NBR

CLEAN EDGE ASIA PROJECT

The Geopolitics of Renewable Energy

BY NIHARIKA TAGOTRA
CLEAN EDGE ASIA FELLOW

Renewables have been identified globally as the key technology and energy source for mitigating climate change. Since the Kyoto Protocol went into effect in 2005, and as discussions around climate change mitigation have accelerated, the interest in renewable energy has also increased. More broadly, the last two decades have seen global leaders convening several conferences to discuss matters pertaining to renewable energy policies and the financing and technology associated with it. These included, among others, the World Summit on Sustainable Development (2002), the Annual G-8 Gleneagles Dialogue, the International Renewable Energy Conference in Bonn (2004), and the International Renewable Energy Conference in Beijing (2005).

The concluding resolution of the Bonn Conference supported the establishment of the International Renewable Energy Agency (IRENA), which came into existence in 2009 as the first intergovernmental organization for the promotion of renewables. The establishment of IRENA was pivotal in institutionalizing the promotion of renewable energy globally. In 2012, the Intergovernmental Panel on Climate Change (IPCC) published an assessment of renewable energy's "potential role in the mitigation of greenhouse gas emissions."[1] The report underlined that greenhouse gas emissions from human activities "contributed significantly to the historic increase in overall atmospheric GHG concentrations," compounding the impact of naturally occurring release of greenhouse gases, such as from photosynthesis and volcanic eruptions. The attempts to balance the increasing energy demand with the need for lowering greenhouse gas emissions, therefore, can be successful with the increased deployment of renewable energy technologies. The IPCC report thus identified renewable energy as one of the most crucial mitigation options available.

Given the collective and concerted efforts toward mitigation of climate change, the global renewable power capacity saw a jump from 800 (GW) in 2004 to 1,560 GW in 2014.[2] It further increased to 2,378 GW in 2018, accounting for over a third of global power capacity.[3] Of all the sources of renewable energy, solar and wind energy technology deployments had the maximum growth in the period from 2004 to 2014. China, in particular, led the global transition to renewable energy during this period, as the country alone added around 240 GW of renewable energy capacity. In the same duration, India added around 30 GW of renewable energy capacity. In 2018, China possessed 728 GW of renewable energy capacity, accounting for 38.3% of its total installed power capacity, while India possessed around 118 GW, with a share of 34.2% of its total installed capacity.[4]

This essay explores the trends in the development of the global renewable energy industry, with a specific focus on the growing geopolitical considerations around renewable energy. The first section provides an overview of critical minerals and renewable energy technologies. The essay then examines the nature of demand for renewable energy, the increasing monopolization and concentration of supply chains of rare earths, and the subsequent impact of all these developments on the global efforts toward climate change mitigation.

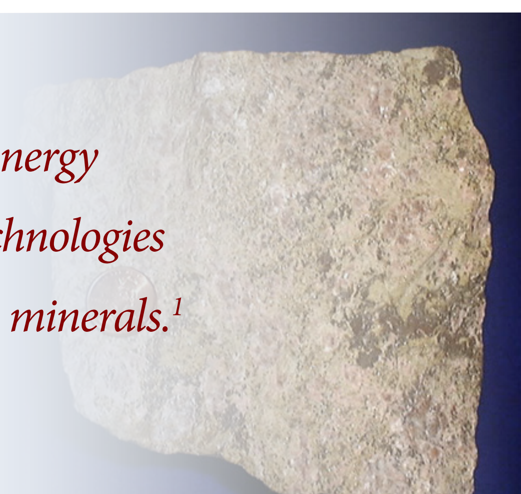
Critical Minerals and Renewable Energy Technologies

The renewable energy industry is premised heavily on the sourcing of critical and rare earth minerals, including lithium, cobalt, copper, gold, and uranium, among others, for the manufacture of solar panels, wind turbines, and related storage technologies. This section will discuss these technologies along with critical minerals.

Renewable energy technologies. Analysis of the metal components of renewable energy technologies makes evident the fact that these technologies depend extensively on a wide range of rare earth minerals. The sourcing and costs of these minerals determine the pricing of these technologies.

The dominant technology in the solar sector is the crystalline silicon solar photovoltaic panel consisting of "76% glass, 10% polymer, 8% aluminum, 5% silicon, 1% copper, less than 0.1% silver and other metals (tin and lead)."[5] For the manufacture of wind turbine components, the metals used include "iron ore, copper, aluminum, limestone and carbon." In addition, the

Analysis of the metal components of renewable energy technologies makes evident the fact that these technologies depend extensively on a wide range of rare earth minerals.[1]



1

magnets used in turbine generators contain certain rare earth minerals including neodymium and dysprosium, and an estimated "20% of all installed wind turbines use rare earth magnets."[6] The other 80% of installed wind turbines utilize permanent magnets, but to lower costs and improve efficiency permanent magnets are increasingly making use of rare earth minerals like neodymium and dysprosium.

Another key technology in the renewable energy sector is battery technology, which helps in the storage and long-term use of generated renewable power and is key to the design of electric vehicles. The storage technologies rely heavily on the use of cobalt and lithium, specifically lithium-ion batteries.

Lithium. Globally, lithium is concentrated in Australia, Chile, Argentina, Bolivia, China, Zimbabwe, Portugal, Brazil, and Namibia.[7] Australia currently is the largest producer of lithium, producing about 51,000 metric tonnes (MT) in 2017–18, and holds about 2.7 million MT of identified lithium reserves. Most of its lithium supply is exported to China as spodumene. After Australia, Chile is the second-largest producer of lithium. In both Australia and Chile, the companies owning and developing lithium mines are owned in part by China. Talison Lithium, an Australian mining firm, is partly owned (51% stake) by Tianqi Lithium, a major Chinese mining company. Tianqi Lithium also has a nearly 24% stake in SQM, a top lithium producer for Chile. With this portfolio, China effectively controls about 70% of the world's lithium production and most of the world's lithium-processing facilities. China also effectively dominates lithium-ion battery production, producing around 73% of the 316 gigawatt-hours of "global lithium cell manufacturing capacity."[8] The United States comes a distant second, producing only 12% of this capacity.

Cobalt. Cobalt serves as the cathode material, a type of electrode, in many lithium-ion batteries. Globally, cobalt is found in countries such as the Democratic Republic of Congo (DRC), Russia, Australia, Canada, Cuba, the Philippines, Madagascar, Papua New Guinea, and Zambia. The DRC is by far the world's largest producer, accounting for roughly 58% of global production and possessing 50% of the known global reserves of cobalt. In 2017–18, the DRC produced roughly 64,000 MT of cobalt.[9] The cobalt mines in the DRC witness participation by some of the world's largest cobalt majors such as Swiss-owned Glencore, which owns and operates the Mutanda and Katanga mines, and China Molybdenum, which owns a nearly 80% stake in the Tenke Fungurume mine. The mine has one of the world's largest concentrations of cobalt, and most of its output is consumed by China.

Graphite. Graphite materials are the dominant active anode material, another type of electrode, used in lithium-ion batteries and a major component in rechargeable batteries. China, India, Brazil, Canada, Mozambique, Russia, Ukraine, Pakistan, and Norway remain the highest producers of graphite globally. China was the world's largest graphite producer in 2017 and produced 780,000 MT of the metal. It accounted for 65% of world graphite mining in 2018, and 35% of the total global consumption.[10]

Rare earth minerals. Rare earth minerals are used in the manufacturing of solar panels and wind turbines. Of the seventeen rare earth minerals, indium, dysprosium, praseodymium, neodymium, and terbium are used extensively in the renewable industry. The global deposit reserves of these minerals are estimated at 120 MT, with the United States and China possessing a large share of them.[11] China, however, possesses around 85% of the global processing capacity for rare earth minerals, equivalent to 220,000 tonnes, almost five times the total capacity of the rest of the world.[12] This gives China a near monopoly over the supply of rare earth minerals. The country decided to use these resources as a strategic commodity, to its advantage, in a decision taken in the 1980s under its Mineral Resources Law.

Geopolitical Considerations

China's monopolization of renewable production and supply chains. The monopolization of the production and supply chains of the critical minerals is integral to China's energy security strategy. In 1990 the government declared rare earth minerals as a "protected and strategic mineral," which prohibited foreign investors from mining them in China or participating in their smelting or separation projects, except for through joint ventures with Chinese companies.[13] Before 2003, any such joint ventures with a foreign investor required clearance from the Ministry of Foreign Trade and Economic Cooperation. In addition to this requirement, the domestic rare-earth producers and those in a joint venture with foreign companies were issued separate rare earth export quotas. Besides, the Chinese government policies encouraged exports of "high value downstream products" that required rare earth minerals, such as cell phones and computer chips, while discouraging exports of rare earth minerals as raw materials. This translated into China accounting for nearly 58%, or 140,000 MT, of the total global rare earth production in the year 2020.[14]

This monopoly over the production of rare earths even allowed China to weaponize exports of these minerals. For example, in 2021, amid its ongoing trade war with the United States, China announced curbs on the production and export of the seventeen rare earth minerals, which are crucial to produce F-35s, electric vehicles, and wind turbines, among other strategically important items.[15]

Moreover, China's near monopoly over the production and value chains of the raw materials used in renewable energy production has strengthened the country's domestic renewable energy industry. Renewable energy is an important component of the Belt and Road Initiative (BRI). In 2020, over half of energy investments under BRI went into this sector, accounting for 57%, or $11 billion, of the total energy investments by China.[16] This marked an increase from the previous figure of 38% recorded in 2019. China's domestic solar industry also witnessed a remarkable rise, considering that by 2021 eight of the top ten solar companies in the world that dominated the global solar supply chains were Chinese.[17] By 2021, China was controlling nearly 64% of the global production of the polysilicon material that is key to manufacturing solar ingots and wafers used as a part of solar panels and a total 100% production capacity of solar ingots and wafers themselves. Cumulatively, China controlled 80% of the global solar-cell manufacturing capacity by the end of 2020.

Response to the China challenge. Overdependence on China for supply of critical minerals that are key to the production of renewable energy technologies worldwide has sparked concerns over the reliability and resilience of their supply chains. To mitigate the risks stemming from such overdependence, countries have announced strategies for ensuring the diversification of supply chains. The United States, for instance, in 2017 announced the Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals. As a part of this strategy, the U.S. Department of Commerce submitted a report to the president in June 2019. The report outlined aspects of a national strategy for reducing the country's reliance on imports for critical minerals, assessed the progress on developing recycling and reprocessing technologies for critical minerals, discussed the technological alternatives to these minerals, and presented opportunities to develop these minerals in collaboration with U.S. allies and partners and support the U.S. private sector in exploration.[18] Accordingly, the U.S. Department of Energy charted an R&D roadmap, which served to identify the solutions to the challenges and potential opportunities for diversifying the supply chains of rare earths and critical minerals.

India, too, has been devising strategies to reduce its dependence on China for the supply of inputs for its renewable industry. To counter China's monopolization of lithium and cobalt production, India has been venturing out to look for mineral assets in countries abroad. As recently as in 2020, it successfully established a joint venture known as KABIL (Khanij Bidesh India Limited), which has entered into agreements with countries such as Australia, Argentina, Chile, and Bolivia for the acquisition of mines producing strategic minerals such as lithium and cobalt.[19]

Additionally, the alarming dominance of Chinese solar cells and equipment in India's renewable market and the challenge it presented to Indian renewable manufacturers prompted the Indian government to impose a basic custom duty on all imported cell, modules, and inverters, which went into effect in April 2022.[20] The 40% duty on solar modules and 25% duty on solar cells were intended to make imports costlier and incentivize domestic manufacturing of these components. These duties effectively replaced the 15% safeguard duty that had been imposed on imports from Malaysia and China since 2018. Combined with the restrictions on investment from neighboring countries, these trade restrictions were meant to safeguard the domestic renewable energy sector from Chinese dominance and prevent China from controlling Indian energy security.

Implications for Global Efforts to Mitigate Climate Change

As the world transitions to clean energy, the market for renewable technologies could become a seller's market, like the one that existed for oil, but this time with a near monopoly. According to estimates from the International Energy Agency, to achieve a net-zero carbon world by 2050, around 88% of the global electricity generation must come

Any disruption to production chains originating from China can lead to a situation that puts in jeopardy the manufacturing of solar photovoltaics, batteries, and electric vehicles around the world, thus seriously challenging the global energy transition efforts.

from renewables, while 61% of global transportation must be fueled by renewables.[21] This becomes even more significant given the fact that several of the world's largest emitters, including the United States and China, have announced their net-zero ambitions on the back of their domestic renewable energy industries, which have become fundamental to driving the energy transition in these countries.

The perils of overdependence on a particular country or region have been exposed during the Covid-19 pandemic. Supply chain disruptions at one end of the world have caused the manufacturing sector to nearly collapse in other parts of the world. In the renewable energy sector, any disruption to production chains originating from China can lead to a situation that puts in jeopardy the manufacturing of solar photovoltaics, batteries, and electric vehicles around the world, thus seriously challenging the global energy transition efforts.

Another threat to global supply chains for renewable energy technologies is that the ongoing geopolitical competition between the United States and China could easily escalate into economic warfare, as was the case with the U.S.-China trade war witnessed in 2019–20. This scenario becomes even more significant in light of the fact that most countries' net-zero ambitions are premised on enhancing the share of renewable and clean energy in their total energy mix. Such a commitment would translate into a steep demand for renewable energy technologies. This would in turn put great pressure on the existing supply chains, which, as noted above, are already constrained by the pressures of the pandemic. Any shortfall in the production or supplies of these inputs could reduce the accessibility and affordability of clean energy technologies, jeopardizing global climate change mitigation efforts.

The way forward will rely extensively on the pace at which countries are able to strengthen their domestic manufacturing base and supply chain resilience for renewable energy technologies through enhanced diversification. Countries also must explore innovative alternatives to the existing technological bases. Green hydrogen, nuclear energy in the form of advanced reactor design, hydrogen compressed natural gas, and other emerging technological options may also become increasingly viable in the near future, adding another dimension to the clean energy transition for countries around the world.

Niharika Tagotra is a Clean EDGE Asia Fellow at the National Bureau of Asian Research. She is a nuclear physicist and currently a doctoral candidate in international politics in the School of International Studies at Jawaharlal Nehru University in New Delhi. She is concurrently working as a senior research specialist for the World Resources Institute in India.

Endnotes

1 Intergovernmental Panel on Climate Change, *Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change*, ed. Ottmar Edenhofer et al. (Cambridge: Cambridge University Press, 2012).

2 REN21, *The First Decade: 2004–2014* (Paris: REN21, 2014).

3 3 REN21, *Renewables 2019: Global Status Report* (Paris: REN21, 2019).

4 "China's 2018 Renewable Power Capacity Up 12 Percent on Year," Reuters, January 28, 2019, https://www.reuters.com/article/us-china-renewables/chinas-2018-renewable-power-capacity-up-12-percent-on-year-idUSKCN1PM0HM; and Press Information Bureau (India), "Year End Review 2018-MNRE," December 10, 2018, https://pib.gov.in/pressreleaseshare.aspx?prid=1555373.

5 Damien Giurco et al., "Requirements for Minerals and Metals for 100% Renewable Scenarios," in *Achieving the Paris Climate Agreement Goals*, ed. Sven Teske (Cham: Springer, 2019), 437–57.

6 Giurco et al., "Requirements for Minerals and Metals for 100% Renewable Scenarios."

7 Chile, Argentina, and Bolivia form what is known as the "lithium triangle."

8 Robert Rapier, "Why China Is Dominating Lithium-Ion Battery Production," *Forbes*, August 4, 2019, https://www.forbes.com/sites/rrapier/2019/08/04/why-china-is-dominating-lithium-ion-battery-production/?sh=6ae8b3d93786.

9 "Cobalt Mining in the Democratic Republic of Congo," Cobalt Institute, https://www.cobaltinstitute.org/cobalt-mining-in-the-democratic-republic-of-congo.

10 Vladimir Basov, "Global Graphite Production Up in 2021 as China Cements Its Top Producer Status," Kitco News, February 8, 2022, https://www.kitco.com/news/2022-02-08/Global-graphite-production-up-in-2021-as-China-cements-its-top-producer-status.html.

11 Shebonti Ray Dadwal, "China's Continuing Rare Earth Dominance," Manohar Parrikar Institute for Defence Studies and Analyses, September 27, 2019, https://idsa.in/idsacomments/china-continuing-rare-earth-dominance-shebonti-270919.

12 "U.S. Dependence on China's Rare Earth: Trade War Vulnerability," Reuters, June 28, 2019, https://www.reuters.com/article/us-usa-trade-china-rareearth-explainer/u-s-dependence-on-chinas-rare-earth-trade-war-vulnerability-idUSKCN1TS3AQ.

13 Pui-Kwan Tse, "China's Rare-Earth Industry," U.S. Geological Survey, Report, 2011.

14 "Major Countries in Rare Earth Mine Production Worldwide 2020," Statista, https://www.statista.com/statistics/268011/top-countries-in-rare-earth-mine-production.

15 Sun Yu and Demetri Sevastopulo, "China Targets Rare Earth Export Curbs to Hobble U.S. Defence Industry," *Financial Times*, February 16, 2021, https://www.ft.com/content/d3ed83f4-19bc-4d16-b510-415749c032c1.

16 Christian Shepherd, "China Pours Money into Green Belt and Road Projects," *Financial Times*, January 26, 2021, https://www.ft.com/content/8ec30baf-69e9-4d73-aa25-13668dcb659f.

17 Kenneth Rapoza, "How China's Solar Industry Is Set Up to Be the New Green OPEC," *Forbes*, March 14, 2021, https://www.forbes.com/sites/kenrapoza/2021/03/14/how-chinas-solar-industry-is-set-up-to-be-the-new-green-opec/?sh=3d4530f1446d.

18 U.S. Department of Energy, *Critical Minerals Rare Earths Supply Chain: A Situational White Paper* (Washington, D.C., April 2020), https://www.energy.gov/sites/prod/files/2020/04/f73/Critical%20Materials%20Supply%20Chain%20White%20Paper%20April%202020.pdf.

19 "India to Acquire Lithium, Cobalt Mines in South America, Australia," *Hindu*, January 4, 2022, https://www.thehindubusinessline.com/news/india-to-acquire-lithium-cobalt-mines-in-south-america-australia/article38105753.ece.

20 "Duty on Solar Modules, Cells to Continue; Don't Want Imports: R K Singh," Press Trust of India, June 10, 2022, available at https://www.business-standard.com/article/economy-policy/duty-on-solar-modules-cells-to-continue-don-t-want-imports-r-k-singh-122061000307_1.html.

21 International Energy Agency, "Net Zero by 2050," May 2021, https://iea.blob.core.windows.net/assets/4719e321-6d3d-41a2-bd6b-461ad2f850a8/NetZeroby2050-ARoadmapfortheGlobalEnergySector.pdf.

Page 1: Pixabay. Page 3: U.S. Government. Page 5: Pixabay.

NBR

THE NATIONAL BUREAU *of* ASIAN RESEARCH

1414 NE 42ND STREET, SUITE 300
SEATTLE, WA 98105 • 206-632-7370

1819 L STREET NW, NINTH FLOOR
WASHINGTON, D.C. 20036 • 202-347-9767

WWW.NBR.ORG @NBRNEWS