Research Analyses:
Great-Power Competition and Global Trade

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Chasing the Sun:
US-China Green Energy Technology Competition

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Competition over clean technologies including solar panels, smart grid components, and battery storage has escalated as states seek to avoid the worst effects of climate change and profit from new industries in the transition away from fossil fuels. Establishing a comparative advantage in renewable energy technology affords strategic benefits to great powers, similar to competition in other sectors with economies of scale like semiconductors, information technology, and telecommunications.[1] However, as renewable energy is currently more expensive than fossil fuels, attracting investment in green technology requires state intervention in the energy market. In recent years, industrial policies like local content requirements and industrial tax credits have gained popularity as a growth strategy for large economies seeking to develop competitive export industries in emerging green technologies, including China, Brazil, and South Africa.[2] At the forefront of green

technology innovation, the United States and China provide contrasting models of policymaking and competition in the international market.

This newsletter article analyzes the contours of US-China clean technology competition and green industrial policy, as each superpower strives to cultivate a competitive renewable energy market. While the US originally led in green technology innovations like solar panel manufacturing and electric vehicles development, China has successfully leapfrogged past US firms and come to dominate the global market, particularly in easily scalable products.[3] This article traces the origins of these great powers' industrial policy strategies to their domestic energy market structure and analyzes implications for clean energy technology governance going forward. I first briefly discuss how green technology poses strategic benefits to these superpowers. Then, I outline the US and China's divergent strategies in clean energy technology competition, based on energy sector institutions, renewable energy business coalitions, and domestic legacies of industrial policy. I conclude with a discussion of implications of these superpowers' strategies for global green technology governance, particularly in emerging economies reliant on international technology.

Why green technology competition?

Leadership in renewable energy technology provides strategic political and economic benefits to states. First, investment in clean energy infrastructure increases domestic energy security. Investment in both grid infrastructure and renewable energy technology can mitigate disasters like the 2021 Texas power crisis, through creating a sustainable and resilient energy grid capable of re-calibrating to shocks and local energy generation.[4] Energy infrastructure is a strategic asset; in 2020, a foreign drone even targeted an electrical substation in Pennsylvania.[5] Regardless of whether interruptions to power supply are from natural disasters or foreign intervention, domestic clean energy generation and investment in grid infrastructure both increase energy security. Second, leading renewable energy technologies are subject to economies of scale, with manufacturing leaders developing robust export industries that cultivate downstream spillovers in other segments of the renewable energy supply chain like installation and engineering.[6] Leadership in renewable energy technology, particularly manufacturing, provides strategic political benefits, while laggards like the United States have turned to protectionist retaliation after losing market share.[7] Overall, renewable energy investment provides both strategic benefits to energy security and economic opportunities for growth, particularly with export oriented technologies.

The United States: Fragmented Competition

The US is currently underachieving in its green technology ambitions due to a legacy of fragmented market-based domestic energy policy, with individual states selecting into a patchwork of renewable energy incentives. Due to lack of national oversight over the domestic energy grid, fragmentation with the clean energy coalition, and focus on market-based incentives, the United States lacks a coordinated policy approach to green technology governance.[8] First, the utilities managing domestic energy consumption are strongly opposed to renewables, and currently outside the scope of national regulation. From a regulatory perspective domestic energy generation is highly federalized, with regional utility monopolies subject to regulation based on often opaque local politics.[9] These utility monopolies have successfully, repeatedly, opposed national climate policies like the Clean Power Plan. For

example, a large coalition of utility providers filed a lawsuit against the Environmental Protection Agency in West Virginia vs. EPA, expressing grievances related to timelines for compliance and cost of renewable energy integration.[10] At the state level, these utilities have even paid hired actors to speak at court hearings over solar subsidies like the Feed in Tariff, impeding green industrial policymaking across multiple levels of government.[11]

Second, firms within the domestic renewables industry hold different policy preferences, and intra-industry conflict has inhibited renewable energy leadership. The renewable energy coalition within the United States is fragmented, with firms operating in low skilled sectors like solar panel manufacturing at odds with those in services like installation and engineering. As discussed below, Chinese green industrial policy in 2009 rapidly decreased the global price of solar photovoltaic (PV) panels, resulting in surge of panels imports to the United States.[12] The influx of Chinese PV and rise in domestic installation created new downstream markets for renewable firms in project development, engineering, and procurement, which now dwarf the manufacturing industry in terms of employment and value added.[13] Despite growth in solar jobs and domestic installation, the influx of Chinese imports prompted backlash from the US solar manufacturing industry, which could not compete with the cheaper panels produced at scale.[14] These manufacturing firms, despite opposition from other thriving firms benefitting from the low cost of renewable energy, chose not to invest in R&D and instead successfully took the antidumping case to the International Trade Commission. These tariffs fragmented the renewable energy coalition, increasing the uphill battle for overall renewable energy deployment.

Finally, the United States has a history of market-led economic development, and broader aversion to state intervention in commercial technologies. From the fragmentation of the telecommunications industry to lack of federal guidance over digital technology privacy standards, the United States government maintains a laissez faire capitalist approach to the regulation of commercial, albeit strategic, sectors.[15] The US has typically pursued the development of clean energy technology from a security-oriented perspective, turning control of innovation to the private sector at commercial stages of deployment. For example, solar panels were originally a Department of Defense project, but later turned to private control. In 2009, the Obama administration allocated 2.3 billion in tax credits for solar firms under the American Recovery and Reinvestment Act, with high publicization of the administration's commitment to renewable energy.[16]

The US firm Solyndra received $535 million in loan guarantees through this program to produce high efficiency alternatives to existing polysilicon modules. However, concurrent Chinese industrial policy ultimately flooded the global market with cheap PV panels. Prices in the US crashed, and Solyndra spiraled into bankruptcy after abandonment from the venture capital funding sources necessary for the firm to scale up operations, effectively tanking the high-efficiency market.[17] This infamous example is often used to highlight the costs of picking winners, rather than placing emphasis on the successes of state led innovation that originally brought solar technology to fruition. Perhaps most importantly, work has recently highlighted that China holds specific advantages in low complexity technologies deployed at scale, rather than niche products with monopolistic firms producing differentiated goods like electric vehicles.[18] In selecting choice of industrial policy, policymakers

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may do well to consider domestic comparative advantage in the context of global supply chains.

China's Energy Market: Centralized Coordination

Chinese green technology governance sharply contrasts with the United States' fragmented approach. China's domestic structure emphasizes strong government involvement in energy planning, with state-owned enterprises taking a lead in coordinating green industrial policy. The 2005 Renewable Energy Law set national policy targets that only exist on a subnational level in the United States, including renewables subsidies and investment tax credits.[19] This allows the Chinese government to exert significant influence on energy sector development, empowering national champions to experiment and adopt newly emerging technologies. This applies to both energy generation and also grid infrastructure, with two national companies pursuing coordinated grid modernization to accommodate renewables: State Grid Corporation of China (SGCC) and China Southern Power Grid (CGC).[20] While grid operators typically only operate at the domestic level, State Grid defies conventional wisdom and has expanded to invest in Southern Europe, Northern Africa, and significant portions of Southeast Asia, as part of a global electricity grid network through the United Nations Global Grid Interconnection Organization.[21] Broadly, these centralized energy planning institutions have facilitated a coordinated push for renewable energy.

Second, in contrast to the US, China's domestic renewable energy coalition is not fragmented along supply chain lines. Where the United States has struggled to maintain competitive viability in renewable component manufacturing, Chinese industrial policy capitalizing on technology transfer and indigenous innovation has challenged Western firms in export markets while expanding a domestic consumer base for renewable energy technology.[22] China's advances in cheap solar panel manufacturing have benefitted domestic consumers in emerging economies, expanding access to clean energy due to cost declines.[23] Through state subsidization of national champions and coordination across the energy system through centralized planning institutions, China has excelled in low-complexity technologies where economies of scale dominate.[24]

Even after the US solar tariffs, Chinese manufacturing firms relocated production to Thailand, Malaysia, Indonesia, and Vietnam, maneuvering around

protectionist barriers. This technology shock provided capital and investment for small states to enter the global solar market and offered China both low-cost production and potential new export markets.[25] In sectors with higher product differentiation like electric vehicles, the US and European model of market-based competition, rather than state subsidized national champions and focus on scale, remains viable.[26] Yet as China continues upgrading the quality of manufactured goods and invests in basic infrastructure necessary to deploy RE in emerging markets, Western states may face greater competition over design rather than scale.[27] And in energy, the real strategic advantages lie in the network effects of grid integration and cross border energy flows in the developing world.[28] China's strategy places emphasis on establishing and locking in these networks of power.

Finally, China's green industrial policy strategy reflects broader patterns of state subsidization, provincial competition, and scalability for international export markets. Where the United States relies on state subsidization of early-stage technology development, but primarily private sector focus on commercialization and deployment at scale, the Chinese government is highly involved in clean technology governance beyond early stages of development and deployment, focusing on scale-up to export markets.[29] China's "cadre management" system attaches political benefits for party members to industrial performance in critical industries including solar energy,.[30] This facilitates competition amongst provinces to attract investment and develop export oriented renewable energy firms. China's green technology strategy echoes traditional industrial policy focused on reciprocal control mechanisms, tying state support to fledgling industries with performance measures.[31] This model allows the state to encourage competition in critical industries, ostensibly avoiding the "picking winners" dilemmas, without ceding influence over technological development, as in the Solyndra case and decline of the competitive US solar industry.

Conclusion: Implications for Global Green Technology Governance

The dynamics of US-China clean technology competition have important implications for both the renewable energy industry and climate governance more broadly. Historically, Western firms and institutions were the driving force behind green technology innovation and diffusion at the global level. More recently, China has concentrated its investment on countries overlooked by Western firms, particularly in Africa, Southern Europe, and Southeast Asia.[32] Fueled by the trade war, China has brought solar panel manufacturing and later grid investment to emerging markets, establishing new networks of power in countries like Kenya, Laos, and Cambodia, that are beginning to industrialize and meet rising energy demand using Chinese technology.[33] Whereas Western climate funds have supported one off projects and typically benefit the largest developing economies, China's international institutional investment in both renewable energy like solar and wind, and supporting infrastructure like ultra-high voltage transmission cables, has focused on building coalitions of small states through regional energy networks.[34] As the US focuses on revitalizing its domestic renewables industry, working through political polarization around environmental policy in the aftermath of the Trump presidency, China is increasingly focused on scaling up renewables at the global level.[35]

China's green industrial policy strategy targets synergies between different renewable energy technologies and provides an example of the extent

to which state coordination can carve a pathway for large scale renewable energy deployment.[36] Through developing a low-cost solar manufacturing complex and funding the expansion of grid technology overseas, China is coupling investment in clean energy generation with critical infrastructure upgrading, particularly in strategic export markets.[37] Rather than invest in innovation, the US has pursued a protectionist strategy focused on safeguarding legacy industries in manufacturing, while struggling to achieve high domestic renewables penetration at home. Renewable energy technology and grid infrastructure are costly and path dependent components of energy transition, and Chinese green technology success today may entrench its status as a leader in renewable technology in years to come.

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