Geoeconomics of Clean Energy: Trade Conflicts, Strategic Rivalries, and the Fragmentation of Global Decarbonization Pathways

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Abstract

This article examines how geopolitical rivalries and trade disputes are reshaping the global renewable energy landscape and influencing the deployment of decarbonization technologies. With countries increasingly reliant on critical minerals and clean technologies, the transition away from fossil fuels is no longer just an environmental imperative but a strategic geopolitical shift. The U.S.-China-EU power dynamic has led to both innovation and fragmentation in green technology supply chains, with protectionist policies raising costs and limiting access especially in the Global South. Regional case studies of China, the European Union, Africa, and Saudi Arabia highlight varying opportunities and vulnerabilities shaped by trade barriers, energy security concerns, and shifting alliances. While competition has driven down costs and spurred technological advances, it also threatens to create a divided global energy transition. The article concludes with key policy recommendations: fostering international cooperation, easing trade barriers, promoting technology transfers, and ensuring sustainable and equitable access to critical resources. Achieving a successful, inclusive net-zero transition will require balancing national interests with global climate goals through diplomacy, equity, and innovation.

Introduction

Renewable energy and decarbonization technologies are central to combating climate change, with renewables like solar and wind contributing 29% of global electricity in 2022, projected to reach 35% by 2025 (IEA, 2023). Investments in renewables hit $623 billion in 2023, reflecting their economic and environmental importance (Bloomberg NEF, 2024). Decarbonization technologies, such as green hydrogen and carbon capture, are vital for net-zero targets, with green hydrogen potentially meeting 10% of global energy demand by 2050 (IRENA, 2022). However, trade disputes, like U.S.-China tariffs on solar panels, and geopolitical rivalries among the U.S., EU, and China disrupt supply chains and technology diffusion (Lewis, 2019). This article explores how these tensions shape renewable energy industries and decarbonization efforts, analysing geopolitical contexts, trade impacts, rivalry's role, regional case studies, and policy implications.

1. Geopolitical Context of Renewable Energy and Decarbonization

The transition from fossil fuels to renewable energy constitutes not merely an energy shift but a reconfiguration of global power dynamics. Countries are now competing for dominance over essential minerals such as lithium, cobalt, and rare earth elements, rather than relying on oil and gas. These are essential for the production of solar panels, wind turbines, and batteries.

The IEA (2023) forecasts that the demand for these minerals would treble by 2040 under existing policy, emphasising their strategic significance. In 2023, investments in renewable energy reached $623 billion, primarily due to the surge in solar and wind energy (Bloomberg NEF, 2024).This transition introduces a novel power dynamic "geoeconomics," wherein nations seek autonomy by managing technology, and "geopolitics," through which influence is exerted via commerce and innovation. An exemplary instance? China. It commands solar industry, with more than 80% of the global capacity. This reallocates influence from resource-abundant nations to technologically advanced ones (Wood Mackenzie, 2023). However, it also engenders weaknesses. Disruptions in supply chains adversely affect energy security, underscoring the significance of comprehending global energy politics.

2. Trade Disputes and the Impact on Renewable Energy Sectors

Trade disputes substantially hinder renewable energy sectors by escalating expenses and delaying initiatives. The U.S.-China trade conflict exemplifies this, as U.S. tariffs reaching 50% on Chinese solar imports in 2024 increase installation expenses and encourage panel stockpiling (Carnegie Endowment, 2025). China's dominance of 80% of the global solar panel components industry, encompassing polysilicon and wafers, leads to supply chain vulnerabilities, since trade barriers or export restrictions on rare earths might destabilise global markets (Wood Mackenzie, 2023; Reuters, 2021). Environmental policies reduce these effects; the U.S. Inflation Reduction Act (IRA) of 2022 promotes domestic manufacturing, thus reducing dependence on imports (White House, 2022), whereas the EU's Carbon Border Adjustment Mechanism (CBAM) promotes cleaner imports but poses potential trade conflicts (European Commission, 2023). Nonetheless, regional trade agreements such as the Regional Comprehensive Economic Partnership may emphasise growth in lieu of sustainability, thereby exacerbating emissions if left unregulated (UNCTAD, 2022). These conflicts aggravate "greenflation," rendering renewable energy less accessible, particularly in developing countries.

3. The Impact of Geopolitical Rivalry on the Development of Renewable Energy

Innovation and fragmentation in the development of renewable energy are both influenced by the

geopolitical rivalry between the United States, the European Union, and China. China's Made in China 2025 initiative is designed to establish itself as a leader in high-tech sectors, including renewables, while the U.S. IRA and EU Green Deal Industrial Plan support domestic sustainable tech (State Council of China, 2015; White House, 2022; European Commission, 2023). This competition has resulted in a reduction in the cost of solar panels, as China's investments have made renewable energy sources more accessible (IRENA, 2022). Nevertheless, protectionist policies, such as the United States' restrictions on Chinese technology, exacerbate inequalities by restricting the diffusion of technology to developing nations. The European Union's renewable energy target was expedited to 42.5% by 2030 as a result of the Russia-Ukraine conflict, which decreased its dependence on Russian gas (European Commission, 2023). Global energy markets are transformed by strategic alliances, such as Saudi Arabia's renewable partnerships with China (Carnegie Endowment, 2025). Although rivalry encourages innovation, it poses a risk of fragmenting supply chains and impeding global decarbonisation initiatives.

4. Regional Case Studies: A Wide Range of Effects

China: Dominance and Dependence

Wood Mackenzie (2023) notes that tariffs imposed by the United States and the European Union are impeding China's export markets, despite the fact that it manufactures over 80% of the world's solar panels. The vulnerabilities in Xinjiang, a critical polysilicon centre, are further exacerbated by potential sanctions and geopolitical risks (IEA, 2022). The Belt and Road Initiative (BRI) prioritises renewable initiatives, with solar, wind, and hydro comprising 55% of energy investments in 2023. Nevertheless, it has the potential to create economic dependency in associate countries (Climate Change News, 2023). Cost reductions are the responsibility of China's leadership; however, it must also address trade and geopolitical challenges (Tang et al., 2015).

The European Union: A Crisis-Induced Accelerated Transition

The European Union's response to the Russia-Ukraine conflict is a 42.5% renewable energy target by 2030, which is motivated by the necessity of replacing Russian gas (European Commission, 2023). The Green Deal Industrial Plan advocates for the advancement of indigenous renewable technology by opposing U.S. IRA incentives. Nevertheless, the European Commission (2023) has identified supply chain hazards associated with the dependence on Chinese solar panels. The EU maintains a balance between energy security and climate objectives, despite the persistence of regional disparities in infrastructure.

The opportunities and challenges of Africa

30% of the world's critical mineral reserves, which are essential for renewable energy, are located in Africa. Nevertheless, the U.S.-China rivalry is the cause of the region's severe lack of infrastructure and technology access (IMF, 2024). Despite the fact that countries like the Democratic Republic of Congo leverage mineral agreements, the adoption of green technology is impeded by trade disputes (SAIIA, 2023). Geopolitical neutrality may yield more advantageous terms; nevertheless, sustainable development necessitates investments in local processing activities.

Saudi Arabia: Diversification Through Renewables

Saudi Arabia's Vision 2030 targets 50% renewable energy by 2030, with Chinese partnerships driving projects like the Sudair Solar PV plant (Vision 2030, 2016; ACWA Power, 2021). These ties shift geopolitical alignments, challenging U.S. influence. Trade disputes could disrupt technology imports, but Saudi Arabia's strategic pivot enhances its role in the global energy transition.

5. Implications for Global Decarbonization and Policy Recommendations

Trade disputes and geopolitical rivalry pose significant challenges to decarbonization by increasing costs and limiting technology access, particularly for developing nations. Protectionism fragments supply chains, while mineral dependencies create vulnerabilities. However, competition drives innovation, as seen in cost reductions from Chinese solar production (IRENA, 2022). To address these issues, the following policies are recommended:

- Enhance Multilateral Trade Agreements: Reduce tariffs on clean technologies to improve access, fostering global collaboration (UNCTAD, 2022).
- Promote Technology Transfers: Encourage licensing and joint ventures to bridge technology gaps in developing nations (IRENA, 2022).
- Establish Critical Mineral Alliances: Create international frameworks for stable, sustainable mineral supply chains (IEA, 2023).
- Support Local Manufacturing: Incentivize clean tech production in mineral-rich regions to boost economic resilience (IMF, 2024).
- Enforce Sustainability Standards: Implement responsible mining practices to minimize environmental and social impacts (UNEP, 2024).

The future of decarbonization hinges on balancing national interests with global climate goals through diplomacy and equitable policies, ensuring an inclusive energy transition.

Conclusion

This article has illuminated the intricate ways in which trade disputes and geopolitical rivalries shape the trajectory of renewable energy industries and decarbonization technologies globally. Trade disputes, such as the U.S. tariffs of up to 50% on Chinese solar imports in 2024, have disrupted supply chains, escalated costs, and delayed renewable energy projects, contributing to "greenflation" that disproportionately affects developing nations (Carnegie Endowment,

2025). Simultaneously, geopolitical rivalries among major powers the U.S., EU, and China have driven significant innovation, as evidenced by the rapid decline in solar panel prices due to China's manufacturing scale, which produces over 80% of global panels (Wood Mackenzie, 2023). Yet, these rivalries also foster protectionist policies, such as U.S. restrictions on Chinese clean technology, limiting technology diffusion to regions like Africa, where access to green tech remains constrained despite abundant mineral resources (IMF, 2024). Regional case studies further highlight this complexity: China's solar dominance is tempered by trade barriers and geopolitical risks in Xinjiang, the EU accelerates its 42.5% renewable energy target by 2030 in response to the Russia-Ukraine conflict, Africa navigates opportunities and challenges in leveraging its 30% share of global critical minerals, and Saudi Arabia strategically diversifies through Chinese partnerships under Vision 2030 (European Commission, 2023; SAIIA, 2023; Vision 2030, 2016). These findings underscore the dual role of trade and geopolitics as both catalysts for progress and barriers to equitable decarbonization.

The significance of these dynamics is profound in the global fight against climate change. Renewable energy and decarbonization technologies are indispensable for achieving the Paris Agreement's goal of limiting global warming to 1.5°C. The International Energy Agency's Net Zero by 2050 scenario projects that renewables must supply over 60% of global electricity by 2030, a target that demands unprecedented deployment of clean energy technologies (IEA, 2022). However, trade disputes and geopolitical tensions threaten to derail this progress by increasing costs, fragmenting supply chains, and perpetuating inequalities in technology access. Failure to address these challenges risks delaying the global energy transition, exacerbating climate impacts, and undermining sustainable development goals, particularly in vulnerable regions where energy poverty remains a pressing issue.

The interplay between trade policies, geopolitical strategies, and clean energy development presents both challenges and opportunities. On one hand, geopolitical competition has lowered costs and accelerated technological advancements, making renewables more accessible in some markets. For instance, China's investments have reduced solar panel costs by 80% over the past decade, benefiting global adoption (IRENA, 2022). On the other hand, protectionism and resource nationalism can create a fragmented energy landscape, where wealthier nations advance rapidly while others lag, deepening global disparities. This fragmentation could lead to a two-tiered energy system, where developed nations achieve net-zero targets while developing countries remain reliant on fossil fuels, perpetuating environmental and economic inequities. The qualitative analysis in this article highlights the need for a balanced approach that harnesses the benefits of competition while mitigating its divisive impacts.

To navigate these complexities, policymakers must prioritize international cooperation and equitable access to clean energy technologies. Reducing trade barriers, such as tariffs on environmental goods, can enhance affordability and accelerate deployment, particularly in low-income countries. Multilateral frameworks, inspired by initiatives like the World Trade Organization's negotiations on environmental goods, could facilitate the free flow of renewable technologies, building on the Asia-Pacific Economic Cooperation's commitment to reduce tariffs on 54 environmental products (World Trade Organization). Promoting technology transfers through licensing agreements and joint ventures can bridge the gap for developing nations, enabling them to build local capacity and participate in the global energy transition. Additionally, establishing international alliances for critical minerals, as suggested by the IEA, can ensure stable and sustainable supply chains, reducing dependency on single nations and mitigating geopolitical risks (IEA, 2023). Investing in research to diversify supply chains and develop alternative materials can further enhance resilience. Finally, enforcing sustainability standards in mining and manufacturing, as advocated by the United Nations Environment Programme, is essential to minimize environmental and social harms, ensuring that the energy transition aligns with broader sustainability goals (UNEP, 2024).

Looking forward, the global energy transition is as much a geopolitical endeavour as it is a technological one. While trade disputes and geopolitical rivalries pose significant hurdles, they also offer opportunities for strategic partnerships and innovation. By fostering collaboration, promoting equitable access, and implementing sustainable practices, the global community can overcome these challenges and achieve a successful, inclusive transition to a low-carbon future. Policymakers, researchers, and stakeholders must work together to address the geopolitical dimensions alongside technological advancements, ensuring that the benefits of renewable energy and decarbonization are realized worldwide. The path to net-zero emissions demands not only innovation but also diplomacy, equity, and a shared commitment to a sustainable planet.