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MINING THE FUTURE

How China is set to dominate the next Industrial Revolution.



ILLUSTRATION BY GWEN KERAVAL

A fight between the United States and China is brewing over 5G and the question of who can be trusted to control the world's wireless infrastructure. But scant attention is being paid to an issue of arguably greater importance to the future of the world's economy and security: China's control of the raw materials necessary to the digital economy.

No new phone, tablet, car, or satellite transferring your data at lightning speed can be made without certain minerals and metals that are buried in a surprisingly small number of countries, and for which few commonly found substitutes are available. Operating in niche markets with limited transparency and often in politically unstable countries, Chinese firms have locked up supplies of these minerals and metals with a combination of state-directed investment and state-backed capital, making long-term strategic plays, sometimes at a loss. Through in-depth analysis of company reports and disclosures, mapping of deal flows, quantification of direct and indirect equity stakes, and other primary research, FP Analytics has produced the first consolidated review of this unprecedented concentration of market power. Without rhetoric or hyperbole, this factbased analysis reveals how rapidly and effectively China has executed its national ambitions, with far-reaching implications for the rest of the world.

China's 13th Five-Year Plan declared 2016 to 2020 a "decisive battle period" for the nonferrous metal industry and for building a well-off society.¹ Its hallmark initiative, "Made in China 2025," aims to build strategic industries in national defense, science, and technology. To meet these objectives, in October 2016, the Ministry of Industry and Information Technology announced an action plan² for its metals industry to achieve world-power status: By deploying state-owned enterprises and private firms to resourcerich hot spots around the globe, China would develop and secure other countries' mineral reserves—including minerals in which China already holds a dominant position.

The timing could not have been better. The fall in metal commodities prices from 2011 to 2015 left many mining companies desperate for capital. Even the largest global players, such as Anglo American, had to slash their workforces and shed assets.^{3,4} By directly acquiring mines, accumulating equity stakes in natural-resource companies, making long-term agreements to buy mines' current or future production (known as "off-take agreements"), and investing in new projects under development, Chinese firms traded much-needed capital for outright control or influence over large shares of the global production of these resources. Despite China's slowing growth and a

A Vast Sum of Parts *China's control or influence over critical minerals and metals that power modern technology is unrivaled.*

Electric Vehicles	Solar Panels	Smartphones
RARE EARTH ELEMENTS80%	GALLIUM 94%	RARE EARTH ELEMENTS80%
GRAPHITE/GRAPHENE 70%	GRAPHITE/GRAPHENE 70%	GRAPHITE/GRAPHENE 70%
LITHIUM 59%	INDIUM 41%	LITHIUM 59%
VANADIUM 56%		INDIUM 41%
COBALT 36%		
Wind Turbines	Satellites	Semiconductors
GRAPHITE/GRAPHENE 70%	GALLIUM 94%	GALLIUM 94%
VANADIUM 56%	RARE EARTH ELEMENTS 80%	RARE EARTH ELEMENTS80%
COBALT 36%	VANADIUM 56%	GRAPHITE/GRAPHENE 70%
	COBALT 36%	INDIUM 41%

SOURCES: USGS; FPA ANALYSIS OF COMPANY FILINGS, DEAL FLOWS, EQUITY STAKES AND OFF-TAKE AGREEMENTS

major pullback in its foreign direct investment in other sectors, the government has maintained robust financial support for resource acquisition; mergers and acquisitions in metals and chemicals hit a record high in 2018.⁵

PART I 'Going Out and Bringing In'

Though it boasts a rich endowment of natural resources at home, China lacks significant reserves of three resources vital to its tech ambitions: cobalt, platinum-group metals, and lithium. It has successfully employed two strategies to secure control of them. One is driven by China's stateowned enterprises (SOEs), which use development finance and infrastructure investment to embed themselves in higher-risk countries, establishing close ties with government leaders. The second is investment by state-linked private firms in market-based economies. Both strategies have shown agility and an ability to effectively adapt to local circumstances to achieve the same end.

SOE Strategy, Cobalt, and the Case of the Democratic Republic of the Congo

With few governments having articulated, let alone implemented, an explicit resource strategy, China is more than a decade ahead in the game. At a gathering last June in Lubumbashi, the mining capital of the Democratic Republic of Congo (DRC), representatives from 35 Chinese mining companies announced the creation of the Union of Mining Companies with Chinese Capital to coordinate communication with the DRC's government.6 The announcement was less an inauguration than a formalization of the deep, long-term relationships between Chinese industry and DRC government officials that have been cultivated for decades: China now owns or has influence over half of the DRC's cobalt production,⁷ and has a massive stake in its mining industry. Six months ahead of the presidential elections, the event also sent a strong message to candidates about China's deep investment in copper and cobalt mining-which constitutes 80 percent of the DRC's export revenue⁸ and thousands of jobs—and its capacity to influence the future of the DRC's economy.

China's notably high tolerance for political and security risk and its ability to embed firms in the development of local industry have not only enabled Chinese SOEs to gain footholds in complex natural-resource markets, but given them a competitive edge over their rivals in the industry. Its patient acquisition of the DRC's cobalt resources serves as a case in point.

The DRC is home to nearly two-thirds of the world's cobalt production and half of its known reserves.9 Those resources are the prime target of investors for the booming battery industry. Over a decade of steady engagement, China has staked out a dominant position by developing strong political ties and investing in production assets and related infrastructure. Using development financing, in 2007, the Export-Import Bank of China issued¹⁰ \$6 billion for infrastructure (a figure later reduced to \$3 billion) and \$3 billion for copper and cobalt mine development.¹¹ Projects were run by Sinohydro and China Railway Group in exchange for a 68 percent mineral stake in the Sicomines copper and cobalt mine, thought to be one of Africa's largest.¹² China deepened the DRC's reliance on Chinese capital by committing to finance the revitalization of the DRC's state-run company Gécamines,13 strengthen the country's core industrial sector, and create needed jobs through additional sector investments.14

By targeting debt-stressed mining companies already established in the DRC, China's SOEs and private firms have secured equity shares and influence over a majority of its mines, including majority stakes in the Tenke Fungurume mine, which holds one of the world's largest, highest-grade deposits of copper and cobalt. China Molybdenum bought the majority stake (56 percent) from U.S. company Freeport-MacMoRan in 2016, and recently bought an additional 24 percent stake from Chinese private-equity firm BHR Partners.^{15,16,17} Over time, China has secured ownership over 10 out of the DRC's 18 major operational mines, six major development projects, and a



A worker watches a conveyor belt loaded with chunks of raw cobalt at a plant in Lubumbashi, the mining capital of the Democratic Republic of the Congo, on Feb. 16, 2018. SAMIR TOUNSI/AFP/GETTY IMAGES

three-year off-take deal from the DRC's (and the world's) largest cobalt mine,¹⁸ effectively establishing influence over 52 percent of the country's production.¹⁹

Recognizing the continued demand from global industry, former President Kabila and DRC officials implemented a 50 percent tax on superprofits in a revised mining code,²⁰ creating even more uncertainty about the country's future cobalt production. Before leaving office, Kabila declared cobalt a "strategic" metal and tripled the royalty tax, to boost local governments' profit share from the sector.²¹ Similar taxes are being considered in neighboring Zambia.

Despite the DRC's recent election and uncertainty about how the new president will engage with the mining industry, China and its local firms continue to reinforce their impact on the local economy and engage collectively with the DRC's political establishment. The recent formalization of the Union of Mining Companies with Chinese Capital has been set up to do just that.

Replicating the State-Owned Enterprise Model

China's SOE-driven strategy remains dominant throughout Africa, where adverse market sentiment and financial hardship in the mining industry have opened the door for SOE investment across the region. Notably, SOEs, in partnership with the China-Africa Development Fund, a Chinese state-funded institution, have expanded in South Africa's Bushveld Complex,²² a mineral-rich geological formation that contains the world's largest reserves of platinum-group metals²³—critical for making catalytic converters, which are essential for reducing automobile emissions—and the world's highest-grade and third-largest deposit of vanadium, a resource integral to a broad range of high-tech industries, from renewable-energy storage to aerospace and defense.

By leveraging state resources, China's SOEs and private firms have made at least eight major equity and off-take plays in platinum-group metals in the Bushveld Complex.²⁴ Such investments in South Africa's highly concentrated and strategic resource deposits have helped make metals the country's leading source of export growth,²⁵ with nearly 50 percent of its metal exports going to China²⁶ —tying South Africa's economic welfare directly to Chinese investment.

Private Firms and the Extension of State Strategy Abroad

China is also proving agile at adapting to conditions in market-oriented, democratic countries, using privately owned companies that are backed by state capital. By incrementally acquiring equity stakes in major local resource companies and financing junior developers, Chinese firms are strengthening their market presence while overcoming local concerns about foreign control over strategic domestic resources, such as niobium in Brazil and tantalum in Australia.Nowhere is this privately driven resource strategy more evident than in the three countries where nearly 90 percent of global lithium production and more than three-quarters of the world's known lithium reserves are located: Chile, Argentina, and Australia.²⁷ In just six years, China has come to dominate the global market: More than 59 percent of the world's lithium resources are now under its control or influence.28

With the backing of state-owned banks, China's industrial chemical giants-Tianqi Lithium and Ganfeng Lithium-have become the world's third-largest producer of lithium²⁹ and third-largest producer of lithium chemical compounds,30 respectively. The chairmen of both companies have risen within the ranks of Chinese politics over the past few years, just as China was beginning to prioritize securing supplies of rare metals. In 2013, Tianqi's chairman, Jiang Weiping, became a member of the Standing Committee of the Political Consultative Conference of Sichuan province,³¹ and he was made a delegate to the National People's Congress in 2018.³² Ganfeng's chairman, Li Liangbin, became a member of the Standing Committee of the 12th Political Consultative Conference of Jiangxi province in 2018.33 These two companies, along with other Chinese firms, have expanded their investments and integrated operations in three distinct markets by acquiring a major stake in the leading producer in Chile, financing new development in Argentina, and acquiring mines and building up processing capacity in Australia.

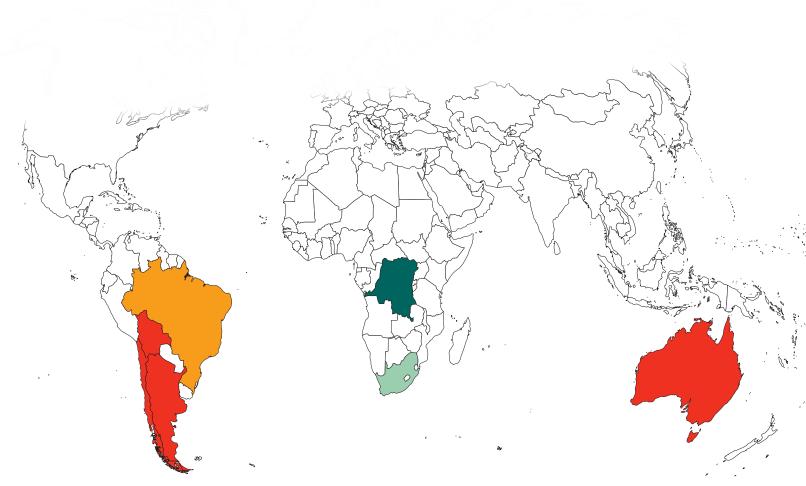
Growing Equity in Latin America's Lithium Leaders

In early 2018, Tianqi Lithium made a bold play to acquire a 24 percent stake in Chilean rival Sociedad Química y Minera (SQM), the world's second-largest lithium producer. Chile is home to 57 percent of the world's known lithium reserves, ³⁴ the world's largest known concentration, and SQM controls roughly half the country's production. In the industry's biggest mergers-and-acquisitions deal to date, Tianqi made a \$4.1-billion bid on SQM's shares, \$3.5 billion of which was financed by China's CITIC Bank International,³⁵ whose parent company, CITIC Group, is among China's largest state-owned financial and industrial conglomerates.³⁶

The Chilean government has traditionally held a relatively tight rein on its lithium resources, which have long been considered strategic for the nation's nuclear industry. The size of the deal with Tianqi heightened concerns in Chile over a foreign entity controlling those resources, and the potential for a cartel to form—spurring public opposition and antitrust and constitutional court challenges by SQM's majority shareholder. After months of legal battles and debate, the Constitutional Court of Chile dismissed the antitrust claims,³⁷ allowing Tianqi to secure the deal in December. Though the final agreement³⁸ included restrictions on Tianqi's board and committee participation and its access to SQM's sensitive data, Tianqi's equity position still confers considerable influence over SQM.

But the SQM deal is just one piece of a deepening economic relationship³⁹ with Chile, including Chinese investments in the local lithium industrial base, exports of electric buses to Chile, and an upgraded trade agreement between the two countries that just came into force in March 2019.⁴⁰ In April 2018, China's ambassador to Chile, Xu Bu, stated to local news outlets that opposition to the sale "could leave negative influences on the development

In just six years, China has come to dominate the global lithium market: More than 59 percent of the world's lithium resources are now under its control or influence.



Chinese Resource Strategy

China is securing minerals and metals for which it is net import reliant.

COBALT

Democratic Republic of the Congo

PRODUCTION: 61%

RESERVES: 49%

CHINA'S INFLUENCE: Influence over 52% of cobalt production with equity stakes and supply agreements

NIOBIUM		
Brazil		
PRODUCTION:	88%	

RESERVES: 80%

china's influence: Stakes in 100% production

PLATINUM GROUP METALS (PGMS)

South Africa

PRODUCTION: 54%

RESERVES: 91%

CHINA'S INFLUENCE: Stakes in ²/₃ of all major PGM sites

LITHIUM Argentina

PRODUCTION: 10%

RESERVES: 14%

CHINA'S INFLUENCE: Stakes in 41% of major planned projects accounting for 37% of reserves

Australia

PRODUCTION: 58%

RESERVES: 19%

china's influence: Stakes in 61% of production

Bolivia

PRODUCTION: NONE

RESERVES: Believed to be among the world's largest

CHINA'S INFLUENCE: Stakes in 100% of development via an equity agreement

Chile

PRODUCTION: 21%

RESERVES: 57%

CHINA'S INFLUENCE: Stakes in 67% of Chile's output

PRODUCTION AND RESERVES FOR 2017. SOURCES: USGS; FPA ANALYSIS OF COMPANY FILINGS, DEAL FLOWS, EQUITY STAKES AND OFF-TAKE AGREEMENTS

of economic and commercial relations between both countries, ^{*41} and has since reportedly made other economic threats. ⁴² Tianqi is now seeking permission to develop Salar de La Isla, Chile's second-largest lithium brine deposit, ⁴³ in partnership with U.S.-based lithium company Albemarle, the other major player in Chile's lithium industry. Tianqi has the majority stake in the joint venture. ⁴⁴

Leveraging Capital Across Developing and Developed Markets

In a cash-strapped industry, Chinese firms are financing mine expansion and new development in exchange for a guaranteed supply of lithium in both mature and emerging markets. In Argentina, where President Mauricio Macri is eliminating mineral export taxes, reducing corporate tax rates, and allowing profit repatriation, China is establishing a dominant position in the nascent sector with "streaming deals," which provide development capital in exchange for future lithium yields to help projects get off the ground. Chinese firms, led by Ganfeng, have stakes in 41 percent of the country's major planned projects that account for 37 percent of Argentina's reserves.⁴⁵ This raw-material strategy is already coming to fruition: Lithium export volumes from Argentina to China rose nearly fourfold from 2015 to 2017,46 and China has secured access to the country's lithium for the longer term.

This same strategy, combined with asset acquisition, has also been successful in Australia, whose proximity to China, significant lithium reserves, and broad political support for mining investment have attracted Chinese investment. Tianqi and Ganfeng have established stakes in 91 percent of the lithium mining projects underway and 75 percent of the country's reserves, including some of the world's largest.⁴⁷ By taking over Talison Lithium, Tianqi captured a majority stake in the Greenbushes mine, which accounts for roughly 40 percent of global lithium production.⁴⁸ Together, Chinese firms have secured deals with nine of the 11 major operations and projects in the pipeline in Australia, two-thirds of which are exclusive.⁴⁹

Growing the Global Footprint

Having already consolidated control over global lithium supplies, Tianqi and Ganfeng are just getting started. Both filed for initial public offerings last fall with the intent to raise capital for further expansion. Ganfeng raised \$421 million in its October 2018 initial public offering,⁵⁰ which included four state-linked cornerstone investors.⁵¹ Last November, Tianqi received the necessary approvals from the China Securities Regulatory Commission to prepare for its Hong Kong listing,⁵² the proceeds from which will be deployed in global markets.

PART 2 China Reinforcing Its Resource Dominance

China is also making moves to take an even stronger position in resources it already controls on the global market. Natural resources are abundant in China; it is the No. 1 producer and processor of at least ten critical minerals and metals^{53,54} that are essential to high-tech industries and upon which China's commercial and strategic competitors depend. To reinforce its strength, Chinese firms are acquiring mines and output from the next-largest producers and reserves, giving China both an economic edge in the next high-tech industrial revolution and increasing geopolitical power.

Perhaps the best-known example both of China's natural-resource dominance and its willingness to exploit it is rare-earth elements, a group of 17 elements that (despite their name) are commonly found, but rarely in concentrations that can be economically extracted. They are important materials for the defense, aerospace, electronics, and renewable energy industries. Over the past two decades China has produced more than 80 percent of the world's production of rare-earth elements and processed chemicals.55 In 2010 it cut off exports to Japan56 amid rising tensions over the East China Sea, and the following year it imposed export quotas57 that threw governments and manufacturers into a panic.58 But with the exception of Japan, the attention to this critical vulnerability was short-lived, and little action was taken by other countries reliant on imports to diversify their resources or develop minerals action plans of their own.

China declared rare-earth elements a strategic resource in 1990 and prohibited foreign investment in the sector.⁵⁹ Six state-owned enterprises control the industry, and the government cut production quotas in 2018 by 36 percent.⁶⁰ With global demand for rare-earth elements projected at a compound average growth rate of more than 17 percent to 2025,⁶¹ a supply crunch is likely approaching—and China is already securing other nations' supplies.

Chinese firms have been increasing stakes in mines and securing off-take deals from the world's largest deposits of rare-earth elements. While Russia strictly limits foreign participation in rare-earth element development, Chinese firms have accumulated off-take agreements and stakes in rare-earth element mines in Australia and Brazil. Though Australia's Foreign Investment Review Board denied a 2009 takeover of Australian company Lynas' mine at Mount Weld,⁶² the second-largest rare-earth element oxide producer outside China, Chinese firms have locked in output from the site.⁶³ Northern Minerals, owned by Chinese firms,⁶⁴ is also developing Australia's other major rare-earth elements site, Browns Range; 100 percent of the mine's dysprosium, an element used in magnets and superalloys, will go to China's Lianyungang Zeyu New Materials Sales Co. Ltd.⁶⁵

And in the United States in 2017, China's Shenghe Resources and two U.S. private equity firms acquired the sole U.S. and North American rare-earth element producer and processor, Molycorp, and its idled mining operations at Mountain Pass, California.66 The operation went bankrupt in 2015 due in large part to low prices for Chinese supplies of rare-earth elements, and its sale briefly spurred debate over whether the deal posed risks to national security,⁶⁷ but opponents could not make the legal case to block it. Shenghe holds rights to the mine's output; meanwhile the United States' rare-earth element imports continue to increase, at a cost of \$160 million in 2018 alone.68 Though President Donald Trump has since called for a defense review and assessment of critical minerals, the Committee on Foreign Investment in the United States has not taken further action on the site. Meanwhile, Shenghe and its subsidiaries are continuing to expand internationally, with a major joint-venture development project in rare-earth elements now underway in Greenland.^{69,70} China's decades-long consolidation of strategic resources has only compounded its commercial and geopolitical capabilities, and it shows no sign of slowing down.

Vanadium and Graphite

China is also seeking to expand its dominant market position in vanadium and graphite, securing additional supplies and building integrated supply chains. Vanadium is a transition metal that is used in flow batteries, superconducting magnets, and high-strength alloys for jet engines and high-speed aircraft. Chinese firms already produce 56 percent of the world's vanadium domestically, and China is home to 48 percent of the world's reserves.⁷¹ Now, they are targeting South Africa, ranked third in vanadium production and reserves behind China and Russia.⁷²

In 2015, Hong Kong-based International Resources Ltd., a company whose ownership is opaque, executed a takeover of a major vanadium mine from Russia's Evraz Highveld Steel and Vanadium, which was facing bankruptcy.⁷³ In 2016, China's Yellow Dragon Holdings Ltd. co-invested with Bushveld Minerals, the primary vanadium developer in South Africa's massive Bushveld Complex, to acquire Strategic Minerals, which owned the Vametco vanadium mine and plant.⁷⁴ Yellow Dragon subsequently increased its investment in Bushveld Minerals and has become the fifth-largest shareholder.⁷⁵ The holdings deepen China's influence over South Africa's vanadium resources and its role in the country's emerging high-tech sector. Bushveld



A worker walks across the Jin Yang graphite factory in the town of Mashan, China, on May 28, 2016. MICHAEL ROBINSON CHAVEZ/THE WASHINGTON POST VIA GETTY IMAGES

Minerals is moving to develop an integrated platform to produce vanadium redox flow batteries for distributed energy across South Africa.⁷⁶ The vanadium resources will also flow toward China, feeding its battery industry and the National Development and Reform Commission's planned rollout of 100-megawatt stationary energy storage stations to manage its wind and solar energy.⁷⁷

China's position is even stronger in graphite, a crystalline form of the element carbon whose high conductivity makes it a major component in electrodes, batteries, and solar panels, as well as industrial products such as steel and composites. For the last 20 years, China has been the leading global supplier of graphite, representing nearly 70 percent of the world's production in 2018 and 24 percent of its reserves.⁷⁸ While synthetic graphite, which is produced from petroleum coke, is an alternative, unfavorable economics constrain its use.

Rapidly growing demand for batteries and other end uses, coupled with environmental restrictions in China, are driving prices higher and stimulating investment. New projects are concentrated in Mozambique, where the world's largest graphite mine and fourth-largest known reserves are located.⁷⁹ Already, Chinese firms have secured off-take agreements with the three major developers in Mozambique for the majority of their graphite production,^{80,81} and they are financing new development.⁸²

Now that it controls most of the world's graphite, China has expanded down the supply chain, becoming the world's

Building on Domestic Resource Dominance *China is supplementing its own supplies with investments abroad.*

DOMESTIC PRODUCTION AND RESERVES **RARE EARTH ELEMENTS** GRAPHITE VANADIUM 70% 24% 80% 37% 56% 48% PRODUCTION RESERVES PRODUCTION RESERVES PRODUCTION RESERVES **INITED STATES** Acquisition of the only U.S. REE mine conferring control over strategic source AMBIQUE **SOUTH AFRICA** The three major developers of new Stakes in primary projects all signed vanadium developer and "strategic off-take contracts **AUSTRALIA** with Chinese firms framework" to develop vanadium Stakes in largest redox-flow batteries REE oxide producer and 100% offtake from the second-

PRODUCTION AND RESERVES FOR 2017. SOURCES: USGS; FPA ANALYSIS OF COMPANY FILINGS, DEAL FLOWS, EQUITY STAKES AND OFF-TAKE AGREEMENTS

largest REE deposit

leading producer of anodes, positively charged electrodes that are essential for making lithium-ion batteries. That industry is also highly concentrated: China's Shenzhen BTR New Energy Materials accounts for roughly 70 percent of global anode production.⁸³ The next-largest player is Japan's Hitachi Chemical, at 20 percent;⁸⁴ Japan is 90 percent reliant on China for its graphite.⁸⁵ China is channeling increasing volumes of graphite toward its booming domestic battery and new electric-vehicle industries, stockpiling domestic production and reducing graphite exports, which could result in a supply crunch for other end users. In 2016, China consumed 35 percent of the world's graphite production.⁸⁶

PART 3

Controlling the Fuel of the Future

This resource consolidation could determine whether China is able to overcome the last major hurdle to achieving its ambitions: a competitive semiconductor industry. The lifeblood of high-tech industries, semiconductors are made of the very minerals and metals over which China is securing control. Semiconductors can be pure elements or compounds and altered with impurities to improve their conductivity. Several materials are now being used to improve speed and performance, including rare-earth elements, graphite, indium, gallium, tantalum, and cadmium. China is the dominant producer of five out of the six, controls more than 75 percent of the world's supply of three,⁸⁷ and is consolidating control over them all.

However, China still lacks the technological capability to produce semiconductors on par with the industry's leading companies and remains highly dependent on imports, at a cost of roughly \$260 billion per year.⁸⁸ The government is keenly focused on ending its dependency by acquiring the technological expertise to surpass its rivals. It poured nearly \$20 billion into highly targeted research and development to that end from 2014 to 2017,⁸⁹ and it is only intensifying its focus.

Should China succeed technologically, its capacity to scale production and flood markets (as it has already done with solar panels and wind turbines) has serious implications not only for leading semiconductor producers, but also for national security, if Chinese-manufactured chips are embedded in the devices upon which our data-driven lives, our economies, and our defense systems increasingly depend. While government and industry officials have started to restrict semiconductor sales and scrutinize Chinese acquisition of technology firms-e.g., the United States' temporary ban on selling semiconductors to ZTE, or the recent flare-up over Huawei-such moves are strengthening China's resolve to develop its domestic industry. More attention should be paid to its efforts to consolidate critical raw materials and the computing power they confer.

This is not a foregone conclusion. It will, however, require us to fundamentally rethink how we understand strategic industries and the long-term investments needed to ensure economic prosperity and national security in the digital age. Some countries are waking up to these strategic vulnerabilities and starting to act on them. In April, U.S. government officials announced plans to meet with lithium industry leaders and automakers with the intention of developing a national electric-vehicle supply chain strategy. It is a start.



This report was produced by FP Analytics, the research division of the FP Group. Access it online at <u>ForeignPolicy.com/miningthefuture</u> (requires subscription).

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