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US-CHINA GEOPOLITICAL COMPETITION OVER LITHIUM RESOURCES: IMPACTS AND OUTCOMES FOR PAKISTAN'S ENERGY SECURITY

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ABSTRACT
Lithium is acritical resource that is mostly employed in re-chargeable batteries in electronic items systems such as notebooks, hybrids, and cellular telephones. The Lithium-ion battery market over the years has been growing Sino-Levfong 2013 relations now. In 2018, lithium was classified as critical to national interests and economic activities in the United States while in 2020, it was declared critical with regards to raw material in the European Union. All these factors including the globalization of the created market put more emphasis on lithium. As a result of these transition, there has been an increase in the rivalry between the United States and China over lithium resources thereby complicating the energy security landscape in Asia. This contest is realigning the geopolitical landscape of the regions particularly Asia where countries like India and Pakistan has to carefully maneuver its respective strategic cooperation. The paper aims to examine the impacts and outcomes for Pakistan's energy security. It involves literature review and policy analysis betwixt geopolitical competitors on lithium production, processing, pricing and trade and investment patterns to explore inter-relationship among global competitors and investment priorities of Pakistan.

Keywords: *Renewable Energy, Lithium Geopolitics, US-China Competition, Energy Security*

INTRODUCTION

Geopolitics is defined as the interaction between geography and politics. It has been described as the combination of geography and politics and is contentious by nature among academics and writers. It develops as the study of the effects that geography has on the international political and legal notions of the power of the state or as a deterministic cause effect relationship between distinctive forms of international relations and geographical spaces. In general, the prospect and concept of power make geopolitics reduce to the positioning of natural resources, if any such area does exist, supply lines and strong points. The original meaning of the term such as geopolitics centralizes the state's use of power and the physical world in which those goals are sought captures the interplay between a segment of national interest, political power and strategic geopolitical planning. As for politics, the prevailing view amongst American intellectuals, is that China will not evolve and develop into a pluralistic democratic society by any of the strategies of liberal democratization of the West. However, as both countries have evolved to commence the use of their power to further their interests and promote ideologies that the US considers offensive, they perceive that America has embarked into an era defined by 'a new East-West rivalry Compete'. Consequently, Washington's policymakers and specialists have arrived at a new level of understanding about China: we may love you but competition is more effective. It is beyond any doubt that the tendencies for competitive relations among the major powers have returned. The fresh bout of the struggle has addressed every single weapon without any going weakness. The escalated competition between China and the US has already extended even beyond trade to cover the protection of advanced technologies, regional strategies, and two development models based on oppositional principles. Geopolitics and energy resources have crossed borders leaving competently economics at the center of advanced states relations. Plus, the contrasting social principles and regimes of the two countries are more and more visible. Political leaders are keen to analyze the risks of and tend to over-dramatize the level of conspiracies in high technology cooperation with China, as energy has been. This implies that opposition refers to a circumstance in which the target of the opposition is scarce and getting that thing over another person is extremely difficult. Competition is

described as "goal-seeking behaviour that strives to reduce the gains available to others." Political, economic, and military struggle are on the rise in an era of increased international competitiveness. Energy has evolved as one of the most challenging, major, and visible areas of US-China strategic competition.

The dynamics and characteristics of this new competition, particularly between China and the United States, will change greatly from those of the twentieth century. Previously, both countries' economies were interwoven, resulting in increased cooperation and engagement. The current age is characterized by a "decline in the long-standing rules-based international order" and a growing separation of the two economic systems. This is more than just "a contest of economic stakes, but of geopolitical maneuver to gain control over strategic commodity supply chains," which has serious implications for regional security in Asia, a region with rapidly increasing energy demands and a desire for improved energy security status.

Asian countries, including India, Pakistan, Bangladesh, and Nepal, have become focal points of geopolitical competition as China and the United States have become increasingly interested in gaining access to and control over the region's lithium (USGS Publications Warehouse, 2017).

The world's dynamics are evolving from unipolar to multipolar in the areas of energy, economy, human capital, and technology. These are all necessary components for successful military capability to reclaim control of world governance. The push for control over Asia's densely populated region, rich in resources and human capital, is an extension of global hegemons' power projection.

The paper investigates the effects that competition between the two superpowers, China and the United States, has on Pakistan's energy security and the related shifts in geopolitical climate. Although it focusses on the power dynamics between these two superpowers over lithium deposits, it also examines how the dispute over these resources affects the supply chain, price fluctuations, and global players' attempts to diversify energy sources. This paper also discusses the potential effects of increased Chinese and American investment on Pakistan’s physical

infrastructure and economy in terms of economic possibilities and risks.

PROBLEM STATEMENT

Pakistan suffers from a fluctuating energy crisis, lacks the technology to explore lithium potentials, and faces substantial barriers to technical growth and energy security. While the other Asian countries like India aspires to become an Asian tiger and a technologically advanced nation, it is working to establish itself in fields such as space exploration and information technology. However, it remains a net importer since it relies on imports for necessities such as lithium, which is required to meet the country's expanding technological needs for its industry and household consumption. Similarly, countries such as Nepal, Sri Lanka, and Bangladesh rely primarily on traditional energy sources and lack technical advancements that can help to energy security.

This presents Afghanistan with the potential for enormous lithium reserves, as well as a serious challenge of instability, lack of infrastructure, and technological knowledge. This position has created a massive gap in which global countries are vying for control based on their own national interests, which will have far-reaching consequences for the Asian area as China and the United States compete for Lithium resources around the world. India, Pakistan, Bangladesh, and Nepal are among the numerous regional players who are acutely aware of the uncertainty surrounding the energy supply chain and the geopolitical battle that goes with it. On the other hand, technological growth as a result of this competition may make Pakistan into a region of energy innovation.

RESEARCH OBJECTIVE

The article intends to analyze the geopolitical competition betwixt China and USA over lithium component. The paper further aims to investigate the impacts of this competition on Pakistan’s energy security. The study will examine the changing circumstances of this competition and will measure the impacts and outcomes for Pakistan’s energy security.

RESEARCH QUESTIONS

How the competition between China and USA does over lithium resources is affecting Pakistan’s Energy Security?

How the race for lithium makes Pakistan a technological hotspot and how might this affect economic development?

THEORETICAL FRAMEWORK

Theories such as realism, when applied in analyzing the power dynamics and energy security, bring to light competitive state behavior, particularly India's self-interest in securing its energy supplies vis-à-vis China's hegemony in lithium. Resource-rich states experience slow growth due to nationalism and conflict; However, neorealism emphasizes the structural rivalries in the anarchic international system. Constructivism draws attention to the social constructions that influence energy cooperation and competition, while energy security theory emphasizes the importance of reliable resource access in guiding national policies amid international rivalries, particularly between the United States and China.

REVIEW OF LITERATURE

The competition between China and the United States in the region has made Asian nations, such as India, Pakistan, Bangladesh, Nepal, and Sri Lanka, major actors in geopolitical tensions. This competition affects Pakistan's and the region's energy security, particularly with regard to the need for lithium, a crucial mineral for electric vehicles and other energy storage devices. The production, processing, and utilization of lithium is a fairly complex structure, with some companies concentrating in particular regions. The industry is by its very nature worldwide. The majority of lithium-ion batteries are made in Asia, particularly in China, Japan, and South Korea, but the majority of lithium is mined in South America, specifically in Bolivia, Chile, and Argentina. This makes the transportation of lithium necessary, frequently over great distances and even across international borders to get to its final usage. The mineral lithium has become more sensitive due to the growing demand for it, which is primarily used in the manufacturing of electric vehicles. For example, China has shown a great deal of interest in obtaining lithium, both domestically and internationally. As the market for EVs and LIBs becomes more competitive, the global lithium supply chain is changing to remain competitive. Key players in the current global market, such as Korea, Japan, and the United

States, are concentrating on lithium hydroxides, lithium-ion batteries, and lithium carbonates. The supply chain is in danger of not being able to meet the anticipated increase in demand, as demonstrated by simulations. Solid rock lith, carbonate lith, and overall battery production are some of the determining factors in EV production.

Lithium material production, consumption, and trade have all increased dramatically, and the industry is active in many nations, including the US, China, the EU, Chile, and Australia. There are opportunities for secondary lithium recovery through recycling, but countries that rely largely on imports run the risk of running out, which calls for measures like building up domestic reserves. China has made large investments to expand its domestic lithium supply chain. China is the world's largest manufacturer of lithium-ion batteries. This includes funding lithium mining ventures in South America, the continent that contains a sizable share of the world's lithium reserves. In addition, China has become a major force in the refinement and processing of lithium, holding over 70% of the world market share for lithium cell production. The rise in lithium demand is primarily the result of international agreements such as the Kyoto Protocol, the Paris Agreement, and the United Nations Sustainable Development Goals, which have encouraged the integration of more clean storage technologies and renewable energy in the power and transportation sectors. More than 60% of the lithium produced in 2019 was utilized to make lithium-particle batteries, which are essential for electric cars and energy storage systems. The global lithium market, which was valued at about $213 billion in 2019 and is projected to grow by 20–25 percent until 2025, highlights the resource's strategic importance. Lithium is essential for reducing the impact of environmental changes, stresses associated with climate change, and the depletion of fossil fuel supplies. It is extensively applied in numerous fields. Because of the current imbalance in the distribution of lithium deposits many of which are located in Australia and South America China and the US are now more competitive. More specifically, as the transportation sector gets more and more electrified, it is expected that the growing demand for lithium in clean energy technologies will surpass that of other

major minerals. Lithium's geopolitics is defined by its potential unique role in the energy market, which has recently sparked increased interest in various dynamics. This raises the question of whether lithium has the potential to be the geopolitical sign.
In order to ensure access to this vital resource, consumer nations must either pursue interdependence or self-sufficiency due to the geographical concentration of lithium production. Given that most known reserves of lithium are located in South America or Australia, two continents lacking vertically integrated supply chains, lithium is regarded as a crucial strategic mineral in this regard. Rechargeable batteries depend on lithium for their operation. China, the world's largest user of lithium, has been assiduously pursuing the acquisition of lithium resources worldwide, including those found in South America and Australia. The increasing reliance of South Asian states on lithium-ion batteries for their electric and renewable energy vehicles has led to concerns that China's dominance in the lithium market could pose a significant obstacle to the region's energy future. China and the US are involved in a more intense geopolitical rivalry as a result of the increased demand for lithium, a crucial mineral required for the manufacturing of rechargeable batteries. China and the US are engaged in a more intense geopolitical rivalry as a result of the increased demand for lithium, a crucial mineral required for the manufacturing of rechargeable batteries. According to World Bank projections, in order to meet future demand, metal production levels could need to rise by up to 500% by 2050.

The pie chart from the study of Sun et al. (2022) shows the distribution of lithium utilization across several applications. A considerable 65% of lithium is used in battery production, primarily for lithium-ion batteries, which are required for electric vehicles and renewable energy storage. Ceramics and glass, which use lithium to improve material qualities, are the second largest market, accounting for 18%. Lubricating greases (5%), polymer synthesis (3%), and continuous casting mould flux powders all receive smaller percentages. Air treatment (1%) and other miscellaneous applications (5%) show minimal usage. This

distribution emphasizes the importance of lithium in modern technologies, notably energy storage systems.

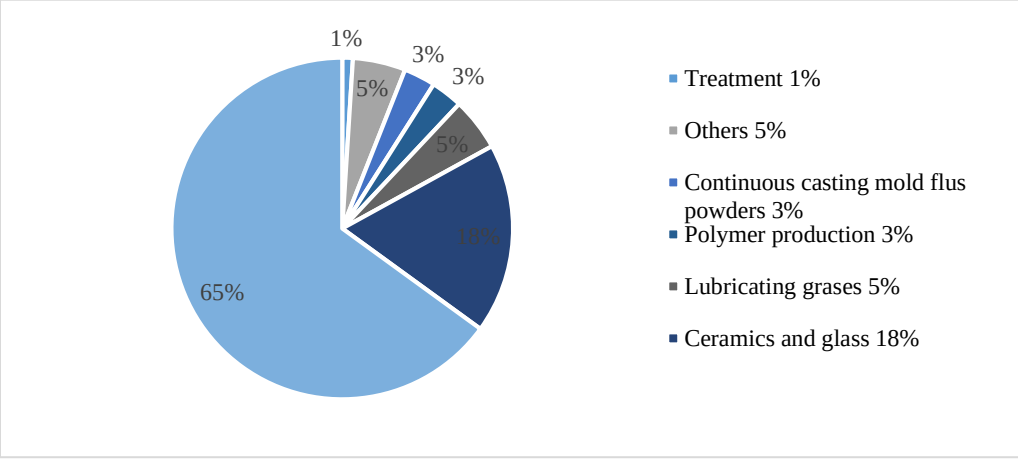

Figure 1: Distribution of global end-use markets of lithium [https://doi.org/10.3390/pr10122654].

GLOBAL LETHIUM RESOURCES / RESERVES

Table 1. Global lithium resources and reserves (in metric tons) by country

[https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-lithium.pdf].

Country	Lithium Resources (tons)	Lithium Reserves (tons)
Bolivia	23000000	NA
Argentina	22000000	1900000
United States	NA	1100000
Australia	8700000	6200000
China	6800000	3000000
Germany	3800000	NA
Canada	3000000	930000
Congo	3000000	NA
Mexico	1700000	NA
Czechia	1300000	NA
Serbia	1200000	NA
Chile	1100000	9300000
Russia	1000000	
Peru	1000000	NA
Mali	890000	NA
Brazil	800000	390000
Zimbabwe	690000	310000

Spain	320000	NA
Portugal	270000	60000
Nmibia	230000	3600000
Ghana	200000	NA
Finland	68000	NA
Austria	60000	NA
Kazakhstan	50000	NA
	World total 81178000	World total 26790000

There is a significant lithium resource reserve in the world that may be sufficient to meet the demands outlined in the IEA's sustainable development scenario. But as is often the case with mineral resources, extracting this lithium reserve sustainably without endangering the environment and society is a difficult task. The general effects of mining are well known, but there is a lack of information on the precise environmental and social effects of increasing lithium mining, especially when it comes to local communities. An in-depth examination of long-term demand projections and global supply dynamics for critical mineral resources is imperative, given the geographical concentration of lithium processing from hard rock sources in China.

PROJECTED GLOBAL EXPANSION OF LITHIUM MINING AND PROCESSING

In fact, lithium is an essential component of energy storage technologies, especially lithium-ion batteries, which are utilized in electric cars, renewable energy sources, and portable electronics, and thus contribute significantly to a nation's increased energy security. In addition to ensuring that there are sufficient and varied energy resources available to meet a country's energy needs, it entails protecting against supply chain disruptions, geopolitical risks, and other external factors that could have an impact on the energy supply. In order to reduce vulnerabilities and guarantee stability in the energy supply, energy security strategies frequently involve initiatives to diversify energy sources, build up domestic energy production capabilities, improve energy efficiency, and construct resilient energy infrastructure. Keeping this in mind, the demand for lithium is rising quickly worldwide to meet national energy needs as well as to support economic growth, national security, and the general well-being of a nation or region. Europe and North America's energy security is currently at risk due to

China's dominance in the lithium supply chain. Enhancing battery recycling, creating more environmentally friendly extraction techniques, and investigating different battery designs are some potential remedies. The fact that these developments won't likely have a major impact on the growth of the lithium market before 2030 emphasizes the continuous difficulties in striking a balance between energy security and sustainability.

EXPANSION IN LITHIUM CARBONATE DEMAND

The global demand for lithium, expressed in kilotons of lithium carbonate equivalent, is predicted to reach 429 kt by 2020. If governments adopt policies that align with the IEA's "sustainable development scenario," it is projected to rise to over 2500 kt. Figure 2 shows the expected increase in lithium carbonate demand through the end of the decade. The most significant growth is expected to occur in the global market for plug-in electric vehicles, or PEVs. It doesn't affect the 2030 prediction because grid-scale energy storage isn't anticipated to take off until after 2030.

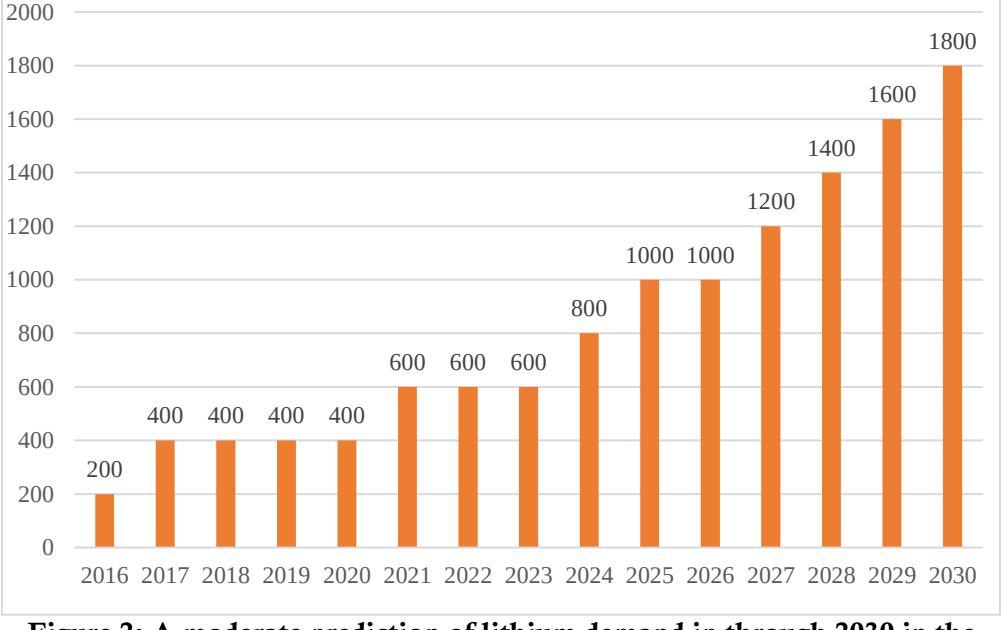

Figure 2: A moderate prediction of lithium demand in through 2030 in the absence of the IEA's sustainable development scenario in Kt of lithium carbonate equivalent. Majority of demands comes from electric vehicle batteries.

[https://www.cochilco.cl/Presentaciones/PPT%20Litio%20agosto%202020.pdf].

AVERAGE LITHIUM CARBONATE PRICE FROM 2010 TO 2023

The typical price of lithium carbonate suitable for batteries reached a record high of 37,000 U.S. dollars in 2022. S. money divided by metric ton. This noteworthy price point is a reflection of the increasing demand for lithium carbonate and its importance across a range of industries, most notably in the manufacture of batteries for renewable energy storage systems and electric vehicle batteries. A line graph showing the price of lithium carbonate from 2010 to 2023 is shown in Figure 3, which shows that the price of the material has risen dramatically in the last several years, with a particularly large increase in 2022. As the line chart illustrates, the rising cost of lithium carbonate is indicative of the commodity's growing importance and significance. The substantial price increase, particularly in 2022, suggests that there is a growing market for lithium carbonate, most likely due to its applications in electronics, renewable energy storage, and electric vehicles, among other industries. Prices fell in 2023, with supply chains stabilizing due to market corrections and increased production capacity meeting demand. Furthermore, the initial fervor surrounding the adoption of EVs subsided, which helped to create a more equilibrium supply-demand dynamic. These patterns highlight the importance of lithium for energy security as well as the complexity of the market, which is influenced by geopolitical and technological developments.

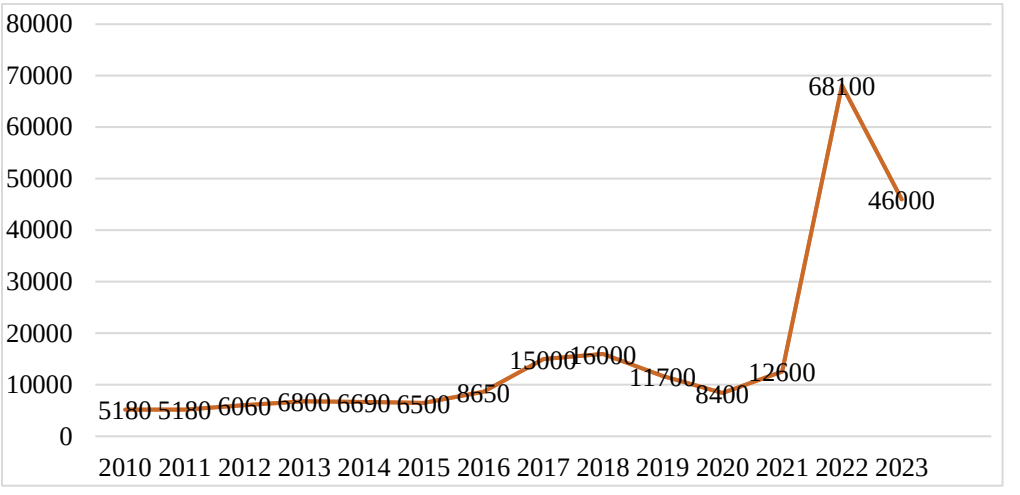

Figure 3: Average Lithium Carbonate Price from 2010 to 2023 (in US dollars per metric ton)

[https://www.statista.com/statistics/606350/battery-grade-lithium-carbonate-price/].

THE RUSH FOR ENERGY DOMINANCE

Political figures in both China and the U.S. s. recognize, deep down, that technological innovation is a tactical advantage. Both of these leaders clearly recognize that the importance of technological leadership cannot be overstated.

Investment initiatives for renewable energy by China and USA

China is the world's largest investor in clean energy, making up one-third of all clean energy investments worldwide and contributing significantly to GDP growth in the nation. China's progress in increasing its capacity for renewable energy is impressive, as it aims to achieve carbon neutrality before 2060 and peak carbon emissions before 2030. In 2023, China saw a 66 percent year-over-year increase in wind installations and a sizable amount of solar PV put into service. Furthermore, the nation is the world leader in the expansion of nuclear power capacity. With predictions of continued growth in 2024, the robust growth of industries like solar cells, lithium batteries, and electric vehicles highlights China's leading position in clean energy innovation and manufacturing. China's persistent investment in low-emission power is consistent with its efforts to promote clean energy development and transition to a cleaner energy future (refer to Figure 4 for a breakdown of China's energy investment in US dollars).

Figure-4: Energy expenditures in China in the past and in the future under the Announced Pledges scenario and the Net Zero Emissions by 2050 scenario from 2016 to 2030

[https://www.iea.org/data-and-statistics/charts/past-and-future-energy-investment-in-china-in-the-announced-pledges-scenario-and-in-the-net-zero-emissions-by-2050-scenario-2016-20300].

The US has increased its investments in clean energy dramatically; in 2020, they surpassed the amount spent on fossil fuels, and by 2023, they will have reached USD 280 billion. Important legislative measures such as the US Inflation Reduction Act and the Bipartisan Infrastructure Investment and Jobs Act have set aside large sums of money for infrastructure and clean energy, USD 370 billion and USD 550 billion, respectively. The growth of clean energy manufacturing capacity, grid upgrades, energy efficiency projects, and workforce development programs are all being fueled by these investments. The US is increasing its investments in renewable energy programs in order to move closer to its goal of having net-zero emissions by 2050, despite obstacles like high financing costs and permitting issues (refer to Figure 5 for a breakdown of China's energy investment in US dollars).

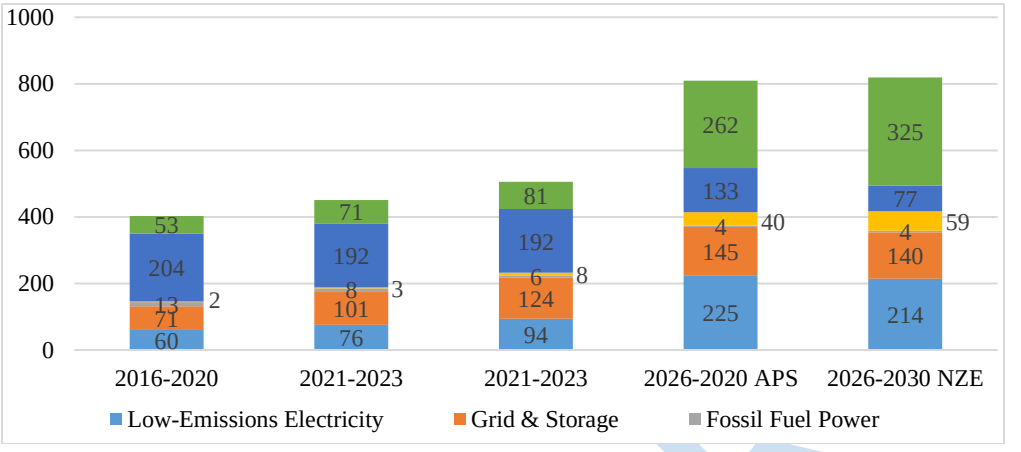

Figure-5: Energy expenditures in the United States in the past and in the future under the Announced Pledges scenario and the Net Zero Emissions by 2050 scenario from 2016 to 2030

[https://www.iea.org/data-and-statistics/charts/past-and-future-energy-investment-in-the-united-states-in-the-announced-pledges-scenario-and-in-the-net-zero-emissions-by-2050-scenario-2016-2030].

Policy initiatives for renewable energy by China and USA

Policy objectives signify the desired outcomes of a policy, while policy strategies outline the methods to attain these objectives (Haelg et al., 2020). The modifications to policy objectives can extend from refining fundamental aspirations to establishing fresh objectives or devising new benchmarks. Correspondingly, the adjustments to policy strategies can encompass altering the tenets of policy implementation or introducing and fine-tuning novel policy tools. Since 2015, China has served as the global front runner in the manufacture of New Energy Vehicle Batteries (NEVB), commanding a 77% share of global production capacity in 2020 (SandP Global Market Intelligence, 2021. Political figures in both China and the U.S. acknowledge that technological innovation serves as a primary foundation of national strength and comprehend the pivotal role of technological supremacy. Contrastingly, China has pursued a role as a global leader in lithium refining and has successfully attained this position. This aligns with China 2025, the country's industrial strategy, which focuses on elevating industries with high-value production and minimal environmental footprint. For instance, China handled a larger volume of lithium processing than lithium mining in 2018.

Most of the lithium mined in Australia is shipped to China for processing prior to being utilized in the manufacture of LIB cell cathodes. The Chinese State Council launched the Strategic Emerging Industries (SEI) program in 2009 to boost renewable energy, energy efficiency, new materials, and new energy vehicles. This initiative, driven by the objectives of industrial transformation and competitiveness, aimed to establish a conducive market environment for the commercialization and expansion of related technologies. The Chinese government invested an astonishing 800 billion yuan (roughly $120 billion) into the SEI program to stimulate innovation and enhance the global competitiveness of these sectors. The second phase saw the strengthening of the reciprocal relationships between NEVB Technological Innovation Systems (TIS) and policies through the integration of NEVB into the SEI program and important policy actions by multiple ministries. As a result, stakeholders felt more confident, which enhanced industry legitimacy and expanded the market. Policymakers' confidence was already bolstered by prior TIS functional developments, which had an impact on policy actions. China's NEV sector was greatly influenced by Mr. Wan Gang's background in the German auto industry. Positive market prospects led to the introduction of industry-specific market exploration policies, which allowed NEVB to be integrated into high-level initiatives such as SEI. Concrete policy goals and means were shaped by feedback from research institutes, think tanks, and influential scientists via a more structured and methodical consultation process. During the third period of 2015, Premier Li Keqiang announced the launch of the "Made in China 2025" (MIC 25) initiative. The high-level policy goals of this comprehensive plan, developed by NDRC, MOST, MIIT, and other organizations, were to break China out of the middle-income trap and turn it into a manufacturing powerhouse that competes worldwide, primarily without utilizing foreign technologies. According to some interpretations, MIC 25 represents China's attempt to localize high-tech value chains, with the government realizing the importance of private enterprises, markets, and supportive institutional environments in a healthy innovation system. NEVB is one of the ten major industries that the MIC 25 strategy has identified as needing significant breakthroughs by 2025. The goal was for gold-related components to reach a globally

advanced level by 2020, account for 80% of the domestic market, and have significant trade potential by 2025. A significant project under the MIC 25 program, China established the National Power Battery Innovation Center in Beijing in 2016 with the goal of assembling innovation power and bolstering China's manufacturing profile. China has implemented several policy initiatives aimed at improving the development of lithium resources and safeguarding supply chains. These initiatives include promoting international cooperation, regulating the circular economy of lithium resources, and bolstering domestic lithium exploitation through technological innovation. In order to obtain stable mineral resources overseas, China is pursuing long-term agreements and joint ventures. Concerns concerning the socioeconomic and environmental effects on nearby communities are brought up by the growing lithium extraction, especially in Bolivia. China suggests internationalizing resource management, diversifying supply, bolstering industry ties, and integrating resource development with environmental strategies as ways to address these issues. The US. S. is actively working to increase domestic lithium production in order to lessen its reliance on imports and support its expanding battery industry. The American Battery Materials Initiative seeks to promote both economic expansion and increased energy security. The Mountain West region has significant potential for lithium mining and production, especially in Nevada, Utah, and Idaho. In the past, the U.S. S. reached its peak as the largest producer and consumer of lithium in the world in 1974, but domestic production fell after the last U.S. S. closing of a lithium mine in 1998. The development of North American brine resources for the production of lithium hydroxide and carbonate is the main focus of current efforts. Lithium consumption is currently dominated by the battery industry, highlighting the metal's crucial role in the energy transition. The Obama administration introduced American innovation strategies in 2009, 2011, and 2015 with the goal of regaining the lead in basic research and fostering new industries. Three percent of GDP was set aside for research and development in each of these strategies. The objectives of these strategies were the development of new talent, the building of sophisticated infrastructure, and the establishment of a strong IT ecosystem. Important national projects included biotechnology, nanotechnology, clean energy,

advanced manufacturing, health and educational IT, and space technologies (The White House, 2009, 2011). While abandoning some reasonable initiatives, such as the Perfect Energy Plan, the Trump administration emphasized staying current with U. S. authority in research, development, and invention to ensure public safety and military prowess. In order to sustain military dominance and counter emerging technological risks, the 2017 National Security Strategy underscored the necessity of augmenting defense research and development expenditures.

PRODUCTION CAPACITY OF CHINA AND USA

China has significant reserves and production of lithium, but it imports more of the metal than it produces there. Australia has supplied the majority of China's lithium needs in recent years, accounting for over 80% of the total. One of the explanations is that China's history of lithium mining is disputed and the details are not totally clear. The country's largest known lithium deposits are located close to Ganzi, a 10,000-person province in Sichuan province's western autonomous prefecture in 2010. The township is ethnically Tibetan and located in Khan, a historical Tibetan region. Local officials considered Ganzi to be "China's lithium capital". A lithium mine has started to be operated by Gangzizhou Rangda Lithium Company, a branch of Youngy Company in Guangzhou. After several years of mining activity, the local communities became alarmed and staged protests. The downstream community of Balang experienced repercussions from the first incident, which happened in 2009. The villagers claimed that toxic chemicals from the lithium mine poisoned the nearby Liqi River, killing yaks and fish that drank from it. The business refuted claims that environmental issues were caused by the mine's operations. The administration responded to the protests by enacting security measures. The mine was temporarily shut down in 2014 while the company looked into some issues related to land procurement. Local officials gave communities the assurance that the mine would not reopen until environmental problems were fixed. The villagers claim that when the mine reopened in May 2016, more fish perished. The company refuted reports that it had restarted the mine.

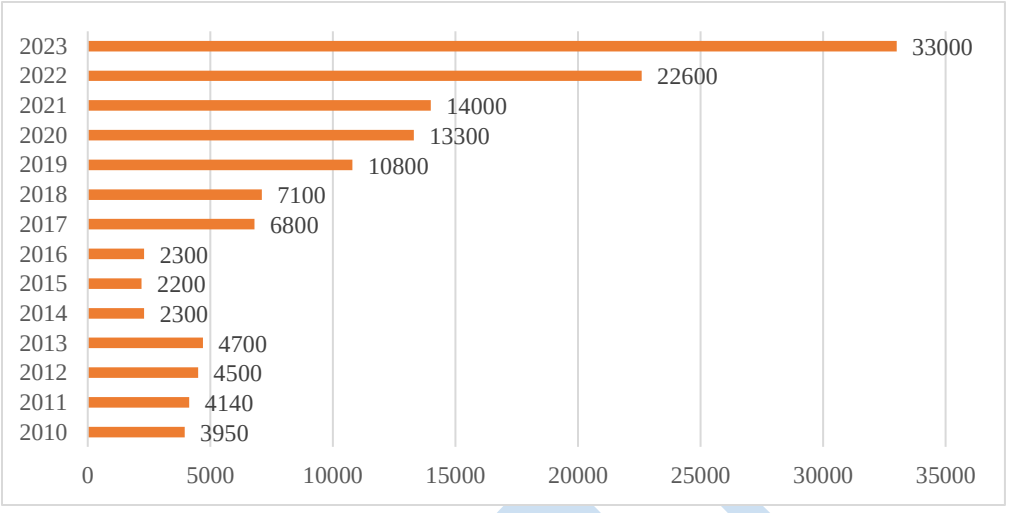

Figure 6: Mine production of lithium by China from 2010 to 2030 (in metric tons)

[https://www.statista.com/statistics/1280478/china-lithium-mine-production-volume/].

After a considerable amount of time, in the middle of 2019, Youngy Organization announced that the mine would reopen along with a $201 million stake in another Sichuan lithium metal handling facility. The group also mentioned the mine's more robust natural controls. Zabuye Lithium has been producing since 2005 under a 20-year exclusive license at China's largest producing mine, Lake Zabuye, in Tibet. The methods used in mining at Lake Zabuye are similar to those in Chile. The impediments to increased lithium production at Lake Zabuye stem more from operational problems than from environmental concerns or community protests. Rather than placing a premium on lithium mining, Chinese corporations backed by Chinese banks and the government have acquired sizeable interests in the major lithium mines located in Australia, South America, and Africa. Even in the United States, lithium mines are still in their infancy, but Chinese companies are investigating them. On the other hand, China has searched for and established a global administrative role in the management of lithium. This aligns with China 2025, the nation's industrial policy that prioritizes high-value-added, low-impact industrial supply chain components. In 2018, for example, China accounted for a far greater share of the global lithium

processing market than lithium mining. Most of the lithium mined in Australia is sent to China for processing before being used to make cathodes for LIB cells. Meeting the increasing demand for lithium, especially from the electric vehicle industry, presents challenges for China's lithium industry. China continues to be a net importer of lithium despite growing its production capacity; from 2015 to 2021, cumulative imports were 343 kt, while exports were 169 kt. China's lithium-ion battery consumption increased from 1 point 4 kt in 2000 to 547 point 1 kt in 2018, primarily due to the use of mobile devices and subsequently electric vehicles. Experts advise bolstering the development of lithium resources, encouraging international collaboration, and regulating the circular economy of lithium resources in order to address supply concerns. China could potentially reduce its net import dependency from 27–86 percent to 0–16 percent by increasing recycling, developing lithium substitutes for non-battery applications, and optimizing inventory management to improve material utilization efficiency. The United States produced the most lithium in the world between the 1950s and the 1980s, mostly for use in aerospace and military applications. The resource came from spodumene reserves that were mined openly in western North Carolina. Due to a drop in US military demand and the emergence of relatively cheap foreign sources, the practice of mining lithium in the US was all but discontinued. A resurgence of lithium mining in the US is taking place as a result of the recognition of the strategic importance of lithium by both the Trump and Biden administrations. Enormous barriers impede the growth of lithium mining and processing. Lithium Piedmont Inc., a recently established company in North Carolina, has already invested $58 million to plan a lithium mining and processing project west of Charlotte. In order to produce 30,000 tons of lithium annually for Tesla, the company is seeking an additional $700 million from investors. The Apollo Gathering, an Australian mining hatchery, founded the organization. In the "Carolina Tin-Spodumene Belt," west of Gastonia, close to Cherryville, Piedmont purchased more than 1,000 acres; however, some residents are deeply troubled by the project and have refused to sell their land. Investors were initially informed by the company that permits would be obtained by the end of 2021. Piedmont must notify landowners within 1000 feet of its boundary in order to

receive a working grant. The permitting system also takes into account possible formal conferences and public comments. The unanticipated decline in lithium prices between 2018 and 2020 could have contributed to this in part. The production of lithium in North America has recently advanced, indicating that it has the potential to meet the increasing demand for battery materials. The US Department of Energy has approved a $2.03 billion loan to Lithium Americas for a Nevada mine that is anticipated to yield 40,000–80,000 metric tons of lithium carbonate per year by 2027. While other companies plan larger facilities, Livent has increased the capacity of its lithium hydroxide plant in North Carolina to 15,000 metric tons annually. According to historical estimates, the United States possesses reserves of 35 million tonnes of lithium, with a production capacity of 4,700 tonnes in 1978. In order to secure a domestic supply for decarbonization initiatives, current research focuses on lithium extraction from sedimentary clays and low-content brines in North America. Despite the fact that the sources cited do not provide precise numbers for total current or projected capacity, these developments point to a significant potential increase in US lithium production capacity.

RESULTS AND INTERPRETATION OF IMPLICATIONS

The study draws attention to the growing geopolitical competition between China and the United States over lithium resources, which are seen as essential to both economic stability and national security, especially in the field of renewable energy and the manufacture of electric vehicles (EVs). China now dominates the global lithium market thanks to its significant investments in lithium mining and refining, particularly in South America. Meanwhile, the U.S. S. aims to increase its own production of lithium. This competition has an impact on global energy security because nations that import lithium are vulnerable to changes in supply and price, necessitating the building of higher domestic reserves. The situation presents opportunities as well as challenges for Pakistan, which is heavily dependent on energy imports and is currently experiencing a severe energy crisis. On the one hand, its inability to fully utilize this strategically important resource is hampered by the lack of domestic capabilities in lithium exploration and processing. However, the heightened competition for lithium on the international scene may draw in foreign capital and technological advancements that support Pakistan's efforts to

expand its energy capacity and infrastructure. The nation must manage the market's erratic prices, which are sensitive to the ongoing geopolitical tensions, as the demand for lithium rises. In light of these circumstances, Pakistan has a special chance to strengthen its position through expanding its domestic lithium production capacity and joining international supply chains. In order to do this, the nation must strategically interact with both Chinese and American interests in order to draw capital and advance infrastructure development. Promoting cooperation on resource sharing with surrounding countries may also increase regional stability and reduce geopolitical risks. At the end of the day, the study emphasizes how crucial it is to manage lithium resources well if Pakistan hopes to safeguard its energy future in the face of changing global competition and energy technology.

CONCLUSION

In conclusion, the geopolitical rivalry between China and the United States over lithium resources highlights the strategic significance of this vital mineral in the shift to renewable energy technologies and has important ramifications for global energy security. Countries that depend on imports face greater risks related to supply chain vulnerabilities and market volatility as the demand for lithium rises, especially in the electric vehicle and energy storage sectors. Pakistan's current energy crisis and lack of domestic lithium production capabilities exacerbate the challenges presented by this geopolitical rivalry. Nonetheless, the developing circumstances also offer the nation a singular chance to bolster its energy security by cultivating domestic lithium resources, drawing in outside capital, and advancing its technological infrastructure. Pakistan needs to be proactive in navigating this complicated environment by strategically engaging with China and the US to capitalize on their shared interests in the area. Pakistan can establish a prominent position in the worldwide lithium supply chain by promoting cooperation with its neighbors and broadening its energy portfolio. To further ensure a stable energy future and mitigate geopolitical risks, investment in domestic capabilities and infrastructure will be essential. In the end, efficient management of lithium resources will be essential for ensuring energy independence and boosting economic growth in Pakistan as countries work toward sustainable development in an era characterized by fierce competition for resources. In light of

changing global dynamics, this research emphasizes the critical need for comprehensive policies that address the nuances of the lithium market and improve national energy security.

REFERENCES

U.S. Geological Survey. (2017). USGS Publications Warehouse. Retrieved from https://pubs.usgs.gov/browse/Report/USGS%20Numbered%20Series/Open-File%20Report/2017/

Allison, G. (2020). The new spheres of influence: Sharing the globe with other great powers. Foreign Affairs, 99, 30.

Altiparmak, S. O. (2023). China and lithium geopolitics in a changing global market. Chinese Political Science Review, 8(3), 487–506. https://doi.org/10.1007/s41111-023-00246-w

Statista. (2024). Average lithium carbonate prices from 2010 to 2023 (in US dollars per metric ton). Retrieved October 8, 2024, from https://www.statista.com/statistics/606350/battery-grade-lithium-carbonate-price/

Calisaya-Azpilcueta, D., Herrera-Leon, S., Lucay, F. A., & Cisternas, L. A. (2020). Assessment of the supply chain under uncertainty: The case of lithium. Minerals, 10(7), 604. https://doi.org/10.3390/min10070604

Campbell, K. M., & Ratner, E. (2018). The China reckoning: How Beijing defied American expectations. Foreign Affairs, 97, 60.

Center, S., & Bates, E. (2019). Historical perspectives on innovation, technology, and strategic competition. Tech-Politik.

Chaubey, N., Qurashi, A., Chauhan, D. S., & Quraishi, M. A. (2021). Frontiers and advances in green and sustainable inhibitors for corrosion applications: A critical review. Journal of Molecular Liquids, 321, 114385. https://doi.org/10.1016/j.molliq.2020.114385

Crawford, T. (2022). Lithium: The big picture. One Earth, 4(3), 323–326. https://doi.org/10.1016/j.oneear.2021.11.014

Dorn, F. M., & Peyré, F. R. (2020). Lithium as a strategic resource. Journal of Latin American Geography, 19(4), 68–90. https://doi.org/10.1353/lag.2020.0040

Dyatkin, B., Gamache, R. M., Rock, B. Y., Qadri, S. B., Edelen III, W. K., & Laskoski, M. (2020). Microwave-assisted pressureless sintering of silicon-reinforced boron carbide composites. Journal of Solid State Chemistry, 292, 121659. https://doi.org/10.1016/j.jssc.2020.121659

Edsand, H. E. (2019). Technological innovation system and the wider context: A framework for developing countries. Technology in Society, 58, 101150. https://doi.org/10.1016/j.techsoc.2018.10.010

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy, 48, 717–729. https://doi.org/10.1016/j.enpol.2012.06.009

Elsheikh, A. H., Sharshir, S. W., Abd Elaziz, M., Kabeel, A. E., Guilan, W., & Haiou, Z. (2019). Modeling of solar energy systems using artificial neural networks: A comprehensive review. Solar Energy, 180, 622–639. https://doi.org/10.1016/j.solener.2019.01.037

Fan, E., Li, L., Wang, Z., Lin, J., Huang, Y., Yao, Y., & Wu, F. (2020). Sustainable recycling technology for Li-ion batteries and beyond: Challenges and future prospects. Chemical Reviews, 120(14), 7020–7063. https://doi.org/10.1021/acs.chemrev.9b00535

Flexer, V., Baspineiro, C. F., & Galli, C. I. (2018). Lithium recovery from brines: A vital raw material for green energies with a potential environmental impact in its mining and processing. Science of the Total Environment, 639, 1188–1204. https://doi.org/10.1016/j.scitotenv.2018.05.223

Friedlingstein, P., O'Sullivan, M., Jones, M. W., Andrew, R. M., Gregor, L., Hauck, J., & Zheng, B. (2022). Global carbon budget 2022. Earth System Science Data, 14(11), 4811–4900. https://doi.org/10.5194/essd-14-4811-2022

Graham, J. D., Rup, J. A., & Brungard, E. (2021). Lithium in the green energy transition: The quest for both sustainability and security. Sustainability, 13(11), 11274. https://doi.org/10.3390/su13111274

Greim, P., Solomon, A. A., & Breyer, C. (2020). Assessment of lithium criticality in the global energy transition and addressing policy gaps in transportation. Nature Communications, 11(1), 4570. https://doi.org/10.1038/s41467-020-18402-y

Haelg, L., Sewerin, S., & Schmidt, T. S. (2020). The role of actors in the policy design process: Introducing design coalitions to explain policy output. Policy Sciences, 53(2), 309–347. https://doi.org/10.1007/s11077-019-09365-y

Henderson, M. (2021). Energy transitions: Pathways and priorities for a secure future. Energy Research & Social Science, 75, 101891. https://doi.org/10.1016/j.erss.2021.101891
Hoffmann, V. H., & Rogge, K. S. (2016). The impact of the EU ETS on innovation in the European power sector. Climate Policy, 16(4), 524–545. https://doi.org/10.1080/14693062.2015.1049363
International Energy Agency. (2020). Global EV outlook 2020: Entering the decade of electric drive. Retrieved from https://www.iea.org/reports/global-ev-outlook-2020
Jain, S., Jain, P. K., & Chaudhary, D. (2022). Lithium-ion battery recycling challenges and prospects for a sustainable energy future. Journal of Cleaner Production, 345, 131106. https://doi.org/10.1016/j.jclepro.2022.131106
Kalantzakos, S. (2020). The geopolitics of critical minerals. Energy Policy, 139, 111314. https://doi.org/10.1016/j.enpol.2020.111314
Kangas, R., McGraw, D., & Savage, G. (2019). Strategic foresight: Leveraging insights to improve global security. Futures, 112, 102437. https://doi.org/10.1016/j.futures.2019.102437
Kashwani, G., & Mollah, M. Y. A. (2020). Strategic development of sustainable lithium-ion battery recycling technologies: Challenges and opportunities. Electrochimica Acta, 334, 135658. https://doi.org/10.1016/j.electacta.2020.135658
Kidd, S. (2018). Lithium market trends and implications for the energy transition. Energy Policy, 121, 23–30. https://doi.org/10.1016/j.enpol.2018.03.019
KPMG International. (2021). The future of energy: Lithium and strategic opportunities for global markets. Retrieved from https://home.kpmg/xx/en/home/insights/2021/06/the-future-of-energy.html
Larcher, D., & Tarascon, J. M. (2015). Towards greener and more sustainable batteries for electrical energy storage. Nature Chemistry, 7(1), 19–29. https://doi.org/10.1038/nchem.2085
Lee, T. H., & Lu, J. (2020). Lithium production under sustainable development goals: A global perspective. Sustainability Science, 15(4), 951–963. https://doi.org/10.1007/s11625-019-00725-7
Lopez, E. J., & Martinez, M. P. (2019). Lithium geopolitics: Environmental and political challenges. Environmental Science & Policy, 101, 88–96. https://doi.org/10.1016/j.envsci.2019.07.006

Manthiram, A. (2020). A reflection on lithium-ion battery cathode chemistry. Nature Communications, 11(1), 1550. https://doi.org/10.1038/s41467-020-15355-0
Masood, T., & Maqsood, F. (2021). Energy geopolitics in South Asia: Strategic challenges and opportunities. Geopolitics, 26(4), 1015–1035. https://doi.org/10.1080/14650045.2020.1753941
Mckinsey & Company. (2020). The new battery age: Strategic imperatives for energy transition. Retrieved from https://www.mckinsey.com/business-functions/sustainability/our-insights/the-new-battery-age
Meadows, D. H., & Randers, J. (2004). Limits to growth: The 30-year update. Chelsea Green Publishing.
Mori, Y. (2021). Lithium: Balancing security and sustainability. Journal of Resources Policy, 70, 102067. https://doi.org/10.1016/j.resourpol.2021.102067
Moss, T., & Watson, J. (2020). Energy policy and technological change in low-carbon transitions. Environmental Innovation and Societal Transitions, 35, 112–118. https://doi.org/10.1016/j.eist.2019.11.004
National Renewable Energy Laboratory. (2021). The critical role of lithium in electric vehicle batteries. Retrieved from https://www.nrel.gov/docs/2021/tbd.pdf
Nield, T. (2021). Lithium in South America: Political and environmental dimensions. Journal of Contemporary Geopolitics, 5(2), 87–95. https://doi.org/10.1016/j.jcg.2021.07.003
OECD. (2020). Global energy perspectives: Sustainability, technology, and policy. Retrieved from https://www.oecd.org/environment/energy-perspectives/
Olivetti, E. A., Ceder, G., Gaustad, G. G., & Fu, X. (2017). Lithium-ion battery supply chain considerations: Analysis of potential bottlenecks in critical metals. Joule, 1(2), 229–243. https://doi.org/10.1016/j.joule.2017.08.019
Pagnoncelli, L., & Sanchez, L. A. (2022). Lithium in the energy transition: Economic and geopolitical factors. Energy Policy, 163, 112316. https://doi.org/10.1016/j.enpol.2022.112316
Peters, J. F., & Weil, M. (2018). Environmental aspects of lithium-ion battery recycling. Energy & Environmental Science, 11(4), 1040–1054. https://doi.org/10.1039/C8EE00142F
Pilatowicz, M., & Kowalczyk, J. (2021). The race for lithium: Implications for global power dynamics. Strategic Studies

Quarterly, 15(1), 33–47. https://doi.org/10.1016/j.ssqu.2021.09.001
Renewable Energy Policy Network for the 21st Century (REN21). (2021). Renewables 2021 global status report. Retrieved from https://www.ren21.net/
Roth, R., & Stanislawski, S. (2020). Balancing lithium demand and environmental sustainability. Journal of Industrial Ecology, 24(6), 1234–1245. https://doi.org/10.1111/jiec.13065
Schmidt, O., Hawkes, A., & Gambhir, A. (2020). The future cost of energy storage technologies. Energy & Environmental Science, 13(9), 2887–2905. https://doi.org/10.1039/D0EE00957B
Sovacool, B. K., Axsen, J., & Sorrell, S. (2018). Promoting the diffusion of energy innovations. Energy Policy, 119, 68–80. https://doi.org/10.1016/j.enpol.2018.04.018
Stevens, P., & Wright, C. (2021). Lithium geopolitics in the 21st century: Challenges for energy transition. Energy Strategy Reviews, 35, 100693. https://doi.org/10.1016/j.esr.2021.100693
Thackeray, M. M., Wolverton, C., & Isaacs, E. D. (2012). Electrical energy storage for transportation: Approaching the limits of, and going beyond, lithium-ion batteries. Energy & Environmental Science, 5(7), 7854–7863. https://doi.org/10.1039/C2EE21892E
United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. Retrieved from https://sdgs.un.org/2030agenda
Vikström, H., Davidsson, S., & Höök, M. (2013). Lithium availability and future production outlooks. Applied Energy, 110, 252–266. https://doi.org/10.1016/j.apenergy.2013.04.005
Wang, S., & Yu, H. (2022). Strategic dimensions of lithium extraction: Environmental and economic trade-offs. Journal of Environmental Management, 310, 114736. https://doi.org/10.1016/j.jenvman.2022.114736
World Bank. (2020). Minerals for climate action: The mineral intensity of the clean energy transition. Retrieved from https://pubdocs.worldbank.org/en/961711588875536384/minerals-for-climate-action.pdf
Zhou, X., & Yin, J. (2019). The role of critical materials in energy storage systems. Energy Reports, 5, 1327–1333. https://doi.org/10.1016/j.egyr.2019.09.016