the purchase of medical imaging products. The U.S. leads the PRC in the value-added production of irradiation, electromedical, and electrotherapeutic equipment.⁷⁹ This industry category includes devices such as X-rays, CT scanners, PET scanners, MRI equipment, ultrasound equipment, and other

⁷⁸ Blood Sciences, Cell Sciences, Genetics and Molecular Pathology, Infection Sciences, Pharmaceutical Sciences and Medical Devices

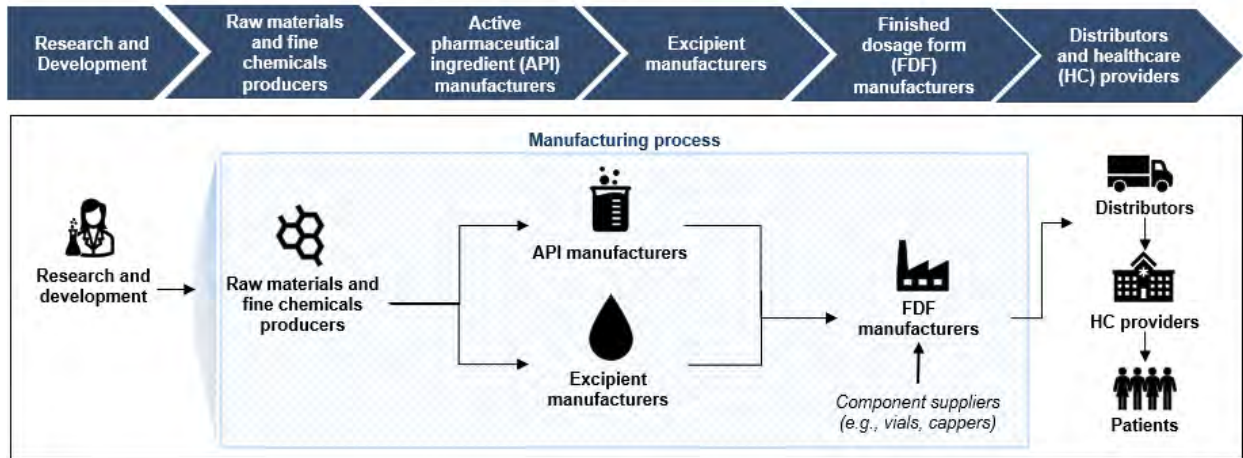
⁷⁹ [Oxford Economics](#)

imaging devices such as electrocardiographs. In 2022, the U.S. had \$24.7 billion in value-added production activity compared to \$9.9 billion for the PRC, a difference of nearly 2.5 times. Of note, the PRC medical device market has been growing at a steady rate in recent years.⁸⁰

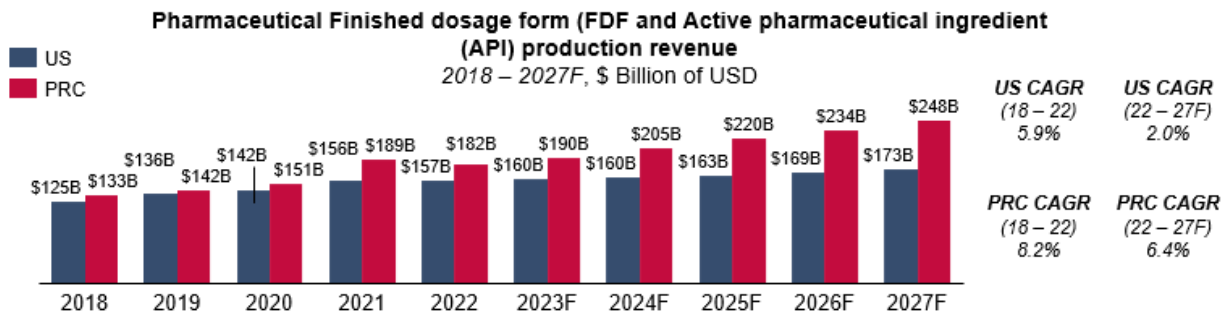
Spotlight: Pharmaceutical Drugs (Small-Molecule Drugs)

There are two key segments of the overall market for pharmaceutical drugs—small-molecule drugs and large-molecule drugs. Small-molecule drugs are molecular compounds produced via chemical synthesis, typically administered them orally and account for 90 percent of all available drugs.^{81, 82, 83}

Pharmaceutical drugs value chain



PRODUCTION (Capacity)



In 2022, the PRC’s share of global production—including both active pharmaceutical ingredients (APIs) and finished dosage forms (FDFs)—was almost 1.2 times greater than that of the United States. The growth rate of U.S. production lagged the PRC’s growth rate by 2.3 percent year-over-year from 2018 to 2022 and is expected to trail the PRC’s growth rate by 4.4 percent year-over-year from 2022 to 2027.⁸⁴ Therefore, summarizing the chart above, while the PRC currently holds only a slight edge over the U.S. in terms of the production of pharmaceutical drugs, its advantage is forecast to grow in

⁸⁰ [Oxford Economics](#)
⁸¹ [University College London](#)
⁸² [Pharma Offer](#)
⁸³ [Emory University](#)
⁸⁴ [Oxford Economics](#)

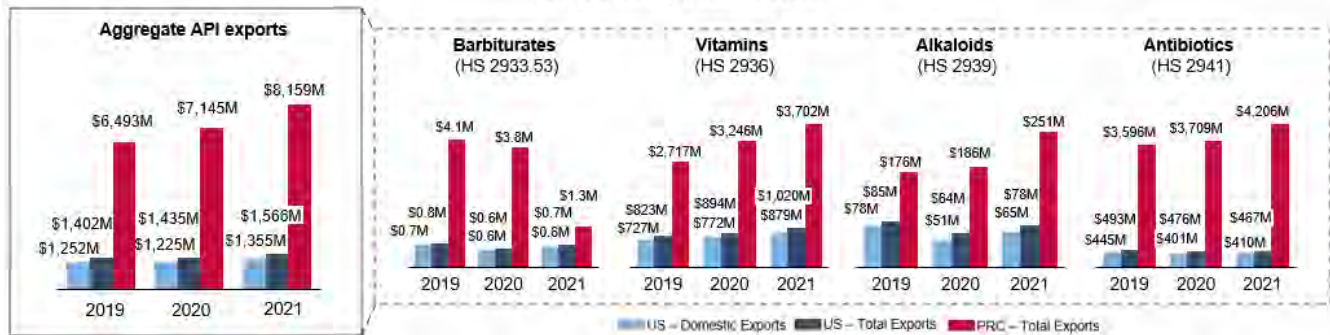
coming years.⁸⁵ Of note, measuring production in dollar value terms may deflate the true advantage held by the PRC due to the lower-price product focus of PRC manufacturing, which indexes heavily on APIs and generic FDFs.

The United States is the global leader in branded drug manufacturing and has thus far maintained its edge in new drug development due to high R&D spending and strong intellectual property protection. The U.S. is the world’s foremost developer of novel drugs; American companies are responsible for 44 percent of all medications in the R&D pipeline worldwide, more than double any other country.⁸⁶ New drug discovery and clinical trials require high up-front investment, limiting global market participation to well-funded pharmaceutical companies. The combination of strong intellectual property protection and a developed healthcare system with high expenditures have underpinned the rise of large American pharmaceutical companies. The U.S. provides patent protection for new drugs for 20 years and has the highest global per-capita spending on prescription drugs. For these structural reasons it has consistently led the world in new drug development over the past 20 years, with the PRC’s rise not yet denting the country’s share of new medications.⁸⁷

However, the actual production process for APIs and generics has been largely offshored, driven by both the commoditized nature of these products and lower manufacturing costs in countries such as the PRC and India.^{88, 89} Today, U.S. manufacturing of APIs and generics is extremely limited.⁹⁰ U.S. producers of both APIs and generics face steep pricing pressure from foreign firms, explaining recent divestitures and greater focus on higher-margin patented drugs, which are still largely produced domestically.⁹¹

EXPORTS (Demand)

**Domestic and Total Active pharmaceutical ingredients (API) exports
2019 – 2021, \$ Million USD**



⁸⁵ [Atlantic Council](#)

⁸⁶ [International Quality and Value Institute Advisors](#)

⁸⁷ See: [Harvard School of Public Health](#) and [International Quality and Value Institute Advisors](#)

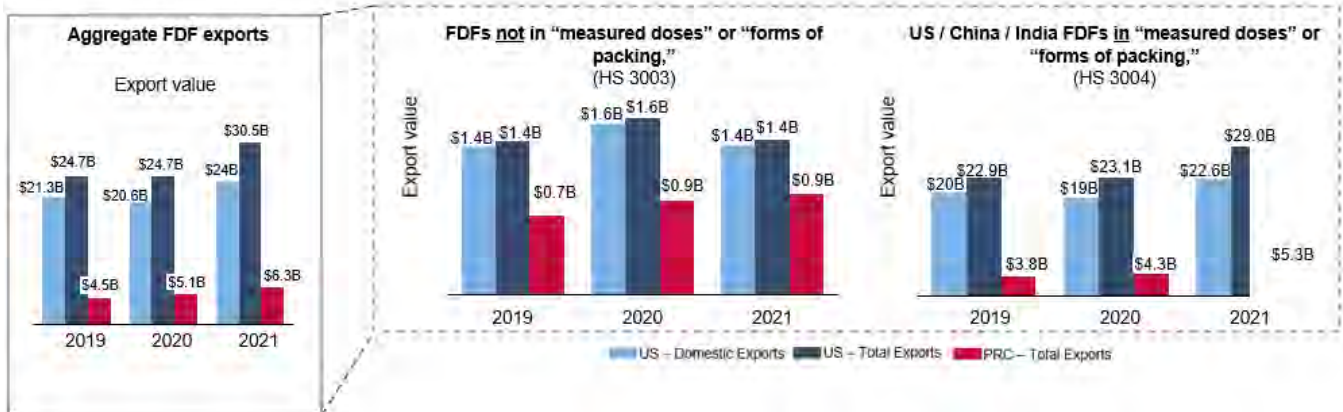
⁸⁸ [The Guardian](#)

⁸⁹ [Ernst and Young](#)

⁹⁰ [United States-China Economic and Security Review Commission](#)

⁹¹ [United States-China Economic and Security Review Commission](#)

**Domestic and Total Finished dosage form (FDF) exports
2019 – 2021, \$ Million USD (Export value) and Millions KG (Net weight)**



EXIM shows Total U.S. Exports to ensure an “apples-to-apples” comparison with PRC Total Exports but must also show Domestic U.S. Exports to highlight the subsegment EXIM can support.

Domestic Exports—Commodities grown, produced or manufactured in the U.S., including commodities imported from foreign countries that have been significantly changed or enhanced in value, in either the United States or a Foreign Trade Zone.

Total Exports—Domestic Exports plus Commodities of foreign origin that have entered the U.S. but are "re-exported" in substantially the same condition as when imported.

The U.S. is a global leader in brand-name FDF exports. In 2021, the trade value of U.S. FDF exports was 4.9 times larger than that of the PRC.⁹² The U.S. leads in trade value because of its dominance in the export of higher-priced brand-name drugs. U.S. FDF exports are the third highest globally by trade value (after Germany and Switzerland) due to the presence of leading pharmaceutical companies that enjoy high profit margins from patented drugs.^{93, 94} When measured in kilogram terms rather than dollar value, the U.S. lags PRC exports of FDFs by a factor of 3.6 times, likely due to the fact that production in the PRC focuses on cheaper generics. Therefore, it is worth noting that the PRC exports a higher volume of FDFs each year, despite the U.S. advantage.

The U.S. runs a trade deficit for generic drugs, which represent most drugs prescribed in the United States today, at around 90 percent. The U.S. also lags substantially in exports for key APIs used in both generic and name-brand FDFs. The U.S. has offshored production of generics and APIs due to lower investment attractiveness and cost pressures from overseas manufacturing. The low margin, high-volume nature of generics and APIs has largely led major U.S. pharmaceutical companies to avoid recent investment, with production moving out of Western countries and into cheaper markets such as the PRC.⁹⁵ Today, 70 percent of all facilities making APIs and generics for the U.S. are located abroad, primarily in the PRC and India.^{96, 97}

The U.S. government has taken measures to support the country’s pharmaceutical exports; however, U.S. companies remain highly dependent on PRC APIs as inputs for domestically produced drugs. In recent years, EXIM has supported American API exports. For example, in December 2020, EXIM authorized \$2.2 million in working capital loan guarantees for Cayman Chemicals, a Michigan-based API

⁹² [United Nations Comtrade Database](#)

⁹³ [United Nations Comtrade Database](#)

⁹⁴ [University of California, Berkeley](#)

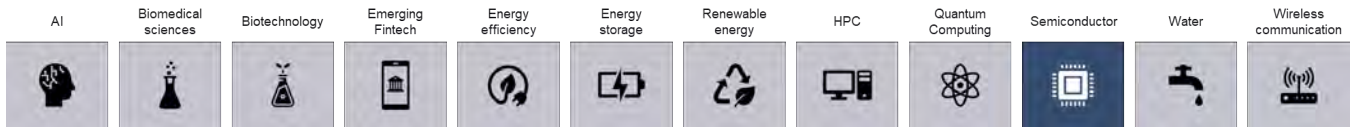
⁹⁵ [World Bank](#)

⁹⁶ [United States Food and Drug Administration](#)

⁹⁷ [The Pharma Letter](#)

manufacturer. Prior to this loan, EXIM had primarily supported exports of non-medicaments such as diagnostic tests and lab instruments.⁹⁸ While the U.S. is increasing its investments in domestic API production, it depends heavily on PRC API imports for some specific products. Today, U.S. FDF exports for some specific products hinge on API imports from the PRC—illustrating the countries' interdependence in this space.

⁹⁸ [Export-Import Bank of the United States](#)



Semiconductor and Semiconductor Machinery Manufacturing

Scope

EXIM defines the Semiconductor and semiconductor machinery manufacturing transformational export area as semiconductors and other equipment or services related to the semiconductor industry.

EXIM has segmented this definition into five major elements of its value chain: R&D and Design; Semiconductor Manufacturing Equipment; Input Materials’ Semiconductor Fabrication and Assembly; Testing; and Packaging.



EXIM Activity

From January 2020 to September 2023, EXIM has authorized 25 transactions worth over \$35 million that qualify under the Semiconductors transformational export area, all of which are short-term insurance and working capital transactions.

Capacity and Demand Overview

At the time of this report, U.S. companies are leaders in R&D and chip design, the most complex and valuable stages. Before the 2010s, integrated device manufacturers —or vertically integrated companies performing all steps in the value chain—dominated the semiconductor industry. However, vertical specialization increased over time as pure-play companies leveraged economies of scale and process efficiencies.⁹⁹ During the 2010s, foundries proved more agile in producing increasingly smaller transistors, specifically 16 nanometer (nm), 10 nm, and seven nm technology nodes, and established a lead that they have not relinquished.¹⁰⁰ Today, pure-play foundries dominate fabrication of advanced chips, acting as contract manufacturers for “fabless” semiconductor firms. Intel, however, which manufactures almost half of its chips in the U.S., remains a strong competitor as the leading global integrated device manufacturer.

EXIM’s Make More in America initiative, which provides domestic term financing to U.S.-based projects, has the potential to support fabrication production. U.S.-based industry lags the PRC in wafer production for >10nm less advanced chips and exports of all chips, but leads in the production of advanced chips (<10 nm).

Spotlight: Fabrication

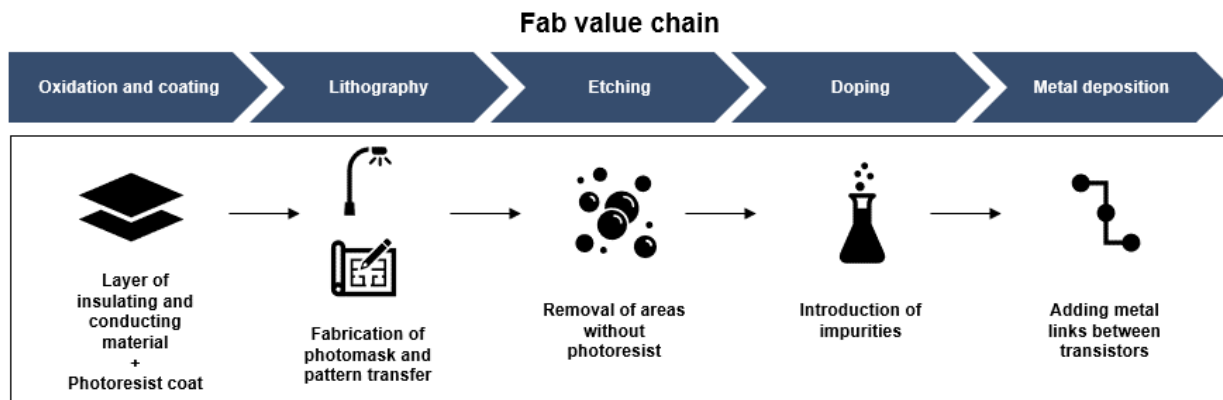
Semiconductors are partially conductive materials, typically composed of silicon integrated circuits, that underpin the functioning of modern electronic devices such as computers, home appliances,

⁹⁹ [Center for Security and Emerging Technology](#)

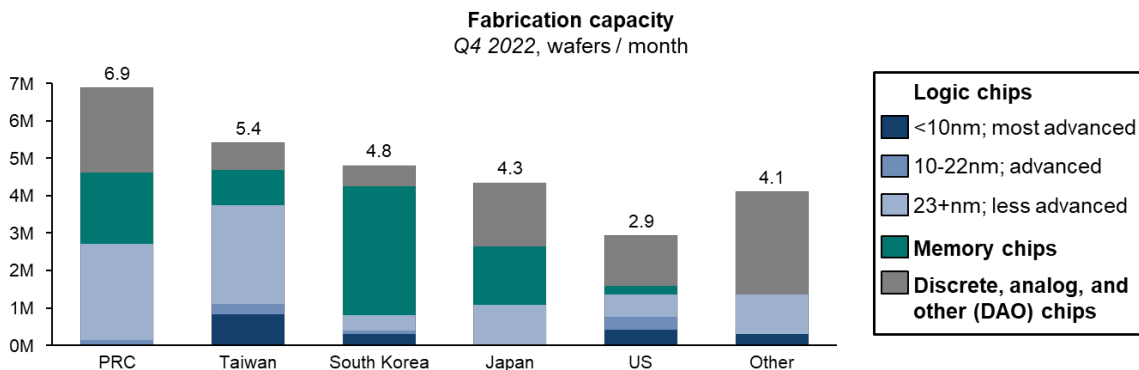
¹⁰⁰ [SemiAnalysis](#)

medical equipment, electric vehicles, and military systems. In general, smaller node sizes entail greater processing power. The world’s most advanced chips have less than 10 nm nodes and are used in power computation-intensive technologies such as artificial intelligence. Securing access to semiconductors—particularly advanced chips—is increasingly crucial to the economic and national security of the U.S.^{101, 102}

During manufacturing, or fabrication, production sites or “fabs” produce chips by completing electrical or photonic circuits on a thin slice of semiconductive material known as a wafer. Finished chips subsequently undergo assembly, testing, and packing before shipping out for distribution. Below is a detailed description of the fabrication stage, the focus of this comparative analysis given its importance to the overall industry.



PRODUCTION (Capacity)



The U.S. lags the PRC in overall semiconductor wafer fabrication capacity. As of Q4 2022, the U.S. produced 2.9 million wafers per month, compared to the PRC’s 6.9 million wafers per month.¹⁰³ The U.S. is fifth globally in terms of overall global fabrication capacity, behind the PRC, Taiwan, South Korea, and Japan. This disparity derives most directly from cost disparities, as fabrication tends to be 30 to 50 percent more expensive in the U.S. relative to in Asia.¹⁰⁴ Despite the U.S.’ first-mover advantage and strong leadership in R&D, higher labor and capital costs and fewer historical

¹⁰¹ [European Environment Agency](#)

¹⁰² [National Institute of Standards and Technology](#)

¹⁰³ [Semiconductor Industry Association](#)

¹⁰⁴ [Hearing in Senate Committee on Commerce, Science, and Transportation](#)

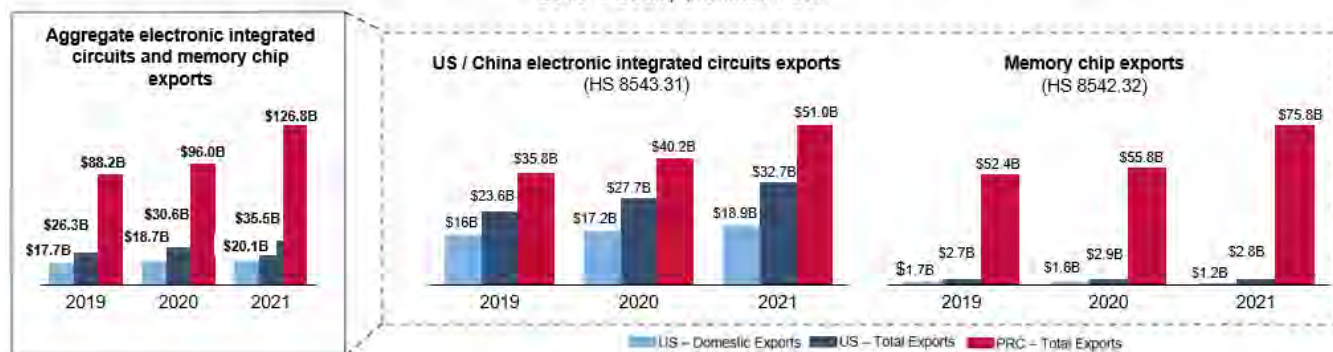
government incentives compared to East Asian countries eroded investment in new manufacturing.¹⁰⁵ For instance, the PRC, South Korea, Taiwan, and Japan have consistently provided strong domestic tax credits and other incentives for local production, such as the huge investments made in the PRC's 2014 National Integrated Circuit Plan.¹⁰⁶ As a result of all these factors, 75 percent of the world's fabrication occurs in Asia today.¹⁰⁷

The U.S. has maintained an advantage over the PRC in the fabrication of advanced chips with node sizes less than ten nanometers. In Q4 2022, the U.S. share for advanced chips was 16 percent, second in the world after Taiwan, which had 60 percent; meanwhile, the PRC's share in the space remains negligible (less than 1 percent).¹⁰⁸ U.S. market share in this space comes from its leading design capabilities, and companies and research institutions that produce a subset of advanced chips domestically. However, U.S. advanced chip foundries still significantly lag TSMC in scale and technological advancement, and cutting-edge chips designed by leading U.S. fabless companies primarily undergo manufacturing in Taiwan.¹⁰⁹

The U.S. government has recently taken strong measures to boost domestic semiconductor fabrication capacity, particularly for advanced chips. The Chips and Science Act, which President Biden signed into law in 2022, will provide over \$39 billion in for investment in semiconductor facilities and equipment in the United States.¹¹⁰ Leading manufacturers have since announced more than \$166 billion in domestic investments. This includes the construction of 15 new fabrication facilities and 10 announced future builds.^{111, 112} Moreover, leading companies have announced plans to build 3 nm and 4 nm chips in the U.S. in the next two years. All in all, the Chips and Science Act is helping to grow U.S. semiconductor production, but, in the short term, the PRC still benefits from structural advantages in cost competitiveness for less advanced chips, and the U.S. retains strong dependence on Taiwan for advanced chips.

EXPORTS (Demand)

Domestic and Total Electronic integrated circuits and memory chip exports
2019 – 2021, \$ Billion USD



¹⁰⁵ [European Environment Agency](#)

¹⁰⁶ [United States International Trade Commission](#)

¹⁰⁷ [Semiconductor Industry Association](#)

¹⁰⁸ [Semiconductor Industry Association](#)

¹⁰⁹ [Harvard Belfer Center](#)

¹¹⁰ [United States Congress- CHIPS Act](#)

¹¹¹ [Semiconductor Industry Association](#)

¹¹² [Semiconductor Equipment and Materials International](#)

EXIM shows Total U.S. Exports to ensure an “apples-to-apples” comparison with PRC Total Exports but must also show Domestic U.S. Exports to highlight the subsegment EXIM can support.

Domestic Exports—Commodities grown, produced or manufactured in the U.S., including commodities imported from foreign countries that have been significantly changed or enhanced in value, in either the United States or a Foreign Trade Zone.

Total Exports—Domestic Exports plus Commodities of foreign origin that have entered the U.S. but are “re-exported” in substantially the same condition as when imported.

The U.S. trails the PRC in semiconductor chip exports, stemming from the PRC’s leadership in producing larger node, less advanced chips, which represent the bulk of the global market. In 2021, the value of PRC semiconductor exports was nearly four times greater than that of the U.S., at \$127 billion versus \$35 billion.¹¹³

Despite the large amount of imports, semiconductors are the fifth largest U.S. export and make up a key share of imports for areas like the EU, Canada, and Mexico, with international sales representing 80 percent of U.S. semiconductor industry sales.¹¹⁴ Assembly, testing, and packaging (ATP) is the final step of the semiconductor value chain, and the country where ATP takes place is often credited with exporting the value of the entire semiconductor, regardless of where fabrication occurs.

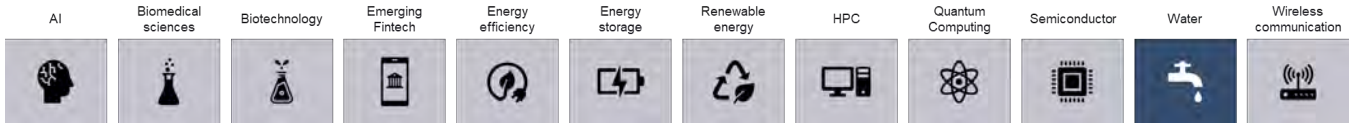
In sum, the Chips and Science Act is boosting investments in U.S. manufacturing capacity, which creates downstream benefits on exports. Examples include one company’s plans to invest approximately \$40 billion to bring more memory chip manufacturing to the U.S. by 2025.¹¹⁵ The Department of Commerce has also announced restrictions on the export of advanced chips and chip manufacturing equipment to the PRC, impacting U.S. and allied nations’ trade with the large PRC electronics market.¹¹⁶

¹¹³ [United Nations Comtrade Database](#)

¹¹⁴ [Semiconductor Industry Association](#)

¹¹⁵ [The White House](#)

¹¹⁶ [Bureau of Industry and Security](#)



Water Treatment and Sanitation

Scope

EXIM defines the Water Treatment and Sanitation transformational export area as equipment or services related to the production or distribution of potable water for human consumption or the collection or treatment of wastewater, regardless of origin.

EXIM segmented this definition into five principal industries: Water Treatment;

Wastewater Treatment; Industrial Wastewater Treatment; Desalination and Mobile Water Treatment.

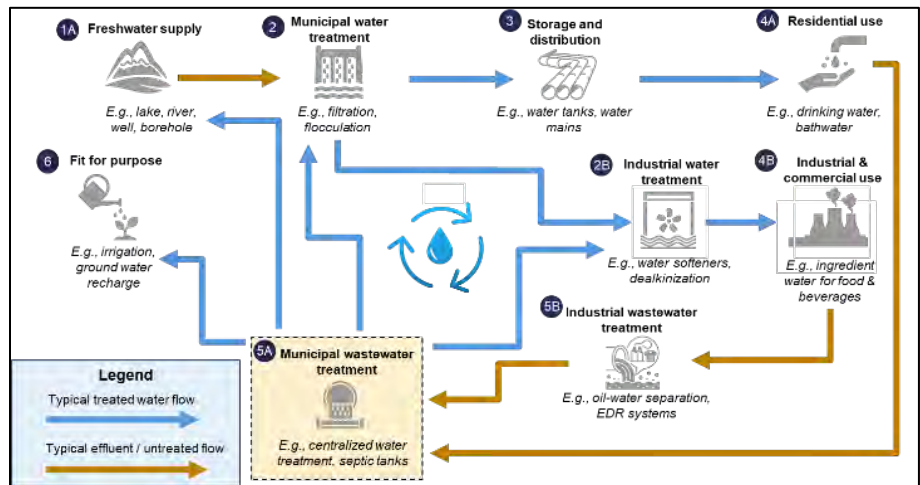
Note that for the purpose of this analysis, EXIM is excluding point of use water treatment systems, which are installed at a single water connection such as a kitchen faucet or include other products targeting consumers such as water pitchers or filtered thermoses.

EXIM Activity

From January 2020 to September 2023, EXIM has authorized 35 transactions worth approximately \$65 million that qualify under Water Treatment and Sanitation, \$6 million of which was for medium-term guarantees and \$58 million for short term insurance and working capital loan guarantees. The exported products included a mix of water treated treatment and wastewater treatment goods and services.

Capacity and Demand Overview

Since 2018, the global market for municipal drinking water treatment has grown at a compound annual growth rate of 2.3 percent, from around \$77 billion to about \$88 billion in 2022 and is slated to reach almost \$99 billion by 2017.¹¹⁷ The industry's slow top-line growth is due to the government-driven, slow capital expenditure growth in "mature" water markets such as the United States and Europe, which account for most of global spend. The United States' more built-out water infrastructure—which involves more annual operational expenses than new capital expenditures—and smaller total population and water demand relative to the PRC result in a relatively smaller domestic market, which creates less domestic demand for U.S. businesses. Nonetheless, the export potential remains high. Despite the market's slow growth in dollar terms, nearly two billion people worldwide lack access to



¹¹⁷ [Global Water Intelligence](#)

safe drinking water, and climate change and ecosystem pollution are further exacerbating water shortages.^{118, 119}

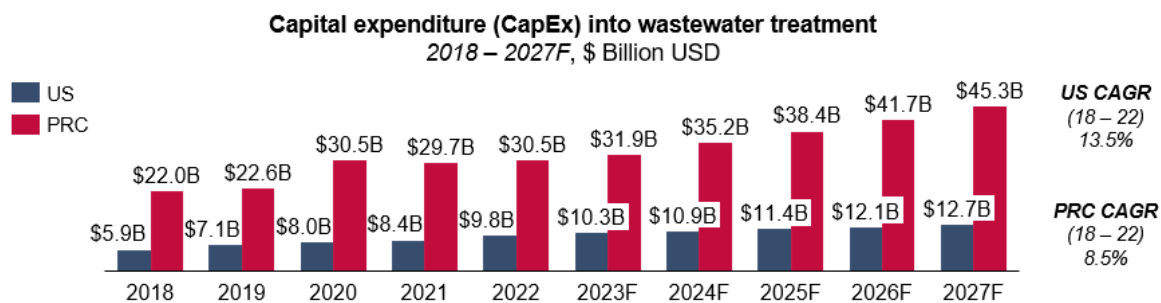
At the time of this report, in general, U.S. water treatment and sanitation production and chemical exports are on par with the PRC; however, chemical exports lag the PRC in the Water Treatment Segment of the Water Treatment and Sanitation transformational export area. And as the Spotlight below demonstrates, U.S. business lag the PRC in demand for equipment exports.

Spotlight: Wastewater Treatment

Wastewater treatment has increasingly represented an investment focus area for U.S. and overseas communities and industries. Driving factors include increasing global water scarcity challenges due to impacts from climate change—as well as discoveries of new purification technologies and the harms associated with contaminants such as polyfluoroalkyl substances.¹²⁰ The wastewater treatment process varies highly based on contaminants, location, and where water is going.



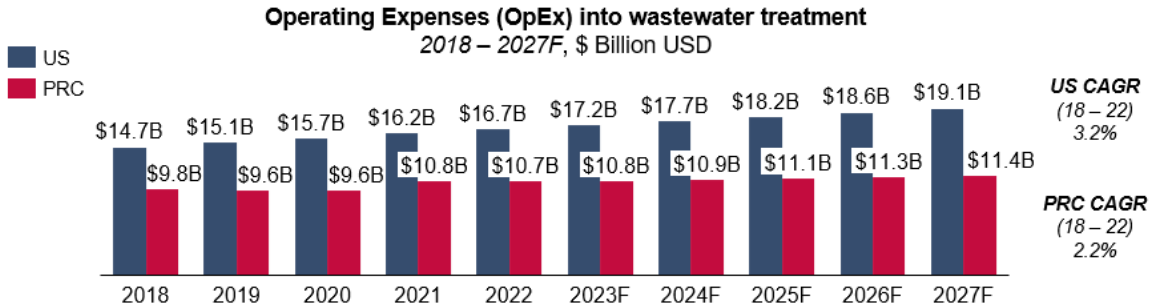
PRODUCTION (Capacity)



¹¹⁸ [United Nations](#)

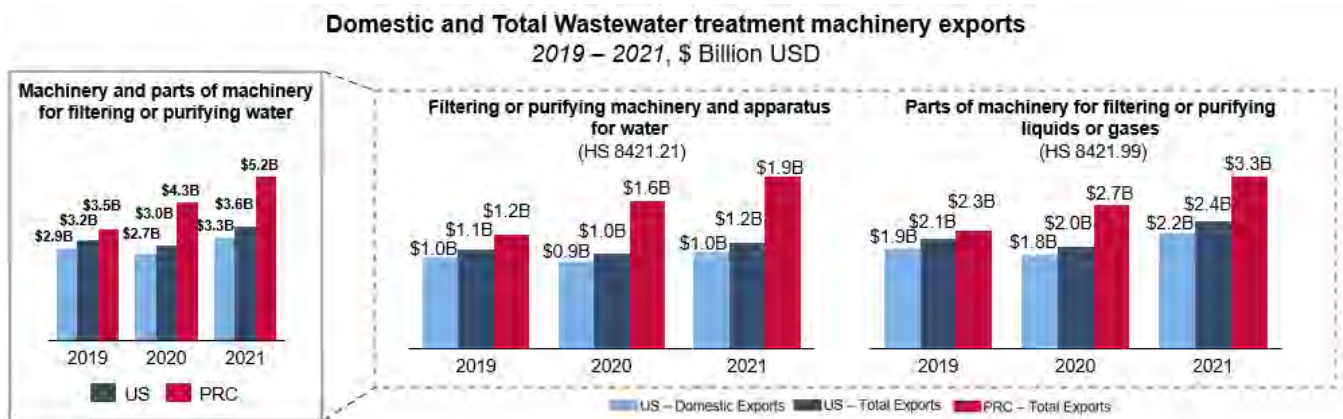
¹¹⁹ [World Bank](#)

¹²⁰ [Export-Import Bank of the United States](#)



As of 2022, the United States lagged the PRC in capital expenditure by three times but led the PRC in operating expenses by 1.5 times. The United States spends more on operating expenses to maintain and run wastewater treatment plants because its wastewater infrastructure is more developed, thereby providing domestic market incentives for U.S. business to optimize around maintenance of existing water infrastructure instead of constructing new water infrastructure. However, government funding and system updates are likely to have an impact on capital expenditures. The 2021 Infrastructure Investment and Jobs Act allocated about \$55 billion for water infrastructure improvements above EPA baseline, including grants targeting wastewater treatment efficiency, sewer overflow and stormwater reuse, small-to-medium-sized municipal treatment plants, and workforce recruitment and retention.¹²¹ In order to help mitigate wastewater issues domestically, in 2022, the USDA and EPA announced a joint program to provide marginalized communities with wastewater treatment. Some U.S. cities, such as Houston and Corpus Christi, have received court orders to upgrade their municipal wastewater systems.¹²² In the U.S., public utilities operate most wastewater treatment, in contrast to the private-public partnerships adopted in much of the globe—including the PRC.¹²³

EXPORTS (Demand)

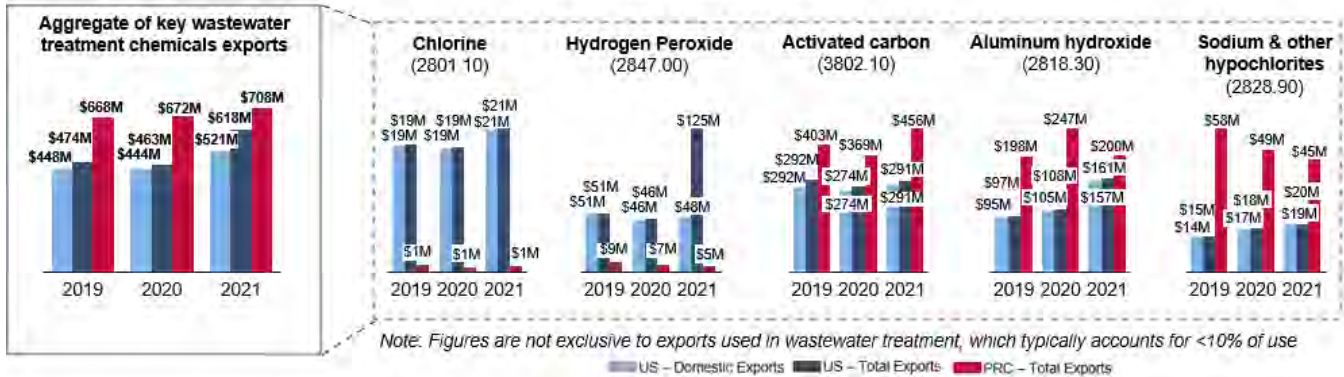


¹²¹ [United States Congress- H.R. 3684 Infrastructure Investment and Jobs Act](#)

¹²² [Houston Public Works](#)

¹²³ [International Trade Administration](#)

**Domestic and Total Wastewater chemical exports
2019 – 2021, \$ Million USD**



EXIM shows Total U.S. Exports to ensure an “apples-to-apples” comparison with PRC Total Exports but must also show Domestic U.S. Exports to highlight the subsegment EXIM can support.

Domestic Exports—Commodities grown, produced or manufactured in the U.S., including commodities imported from foreign countries that have been significantly changed or enhanced in value, in either the United States or a Foreign Trade Zone.

Total Exports—Domestic Exports plus Commodities of foreign origin that have entered the U.S. but are “re-exported” in substantially the same condition as when imported.

In 2021, the United States lagged the PRC in exports of water filtration and purification by \$1.6 billion in trade value, and exports from the PRC have grown more rapidly than in the U.S.¹²⁴ Notably, engineering, procurement, and construction (EPC) companies often rely on manufacturers from their home countries when building wastewater treatment plants abroad, so the EPC market helps drive the export of treatment equipment. Overall, the United States has a largely domestic-focused wastewater EPC sector, contrasting with the PRC’s international construction focus. The United States does have several established wastewater treatment equipment companies with strong positions in the market.^{125, 126} U.S. water treatment equipment firms are often less vertically integrated compared to European and PRC-based competitors. For example, municipalities own and operate most U.S. wastewater systems—thus, most U.S. water infrastructure construction firms have no operations capabilities. In tenders against foreign competitors with fully integrated delivery models, a more limited services scope can be a disadvantage.^{127,128}

The United States has strong chemical manufacturing capabilities in areas including chlorine and hydrogen peroxide, where it leads the PRC in exports by 21 and 25 times, respectively, but it still relies on PRC imports for several chemicals used in water treatment such as sodium hypochlorite.¹²⁹

However, tightening U.S. regulations on contaminants like polyfluoroalkyl substances have made activated carbon an attractive tool for low-cost, multiple contaminant treatment, possibly limiting the need for traditional chemicals.¹³⁰ Similarly, hydrogen peroxide is a key component of peroxyacids such as performic acid, which is an alternative to chlorine and UV disinfection.¹³¹

¹²⁴ [United Nations Comtrade Database](#)

¹²⁵ [Global Water Intelligence](#)

¹²⁶ [Yahoo Finance](#)

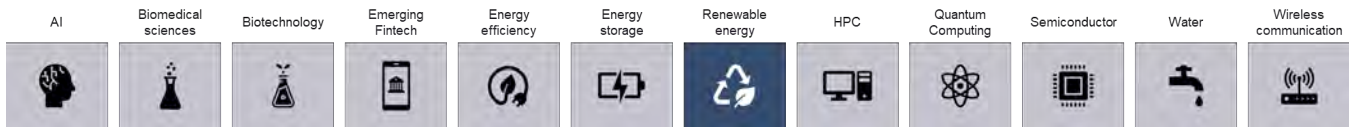
¹²⁷ [Global Water Intelligence](#)

¹²⁸ [University of Arizona](#)

¹²⁹ [Environmental Protection Agency](#)

¹³⁰ [Global Water Intelligence](#)

¹³¹ [Global Water Intelligence](#)



Renewable Energy

Scope

EXIM defines the “Renewable Energy” transformational export area as equipment or services related to the generation or use of energy produced from a naturally renewable source.

EXIM segmented this definition into five industries: Solar Power; Wind Power; Hydro Power; Biomass; and Geothermal.

EXIM Activity¹³²

From January 2020 to September 2023, EXIM has authorized 9 transactions worth over \$960 million that qualify as a Renewable Energy Transformational Export Area. Of note, one transaction for \$907 million for the sale of two photovoltaic plants will open the door for U.S. exporters to the Angolan market.

Capacity and Demand Overview

Renewable energy is an area with great potential for both growing U.S. domestic production capacity and fostering foreign demand for exports. The jobs outlook is strong, particularly as the Inflation Reduction Act supports investments in renewable energy manufacturing to accelerate U.S. job growth.¹³³ Moreover, the export market for renewables is large. In 2021, the most recent year with global data availability, international export trade value in solar photovoltaic (PV) cells (HS code 8541.40) alone totaled \$73.9 billion, indicating a high degree of exportability.¹³⁴

However, at the time of this report, U.S. production and exports broadly lag the PRC in the Renewable Energy industries. In wind energy, the PRC leads the U.S. in manufacturing capacity for all major turbine components and subcomponents. As of 2022, the U.S. had only nine percent of global nacelle manufacturing capacity and seven percent of turbine capacity, with negligible shares of capacity for gearboxes, generators, and rare-earth permanent magnets. By contrast, the PRC accounted for 60 percent of nacelle capacity, 60 percent of blade capacity, 65 percent of generator capacity, and 75 percent of gearbox capacity.¹³⁵ And in hydropower, PRC hydropower exports, like hydraulic turbines, water wheels, and regulators, are currently two times greater than American hydropower exports, and the U.S. is losing market share at a rate of three percent year-over-year.¹³⁶

The only exception is biomass, the process of converting renewable organic material from plants and animals into heat or electricity by burning it or converting it into a liquid or gas fuel, where the U.S.

¹³² In Sec. 2(l)(B) of EXIM’s Charter, which lists the Transformational Export Areas, Renewable Energy is listed distinct from both Energy Storage and Energy Efficiency. EXIM has a separate reporting requirement in Sec. 2(b)(1)(K) that combines renewable energy, energy storage and energy efficiency. For this report, these activities include only those specifically designated as renewable energy under Sec. 2(l)(B).

¹³³ [Department of Energy](#)

¹³⁴ [United Nations Comtrade Database](#)

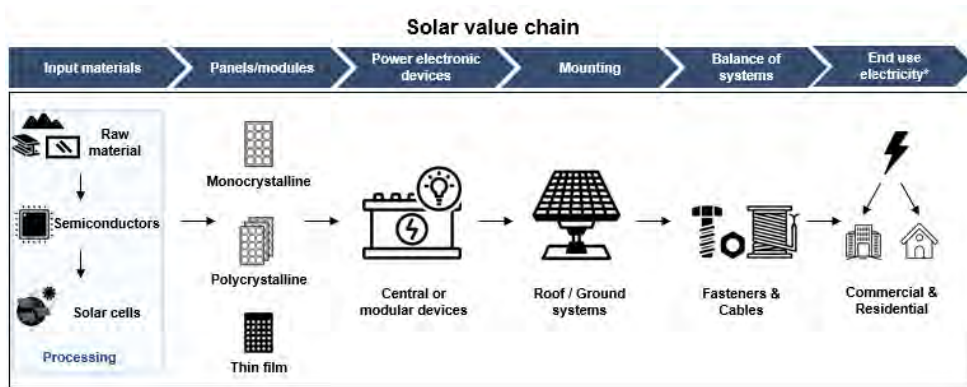
¹³⁵ [Global Wind Energy Council](#)

¹³⁶ [Department of Energy](#)

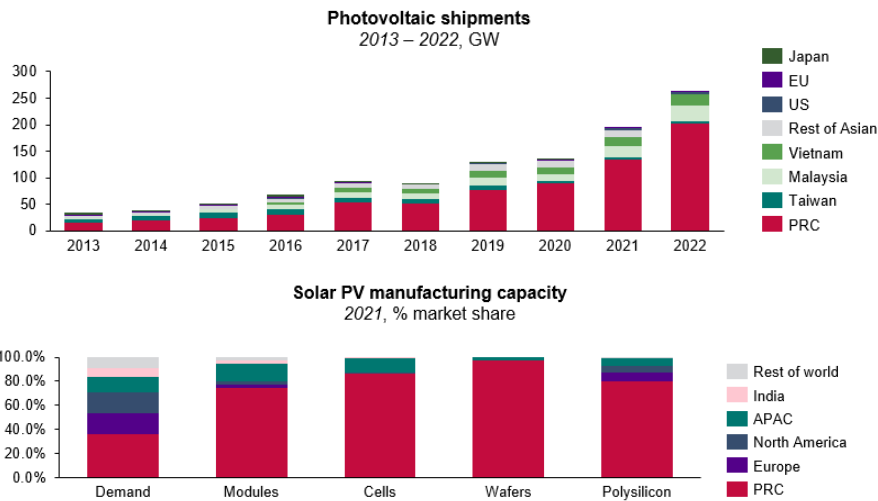
maintains a leadership role globally.¹³⁷ With regard to biomass inputs, U.S. production was 12 times greater than that of the PRC, largely because of America’s large ethanol production capabilities.

Spotlight: Solar

Solar energy production involves taking in light from the sun and converting it into electrical energy, typically via PV solar cells composed of semiconductor materials and arranged in arrays of panels, or modules. Silicon is the most common semiconductor material utilized due to its low costs, high efficiency, and long lifespan, accounting for 95 percent of solar modules worldwide. The remaining five percent of global cells use other semiconductor compositions, such as “thin-film” (e.g., perovskite), organic, quantum dots, and concentration photovoltaic cells.

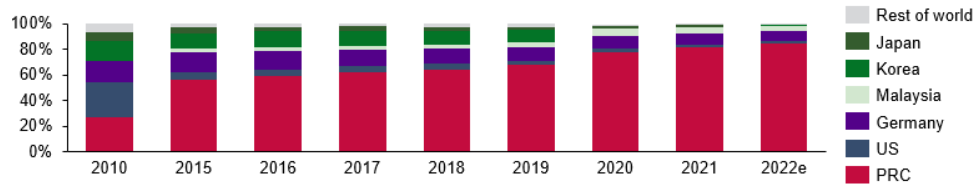


PRODUCTION (Capacity)



¹³⁷ Definitional note: Some industries that create Biomass inputs, for example the act of creating ethanol, can be considered under the Biotechnology transformational export areas, while the industries that convert Biomass inputs into energy are counted under Renewable Energy.

Polysilicon production
2010 – 2022E, % market share



The U.S. lags the PRC in production capacity for solar PV. U.S.-manufactured products accounted for just one percent of global cell and module shipments in 2022 versus 71 percent for the PRC, down from 13 percent in 2004.^{138, 139} The U.S. also has small to negligible shares of the key input polysilicon. The U.S. lost its global leadership in solar PV manufacturing in the late 1970s as large conglomerates spun off their low-profitability solar divisions.¹⁴⁰ The 2010s brought worsening market conditions for U.S. solar manufacturing such as increasing cost pressures, raw material price fluctuations, and PRC-imposed anti-dumping duties.¹⁴¹ U.S. facilities decreased outputs across the value chain—domestic wafer production ended in 2014, domestic cell production ended in 2020, and domestic solar-grade polysilicon production declined by two-thirds from 2013 to 2022.¹⁴² There has also been a shortage of willing private investors in the sector due to low and unpredictable returns, impeding investment to bolster manufacturing.¹⁴³ Fully onshore U.S. manufacturing today is exclusive to “thin-film” panels, a small portion of the total global market.^{144, 145}

To improve U.S. comparative leadership in solar, the Inflation Reduction Act is providing tax credits to encourage the growth of domestic solar manufacturing. From the legislation’s passing through Q1 2023, manufacturers have already announced 110 GW of new U.S. capacity in areas like wafers and cells, and the Solar Energy Industries Association (SEIA) has forecasted that fully domestic modules could be produced as soon as 2025.^{146, 147} However, U.S. manufacturers continue to face cost and scale disadvantages, supply chain constraints, and PRC trade restrictions.¹⁴⁸ Moreover, announced new U.S. capacity as of Q1 2023 would achieve just over half of total 2022 PRC cell and module shipments, and PRC original equipment manufacturers (OEMs) have showed no signs of slowing their growth.¹⁴⁹

¹³⁸ [National Renewable Energy Lab](#)

¹³⁹ [SPV Market Research](#)

¹⁴⁰ [Science Advances](#)

¹⁴¹ [The Atlantic](#)

¹⁴² [National Renewable Energy Lab](#)

¹⁴³ [Massachusetts Institute of Technology](#)

¹⁴⁴ [National Renewable Energy Lab](#)

¹⁴⁵ [International Energy Agency](#)

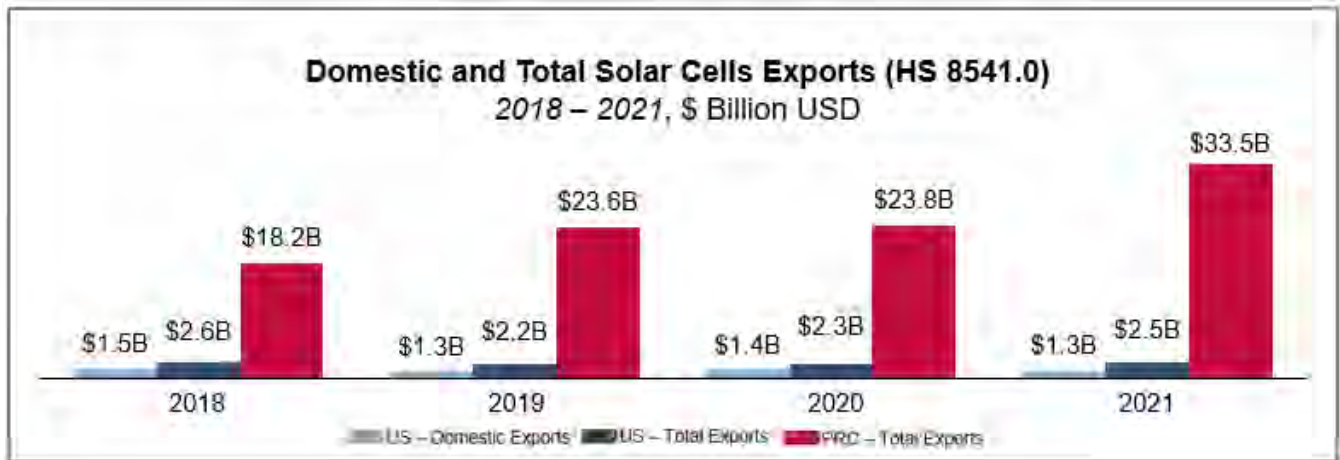
¹⁴⁶ [Solar Energy Industries Association](#)

¹⁴⁷ [National Renewable Energy Lab](#)

¹⁴⁸ [Bloomberg New Energy Finance](#)

¹⁴⁹ [Wood Mackenzie](#)

EXPORTS (Demand)



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Total Exports—Domestic Exports plus Commodities of foreign origin that have entered the U.S. but are “re-exported” in substantially the same condition as when imported.

In the U.S., the solar PV industry is highly reliant on imports of key products like polysilicon, cells, and wafers. Solar imports originate primarily in Southeast Asian countries such as Malaysia and Vietnam due to restrictions on PRC imports. However, much of these countries’ solar manufacturing is controlled by PRC companies, and the PRC retains strong influence over global market supply chains and pricing. COVID-19-related supply shocks laid bare the challenges of U.S. reliance on imports, with solar panel imports decreasing by 20 percent from 2020 to 2021 and U.S. companies facing recent polysilicon shortages due to reduced PRC production. Moreover, the IEA 2022 Supply Chain Report warned about the risks of supply chain concentration in the PRC.^{150, 151}

In 2021, the U.S. exported \$2.5 billion in trade value of solar cells and panels—compared to imports of \$9.6 billion in the same year.¹⁵² Low U.S. exports result most directly from lack of domestic capacity compared to domestic demand, but also less competitive pricing, as U.S. solar technology prices are an average of about 20 percent higher compared to PRC products.¹⁵³ Low global trade shares have also resulted in limited opportunities for EXIM to support U.S. companies selling abroad, with a few recent exceptions.¹⁵⁴ Inflation Reduction Act-driven growth in U.S. manufacturing capacity will help lay the groundwork for more impactful U.S. export financing by increasing market participation and cost competitiveness going forward, and the SEIA predicted that, as a result, the U.S. “will become a solar and storage export powerhouse over time.”¹⁵⁵

¹⁵⁰ [Bernreuter Research](#)

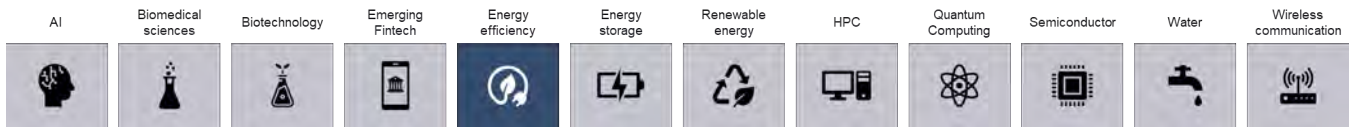
¹⁵¹ [International Energy Agency](#)

¹⁵² [United Nations Comtrade Database](#)

¹⁵³ [International Energy Agency](#)

¹⁵⁴ [Export-Import Bank of the United States](#)

¹⁵⁵ [Solar Energy Industries Association](#)



Energy Efficiency

Scope

EXIM defines the energy efficiency transformational export area as equipment, products, or services selected or implemented for the purpose of reducing energy losses or consumption in a system or application. (e.g., lightbulbs, windows, insulation, smart homes, power management).

EXIM segmented this definition into four larger categories, with at least 22 U.S. industries that align to them.

1. **Industrial Energy Efficiency** (Industrial motors; Water Pumps; Waste Heat Recovery; Iron and Steel Processes; Oil Refinery Processes; Large Heat Pumps for Industrial Processes)
2. **Building Energy Efficiency** (Appliances; Heating and Cooling Systems; Insulation; Lighting; Transformers; Electronics; Water Heaters)
3. **Transportation Energy Efficiency** (Electric Vehicles; High-Speed Rail; Air-Traffic Management; Fuel-Efficient Vehicles; Ships with wind assistance technology)
4. **Infrastructure Energy Efficiency** (Advanced Metering Infrastructure; Public EV Chargers; Electro-mobility for public transport; Alternative Fuels Infrastructure)

EXIM Activity

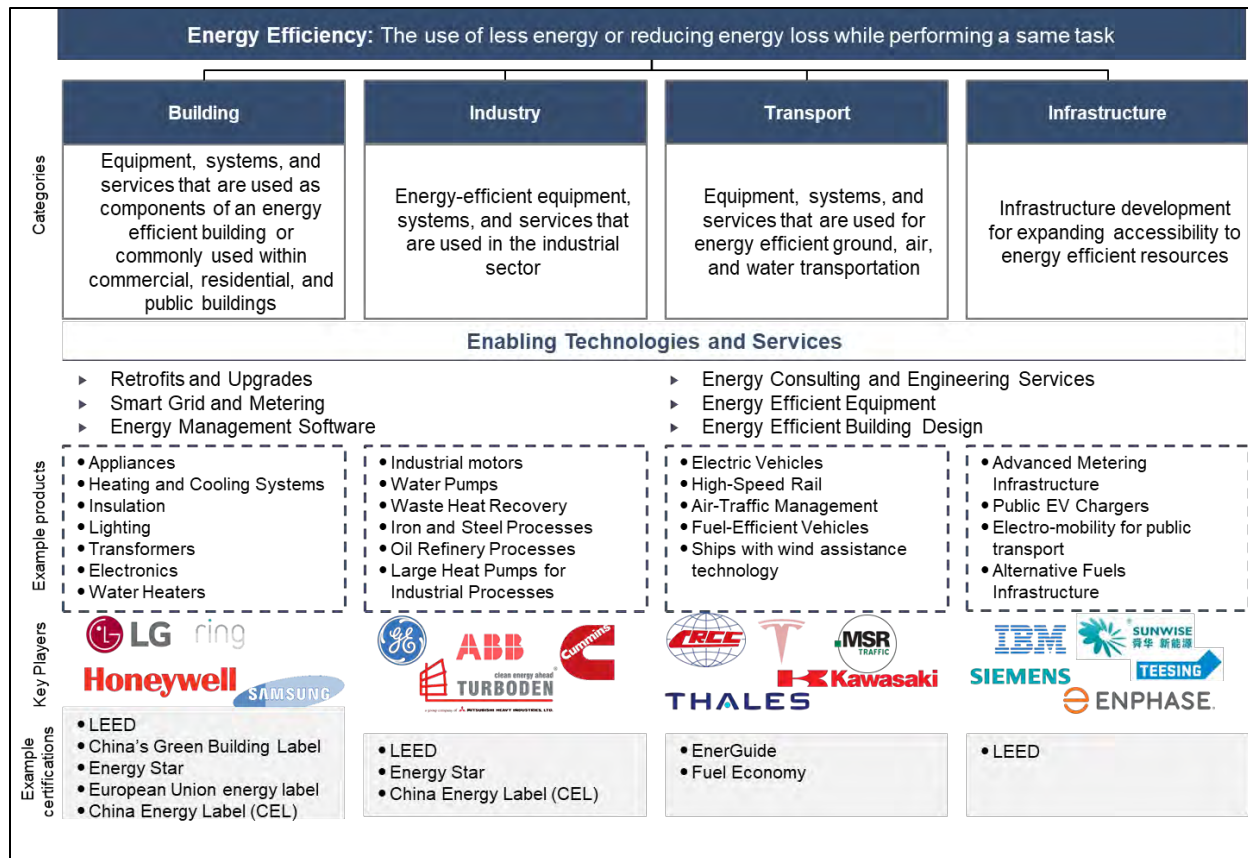
EXIM’s ability to support U.S. jobs in energy efficiency related industries is highly dependent on the nature of the export. Given the breadth of industries and associated goods and services within this definition, EXIM evaluates potential transactions as to whether energy efficiency is the *principal goal* of the transaction, not simply whether it is incidental to, say, a technological upgrade of a system.

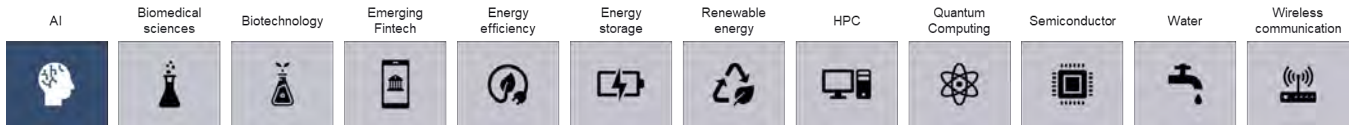
From January 2020 to September 2023, EXIM has authorized 26 transactions worth over \$15 million that qualify under Energy Efficiency. One transaction financed ESS Tech Incorporated’s sale of 20 iron flow battery systems (which was also categorized as an energy storage export) to Sapele Power PLC, which was also EXIM’s Sub-Saharan Africa Deal of the Year in 2022.

Capacity and Demand Overview

As the chart below illuminates the sheer breadth of industries that could qualify under each of the four energy efficiency segments demonstrates that the capacity to produce, and demand for, exports in these industries could be substantial – though this is highly dependent on the nature of the project.

However, that same breadth of applicability makes evaluating energy efficiency with the same precision of other transformational export areas challenging.





Artificial Intelligence

Scope

EXIM's definition is based on the National AI Act of 2020 and the National Security Commission on AI definitions, with an orientation towards exports. But because of how fast the industry is evolving, the breadth of activities and the inherent difficulties overlaying definitions onto actual goods and services, it is admittedly less precise than other transformational export area definitions.

EXIM defines the Artificial Intelligence (AI) transformational export area as equipment or services related to computerized systems intended for making the best decision given changing circumstances, without direct human input or intervention.

EXIM found that Artificial Intelligence can be broadly construed as including AI hardware, AI software, and AI services. Given that AI hardware generally aligns with other transformational export areas (e.g., semiconductors, high performance computing) and AI services can be utilized in a wide variety of industries, EXIM has focused its efforts in this transformational export area on the following AI software industries:

- AI Platforms – Platforms where AI processing and data storage takes place, as well as support for the development of AI models and applications.
- AI Applications – Software that applies AI tools and techniques to enterprise and industry-specific tasks or problems.
- AI Development and Deployment – Tools and platforms used primarily by developers to build, test, and deploy software as well as process, integrate, govern, and analyze data.
- AI Systems Infrastructure - Software solutions that provide foundational layers of software that enable infrastructure hardware resources to host higher-level application development and deployment and application software.

EXIM Activity

From January 2020 to September 2023, EXIM has authorized five transactions worth nearly \$8 million that qualify under Artificial Intelligence. Since 2020, all have been short-term insurance or working capital products. The exports included, for example, AI software and related hardware to provide intelligent inspection and recognition solutions for border customs throughput.

EXIM analysis shows great potential job growth and export potential for American workers in the industries associated with the Software category of the Artificial Intelligence transformational export area. But the role of export finance is less clear. It is uncommon for a buyer to treat software as a long-term capital expenditure that requires debt finance. In fact, EXIM frequently found that the business models of AI-related software companies seek to provide a service managed through normal business operations rather than a one-time depreciable good that clients must finance.

Capacity and Demand Overview

EXIM found both great capacity in, and demand for, U.S. businesses in the industries associated with AI Software. Measuring U.S. industry capacity to produce in this transformational export area, however, is difficult and subjective. Because AI Software related industries are highly dependent on their human capital, this analysis uses employment as a proxy for production capacity.

PRODUCTION (Capacity)

- AI Platforms – There were an estimated 50,200 platform jobs available in the U.S. in 2019; the global platforms market is expected to grow quickly at a 34.7 percent compound annual growth rate, which is expected to drive job growth in the U.S.¹⁵⁶ Nearly 60 percent of top-tier researchers worked for American universities and companies in 2019.¹⁵⁷
- AI Applications – AI applications are the largest employer among AI associated industries. AI applications were responsible for 5.1 million jobs in 2019, equivalent to approximately 3 percent of total U.S. employment.¹⁵⁸
- AI Development and Deployment – Development and deployment companies range from multinational corporations with more than 21,800 developers in the U.S. to companies with less than 1,000 employees.¹⁵⁹
- AI Systems Infrastructure - AI system infrastructure is the second-largest industry within AI software (35 percent), with a global market size of \$118.1 billion in 2021; the U.S. also has the largest market size for *all* AI software at approximately 60 percent, presenting a strong job opportunities outlook for the systems infrastructure segment.¹⁶⁰

EXPORTS (Demand)

AI applications exports are difficult to quantify since there are typically no physical goods involved and AI lacks representative HS or other export codes. But the U.S. industry seems well positioned to play a leadership role globally. The Executive Order on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence issued in October 2023 reflects the United States’ goals to harness the benefits while addressing the risks of AI and to promote innovation and competition for U.S. AI companies globally. The United States government’s focus on responsible development and use of AI technologies will likely build upon the demand for U.S. technology in the AI industry.

- AI Platforms – U.S. companies are the global market leaders, which gives advantages in exports. Top U.S. companies represent 74 percent of the global cloud market, which provides advantage to AI-related cloud services. The industry is still early-stage, but its 35 percent compound annual growth rate over the next five years is promising for exports.¹⁶¹
- AI Applications – The U.S. is well-positioned for AI application exports. The U.S. is the global leader in AI applications investment, accounting for \$82 billion in general purpose AI from 2015-2019, compared to \$42 billion for the PRC.¹⁶²

¹⁵⁶ [Forbes](#); [IDC](#)

¹⁵⁷ [Marco Polo](#); [Harvard University](#)

¹⁵⁸ [CSET](#)

¹⁵⁹ [Zippia](#); [Crunchbase](#); [IDC](#); [CSET](#)

¹⁶⁰ [IDC](#)

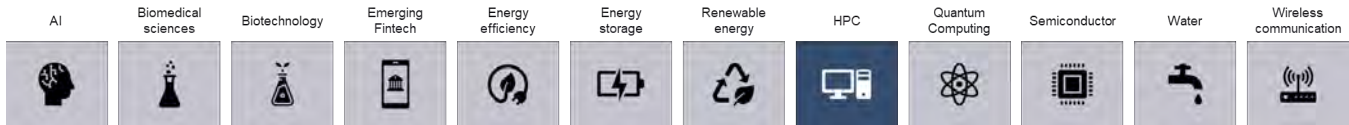
¹⁶¹ [Statista](#); [IDC](#)

¹⁶² [CSET](#)

- AI Development and Deployment – Top development and deployment companies are U.S.-based; in addition, the U.S. leads in new start-ups in key development and deployment segments compared to the PRC, such as AI data management software solutions, where it leads 229 to 37 start-ups respectively.¹⁶³
- AI Systems Infrastructure - Strong global market growth and U.S. market leadership could present export opportunities for U.S. AI system infrastructure companies. The global market is expected to grow at a 14.9 percent compound annual growth rate from 2021 to 2026; in addition, the top five largest global companies by revenue are all U.S.-based.¹⁶⁴

¹⁶³ [IDC](#); [CSET](#)

¹⁶⁴ [IDC](#)



High Performance Computing

Scope

EXIM defines the High-Performance Computing (HPC) transformational export area as equipment or services for computer systems with the capacity to process more than 500 terabytes/day or exceed a speed of 500 teraflops/second.

EXIM segmented this definition into five core industries, but only as they relate to high performance computing (or commonly referred to as a “supercomputer”):

1. **Computing** - Platforms like servers; processors; accelerators; and other hardware that perform computing functions
2. **Networking** - Hardware that supports the high-speed transportation of data between compute clusters and storage nodes
3. **Storage** - Storage platforms used to support the processing; management; and retention of digital data used by HPC computing workloads
4. **Compute and Storage Infrastructure Software** - Abstraction; deployment; orchestration; automation; and management layer for running computing workloads on HPC systems
5. **HPC as a Service** - Service providers delivering HPC resources like computing; storage; networking; and ready-to-use software resources designed for a market and shared by a pool or organizations

Importantly, this definition focuses on the “High Performance” qualifier to the transformational export area, which narrows the related industries to what is more commonly referred to as a supercomputer. So, while there may be general export opportunities in data storage, networking or computing, EXIM focuses on those transactions more directly related to supercomputers.

EXIM Activity

Since January 2020, EXIM has not authorized any transactions under High Performance Computing. EXIM did authorize a preliminary commitment for the Baron Weather Forecasting Project for the purchase of goods and services relating to a complete upgrade and modernization of Ukraine’s national hydrometeorology infrastructure and observation capability. Unfortunately due to the Russian invasion of Ukraine this preliminary commitment never converted to a final authorization.

Capacity and Demand Overview

Top overseas supercomputers use U.S. company products, but where the components are manufactured vary. Most U.S. domiciled companies engage in supercomputer research and development, but leverage components in the related industries manufactured outside the U.S.

Therefore, U.S. capacity and demand analysis in the High-Performance Computing transformational export area is more difficult to discern.

PRODUCTION (Capacity)

Within performance share, the U.S. has a 47.4 percent share compared to the PRC’s 12 percent share, which indicates a U.S. technological advantage in high performance computing. The U.S. is the leader in high-quality HPC research, representing 29.3 percent of the global top 10 percent of HPC publications, compared to the PRC’s 25.6 percent.

Top overseas supercomputers use US company products, but where the components are manufactured vary

LUMI Supercomputer ^{1*}				Leonardo Supercomputer ^{3*}			
Top 500 Global Supercomputer Ranking: #3				Top 500 Global Supercomputer Ranking: #4			
Recipient Organization: LUMI Consortium				Recipient Organization: Cineca			
Country: Finland				Country: Italy			
Research Applications: Solar atmospheric modeling, seismology, and natural language processing ²				Research Applications: Environmental disaster and pandemic risk and mitigation analysis ⁴			
Company	Country of Domicile	Company US Activities	HPC Component	Company	Country of Domicile	Company US Activities	HPC Component
	US	R&D	Systems integration		FR	-	Systems integration
	US	R&D, manufacturing	Compute servers		FR	-	Compute servers
	US	R&D	Processors		US	R&D, manufacturing	Processors
	US	R&D	GPUs		US	R&D	GPUs
	US	R&D	Networking Equipment		US	R&D	Networking Equipment
	US	R&D, manufacturing	System Infrastructure Software	 	US	Manufacturing	System Infrastructure Software

While some HPC manufacturers like HPE Cray have production facilities in the US, other companies like AMD and NVIDIA only have US R&D facilities and outsource production overseas to countries like Taiwan.

Sources: 1) Top500; 2) The Register; 3) Top500; 4) Economic Supercomputer Alliance

Note (*): The LUMI and Leonardo supercomputers were selected for component manufacturer analysis, because they are the two most powerful supercomputers found in Europe.

EXPORTS (Demand)

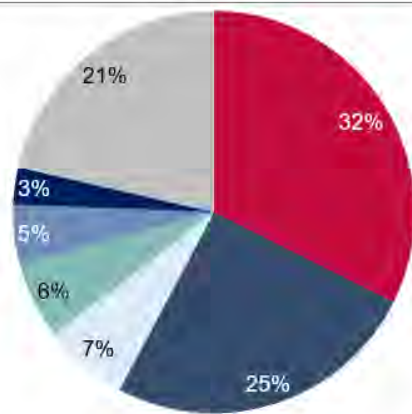
As a source of demand, while the PRC leads in the total number of supercomputers, the United States is the global leader in supercomputers by performance. U.S. organizations have a distinct global advantage in HPC, which presents strong exports opportunities. For example, the University of California is the top research institution in the world by HPC research publications and one U.S.-based firm is the global leader in manufacturing hardware performance.

While the PRC leads in the total number of supercomputers, the US is the global leader in supercomputers by performance

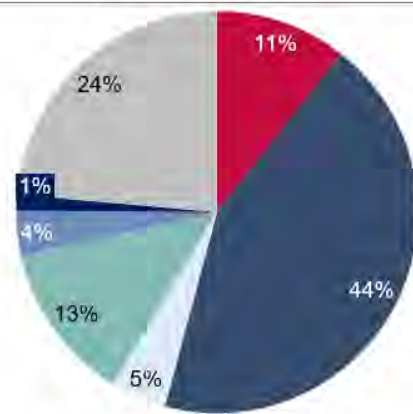
Insights

- **The PRC has a lead in total HPC systems but falls behind in share by performance:** Within performance share, the United States has a 47.4% share compared to the PRC's 12% share, which indicates a US technological advantage in high performance computing.^{1,2}
- **Hewlett Packard Enterprises is the global leader by HPC system performance:** HPE only represents 20% of global systems, beaten out by Lenovo at 32%, but it controls a 44.5% global share in terms of systems performance.^{3*}
- **The PRC is finding success in developing its own HPC technologies:** For example, in 2016 the PRC began using digital signal processors (DSPs) developed by the National University of Defense Technology to reach 100 petaflops on the upgraded PRC supercomputer Tianhe-2.⁴

Distribution of top 500 global supercomputers by country, 2022¹



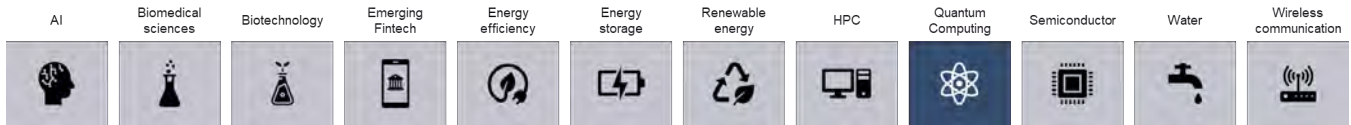
Distribution of top 500 global supercomputers by performance, 2022¹



HPC performance is calculated by how many computing functions a supercomputer can conduct per second (floating-point rate) and is measured in Mflops/s, Gflops/s, or Tflops/s.

PRC Germany France Others
 United States Japan United Kingdom

Sources: 1) [Forbes](#), 2) [BBC](#), 3) [TechCrunch](#), 4) [NewScientist](#). Note (*): HPE's performance share is larger than the US total HPC system performance share, because HPE has been responsible for building several overseas supercomputers, especially in Europe, which is represented in their country performance shares.



Quantum Computing

Scope

EXIM defines the Quantum Computing transformational export area as equipment or services that facilitate the implementation and use of quantum computers (application of qubit superposition processing).

EXIM segmented this definition into five categories : 1) Plant Equipment Providers; 2) Hardware; Devices and Components (photonic networks; superconducting circuits; spin qubits; neutral atoms; and trapped ions); 3) Systems Software; 4) Application Software; and 5) Services.

EXIM Activity

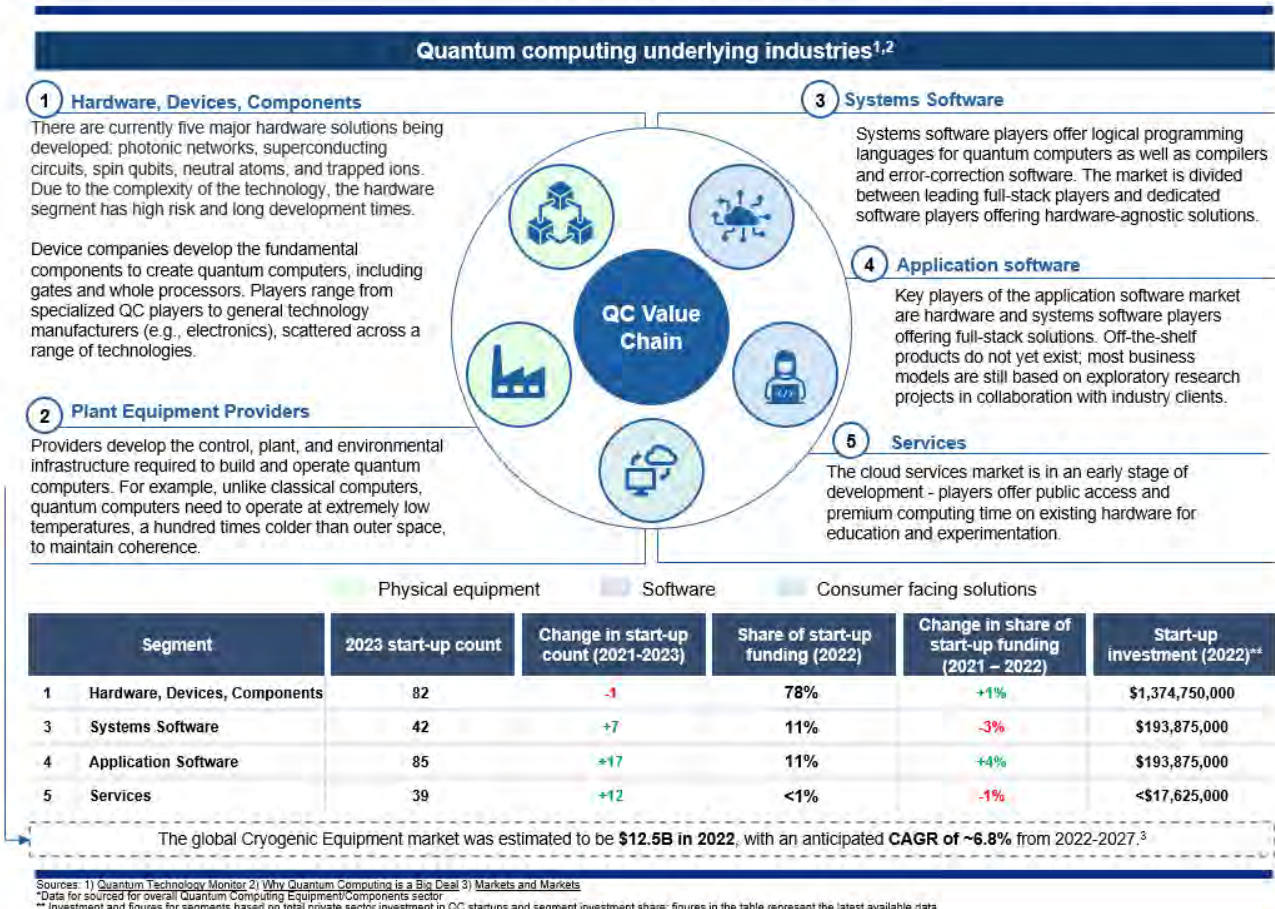
Since January 2020, EXIM has not authorized any transactions that qualify under the Quantum Computing definition in part because the industry and export demand are nascent. Moreover, the U.S. is exploring controls on the export of quantum computing technologies, which could impact EXIM's programs.¹⁶⁵ While there is a plausible role for export credit financing in this area, EXIM has not received any applications to date.

Capacity and Demand Overview

While there is great potential in America's Quantum-related industries, both the capacity to produce, and demand for, U.S. quantum goods and services is nascent.

¹⁶⁵ <https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202104&RIN=0694-AH75>

Quantum Computing is segmented into categories of hardware, software, and services, similar to other computing industries



PRODUCTION (Capacity)

The nascent nature of the quantum industry makes investment the most useful proxy for production estimates. The U.S. has committed over \$3.7 billion to quantum information science research and development over the last five years.¹⁶⁶ Eight out of the 10 largest venture capital and private equity investments in quantum technology start-ups have been in the hardware space, five of which were in U.S.-based start-ups. Quantum hardware start-ups in the United States range in size from 10 - 300 employees.¹⁶⁷ Meanwhile, PRC players have received funds from governments-affiliated funding organizations.¹⁶⁸ As of 2023, the PRC has announced \$15.3 billion of investment into quantum technology research.









¹⁶⁶ [National Quantum Initiative](#)

¹⁶⁷ [LinkedIn](#)

¹⁶⁸ [The Quantum Insider](#)

The U.S. leads in total capital raised for quantum technology companies, while the PRC has committed the most gov't capital to QC research

The U.S., the PRC, and Canada are the first three countries that have achieved a quantum computer for commercial use.

	 United States	 The PRC	 Canada	 Rest of world
Market insights through 2022 (advantages and disadvantages)	6 of 10 largest VC/PE investments in QC have been in the U.S. ¹ Home to 72 QC start-ups (highest quant. of start-ups in the world) ¹ Maximum number of QC qubits at 433, IBM Osprey ⁷ Multiple large tech incumbents with cloud services active on QCs ⁷	52% of all QT related patents granted to the PRC ¹ Aggressive investment in quantum tech/talent; competitor to the U.S. ¹ Maximum number of QC qubits at 66, Zuchongzhi ⁹ Seventh most QC start-ups in the world ^{1**} Lagged U.S., Canada in delivering a QC for commercial use ⁸	Second most QC start-ups in the world ¹ 2 of 10 largest global QC deals in 2022 in Canada ¹ Lowest government funding amongst the first three countries with a quantum computer ¹ Total investment from private sector ~1/4 that of the US ¹	\$8.4B funding from the European Union ¹ QC research is a strategic priority with investment from governments around the world, including the EU, Japan, and the UK ¹ Japan delivered first homegrown QC in March of 2023 ⁶ Lagged U.S., Canada, and China in delivering a homegrown QC ⁵
Companies included				
# of companies 2022*	81	11	28	148
QT capital raised (2001-2022)¹⁰	~\$3.5b	~\$0.9b	~\$0.8b	~\$3.0b
Government investment	~\$3.7b	~\$15.3b	~\$1.1b	~\$14.6b

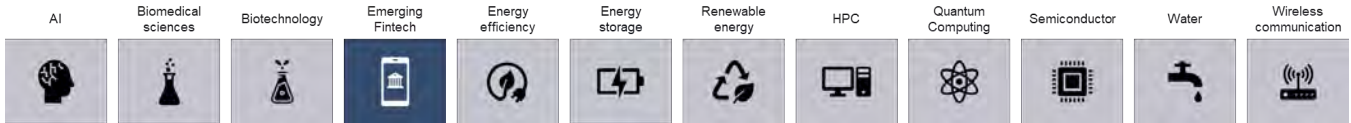
Research points towards the United States' robust capital markets as the most significant reason it leads in the overall Quantum Science market. On top of legislation such as the National Quantum Initiative Act (2018) driving investment, the U.S. is also able to rely on its rich private sector quantum computing ecosystem, including Google, Microsoft, and IBM.^{4, 5}

Sources: 1) Quantum Technology Monitor; 2) American Leadership in Quantum Technology | NIST; 3) Centre for Quantum Technologies; 4) Forbes; 5) Quantum.gov; 6) The Japan Times; 7) IBM; 8) Global Times; 9) Science Alert; 10) Pitchbook
 *Count includes Quantum computing start ups and incumbent companies
 **QT research for the PRC may be primarily through government-funded research institutions

EXPORTS (Demand)

Companies have only recently begun to export quantum computers, including the first U.S. export of quantum technology in 2021, providing Europe with its first quantum computer.¹⁶⁹ Nonetheless, the quantum industry is too nascent for general assertions of the demand for U.S. exports across the quantum transformational export area segments.

¹⁶⁹ Forbes

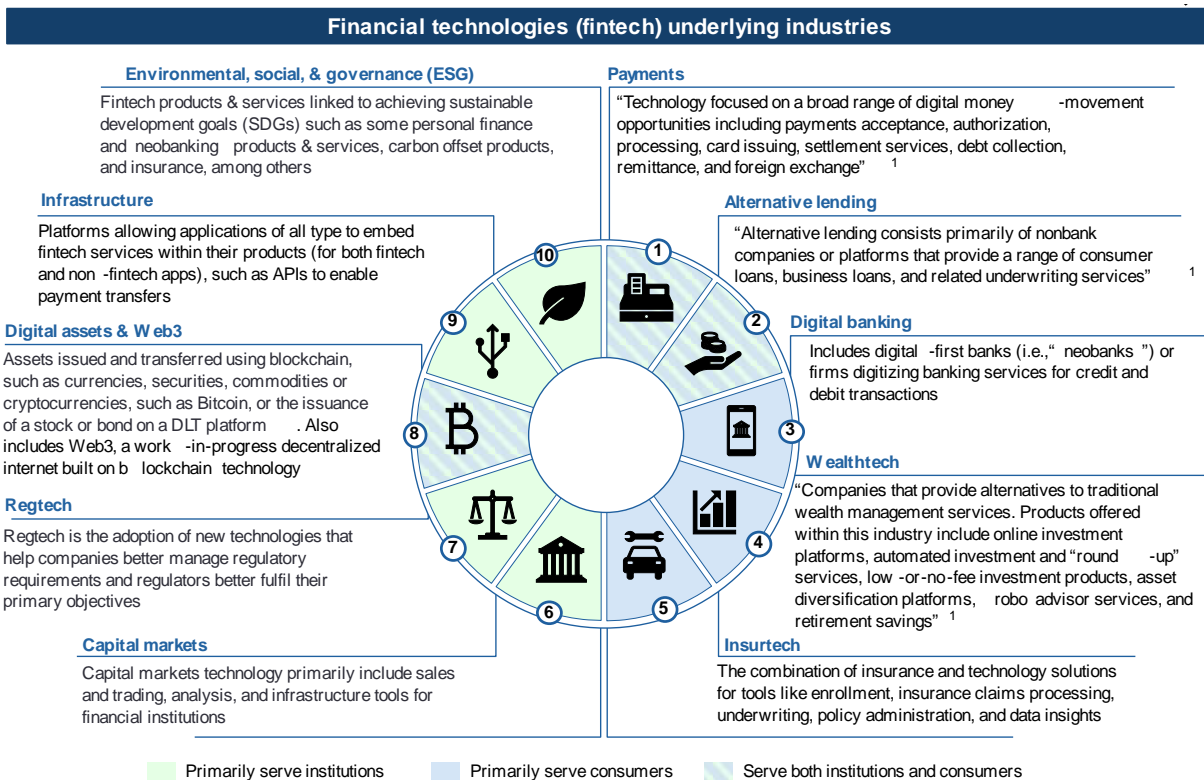


Emerging Financial Technologies

Scope

EXIM defines the “Emerging Financial Technologies” (FinTech) as equipment or services related to the improvement or automation of the delivery and use of financial services.

EXIM segmented this definition into ten associated industries outlined below.



EXIM Activity

From January 2020 to September 2023, EXIM has authorized one transaction worth \$1.4 million that qualifies under Emerging Financial Technologies. The exporter partners with foreign operators to provide software as a service to create financial identities for underbanked communities.

Capacity and Demand Overview

Emerging Financial Technologies is a difficult transformational export area to analyze. Like its findings in Artificial Intelligence, EXIM analysis shows great potential job growth and export opportunity for U.S. companies in the industries associated with FinTech – particularly in payments and alternative lending.

However, the role of export credit finance is unclear. It is uncommon for a buyer to treat FinTech as a long-term capital expenditure that requires debt finance. In fact, EXIM frequently found that the

business models of FinTech-related software companies seek to provide a service managed through normal business operations rather than a one-time depreciable good that clients must finance.

PRODUCTION (Capacity)

Much like the Artificial Intelligence transformational export areas, measuring U.S. industry capacity to produce in this transformational export area is difficult and subjective. The nature of the FinTech industry, however, makes investment the most useful proxy for production estimates.

The PRC vs. USA fintech industries: Comparative advantages & disadvantages



	USA	PRC
Advantages	<ul style="list-style-type: none"> Higher annual investment: U.S. leads the world in fintech funding due to high VC, financial services and “big tech” investments over the last 5 years¹ Greater government independence: U.S. fintech companies are perceived as more independent from State data access compared to PRC firms^{2,3} More competitive market: The proliferation of start-ups and lack of protectionism facilitates innovation and experience facing foreign competition³ 	<ul style="list-style-type: none"> Unparalleled services and adoption: Ant Group and Tencent integrate an unmatched number of fintech services, and the PRC tops the world in adoption of fintech like payments & digital banking⁴ Direct gov’t subsidization: PRC state entities have invested large funds in local <u>fintechs</u> to help them expand⁷ Links to growing unbanked markets: The PRC’s infrastructure <u>projects</u> and emigrant & tourist communities connect to high-growth markets like Indonesia⁵
Disadvantages	<ul style="list-style-type: none"> Less mature market: U.S. fintech adoption has lagged the <u>PRC’s</u>, and Ant Group and Tencent are increasingly looked to as best-in-class in fintech^{4,5} Lobbying / regulation: The influence of 2008 financial regulation and “big finance” lobbying has slowed fintech penetration and may continue to do so⁶ Lower ties to key markets: Southeast Asia and Sub-Saharan Africa represent key areas for fintech’s spread, and the PRC’s ties to these regions have grown thanks to initiatives like B&R⁵ 	<ul style="list-style-type: none"> Data privacy concerns: Adoption of PRC fintech abroad has been hindered by a perception of national security threats in places like India³ Regulatory unpredictability: The PRC’s “crackdown” on big tech stymied investment and showed the PRC’s willingness to rein in Ant & Tencent⁸ Lower domestic competition: Big tech’s domination and government protectionism have led to fewer small competitors and less experience facing foreign competition³

Sources: 1. CB Insights; 2. BBC News; 3. Chorzeempa, Martin. *The Cashless Revolution*, pp.173-178. 2022; 4. EY FinTech Adoption Index; 5. Harvard Business Review; 6. Berkeley Haas School of Business; 7. Capital IQ; 8. Stanford University

EXPORTS (Demand)

Demand for U.S. FinTech exports is similarly difficult to evaluate. On the one hand, large U.S. FinTech providers are clearly in demand globally. As of February 2023, the U.S. had 176 of the world’s 334 FinTech companies with a valuation of more than \$1 billion, representing 52 percent of the global total. In contrast, the PRC has just 13 “unicorns,” or 4 percent of the global total.¹⁷⁰ Additionally, U.S.-based alternative lending FinTechs accounted for 36% of all VC, PE, and M&A deal share in Q4 2022, compared to 26 percent for Asia¹⁷¹ And U.S. digital banks like SoFi and Chime are among the highest-valued FinTechs in the world, and the U.S. saw 39 percent of global deal share in 2022 Q4¹⁷²

¹⁷⁰ [Fintech Labs](#)

¹⁷¹ [CB Insights](#)

¹⁷² [CB Insights](#)





















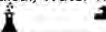















Critical Minerals — Capacity and Demand Analysis

EXIM analysis consistently identified several critical minerals as important factors in determining industry comparative leadership. These minerals represent important raw materials within the upstream stages of industry value chains, affecting leadership of downstream production and exports. They also frequently represented areas of strong PRC market share, disadvantaging U.S. production and exports in transformational export area industries.

By the time of this report, EXIM has analyzed 25 critical minerals closely aligned to the transformational export areas along three dimensions: known reserves; mining; and processing and refining. These are Aluminum, Cobalt, Copper, Lithium, Nickel, Titanium, Tungsten, Zinc, and the 17 rare-earth elements. The findings, summarized below, show the PRC dominates the U.S. across all 25 minerals studied, which creates the conditions for downstream advantages for PRC exporters over U.S. exporters.

Therefore, in September 2022 at the inaugural Mineral Security Partnership Ministerial, EXIM Chair Lewis announced that critical mineral projects important to the value chains of transformational export area industries would be considered under CTEP. Some Members of Congress have also taken a strong interest in how EXIM can better support critical mineral supply chains and work to reduce dependence on the PRC.¹⁷³ As a result, EXIM now has a pipeline of critical minerals opportunities beginning the due diligence process both overseas and here in the United States for projects related to the extraction or processing of minerals such as Lithium, Rare Earth Elements, Nickel, and Titanium.

Sample critical mineral assessment findings

Mineral	Primary TEA(s)	Reserves ¹ vs. PRC	Mining vs. PRC	Processing vs. PRC
Aluminum	Renewable Energy, Energy Storage 	On par 	Lagging 	Lagging 
Cobalt	Energy Storage (battery) 	Lagging 	Lagging 	Lagging 
Copper	Renewable Energy, Energy Storage, Semiconductors, Biomedical, Quantum 	Leading 	Lagging 	Lagging 
Lithium	Energy Storage (battery) 	Lagging 	Lagging 	Lagging 
Nickel	Renewable Energy, Water Treatment, Biomedical 	Lagging 	Lagging 	Lagging 
Titanium	Biomedical, Water Treatment 	Lagging 	Lagging 	Lagging 
Tungsten	Wireless, Semiconductors, Energy Storage 	Lagging 	Lagging 	Lagging 
Zinc	Renewable Energy, Energy Storage, Water Treatment 	Lagging 	Lagging 	Lagging 
Rare-earth elements	Renewable Energy, Wireless, Semiconductors, Quantum, Biomedical, AI, Biotechnology 	Lagging 	Lagging 	Lagging 

¹⁷³ Senator Marco Rubio, "Rubio, Warner Lead Push to Support Critical Mineral Projects," November 16, 2023. Available at: <https://www.rubio.senate.gov/in-response-to-the-peoples-republic-of-chinas-dominance-in-the-industry-senate-intel-chair-and-vice-chair-lead-colleagues-in-push-to-support-critical-mineral-projects/>.

Challenges and Opportunities for Financing Transformational Exports

Challenges

As reflected in the previous pages of this report, EXIM has carefully examined each of the transformational export areas to identify potential opportunities where its financing can facilitate exports and support U.S. jobs. During the previous four years, EXIM's Board has adopted several flexibilities to the agency's policies to support transformational exports, including on content requirements, down payment requirements, and qualification criteria for domestic term financing.

However, financing under the CTEP program is subject to the same statutory framework that governs all EXIM financing. Those existing statutes limit the availability of EXIM financing or impose requirements on borrowers, exporters, and buyers, and therefore also limit the availability of financing under EXIM's CTEP program.¹⁷⁴

This is particularly true when it comes to the ability of the agency to take risk - one of the key challenges facing the agency today. Lending is inherently a risk-taking activity and financial institutions charge fees to bear the risk of non-payment. As a government agency, EXIM's willingness and ability to incur risk is largely defined by the statutory framework within which it operates.

EXIM's risk appetite is defined by three major statutory features: underwriting standards, loan-loss reserve requirements, and the default rate cap.

First, Congress has mandated that the agency's financing demonstrate a "reasonable assurance of repayment." This is the same underwriting standard that EXIM applies to all its transactions.

Next, federal budgetary laws, such as the Federal Credit Reform Act, require the agency to set aside risk-rated loan-loss reserves for its financing. EXIM is then required to charge the borrower at least the minimum amount of fees needed to cover its loan-loss reserves unless the agency has appropriated funds, known as program budget, to make up the difference between the fees collected and the reserve requirement. EXIM is working with the Administration to identify additional resources and flexibilities that would enable the agency to broaden its risk appetite and maintain globally competitive pricing, while ensuring appropriate loss reserves for transactions.

Finally, in 2012, Congress established a two percent default rate cap for the agency. This cap is calculated by dividing the total amount of overdue payments by the total amount of disbursed financing associated with EXIM's active portfolio. Until 2015, if EXIM's default rate ever exceeded this cap, its financing authority would have been held flat, the agency would be subject to a safety and soundness review by an independent third party, and be required to submit a plan to Congress to reduce the default rate, and provide monthly reports on its progress.

In 2015, Congress maintained these oversight controls but also revised the default rate cap language so that, if ever breached, EXIM's financing authority would shrink from \$135 billion to its total

¹⁷⁴ EXIM outlines the challenges to the agency's ability to offer globally competitive financing in its annual Competitiveness Reports to Congress, available at <https://www.exim.gov/news/reports/competitiveness-reports>.

outstanding exposure—effectively freezing the agency’s ability to engage in *any* new lending. This penalty would bring nearly all financing activity by EXIM to a halt – including for small businesses, minority-owned businesses, transactions in direct competition with the PRC, and transformational export areas.

When EXIM looks to level the playing field against the PRC and advance America’s comparative leadership, its ability to do so is sharply limited by the statutory parameters that sharply limit its ability to take risk.

Opportunities

When Congress established CTEP in 2019, it was unclear the extent to which EXIM financing was needed to facilitate U.S. exports in each of the ten transformational export areas. With the research behind this report, the Agency’s authorized product line and the existing boundaries of official export finance, EXIM now has a clearer idea of the opportunities and challenges associated with each of the transformational export areas, generating insights that will focus EXIM on new opportunities moving forward.

EXIM notes that pending Congressional legislation would add, “Civil nuclear facilities, material, and technologies, and related goods and services that support the development of an effective nuclear energy sector” as a transformational export area.¹⁷⁵ Within the nuclear area, there is significant competition among global suppliers who are backed by foreign export credit agencies, including the PRC and Russia.

In recent years, EXIM has seen an increase in interest for financing to procure goods and services related to the development of foreign nuclear power plants, including the development of small modular reactors. In particular, a number of countries are looking to nuclear as a greener technology solution to their energy challenges, as well as an important contributor to diversifying their energy grid and building resilience to geostrategic threats and challenges.

While EXIM has not yet engaged in a detailed study of the nuclear industry to assess its domestic production and export demand, U.S. industry has made significant strides in innovation and is engaged in a large number of opportunities globally.

EXIM is working to counter competition in the nuclear space but faces challenges with constraints on the agency’s risk appetite, as outlined above. Nuclear transactions tend to be for especially large amounts, which raises the possibility that a default of just one transaction could, on its own, trigger the two percent default rate and immediately freeze the agency’s lending.

Should Congress consider adding nuclear technologies to the transformational export areas, its effect would be limited without also addressing the challenges accompanying the agency’s risk appetite.

¹⁷⁵ "Text - S.1928 - 118th Congress (2023-2024): Civil Nuclear Export Act of 2023." *Congress.gov*, Library of Congress, 12 June 2023, <https://www.congress.gov/bill/118th-congress/senate-bill/1928/text>.

Conclusion

Advancing the comparative leadership of the U.S. through exports requires an assessment of where that competition currently stands. This report shows that each transformational export area has its own profile. Some areas are narrowly scoped, others are very broad in nature. Some areas have seen significant financing activity, while others involve technologies that are too nascent or operate business models that don't necessarily leverage debt financing.

And the capacity/demand analyses of this report show EXIM Bank is indisputably a necessary tool to help U.S. businesses compete against firms that benefit from the well documented industrial policies of the PRC.

Where U.S. businesses lead their PRC competitors in capacity to produce and foreign demand, EXIM support helps defend that lead against PRC offers. But in those industries where PRC businesses lead, EXIM support is indispensable in absorbing prudent risks and making financing available to U.S. exporters.

Additionally, critical minerals are a crucial component of multiple transformational export areas - and the U.S. lags the PRC in the proven reserves, mining, and processing of many critical minerals. Thus, while not itself a transformational export area, EXIM has prioritized critical minerals projects that fall within the transformational export areas.

Yet while official export finance is a necessary tool, *alone* it is insufficient.

If transformational export area industries neither produce in, nor export from, the U.S., it is difficult to make available either EXIM or private sector finance to advance U.S. comparative leadership.

This complexity has governed EXIM's approach to seek durable results with a quiet, purposeful urgency.

Moreover, the CTEP mandate does not overrule the requirements and limitations that govern all EXIM activities. As a governmental agency, EXIM's ability to incur risk is largely defined by three major statutory features: underwriting standards, loan-loss reserve requirements, and the default rate cap. Lending is inherently a risk-taking activity, but there are limits to the risks EXIM can take.

Nevertheless, the agency has and will continue to aggressively push the boundaries within its span of control to counter PRC-backed export financing and support America's comparative leadership in the transformational export areas.

Appendix 1: Methodology

Beginning in 2021, EXIM developed an approach to evaluate the 10 Transformational Export Areas (TEAs) legislated by Congress in the December 2019 reauthorization. EXIM’s Comparative Leadership Assessment effort systematically examines the drivers of U.S. or PRC leadership across the more than 100 industries that underlie the 10 TEAs.

A country’s domestic **production** indicates its “capacity” to make products for foreign sale, and its **exports** signal existing “demand” in global markets for these products. EXIM derived estimates of U.S. and PRC production and exports by industry and evaluated the underlying drivers of comparative leadership that contribute to these metrics. EXIM based this analysis on quantitative sources such as global market share reports, trade flows, company financials, as well as a variety of qualitative government, industry, and academic sources.

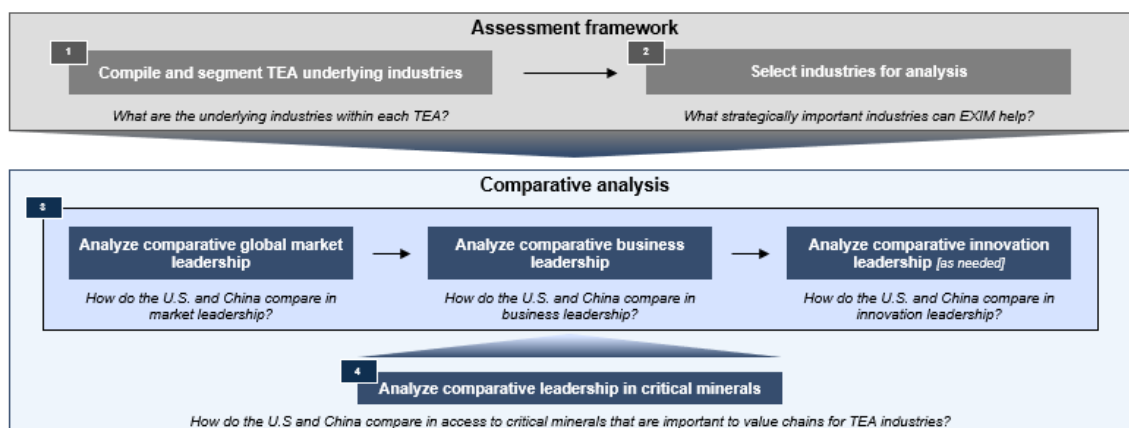
The findings of these evaluations can be summarized as follows:

- 1) In industries where the U.S. is **leading** in production (capacity) and **leading** in exports (demand) compared to the PRC, it is reasonable to conclude that the U.S. **has comparative leadership**.
- 2) In industries where the U.S. is **lagging** in production (capacity) and **lagging** in exports (demand) compared to the PRC, it is reasonable to conclude that the U.S. **lacks comparative leadership**.
- 3) In cases where the U.S. is **leading** in either production (capacity) or exports (demand) and **lagging** in the other compared to the PRC, it is reasonable to conclude that **comparative leadership is contested**.
- 4) In industries where the U.S. is **on par** with the PRC in either production (capacity) or exports (demand), it is reasonable to conclude that **comparative leadership is contested**.

STAGES OF BACKGROUND RESEARCH

EXIM’s process to identify, select, and evaluate TEA industries consists of four sequential stages to identify where EXIM can best advance U.S. comparative leadership against the PRC within the TEAs.

- 1) Segmentation
- 2) Selection for comparative analysis
- 3) Comparative leadership analysis
- 4) Critical minerals analysis



Stage 1: Segmentation

EXIM's Transformational Export Areas (TEAs) are open-ended terms, with each encompassing a variety of industries rather than constituting a single market. For example, industries included within the Renewable Energy, Energy Storage, and Energy Efficiency TEA range from solar power to flywheels to energy-efficient buildings. EXIM therefore began assessment by segmenting each export area into comprehensive, non-overlapping industries.

Government, industry, and academic sources helped analysts segment the TEAs to both reflect how sector participants understand the different industries in each TEA and to identify the best level for conducting industry analysis—with enough granularity to generalize about an industry's leadership and key trends, but not so much specificity to preclude the availability of data on areas like market share and exports. Resulting segmentations ranged in number of identified industries per TEA from 4 (e.g., Quantum Computing) to 31 (e.g., Biomedical Sciences). Note that EXIM separated Renewable Energy, Energy Efficiency, and Energy Storage TEA into its three named areas for segmentation purposes. A full list of segments by TEA appears in the appendix of this report.

Stage 2: Selection for Comparative Analysis

Segmentation yielded over 115 industries associated with the Congressionally mandated Transformational Export Areas. EXIM therefore prioritized its analytic efforts from amongst them using the five variables below. A full listing of the segmentation is available in the appendix "Complete TEAs and Segments."

- 1) *Job growth potential:* How many Americans does this industry employ today? How much growth is expected over the medium to long term? Could EXIM financing support help create additional U.S. jobs?
- 2) *Export potential:* How common is it for goods and services in this industry to be exported to international markets? Do foreign buyers debt-finance the import of these goods and services (e.g. are EXIM's tools relevant?) Are most products physical goods or intellectual property (e.g., software as a service)?
- 3) *Level of U.S. priority:* Has the U.S. government identified this industry as a national priority? For instance, was it included in a relevant executive order or law—or have there been other strategic investments or planning by the U.S. government targeted to this industry?
- 4) *Level of PRC priority:* Has the Chinese Communist Party or a PRC government department identified this industry as a national priority? For instance, do key industrial policy documents such as the 14th Five-Year Plan or Made in China 2025 refer to this industry—or have there been other strategic investments or planning by the PRC targeted to this industry?
- 5) *Innovation potential:* To what extent are upcoming technological advancements expected to transform this industry? How much is this a cutting-edge, nascent technology—or an established, low-innovation market?

EXIM scored each industry from one to five, with one representing the lowest scores in the TEA (e.g., least job growth potential) and five representing the highest scores in the TEA (e.g., highest job growth potential). These scores are based on detailed secondary research, leveraging sources such as U.S. Census Bureau job figures, United Nations Comtrade trade data, and industry research reports—as




well as primary research interviews with industry participants in certain cases. Full scores appear at the bottom of this section.

The aggregate “scorecard” across these five measures prioritized industries for comparative analysis. Additionally, EXIM prioritized industries based on the fit between market needs and EXIM’s tools. For instance, TEA industries with physical goods are more likely to require capital expenditures by foreign buyers, which may require debt finance. Software-defined exports tend to be funded from operational expenditures and not debt financed – and therefore less in need of trade finance support. In certain isolated cases, EXIM staff selected individual industries because the agency was assessing transactions in that industry.








To date, EXIM has completed 16 industries for the initial comparative analysis stage based on the above factors.

Stage 3: Comparative Leadership Analysis



Once selected for further analysis, EXIM analyzed three leadership areas (see below) to assess the comparative leadership of the U.S. relative to the PRC in these industries.





Leadership area	Guiding principle	Key question	Metrics
 <p>Global market leadership</p>	Market share	Is the U.S. leading in the global market compared to other countries?	Global market size; market share by country (e.g., commercial research reports)
	Export strength	Is the U.S. leading in exports in the industry compared to other countries?	Total export volume; export share; export growth; export market share; export market penetration
	Government support	Do U.S. companies in the industry receive more government export support compared to foreign companies?	Export and trade-related financing (e.g., China export credit agency transactions data and public U.S. EXIM Bank data)
 <p>Business leadership</p>	Financial strength	Do U.S. companies in the industry perform better compared to foreign companies?	Aggregated company financial data, including revenue, net income, return on invested capital (e.g., CapIQ financial data)
	Industry leadership	Are U.S. companies industry leaders compared to foreign companies?	Leading companies' share of industry revenue (e.g., % of total industry revenue)
 <p>Innovation leadership</p>	Innovation strength	Is the U.S. more innovative compared to other countries?	Patent / invention strength indexes
	R&D	Is the U.S. leading in research and development compared to other countries?	Total R&D expenditure, industry standards share







Sample comparative leadership findings by industry

Transformational Export Area	Industry	Production vs. PRC	Exports vs. PRC
 <i>Biomedical Sciences</i>	Medical imaging	Leading ✔	Leading ✔
	Pharmaceuticals	Lagging ✘	APIs: Lagging ✘ FDFs: Leading ✔
 <i>Biotechnology</i>	Biofuels	Leading ✔	Leading ✔
	Synthetic Biology	Leading ✔	N/A
 <i>Energy Storage</i>	Battery	Lagging ✘	Lagging ✘
	Hydrogen	Leading ✔	Leading ✔
 <i>Renewable Energy</i>	Biomass	Leading ✔	Leading ✔
	Hydropower	Lagging ✘	Lagging ✘
	Solar	Lagging ✘	Lagging ✘
	Wind	Lagging ✘	Lagging ✘
 <i>Semiconductor</i>	Fabrication	<10 nm chips: Leading ✔	Lagging ✘
		>10 nm chips: Lagging ✘	
 <i>Water Treatment & Sanitation</i>	Water Treatment	On par ⚡	Equipment: Lagging ✘
			Chemicals: On par ⚡
	Wastewater Treatment	On par ⚡	Equipment: Lagging ✘
			Chemicals: On par ⚡
 <i>Wireless Communications</i>	Optical Communications and Networking equipment	Lagging ✘	Lagging ✘
	Satellite Communications	Leading ✔	Leading ✔
	Telecommunications	Lagging ✘	Lagging ✘

Appendix 2: Full List of Transformational Export Areas and Industry Segmentations.

Transformational Export Areas		Segments
	Artificial Intelligence	<ul style="list-style-type: none"> • AI platforms • AI applications • AI application development and deployment • AI infrastructure deployment • AI services
	Biomedical Sciences	<ul style="list-style-type: none"> • Vaccines • Monoclonal antibodies • Pharmaceutical drugs • Medical imaging equipment • Surgical robotics • Blood testing • Blood banking • Cell therapy • Electron microscopy • Radiotherapy • Gene therapy • Molecular diagnostics • Genetic testing • Allergy immunotherapies • Respiratory care devices • Contact lenses • Elderly and disabled assistive devices • Electric nerve stimulation machines • Reading glasses • Hearing aids • Medical furniture • Medical garments • Medical tubing • Orthopedic devices • Sterilization equipment • Surgical drapes • Medical globes • Dental equipment • Advanced wound dressing • Surgical instruments • Rapid diagnostic kits

Transformational Export Areas		Segments	
	Biotechnology	<ul style="list-style-type: none"> • Biofuels • Synthetic biology • Alternative proteins • Bioplastics / biopolymers • Bioinformatic technology • Animal genetics • Fertilizers • Pesticides • Industrial enzymes • Organic acids • Bioengineered seeds • Amino acids • Surfactants • Aroma chemicals • Fermented ingredients • Flavor enhancers • Vitamins • Natural sweeteners 	
	Emerging FinTech	<ul style="list-style-type: none"> • Payments • Alternative lending • Digital banking • Wealthtech • Capital markets • Insurtech • Regtech • Digital assets & Web3 • Infrastructure • ESG 	
	Renewable Energy, Storage and Efficiency	<i>Energy Efficiency</i>	<ul style="list-style-type: none"> • Building • Transportation • Infrastructure • Industrial
		<i>Energy Storage</i>	<ul style="list-style-type: none"> • Battery • Hydrogen • Pumped hydro • Electrical • Compressed air • Flywheel

Transformational Export Areas		Segments	
			<ul style="list-style-type: none"> • Thermal
		<i>Renewable Energy</i>	<ul style="list-style-type: none"> • Solar • Wind • Hydro • Biomass • Geothermal
	High Performance Computing		<ul style="list-style-type: none"> • Servers • Data storage • Networking devices • Central processing units (CPUs) • Graphics processing units (GPUs) • Field programmable gate arrays (FPGAs) • Computing and storage infrastructure software • Infrastructure as a services (IaaS) • Platforms as a Service (PaaS) • Software as a Service (SaaS)
	Quantum Computing		<ul style="list-style-type: none"> • Hardware • Application • Software • Services
	Semiconductor		<ul style="list-style-type: none"> • Fab • ATP • R&D and design • Equipment • Materials
	Water Treatment and Sanitation		<ul style="list-style-type: none"> • Water treatment • Wastewater treatment • Industrial wastewater treatment • Desalination • Mobile water treatment systems • Point-of-use water treatment
	Wireless Communication		<ul style="list-style-type: none"> • Satellite communications • Telecommunications equipment • Optical communications and networking equipment • Wi-fi devices • Near-field communications • TV & radio

Transformational Export Areas		Segments
		<ul style="list-style-type: none">• Infrared detectors• GPS tracking devices• Radio frequency identification• Radar• Wireless audio devices• Sonar systems

