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# Technology, Politics and China's Quest for Energy Dominance

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## Abstract

This paper will empirically investigate the role of technology in international politics through a case study of China's development of renewable energy infrastructure (solar PV and wind energy) and its impact on international politics. This paper looks at how technology helps shape a state's identity using renewable energy technology as an explanatory variable. The paper employs Grygiel's Model of Geopolitics to analyse the case study; geopolitics because much of China's development in the renewable sector has been a function of its geography and abundance of natural resources.

***Keywords:*** China, renewable, energy, technology, solar, wind

## LIST OF ABBREVIATIONS

BRI – Belt and Road Initiative

CCP – Chinese Communist Party

FIT – Feed in Tariffs

GDP – Gross Domestic Product

IR – International Relations

MOEP – Ministry of Electric Power

NDRC – National Development and Reform Commission

NEA – National Energy Administration

PPA – Power Purchase Agreement

PV - Photovoltaic

R&D – Research and Development

S&T – Science and Technology

SCS – South China Sea

SDPC – State Development Plan Commission

SOE – State Owned Enterprise

SPC – State Planning Commission

US – United States of America

USGS – United States Geological Survey

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## Technology, Politics and China’s Quest for Energy Dominance

### Introduction

China has experienced decades of near double-digit economic growth and since the 2000s, has witnessed a growing population and rapid industrialization that has correspondingly driven demand for energy. Its expeditious implementation of economic reforms has elevated it to the status of a global power capable of challenging the US-established status quo. Stability is increasingly being viewed as a function of China’s behaviour vis-à-vis its strategic rivals, primarily the US, and to lesser extent Japan, India, Russia and the littoral states of Southeast Asia. But more importantly, it has been China’s near fanatic fervour to rise as a technologically superior state, as the US emerged post the World Wars, that has generated interest. The modernization of its military, near meteoric rise of installed capacities for renewable sources of energy and technological revolution underscore the importance and role technological advancement plays in a state’s development. Technology and international politics have a near symbiotic relationship and the former has the potential to fundamentally alter the way states exercise their sovereignty in pursuit of their national interests.

China’s abundance of resources like cobalt, lithium, copper and rare earth elements, their advanced mining and processing capabilities and exponential growth in total installed capacities of both solar PV and wind energy that has outpaced that of many developed countries has contributed to a reorientation of the geopolitical landscape along the lines of energy. International Relations (IR) as a discipline has yet to produce a sufficient and nuanced understanding into the relationship between technology and international politics without relegating the former to merely being an intrinsic instrument, on hand and ready to be exercised in the midst of a power struggle. This paper analyses the relationship between technology with the state and with international politics using renewable energy as an explanatory variable by using Grygiel’s geopolitical framework to understand China’s desire to rapidly develop its renewable energy infrastructure; geopolitics because much of China’s development in the renewable sector has been a function of its geography and abundance of natural resources.

## A Technological Nation and its Energy Revolution

China's technological revolution, including its energy revolution, has its roots in historical encounters with foreign powers since the 1800s. From the opium wars in the 1840s to the Japanese invasion, loss of territory and unequal treaties imposed by the West have all been instances that the Chinese consider a shameful part of their history. The protracted nationalist revolution in China was a consequence of the indignities they suffered over which the Chinese Communist Party (CCP) rode to power in 1949 (Li, 2001). At one point, China contributed to more than half the world's GDP along with India. When the CCP finally consolidated its power in 1949, the Chinese economy was in tatters. Millions were in poverty and the country had no industrial development to speak of. Left behind by the industrial revolution that gripped most of the West and contributed to its colonial expansions, China's political elite closed ranks around the decision to restore China to its rightful place in the international system. They agreed that any future economic, industrial, scientific and technological development would be to that end. Modernization would be the solution.

In China this manifested in the rapid development of state institutions and industries. The CCP effectively became the state and Chinese nationalism supplanted the communist ideology to provide legitimacy for the government (Li, 2001).

Underscoring China's thrust towards technological advancement had been the influence of the Soviet Union. The Soviet Union's technical assistance to China took the form of transfer of designs, transfer of expertise in construction, installation, training of workers through instruction in the administrative and technical aspects of production. Technology transfer also took place in the education sector where China replicated the Soviet Union's model of higher and secondary education. Unlike the models of the West that the Chinese believed produced "educated generalists" (Zhang et al., 2006), the latter turned to the Soviet model in the belief that their education system was linked to visions of a developed nation due to the emphasis on the study of specialized subjects based on the needs of the country.

Deeply embedded in this desire for technological superiority lies an ideology that continues to pervade China's technological nativism (here, defined as the need to indigenously develop and advance in the technological sector). The ideology of leadership and public service has continued to permeate Chinese conceptions of technological development since the CCP came to power. This preoccupation with linking technology development and ideology was a consequence of a “post-war national identity crisis” centred around wartime casualties, loss of influence in the region, colonialism and American hegemony (Hecht, 2009). Beneath all this had also been the staunch desire to depart from the West’s model of innovation and promote a technological growth that was closely linked with labour. This belief was widespread in Maoist ideology that also sought to attack the “bourgeois expert” model that solicited foreign technical understandings that led to an inequitable distribution of technical power among workers and ignored the innovative potential of the working class. The Great Leap Forward was aimed at introducing innovation to cut across the “backwardness of Chinese industry” and bring technology to the masses (Lee III, 1973). This manifested in the blurring of lines between technical experts and workers and led to a breakdown in professional roles and responsibilities. Workers were elevated to the level of experts and often engaged in technologically innovative processes that was unscientific in nature. This line of thinking was untenable in the long run and eventually reforms and restrictions were brought in place. Thus, Mao’s theory of innovation was targeted at two forms of social stratification: one, the divide that existed between China and the rest of the developed world at the time and two, the separation of the intelligentsia from the masses. Communists under Mao’s era saw the separation of technical experts from politics as promoting the methods of the foreign that in the context of China would only position it inferiorly vis-a-vis the industrially developed world. In fearing that China would become a technocracy, Mao proposed an egalitarian vision for the relationship between technology and politics that concluded with the launch of the Great Leap Forward.

Yet, the fact that technocrats have historically held an influential position in Chinese politics cannot be disregarded. China has traditionally been widely known to be a meritocratic society. Even under Mao’s leadership, there were several technical workers in units that were responsible for analysing data and providing policy recommendations to the decision-makers although these men were unlikely to be members of the CCP and hence had little to do with the implementation of policies (Li, 2001). The economic fallout from the Great Leap Forward initiated the very phenomenon Mao was working towards breaking down: the separation of technology from politics. Technologists were rehabilitated with the need to salvage the economy and resume operations of industries; especially considering the absence of Soviet specialists. Both the Great Leap Forward and the Cultural Revolution paved the way for technocrats following a massive transformation of the elite. Since the 1980s, the ruling elites have been technocrats and blurred the lines between themselves and politicians.

As Deng Xiaoping took charge of the CCP, he reversed Mao's recruitment policies and abandoned class struggle as the party's target responsibility. His focus shifted towards economic and technological modernization. The CCP turned towards recruiting those who were "more revolutionary, younger, better educated, and more professionally competent" (Li, 2001). Hong Yung Lee, who has studied the transformation of the political elite in China exhaustively from the Thirteenth Party Congress in 1987 to the Fifteenth Party Congress in 1997 observed a meteoric rise in the number of technocrats within the Party. The percentage of politicians with a higher education in the Party increased from 12.8 percent in 1978 to 43.4 percent by 1997. He speculated that this number was only expected to rise in the future (Lee, 1991). Unlike several of the Western countries that feared technocrats and their involvement in politics; considering technocracy to be undemocratic and self-serving, China's experience with the same was different. Chinese technocrats subscribed to their own brand of nationalism - "techno-nationalism". The idea was first pioneered by Robert B. Reich and discussed the idea of competition between states to achieve technological development. Additionally, the Chinese brand of communist ideology and the 'Chinese' way of technological development played a huge role in this; something that is observed by their emphasis on technological nativism. Further, the role technologists played in the post-Great Leap and post-Cultural Revolution period conferred on them a state sanctioned legitimacy.

**Understanding China's investment in Renewable Energy**

The need for a technological China was based on the premise that, in the post-1945 world, geopolitical power was defined by technological superiority. Deng's prescription for China to hide its strengths and bide its time as he brought in economic reforms whilst adhering to the Chinese way of communism is what we are observing in the present. Their way to technological development would be unique and incorporate ideology and tradition and these technologies would in turn embody Chinese characteristics and help restore China's place in the world. Severe poverty and a growing population presented an energy crisis that provided them with an opportunity to revolutionize the energy field. Until this point, China had depended upon its vast coal reserves to sustain itself. As this became increasingly improbable, talk turned to developing underdeveloped energy sectors like solar, wind and hydro. And China has shifted to promoting aggressive technological nativism to becoming the leading country in the production and supply of renewable energy technology.

Increasingly, countries have poured their energy into developing policies that prioritize the promotion of clean and green technologies and China has taken the lead in terms of total investment in this sector. A look at some of the policies that China implemented to promote solar PV and wind energy serve as evidence to understand just how important it was for China to recreate its own industrial phase that developed countries had already experienced. Around the time development of solar and wind energy began to pick up, concern over China's growing energy needs and lack of resources had begun sparking debates about diversifying and shifting to a model of energy self-sufficiency.

Up until 1993, China had powered itself through its vast and cheap coal reserves. However, its ambition to grow economically, lift millions out of poverty and provide electrification to every household shifted China into a net importer. China continues to rely heavily on imports from West Asia alongside domestic coal and limited renewable energy. However, China's rapid growth in renewable technology and rising investment in the Science and Technology (S&T) field has caused wide speculation as to China's growing energy security concerns. They attribute its recent actions in the international system - the aggressive push of the Belt and Road Initiative (BRI) and the projects proposed under it and disputes with Southeast Asian countries over the South China Sea (SCS) as evidence of this vulnerability.

Another reason cited for renewable investment bases itself on China's actions and policies in addressing the ecological crisis that the world is contending with. They look at domestic environmental concerns such as the rising levels of air pollution in cities like Beijing, Shanghai and those centred around coal powered industries and the responses of the Chinese leadership to it. Between 2010 and 2013 Chinese cities experienced hazardous levels of air pollution that was widely reported by international media. This gave way to public outcry about the lack of transparency in air quality indices that subsided after the government promised to increase the frequency of publishing detailed reports on the same. In China, air pollution has resulted in the premature deaths of at least 1.2 million people that has forced the leadership to take action. Premier Li Keqiang announced China's "War on Pollution" in 2014 that would implement measures to reduce environmental degradation (NYT, 2014). China's 12th and 13th Five-Year Plans by the National Development and Reform Commission (NDRC) have also emphasized the need for China to reduce its coal dependency and shift to promoting economic growth by utilizing renewable energy.

Academics cite China bankrolling several wind and solar energy projects overseas as evidence of China becoming the protector of the environment globally. Another major piece of evidence to support China being environmentally conscious has been the landmark Paris Climate Agreement that it negotiated with the US in 2015.

Paradoxically, China has also continued to construct more coal plants, thanks in part to the decentralization policy that was passed in 2014. Previously, the construction and approval of coal plants fell under the purview of the central government. The decentralization gave provincial governments the power to authorize the construction of new coal plants in a bid to generate more growth in their respective provinces.

Another theme that emerges in understanding China's domination of the renewable energy market as well as technology is nationalistic pride. Kennedy (2013) introduces the concept of 'techno-nationalism', pioneered by Robert Reich in 1987, to explain China's development of renewable energy technology. When Reich propounded techno-nationalism, he defined it as the "attempt to protect future American technological breakthroughs from exploitation at the hands of foreigners, especially the Japanese" (Reich, 1987). Despite variants in the understanding of the concept, scholars agree on two fundamental principles: (1) that the nation-state considers technological progress to be of utmost priority and are in constant competition with other states to surpass their technological prowess and (2) techno-nationalism varies within the Asian context as these countries pursue a combination of "nationalistic and liberal policies" (Segal & Kang, 2006) in their pursuit of technological advancement (Kennedy, 2013).

Statements by the former Premier of China, Wen Jiabao, during the financial crisis also allude to how China could not afford to miss the opportunity that the economic crisis had provided. A similar view was exhorted by Xie Zhenhua, Vice Chairman of NDRC and negotiator for China's climate action policies. He called for international cooperation in developing low-carbon green technology and likened the race of countries in renewable technology to the space and arms race during the Cold War (Sina Finance, 2010). Additionally, China also released policies like the "Wind Power Concession Project" in 2003, the "Renewable Energy Law" in 2005 and the "Strategic Emerging Industries" in 2009 along with several state concessions that has had a significant impact in getting China to where it is today (Kennedy, 2013).

## The Development and Evolution of Renewable Energy Policies in China

*Solar Power*

China's solar PV development began in 1958 and became operational in the 1970s (Yang et al., 2003). Beginning in 1993, China's domestic production of solar cells increased by 20-30% annually and until 2002, the PV industry had remained in the R&D stage with government funding but no industrial chain set up around it. Solar PV had as yet not been deployed for civil applications. The State Development Plan Commission (SDPC), in 2002, launched the *Power Supply Plan for Rural Areas without Electricity in the Western Provinces and Regions* policy that suggested renewable energy technology like wind and solar could be the solution for power generation for household consumption in the western regions that lacked electricity. This jump-started the utilization of PV products in civil applications (Honghang et al., 2014). Historically, China's market for solar PV stagnated due to the high cost of PV. It was mostly centred around rural electrification projects that only accounted for a small portion of installations. In 2004 when several countries including Germany introduced a feed in tariff (FIT) and other subsidy policies, the solar PV market saw stimulation as investments increased. China used this opportunity to increase their capacity and reduce production costs rapidly (Zhang & He, 2013). The Chinese government rolled out a series of national policies and regulatory frameworks that created a conducive environment for the solar PV industry to thrive. The *Renewable Energy Law* in 2006 was a major policy that enabled this. Between 2004 and 2008, the capacity of the PV cells was expanding at a rate of 100% and was even ranked first in the world for its capacity (Honghang et al., 2014).

Since 2009, specifically between 2011 and 2012, the Chinese government introduced incentives and subsidies for PV installations, a nationalized FIT scheme that boosted the Chinese solar PV market. Other policies like the *Large-scale PV Power Station Concession Bidding, Golden-Sun Pilot Project* and *Rooftop Subsidy Program* introduced by the NEA, Ministry of Science and Technology and others skyrocketed the development of solar PV post 2009. By 2012 the capacity of Chinese solar PV cells was at 23 GW accounting for nearly 58% of total global capacity (Honghang et al., 2014). A major factor in the growth of China's domestic market were events influencing the behaviour of the international PV market. Following the financial crisis in 2008, the aggressive reductions in incentives and subsidies in

Germany and other Western countries along with investigations of anti-dumping and countervailing against Chinese PV products initiated by the US and the EU drove the Chinese government to support the industry and generate demand for the products (Wang, 2012). There are five major sectors that apply solar PV power: "off-grid solar PV in remote and rural areas, off-grid solar PV for telecommunications, meteorology, transportation and other industries, off-grid solar PV for lights, chargers and other commercial projects, on-grid building solar PV and large-scale solar PV" (Zhang & He, 2013).

The *Renewable Energy Law* initiated in 2005 (came into effect in 2006) was the first national framework to promote the development of renewable energy in China. It outlined five key mechanisms to achieving this: (1) set national targets for renewable energy development that would prove crucial in guiding investment, (2) a mandatory connection and purchase policy wherein grid companies get into business with renewable electricity generators in their jurisdiction to purchase the electricity and supply grid connection services, (3) a national FIT system that incentivized renewable electricity generators for every KWh electricity generated above the wholesale price for electricity that was coal-powered, (4) an arrangement for cost sharing and finally (5) the establishment of the Renewable Energy Development Special Fund that offered financial succour for S&T research activities for renewables, projects, studies on rural utilization and assessments on renewable resources (Schuman and Lin, 2012). Pursuant to these, several other renewable energy policies were released - the *Provisional Administrative Measure on Pricing and Cost Sharing for Renewable Energy Generation* (2006), the *Tentative Management Method for Renewable Energy Development Special Fund* (2006), the *Medium- and Long-term Renewable Energy Development Plan* (2007) and the *11th, 12$^{th}$, 13$^{th}$ and 14$^{th}$ Five-year Plan of Renewable Energy Development* - that helped advance China's growth in the solar PV industry (Zhang & He., 2013).

*Wind Power*

China's first demonstration wind farm was built in 1986 in the Shandong province (Pengfei, 2005). In the demonstration period between 1986 and 1993 small scale demonstration wind farms were built using grants and loans from foreign countries. The wind power industry was slow to develop in the 1990s and most of the projects around that period were either subsidized or non-commercial. Given that this was only eight years after new economic reforms had been introduced, reform in the energy sector was slow to appear. Institutionally, the wind energy was under the electricity sector that was centrally governed. No private parties were allowed to invest in the energy sector. However, with power outages that caused one-fifth of the industry to idle, new changes needed to be enacted to the energy supply structure (Yeh & Lewis, 2004). In 1987 the government relaxed its monopoly over the energy sector and allowed local governments, state owned enterprises (SOEs) and even foreign companies to invest and build power stations. In 1993 an industrialization programme for wind power was proposed. The SPC dictated that the average electricity price from wind power would be calculated based on the operational period of the wind turbines and that the loan repayment period be extended. However, in spite of all these mandates, the industry was slow to develop given the lack of clear policy initiatives. China's first target for wind power generation was for 1000 MW under the *Ride the Wind Programme* introduced in 1997. They partnered with a German company to develop most of these projects. The intent with these foreign partnerships was to gradually introduce a strong localisation programme where 80% of the material was locally sourced. Further in the *Double Increase* plan, as part of the 9th Five Year Plan, projects for over 70 MW of wind power were accorded to Danish companies in 1997 (IRENA-GWEC, 2013). By 2001, China had an installed wind capacity of 404 MW.

However, even with all these concessions the wind power sector was slow to develop. Private investment failed to materialize due to three main reasons. One, the lack of formal protection for investors; two, wind power projects were hardly attractive and provided no incentive for companies to invest in. Further, wind was unable to compete with the highly subsidized coal-based power. Additionally, there was no pool of talent or knowledge on grid connections or wind turbines locally to draw from. Finally, there was no bureaucratic structure to coordinate the development of wind energy. In the absence of all these necessary mechanisms, the Chinese government chose to rely on industrialized countries for support in developing this sector through soft loans and imports (Lema & Ruby, 2007).

The *Strategic Development Plan for Generation of Wind Energy in China 2000 and 2020* was the first comprehensive plan for wind power, issued by the Ministry of Electric Power (MOEP) that laid out ambitious targets to encourage the generation of wind energy. It set 1000 MW to be the target for installed capacity by 2000. Pursuant to this the MOEP issued a regulation as a follow-up to the plan - and asked that utilities begin purchasing electricity from wind farms. This was the first power purchase agreement (PPA) for China in wind. Theoretically, this was a strategy employed to generate and guarantee demand for developers of wind farms.

Additionally, the MOEP also released a fixed tariff for wind and offered other incentives for developers that basically guaranteed them a return on their investment (Zhengming et al., 1999). Following this another branch introduced a strategic plan - the *Program for Development of New and Renewable Energy sources in China 1996-2010*, formulated by the SPC with support from the Science and Technology Commission and Economic and Trade Commission. Understanding that 1000 MW was too ambitious a goal, the SPC lowered it to a third of it. The main goal of the SPC was to regulate the costs of wind turbine installations, import costs and other utility expenses. The absence of a rapid development in the wind energy sector was largely a consequence of a fragmented policy structure and bureaucracy and lack of interministerial coordination (Lema & Ruby, 2007).

Entering the 21st century the development of China's wind energy industry still lagged. In the period between 2000 and 2006 there was a concerted effort to coordinate and reorganize the energy sector in an effort to formulate coherent policies for the wind energy sector. The NDRC proposed the generating demand for wind energy through the concession model. The fact that the total tax levied on wind power was more than what was levied on thermal power discouraged power companies from investing in the renewable energy sector. However, the NDRC and other departments with the government recognized the necessity in developing China's renewable potential as an alternative to traditional sources whose costs were rising and contributing to polluting the environment. The first step was the reduction of value-added tax from 17% to nearly 8% for electricity generated from wind farms (Li, 2004). Understanding that the impact of this would not affect the cost structure drastically, the *Wind Power Concessions Model* was introduced in 2002 and came into effect by 2003. It essentially meant that power companies would be "compelled to produce" electricity generated through wind and grid companies would be "compelled to buy it" (Lema & Ruby, 2007). The results from the concession model were immediate and wind power saw a major increase in installed capacity in the period between 2003 and 2006. The issuance of the *Renewable Energy Law* in 2005 revealed a sharper focus on the wind power industry.

This was referred to as the *Tariff Reform Program* that sought to guarantee demand and competition within the wind energy sector. Owners of large power companies were made to ensure that at least 5% accounted for wind power in their total energy output. Another policy issued on pricing in 2006, *Regulation on Prices and Cost-Sharing in Renewable Energy*, decreed that price for wind power was to be set by the government. The bidding process would determine the price for wind power concessions. The prices for other projects would be determined based on a benchmark set by the unit price for coal powered electricity. Concerns over connectivity to the national grid led to the issuance of the *Approach of Grid Enterprises Purchasing Renewable Energy Electricity* policy that stated that renewable energy projects would get priority rights in the power grid. They would be exempt from grid auctions; instead grid enterprises would be obliged to purchase renewable energy at determined benchmark prices. Further, it stated that if a renewable energy generating company were to suffer an economic loss due to the grid enterprise, it would be the latter who bore responsibility for the losses (Liu & Kokko, 2010). Policies at the provincial levels for wind power were also a major contributor to the share of wind power projects in China. Inner Mongolia was the first province to release a comprehensive policy framework on the wind power initiatives in the region. The *Regulation for Inner Mongolia's Wind Energy Resource Development and Utilization* detailed a regulatory framework for the development of wind energy resources and planning as well as feasibility studies for the proposed projects.

The formulation of these policies and their implementation serves as evidence for us to understand just how important it was for China that it industrialise by prioritising S&T and innovation to be on par with their developed and industrialised counterparts. Around the time development of solar and wind energy began to pick up, concern over China's growing energy needs and lack of resources had begun sparking debates about diversifying and shifting to a model of energy self-sufficiency. Ramping up R&D and focus on S&T were heralded as solutions to what would later transform into a crippling fear over energy security. These policies also provide insight into China's behaviour as a state actor. China has played the long game, as Deng described it, to emerge as a global power in renewable energy technology. The trajectory of its industrialisation and bureaucratic changes in its energy sector have given way to a well-oiled state machinery that continues to stimulate the international market by supporting domestic production for solar PV and wind power to the fullest extent. Competitively driving down the prices for renewable sources of energy is reflective of adopting a strategy of technological nativism.

## The Geopolitics of Renewable Energy

The current geopolitical reality has not, as some analysts and academicians might suggest, always been a China centric one. It is more accurate to refer to it as an Asia-*centric* one. Several countries in East Asia, Southeast Asia and South Asia experienced rapid economic growth in the last two decades that resulted in the shift of the global economic centre of gravity to the East. It is merely China's near double-digit growth as a consequence of expeditious implementation of structural reforms that has elevated it to the status of a global power capable of challenging the US-led international order. The shift in the balance of power from the West to the East has been a recent development in international politics. And this shift is not one that classical theorists like Mackinder and Mahan might call a geopolitical orientation based on the "configuration of lands and seas" (Sprout, 1963) though they might constitute a part of it. Technology has an impact on geography and its development is intrinsic to a state's ability to wield political power in the international system. The impact of technology was already glaringly obvious by the end of the nineteenth century, which is why it is curious how classical IR theory does not account for it in its theoretical frameworks (Ball, 1985). Modern geopolitical theories have now begun realizing the significance of technological development and incorporated them into analytical frameworks.

The rise and fall of empires, power and influence differentials of nations and just the uneven trajectory of a state's achievement in international politics have prompted much speculation on a "master variable" to explain past events, future trajectories and anticipate the reordering of the international system based on changing political relationships (Sprout, 1963). Geopolitical theorizers have either taken science and technological advancement to be that master variable and built their arguments around technological advancement to explain international politics or have neglected it and continue to underestimate its significance. Sprout (1963), however, argues that there has been little attention on factors like institutions and other social factors that are implicit in a nation's technological growth and the way it pursues its national development and proposes an examination of geopolitics from this perspective.

An analysis of China's renewable energy technology and, broadly its technological development benefits from adopting the understanding that Sprout proposed. Jakub J. Grygiel's framework on Geography, Geopolitics and Geostrategy is utilized to put these things in perspective.

Grygiel's work has been seminal in bringing geopolitics back into the fold of international relations. In many ways his work does more than that, as he brings back both geography and history as well. By considering the historical experiences of Venice, the Ottoman Empire and the Ming Dynasty with geopolitical shifts in the sixteenth century, he makes the case for US foreign policy to adjust itself to the geopolitical shift to the Pacific. He proposed a tripartite analytical framework that avoids the traditional models of geopolitics proposed by classical theorists such as Mackinder, Mahan and Haushofer (Stremlin, 2008). Grygiel's premise is that a state's foreign policy or geostrategy must reflect the underlying geopolitics. He argues that only those states that pursue a geostrategy in tandem with the geopolitical environment will see political success and retain their advantage. Given that this argument depends on the relationship between the three, Grygiel (2006) defines geography, geopolitics and geostrategy as follows:

> *Geography is the physical reality, composed of mountains, rivers, seas, wind patterns, and so on. It describes the geological features of the earth, the physical attributes of the land, sea and air environments.....geography is a constant* (p. 21).
>
> *Geopolitics is the human factor within geography. It is the geographic distribution of centres of resources and lines of communication, assigning value to locations according to their strategic importance…not a constant but a variable*...(p. 22).
>
> *Geostrategy is the geographic direction of a state's foreign policy … describes where a state concentrates its efforts by projecting military power and directing diplomatic activity* (p. 22).

*Geography, Geopolitics, and Geostrategy*

| | Change | | |
|---|---|---|---|
| | Level | Type and Cause | Effect |
| Geography | | Tectonic—de facto constant | |
| Geopolitics | Systemic | Slow—rise and decline of empires; new transportation and production technologies | Changes in strategic value of locations, trade routes |
| Geostrategy | State | Varied—dependent on situation on state borders | Success—reflective of geopolitics; failure—nonreflective of geopolitics |

Grygiel's framework for Geography, Geopolitics and Geostrategy
Source: Great Powers and Geopolitical Change

The history and development of China's solar PV and wind energy has led to an unprecedented rise in installed capacity. Both of these energy resources are what you would call variable because electricity production depends on the availability of sun or wind patterns. Spatial and temporal changes and extent of cloud cover contribute to the variability of solar generated electricity. There are several studies on the solar PV potential in China at the national level or are provincial specific. Zhou et al. (2010) utilized sunshine duration and daily irradiation data from 163 meteorological stations to provide a spatial analysis on the distribution of solar radiation in the provinces of Shaanxi, Qinghai, Xinjiang and Gansu.

Following this there have been several other provincial level resource assessments for distribution of solar. He & Kammen (2016) did a resource assessment at the spatial and temporal resolution at the provincial level using 10-year hourly data from 2001 and 2010. They observed that China had a potential stationary capacity between 4700 GW and 39300 GW. Most of these resource rich areas were concentrated in the Northwest provinces, specifically Inner Mongolia, Xinjiang and Gansu. They concluded that the challenges the industry would face would be distribution related and not a depletion of resource.

Similarly, China has favourable conditions for producing wind energy. A study by China's Meteorological Administration found that the potential for wind energy exceeded 253 GW per year. The regions identified to be most conducive was Northern China and the Qinghai-Tibet plateau and the coastal areas of the east (CMA, 2006). A wind resource assessment conducted by He & Kammen (2014) utilized 10 years hourly wind speed data for 200 representative locations to determine wind profiles at the provincial level. From their analysis they found that wind generation could annually reach anywhere between 2000 TWh to 3500 TWh.

China's geographic conditions are extremely favourable for harvesting solar PV and wind energy. Grygiel posits that two variables define geopolitics; one, the location of resources and two, trade routes. He argues that only one of these is necessary for the geopolitical situation to change (Grygiel, 2006). In addition to favourable climatic conditions, China also dominates in the production of rare earth minerals and other critical minerals whose utilization in renewable energy infrastructure is essential. Consisting of 17 elements the distribution of rare earth minerals, not as rare as the name suggests, is scattered – with reserves in Australia, Myanmar, India, the US and China, though China holds the lion's share of rare earth mineral reserves – between 35- 40% (Hanke, 2021). In 2019, China was responsible for nearly 60% of global production of cobalt and rare earth minerals. In the process of refining, China's share is even larger – with nearly 35% for nickel, 50-70% for cobalt and lithium and nearly 90% for rare earth minerals (IEA, 2021). Further, China continues to dominate across the board on three

M’s as Hanke (2021) puts it – (1) Mining and Mineral Engineering, (2) Metallurgical Engineering and (3) Material Science and Engineering. China is aware of just how strategically important its rare earth mineral supply is. As far back as 1992, Deng Xiaoping said that, “the Middle East has oil; China has rare earths” (Thompson, 2022). And, China has shown that it is not afraid to weaponize its monopoly in this sector in tussles with its political rivals evidenced by the export ban on rare minerals it imposed on Japan over dispute with a fishing vessel. The event exposed Japan’s vulnerability as these exports were crucial in “products like hybrid cars, wind turbines and guided missiles” (Bradsher, 2010).

Though the study of hydropower is beyond the scope of this paper, it must be acknowledged that China has huge potential for hydropower as evidenced by the number of dams constructed and the numbers that reflect hydro generated electricity. An analysis of China’s history and renewable generated electricity reforms suggests that China’s energy sector continues to be highly centralised. These reforms in the energy sector are motivated by strategic considerations; to increase production of electricity to meet growing energy needs and fuel economic growth. Renewable energy as a technological advancement has had its impact on geopolitics – by virtue of having an abundance of these particular natural resources, China has gained economic and political leverage in this sector and also managed to influence global perceptions.

The geopolitical orientation to the East has also been a product of discovering new shipping lanes and centres, driven by the gradual rollback of protectionist trade practises and entrance into international markets of some countries. This has also been augmented by the fact that countries like India and China were and continue to face rising demands for energy. An assertive and ascendant China seeks to exert control over lines of communications. This is evidenced by the direction of their foreign policy.

China’s foreign policy, apart from being driven by territorial integrity and state security, is also driven by how successful their perception management has been. Understanding that the balance of power had shifted to Asia, Chinese geostrategies reflect the state’s geographic focus. The BRI and its actions in the SCS are evidence of this. Seeking to revive the prominence it once held, the BRI is aimed at, once again, placing China at the centre of the world. But underscoring this has been the growing energy security concerns that, the author argues have motivated it to undertake expansionist policies. The SCS has been speculated to hold vast amounts of untapped oil and natural gas reserves that if secured would alleviate some of China's concerns. Diversifying its import countries and sources of energy has been another strategy the state has pursued. China's focus on perception management as a driver of foreign policy is evidenced by analysing the language behind some of its policy documents. The country portrays itself as a "responsible rising power" in the region concerned with the growth and security for all nations in the region. It can be argued that even China's development of renewable energy technology is a strategy to manage global perceptions. China has emerged as the world's biggest carbon emitter and its cities suffer from high levels of air pollution. This is because more than 80% of China's energy is generated from coal-powered plants. This was one of the many considerations that went behind developing China's renewable industry. It has remained the biggest investor in renewable energy in the last five years, miles ahead of any of the developed nations. It has also led to China being referred to as a "renewable energy superpower" and associated with the label of a country seeking to gain global clean energy leadership.

At the heart of China's geostrategies are historical experiences, an ideology that continues to guide its foreign policy and a ruling party that will do anything to retain its legitimacy and control over the state. The technocratic leadership have veritably driven the country's ambition to become technologically superior. Many of the top former leaders like Li Peng and Hu Jintao and even Xi Jinping were students of engineering. Li's education had been in hydroelectric engineering at the Moscow Power Institute following which he began a career in the power sector eventually becoming the minister of MOEP in1983 and Party Secretariat in 1985 before making his way to the Standing Committee of the Politburo in 1987. Hu Jintao, the former Party general secretary, also had a background in hydroelectric engineering from Tsinghua University. The current general secretary of the Party, Xi Jinping, also graduated from Tsinghua, specialising in chemical engineering. This pattern suggests that there is a relationship between electrical and political power within the CCP and also implies how invested the top leadership has been in monitoring and restructuring the energy sector (Yeh & Lewis, 2004). It is then no surprise that China has pushed for technological advancements by introducing national policies that prioritise indigenous manufacturing and incentivises companies to invest in renewable energy. This has also rapidly shifted their geostrategies and resulted in an ascendant and aggressive China.

## Conclusion

Solutions to climate change and other ecological crises will mean a massive and transformational overhaul of the existing global energy system and have implications at the individual and systemic level. But more fundamentally, the answer will depend on acknowledging the geopolitical angle in energy and technology politics and making strategic provisions for the same. China's 2010 export ban of rare earths to Japan showed the world that it was ready and willing to weaponize its monopoly on rare earths. A growing consensus has emerged that the "age of green energy will be the age of China" (Thompson, 2022) and for a US that is locked in competition with China, the implications are all the more unsettling. According to data from the United States Geological Survey (USGS) on critical commodities important to renewable energy architecture in 2018, the US was heavily reliant (50% or more) on foreign sources for arsenic, gallium, germanium, indium, tellurium, cobalt, graphite, lithium and manganese. Between 2015 – 2018, China was responsible for 80% of the US's rare earth imports (USGS, 2020). All these components are critical to solar panels, wind turbines and batteries (OCAP, 2019). This is a glaring vulnerability for the US especially when it's seen in the context of China's domination of production of (1) raw materials necessary for batteries, (2) battery anodes and cathodes and (3) cells. Additionally, according to Hanke (2021) Chinese firms are responsible for the production of 72% of the world's solar modules and 45% of its wind turbine.

The current study endeavors to understand how technology negotiates a space for itself in international politics and the national development of states. Technology is not merely an implicit instrument of policymaking. The very development of a particular piece of technology is political in nature and indicative of a state's identity and development trajectory. Simply put, the author believes that in the coming years China's investment in renewable energy technology and market dominance in anything 'green' will become the new battleground for energy geopolitics and technological supremacy.

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