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Strengthening America's Clean Tech Industries

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This paper examines China's emergence as a global leader in clean technology through the use of flexible and adaptive industrial policy tools. Beyond simple tariffs, China has employed a portfolio approach, conducted local policy experimentation, and forged strategic partnerships with global industry leaders to overcome early-stage commercialization barriers and generate cross-sector spillovers. The U.S. should learn from aspects of China's experience with clean technologies to develop its own industrial capacity in these areas. In particular, the U.S. should develop a structured foreign investment framework, create a schedule of protective tariffs for select supply chain segments, and establish a national venture capital fund. These policies will help the U.S. improve its domestic manufacturing capabilities and lay the foundation for future competitiveness across a broad range of technologies.

China has emerged as a global leader in a wide range of clean technology industries, from electric vehicles and batteries to solar and wind. Industrial policy has been central to China's success in these areas, helping to drive scale and innovation in a way that defies traditional market dynamics. The specific industrial policy tools and strategies that China has used in clean tech sectors are not widely understood in the U.S. These tools extend far beyond tariffs and subsidies, encompassing a broad range of actors, such as state-owned enterprises, private firms, local governments, state banks, and public research institutions. This paper outlines key themes and features of China's clean tech industrial policy and offers useful lessons for U.S. efforts to boost domestic manufacturing and improve industrial competitiveness in these areas.

Broad Bets and the Portfolio Approach

U.S. policymakers are understandably careful about spending taxpayer money and interfering with market competition. High-profile failures such as Solyndra and A123 Systems made larger-scale industrial policy efforts politically unpalatable in the U.S. for years. Beijing has taken a different approach that directs resources at target industries more broadly and entails a different risk-taking strategy. Many central government industrial policy measures are aimed at supporting a target industry across the board, such as funding for research and development, consumer subsidies, standard setting, industry regulations, and directional guidance for state bank loans. Company-specific policy support often comes from local government actors and includes local government financing, support with land and infrastructure, and help navigating licensing and permits.

A portfolio approach is key to China's industrial policy strategy, tolerating some degree of risk and unproductive investment in specific companies in order to provide sufficient resources for the sector at large. For example, China's solar manufacturing industry has experienced multiple rounds of expansion, followed by tightening and culling. Winners in one period, such as Suntech, may find themselves overtaken or squeezed out of the market altogether, particularly during times of industry stress such as the 2008 global recession.[1] At the same time, continued industrial policy

[1] Nemet, Gregory. 2019. *How Solar Energy Became Cheap: A Model for Low-Carbon Innovation*. Routledge.

support ensured that while companies might come and go, the industry overall survives, perhaps led by a new generation of companies. Many of China's solar leaders today, such as JA Solar and Tongwei, are part of a generation of companies that mainly rose to prominence after the industry crunch of the late 2000s.[2]

China's approach to electric vehicles offers another example of this portfolio approach. Rather than bet on a single technology, Chinese policymakers and companies invested in a range of powertrain technologies, including battery electric vehicles, hybrids, and hydrogen fuel cells. In contrast, Japan invested heavily in hybrid technology and hydrogen fuel cells, through programs such as the 2017 Basic Hydrogen Strategy.[3] The success of the Toyota Prius, in particular, validated the approach of Japanese automakers to focus on hybrid vehicles, given uncertainty about the cost of batteries and the availability of EV charging infrastructure in key markets, including the United States. However, as the cost of batteries declined, China's approach to covering all three powertrains paid off and positioned the country's automakers for rapid growth in battery electric vehicles. This multi-pronged approach has also provided Chinese automakers with flexibility across global markets, circumventing tariff restrictions targeted specifically at EVs and offering hybrids where consumers remain uncertain about battery electric vehicles. For example, BYD has found success in global markets, including in Europe, with its DM-i plug-in hybrid technology, which offers significant battery-only range before the gas-powered engine kicks in.[4]

Learning from Global Industry Leaders

Rather than trying to reinvent the wheel, China used industrial policy tools to bring in foreign technology and expertise. China offered access to its market in exchange for investments, joint venture partnerships, and technology licensing. One example of this is China's high-speed rail program. In the 2000s, China's then-Ministry of Railways began planning to develop a nationwide high-speed rail network that would eventually come to connect virtually every major city in the country. While China had previously tried to self-develop its own high-speed train platform, China's Ministry of Railways shifted gears and instead sought to bring in global industry leaders. China's Ministry of Railways offered foreign train-makers, such as Siemens, Alstom, Bombardier, and Kawasaki Heavy Industries, the opportunity to participate in what was promised to be the largest high-speed rail buildout in history. In exchange, these foreign firms were required to partner with Chinese train-makers, such as Qingdao Sifang and Changchun Railway Vehicles, and share technology and know-how with these Chinese domestic partners. Over time, China's domestic train-makers were merged into a single state-owned giant called China Railway Rolling Stock Corporation (CRRC) that built on top of technology acquired by foreign partners to develop China's own indigenous high-speed train platform, the CR400AF or Fuxing Hao.[5]

Another example of learning from global industry leaders was China's automotive industrial policy through the 1980s and into the 2020s. Starting in the 1980s, China began

[2] Gallagher, Kelly Sims. 2017. *The Globalization of Clean Technology: Lessons from China*. MIT Press.

[3] Nakano, Jane. 2021. "Japan's Hydrogen Industrial Strategy." *CSIS Energy Rewired*, October 21. https://www.csis.org/analysis/japans-hydrogen-industrial-strategy.

[4] Blenkinsop, Philip. 2026. "EU sets out firm conditions for China EVs to avoid tariffs." *Reuters*, January 12. https://www.reuters.com/world/asia-pacific/eu-issues-guidance-minimum-price-conditions-chinese-evs-2026-01-12/.

[5] Chan, Kyle. 2022. "The Organizational Roots of State Capacity: Comparing Railway Bureaucracies in China and India." *Asian Survey* 63(1): 31-61.

experimenting with requirements for foreign automakers to form joint ventures with Chinese domestic state automakers and jointly produce vehicles in China. This was later formalized in a 1994 policy that capped foreign ownership in these joint ventures at 50%. A wave of foreign automakers participated in this policy, including Volkswagen, Toyota, and GM, drawn by China's growing automotive market. While this early generation of joint venture partnerships helped to develop China's automotive supply chain, it failed to produce a recognizable Chinese national champion on the global stage.[6] However, starting in 2001, China embarked on an industrial policy plan for developing "new energy vehicles" (NEVs).[7] In 2018, China dropped its joint venture requirement for foreign automakers and allowed Tesla to establish an EV plant near Shanghai.[8] The Shanghai government pushed Tesla to work with Chinese domestic suppliers and localize its supply chain, helping China to upgrade its EV industry and provide a stimulating "catfish effect" on local competition.[9]

Local Policy Experimentation

While national industrial policy goals stem from central ministries and political leaders, much of the implementation occurs at the local government level. National-level goals are often set broadly with ample room for policy experimentation at the local level. China's EV industry is a case in point. The Ten Cities, One Thousand Vehicles program, launched in 2009, selected cities, such as Shenzhen and Shanghai, as pilot cities for testing new EV-related policies.[10] Policy tools ranged widely from incentives for installing chargers to special lanes and parking spots for EVs. Many city governments leveraged their own procurement powers to drive demand for their own local EV champions, such as the Shenzhen city government's purchase of BYD buses and taxi cabs.

Local policy experimentation is useful in several ways. It allows for the testing of a wider range of potential policy tools but in a limited manner to mitigate risks of policy mistakes. It provides flexibility for local conditions, such as different battery and charging standards in colder climates. And it offers a way for good policy ideas to spread in a gradual, test-and-check manner. For example, policies around special license plates for EVs first began in cities such as Beijing and Shanghai and then were later adopted as a national-level policy for major cities.

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[6] Huang, Yasheng. 2002. "Between Two Coordination Failures: Automotive Industrial Policy in China with a Comparison to Korea." *Review of International Political Economy* 9(3): 538-573.

[7] Wang, Xiaoli et al. 2021. "Evaluation of China's new energy vehicle policy texts with quantitative and qualitative analysis." *Technology in Society* 67.

[8] Bradsher, Keith. 2018. "China Loosens Foreign Auto Rules, in Potential Peace Offering to Trump." *The New York Times,* April 17. https://www.nytimes.com/2018/04/17/business/china-auto-electric-cars-joint-venture.html.

[9] Yuan, Li. 2021. "In China, Tesla Is a Catfish, and Turns Auto Companies Into Sharks." *The New York Times,* November 30. https://www.nytimes.com/2021/11/30/business/china-tesla-electric-cars.html.

[10] Yao, Yusheng et al. 2022. "When are new energy vehicle incentives effective? Empirical evidence from 88 pilot cities in China." *Transportation Research Part A: Policy and Practice* 165: 207-224.

Timing and Adaptation

China's clean tech industrial policy combines two seemingly contradictory principles: persistence and flexibility. In many cases, China targets the same industries over years if not decades. China's focus on building a world-class auto industry goes back decades, long before the rise of EVs. The same is true for China's railways. This long-term persistence in policy support allows industry players to make long-term investments in research and development as well as manufacturing scale, banking on the certainty that these areas will remain priorities for the central government for the foreseeable future.

At the same time, China's industrial policy has proven to be flexible, particularly in the face of changing industry dynamics or even the international trade environment. In solar, China began with a supply-side effort to support its burgeoning solar industry to export competitively to Europe and elsewhere. But later, when European feed-in tariffs were scaled back, China initiated a large demand-side boost through its rapid deployment of solar power domestically. In the auto industry, Chinese state-owned automakers tried and failed to master core combustion engine technology for years. But a new focus on EVs starting in the 2000s provided a new generation of Chinese automakers, such as BYD and Geely, with an opportunity to compete with and even leapfrog global industry incumbents.

Overcoming the Valley of Death

For early-stage clean tech companies, it can be difficult to survive financially in the transition from prototype development to viable commercialization. This is particularly true for early-stage companies or even large corporations investing in new, unproven technology. Chinese clean tech firms face similar challenges and benefit from policy support during this critical phase. Bank loans and, later, government guidance funds have provided early-stage companies with sufficient capital to establish a fully operational battery or EV plant, ensuring more of these companies have a shot at reaching the production stage and later commercial viability.

In the U.S., there are smaller scale efforts to provide government-backed financing for early-stage companies in strategic industries, such as defense and critical minerals. For example, the Department of Energy's Loan Programs Office was crucial to financing clean energy projects in the U.S. under the Inflation Reduction Act.[11] The Pentagon's Defense Innovation Unit provides financing for companies in dual-use sectors, such as drones and sensors. However, these programs tend to remain relatively small-scale and involve a significant amount of bureaucratic overhead that can be a burden for small companies.

Spillover Effects

Unlike in the U.S. where industrial policy efforts tend to be narrowly targeted on one or a small number of industries, Beijing pursues industrial policy in multiple overlapping sectors simultaneously. As these overlapping sectors develop and mature, they produce broader spillovers that extend industrial policy gains beyond their original targeted area. For example, China's long-

[11] Congressional Research Service. 2022. "Inflation Reduction Act of 2022 (IRA): Department of Energy Loan Guarantee Program." https://www.congress.gov/crs-product/IN11984.

term industrial policy efforts in batteries, EVs, and solar have begun to converge around solar-plus-storage projects that connect large-scale battery systems with solar power equipment.[12] China's booming EV industry feeds into this by supporting scale and development in the battery industry, which spills over into energy storage systems.

In many cases, traditional industries and emerging clean tech sectors overlap and form collaborative synergies. For example, China's world-leading shipbuilding capabilities, a product of decades of industrial policy in this space, allow the country to build specialized wind turbine installation vessels to support its offshore wind industry. China's shipbuilding industry also allows Chinese automakers to build and operate specialized roll-on, roll-off vehicle cargo ships. And China's investments in developing clean technology industries have spillover benefits for other areas. For example, China's strength in EV manufacturing also allows it to build autonomous vehicles at scale. China's battery production capacity is also powering its consumer electronics, drone, and robotics industries. The key takeaway here is to realize that the returns to industrial policy in one clean tech sector can extend to other sectors as well, generating broader economic and innovation spillovers.

Lessons for Strengthening American Clean Technologies

The United States should apply targeted industrial policy to develop its clean technology industries. In addition to supporting climate efforts, building up domestic production capabilities offers a wide range of benefits with bipartisan support, including increasing energy production, job creation, and developing an emerging cluster of technologies centered around batteries and electricity, also known as the "electro-industrial tech stack."[13] These technologies will not only power the traditional industries of today but also allow the United States to be competitive in robotics, drones, autonomous vehicles, and related autonomous systems.

There are several concrete policies the U.S. can pursue that build on its own experience with industrial policy as well as China's experience in terms of both successes and failures. These tools are meant to fit the United States' particular political and social context, including attitudes towards the role of the state in markets and balancing risks related to China.

First, the U.S. should develop a foreign investment framework for bringing in investment from global industry leaders while mitigating potential risks to U.S. national security. The U.S. must accept that it is no longer the global leader in certain technologies, particularly related to clean technology, and harness the technology and know-how of foreign firms who are at the global technology and production frontier. This investment framework would provide incentives for foreign firms, particularly from allies and partners, to establish manufacturing facilities in the U.S. with conditions related to technology transfer, supply chain localization, local job creation, and ownership control. This investment framework could also allow Chinese firms to invest in

[12] Panerali, Kristen, and Zhang Xun. 2024. "The next step for China's clean energy transition: industrial and commercial storage deployment." *World Economic Forum*, June 27. https://www.weforum.org/stories/2024/06/next-step-for-china-s-clean-energy-transition-is-storage-deployment-in-its-world-class-industries/.

[13] McEntush, Ryan. 2025. "The Electro-Industrial Tech Stack Will Move the World." *Andreesen Horowitz*, August 25. https://a16z.com/the-electro-industrial-stack-will-move-the-world/.

production facilities in the U.S. in a limited set of non-sensitive domains, such as battery cells, solar panels, and even electric vehicles that are equipped with non-PRC "connected" technology. Ideally, this framework would define non-sensitive domains and provide mechanisms for evaluating and mitigating risks related to Chinese investment, including data localization requirements and ongoing security audits.

Second, the U.S. Department of Commerce should establish a tariff schedule for imported Chinese clean tech goods that provides temporary and partial protection for targeted segments of American clean tech supply chains. This tariff system would provide temporary space for American firms to invest in research and development and ramp up production capacity in order to become competitive in global markets over the medium-to-long run. Crucially, these tariffs must be phased out according to a fixed schedule to prevent complacency among American domestic firms and encourage them to invest in improving competitiveness. These tariffs could also serve to incentivize Chinese firms to invest in production facilities in the U.S. and work with U.S. partner firms to build up their capabilities.

Third, the U.S. Congress should establish a national venture capital fund that invests in early-stage domestic firms in clean tech and other strategic industries. The idea would be to support these early-stage firms to bridge the "valley of death" and improve their chances of reaching commercialization without influencing the day-to-day operations of private firms. To this end, the U.S. national venture capital fund would limit investments in American private companies to passive equity stakes and refrain from interfering in commercial operations. Unlike loan guarantees, a passive equity stake could also provide upside to the U.S. government and American taxpayers should target companies achieve commercial success. As discussed earlier, some related examples of such an institution include the Pentagon's Office of Strategic Capital and the Defense Innovation Unit.

These policy proposals have a number of risks and limitations. Industrial policy efforts are often at risk of politicization and distortion by special interests. It is important to recognize the difficulty of mitigating these structural factors tied to political economy. For tariffs, there will likely be extensive lobbying over the structure and timing of these tariffs, as well as negotiations over exceptions. Another issue is implementation and execution. For example, the selection and monitoring of target companies for the national venture capital fund is a difficult process, even for experienced private venture capital groups. Lastly, some of these policies may face difficult political constraints and potential public backlash without sufficient public communication and transparency. On the one hand, the importance of U.S. competitiveness in these strategic industries must be made clear to the public. On the other hand, efforts should be made to address public concerns directly, such as mechanisms to safeguard taxpayer resources and reduce fraud and waste.

Ultimately, the U.S. must adopt a new, proactive approach to technology leadership. A pure market-based approach is unlikely to succeed in industries with significant bottlenecks, large economic and climate spillovers, and fierce competition from China. Targeted use of industrial policy as outlined in this paper can enable the United States to remain competitive in clean technologies and lay the foundation for future progress in a wide range of related, emerging areas.