
CHOKEPOINTS OF THE ENERGY TRANSITION: US-CHINA WEAPONIZED INTERDEPENDENCE IN CRITICAL MINERALS AND ITS IMPLICATIONS FOR GLOBAL CLIMATE GOVERNANCE

Rare earth minerals (2023 to onwards), American tariffs, export controls and "prohibited foreign entity" rules for clean-energy tax credits (2022–2026). Qualitative process used for tracing and document analysis, the article identifies three mechanisms through which economic pressure influences climate related decisions.

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ABSTRACT

Contemporary clean energy transition has created a new forms of economic dependence for countries. Solar Panels, lithium-ion batteries, wind turbines and electric vehicles need important minerals, whose refining is highly concentrated in China. This article examine how the United States and China are weaponizing the clean-energy cooperation and outcomes in global climate governance, for their political and economic gains and how this competition is affecting in cooperation and outcomes in global climate governance. This article utilize two theories , Newman's theory of weaponized interdependence and Keohane and Victor's concept of the climate regime complex. This article traces the Chinese's export restriction on gallium, germanium etc ,as a case through which to investigate the strategic use of supply-chain dependence . The United States and China are increasingly competing to control clean-energy technologies. Moreover, this competition divides the world into rival economic and technological groups , also weakens their cooperation on climate change.

including the partnership that helped support the Paris Agreement. It argues that weaponized interdependence turns the energy transition from a global public good into an object of strategic competition. Developing nations are paying more cost, as they were highly depended on low cost Chinese clean-energy technologies, if these Chinese products become expensive developing countries will suffer most to means their climate goals.

KEYWORDS:

Weaponized Interdependence; US-China Relations; Critical Minerals; Rare Earth Elements; Energy Transition; Climate Governance; Regime Complex; Geoeconomics; Export Controls; Global South

INTRODUCTION

From post-Cold War era, economic interdependence was seen as a stabilizing force in great-power relations. Liberal theories argue that trade and investment ties to raise the cost of conflict and encourage cooperation on shared problems such as climate change (Keohane & Nye, 1977). The US-China cooperation on emissions targets in Paris Agreement in 2016 demonstrated that the two largest emitters could cooperate despite strategic rivalry. (Falkner, 2016).

However these assumptions has been challenged highly. Scholars now, realize that interdependence creates asymmetries that states can exploit for their personal gain. Farrell and Newman (2019) describe "weaponized interdependence" which means, "ability of states controlling central positions in global economic networks" to use these connections for strategic advantage, including coercion and restricting access.

This literature mainly focuses on finance, the digital networks and semiconductors. Although previously researchers have paid much less attention to the supply chains of clean energy, even though these supply chains have become a major area of competition between the United States and China. China dominates at large in area of processing of many critical minerals essential to clean-energy technologies. The International Energy Agency (IEA, 2025) identifies China as the leading refiner for 19 of 20 strategic minerals, with an average market share of approximately 70 percent. Since 2023, China is controlling the most exports of rare earth minerals, shows chinas high stakes and US's biggest competitor. Meanwhile, the United States has imposed tariffs on Chinese electric vehicles, solar cells, and batteries and introduced restrictions affecting Chinese-linked entities in clean-energy tax credits through the One Big Beautiful Bill Act of July 2025. Furthermore US withdrawal from Paris Agreement and its announced intention to leave the UN Framework Convention on Climate Change

(UNFCCC) further complicate international climate cooperation (Harvard EELP, 2026). These occurring developments raise a question that “How does the weaponization of clean-energy supply chains by the United States and China affect cooperation and outcomes in global climate governance? This article argues that, weaponized interdependence is turning clean-energy supply chains into instruments of strategic competition, which is potentially undermining the energy transition as a global public good. It examines three mechanisms, first, increasing the costs and uncertainty of decarbonization; second, fragmenting clean-energy technology governance into rival blocs, and third, is weakening bilateral cooperation that supports multilateral climate diplomacy. These developments also raise concerns about climate justice. Many Global South countries depend on affordable clean-energy technologies while facing financial constraints and substantial climate adaptation and mitigation needs. Higher technology costs and supply disruptions may delay their climate targets, deepen existing inequalities, and limit their participation in the energy transition. Thus, geopolitical competition may shift the costs of decarbonization towards countries that have contributed comparatively little to historical greenhouse gas emissions. The article makes two contributions. Theoretically, it extends weaponized interdependence to physical commodity chokepoints in clean-energy supply chains. Empirically, it examines how US-China geoeconomic competition affects the climate regime complex and climate justice in the Global South.

THEORETICAL FRAMEWORK

WEAPONIZED INTERDEPENDENCE MEETS THE CLIMATE REGIME COMPLEX

From interdependence to weaponized interdependence

This concept is not new; the trade has been normalized as a tool of power. Small states depend on the larger partner’s market (Hirschman, 1945). Keohane and Nye explain the two layers of dependence. Sensitivity: how quickly and how much a country is affected by changes abroad. Vulnerability: how much it costs to adjust, such as to find a new supplier or substitute. Both writers argue that asymmetric interdependence can be the source of power and this is close to the idea of weaponized interdependence.

Farrell and Newman (2019) argue that globalization produces centralized network rather than decentralized markets. They introduced a hub and spoke structure in which some countries get central attention. A hub is only a weapon if a government can legally control it and exercise two forms of

power. Panopticon effect: the state can watch what flows through the hub. Chokepoint effect: A single state can block others using a hub. They later extended their work to American economic statecraft. (Farrel & Newman, 2023), and an edited volume tests the concept across sectors (Drezner, Farrell, & Newman, 2021).

The framework was built around networks controlled by the United States, such as SWIFT and the dollar clearing system. Clean-energy supply chains reverse this picture. Here China controls the central nodes, particularly the midstream stages of refining, processing and component manufacturing. This makes the energy transition an important test case: it shows weaponized interdependence operating in physical commodity networks, with the United States as the vulnerable party in some segments and the coercer in others.

Limits of Commodity Coercion

However, some scholars disagree with this strong argument, citing the China-Japan example. In September 2010, a Chinese fishing trawler collided with Japanese Coast Guard vessels near Senkaku Island. These islands are administered by Japan but claimed by China, so any incident there is politically charged. Japan arrested the captain and planned to hold the trial under Japanese law. China treated this as a challenge to its sovereignty claim. China applied an embargo on Japan, and Japan adopted other ways, like smuggling, using substitute minerals, and finding new suppliers. China was unable to create a proper chokepoint effect, as the prices of products made by Japan shot up and some of China's market share dropped. So its strategic effect was short-lived. But when we look at the IEA data, it says that, despite this, in 2020 the world decided to reduce its dependence on China, but according to 2024 reports, the dependence on China has increased much more than in 2020. That supports the claim that today's chokepoints are more durable than in 2010.

The Climate Regime Complex

When it comes to climate change, Keohane and Victor (2011) argue that there is no single global system; instead, there is a 'regime complex', a loose mix of many different organizations that are not tightly connected. These include the UN climate body (UNFCCC), international development banks, technology partnerships, trade agreements, and smaller groups of countries working together. The Paris Agreement accepted this structure. Instead of setting targets for countries from the top, it lets each country set its own target. It also relies on a "catalytic" approach: the hope is that as clean technology becomes cheaper, countries will find it easier to act and will choose to raise their targets over time on their own (Falkner, 2016; Hale, 2016).

The Paris Agreement quietly depended on two things: clean technology getting cheaper through world trade, and the biggest emitters working together. Meckling and Hughes (2017) show that cheap solar came from global supply chains. Allan, Lewis and Oatley (2021) argue that countries now see clean energy less as a cost to share and more as a prize to win, using subsidies to build their own industries. Weaponized interdependence goes even further: countries now use supply chains as weapons to pressure each other.

Analytical Framework

Combining these literature, the article treats clean-energy supply chains as a network with identifiable chokepoints, and the climate regime complex as the arena in which their weaponization has effects. It proposes that weaponization affects climate governance through three mechanisms, illustrated in Figure 1:

Cost Mechanism: Export controls, tariffs and sourcing rules raise the price and uncertainty of clean technology, slowing deployment and weakening the economic logic of the Paris ratchet.

Fragmentation Mechanism: Countries follow different rules, and they form their separate partnerships for minerals and clean energy. This mechanism divides them into competing groups and makes cooperation on climate change more difficult.

Trust Mechanism: Securitization of clean technology erodes the bilateral US-China partnership that historically unlocked multilateral agreement, leaving the regime without its two anchor states acting together.

RESEARCH DESIGN AND METHODOLOGY

This research utilizes a qualitative and theoretical case study design. The unit of analysis in this research is the clean-energy supply chain relationship between the United States and China since 2022. This period covers the introduction of the US Inflation Reduction Act in August 2022, China's first restrictions on energy-related mineral exports in 2023, rising tensions in 2025, and the temporary agreement reached in Busan and what happened afterward. The article uses a step-by-step analysis to understand how specific actions by the US and China affect global climate cooperation (Beach & Pedersen, 2019). For each mechanism shown in Figure 1, it looks for evidence of its effects, such as changes in prices and supply, rules that exclude certain countries or suppliers, or the suspension of climate talks between the two countries. This research utilizes three type of resources. Primary Data announcements of

China's Ministry of Commerce (MOFCOM), US Trade Representative Section 301 determinations, the One Big Beautiful Bill Act (Public Law 119-21) and Internal Revenue Service guidance, and UNFCCC and Paris Agreement records. Institutional data the IEA *Global Critical Minerals Outlook*, IEA supply-chain reports, and solar trade data. Secondary literature peer-reviewed scholarship on weaponized interdependence, energy geopolitics and climate governance, together with policy analyses from research institutes. The article therefore makes plausibility claims about mechanisms rather than precise estimates of their size.

THE STRUCTURE OF CLEAN-ENERGY INTERDEPENDENCE

China serves as a hub in the clean energy supply chain, operating as a center in a hub-and-spoke network. Minerals are mined in many countries, such as Australia, Chile, the United States and several African countries. But the significant refining process and the making of parts happen in China. China built this position over twenty years through proper government planning, state funding, and large-scale production. (Kalantzakos, 2018).

Table 1. Selected clean-energy chokepoints and China's position

Input	Clean-energy use	China's position	Source
Rare earth refining	Permanent magnets in EV motors and wind turbines	About 90% of refining (2024); about 69% of mining (2025)	IEA (2025); GlobalData via EBC (2026)
Graphite processing	Battery anodes	Over 90% of processed output	IEA (2025)
Lithium refining	Battery cathodes and electrolytes	Around 60% of refining	IEA (2025)
Solar PV manufacturing	Polysilicon, wafers, cells, modules	Over 80% across all main stages	IEA (2022)
Gallium and germanium	Power electronics, semiconductors, solar	Dominant global producer; controlled since 2023	MOFCOM (2023)

This concentration has deepened rather than eased. Between 2020 and 2024, the average market share of the top three refiners of key energy minerals rose from 82 to 86 per cent, and the IEA projects only a marginal decline by 2035 (IEA, 2025). Even its optimistic scenarios see China's share of rare earth

refining fall only modestly over the next decade. In short, the chokepoints of the energy transition are structural, not temporary.

Even though China controls refining, the US is not hopeless. Each side depends on the other in some way. The United States controls three hubs: advanced semiconductors and chip-making tools, the dollar-based financial system, and access to consumer markets. China makes more solar panels, batteries, and EVs than it can use at home. So, it needs to sell abroad. If other countries close their markets, Chinese factories lose customers. This is China's weak point. Ember data shows that in 2024, China exported a record 242 GW of solar panels, and its exports to developing countries more than doubled between 2022 and 2024 (Carbon Brief, 2025). In short, each country depends on others in some way; each can put pressure on the other. This is how they can both use trade as a weapon.

A third group of actors sits on the spokes of this network: developing countries. Pakistan illustrates their position. In 2024, it imports 17 GW of solar panels, nearly all from China, overnight making it one of the largest solar markets in the world.(Ember, 2025). Such countries benefit from cheap Chinese clean technology but have little ability to influence the rules governing its trade. They are therefore exposed to collateral damage when the two hubs weaponize the network.

US-CHINA'S GROWING ROLE IN CRITICAL-MINERAL PROCESSING 2022–2026

China's Transition to a Structured Mineral Export Licensing System

China's first ever use of mineral leverage came in 2010, when the rare earth shipments to Japan were halted during a maritime dispute (Gholz & Hughes, 2021). That episode was limited in scope and short-lived.(2025). Since 2023, China has used its 2021 Export Control Law to regulate minerals exports. The law requires licences for certain exports and allows the government to monitor and enforce export rules (FDD, 2025).

These measures have escalated step by step. In 2023, MOFCOM placed gallium and germanium (August) and then graphite (December) under export licensing process . In December 2024,in response to new US semiconductor controls, China banned exports of gallium, germanium and antimony to the United States. In April 2025, in responding to US tariff increases, it imposed case-by-case licensing on seven medium and heavy rare earth minerals. This forced some automakers abroad to limit or pause production (IEA, 2026, as reported by Anadolu Agency). Then most ambitious step came on 9 October 2025.The new rules would have required licences for foreign-made products containing more than 0.1%

Chinese rare earth materials and expanded controls to processing technology, lithium batteries, and graphite used in batteries. (FDD, 2025)

The licensing system also produces a panopticon effect in Farrell and Newman's sense. Applicants must disclose end users and end uses, giving Chinese authorities detailed information on foreign Project Blue, 2025). This reflects the extraterritorial logic of US export controls. After Busan summit of 30 October 2025, China suspended October package for one year, until 10 November 2026, In return, the United States agreed to pause its rule that imposed or extended restrictions to companies at least 50% owned by firms on its restricted list.(Bernama/Anadolu, 2025). The April 2025 controls remained in force.manufacturing and defence supply chains. Post-Busan data suggest licensing is used selectively: Global Trade Alert (2026) finds that China's rare earth magnet exports rose overall after the truce, but that supply was distributed unevenly among trading partners, with comparatively less flowing to the United States.

The United States: Tariffs, Sourcing Rules and De-Risking

Washington's weaponization takes a different form In May 2024, following a Section 301 review, the lithium-ion EV batteries to 25 per cent (USTR, 2024). The Inflation Reduction Act's EV credit had already excluded batteries containing components or minerals from a "foreign entity of concern".

United States raised tariffs on Chinese electric vehicles to 100 per cent, solar cells to 50 per cent and The One Big Beautiful Bill Act, signed on 4 July 2025, went much further. It phased down many IRA clean-energy credits while extending "prohibited foreign entity" restrictions to the main remaining ones, including the clean electricity credits (sections 45Y and 48E) and the advanced manufacturing credit (section 45X). Projects lose eligibility if they receive "material assistance" above set thresholds from entities owned, controlled or influenced by China and other covered nations (Steptoe, 2025). The IRS issued implementing guidance in Notice 2026-15 in February 2026. In effect, US climate subsidies are now conditional on decoupling from Chinese supply chains.

These measures lie within a broader tariff war. During 2025, successive rounds of tariffs pushed the average US duty on Chinese goods to around 57 per cent before the Busan truce reduced it to roughly 47 per cent (Bernama/Anadolu, 2025). Alongside defensive measures, Washington has also pursued supply-side de-risking, including government financing and equity support for domestic rare earth producers.

Table 2. Key weaponization measures in clean-energy supply chains, 2023–2026

Date	Actor	Measure	Target
Aug 2023	China	Export licensing for gallium and germanium	Semiconductors, solar, defence
Dec 2023	China	Export licensing for graphite	Battery anodes
May 2024	US	Section 301 tariff increases on EVs, solar cells, batteries	Chinese clean-tech exports
Dec 2024	China	Ban on gallium, germanium, antimony exports to US	US semiconductor and defence supply
Apr 2025	China	Licensing for seven heavy rare earths and magnets	Global automotive and defence
Jul 2025	US	One Big Beautiful Bill Act prohibited foreign entity rules	Chinese inputs in US clean energy
Oct 2025	China	Extraterritorial rare earth, battery, graphite regime	Global manufacturers (suspended Nov 2025)
Oct 2025	US/China	Busan truce: one-year mutual suspensions	Rare earths, entity-list affiliates rule, tariffs
Feb 2026	US	IRS Notice 2026-15 on material assistance	Clean-energy project sourcing

Interpretation

Three features stand out. First, weaponization is reciprocal: each Chinese escalation in 2024–2025 followed a US measure, and vice versa, producing a tit-for-tat spiral. Second, it is increasingly institutionalized: both sides have moved from ad hoc measures to standing legal regimes that can be switched on and off. The Busan truce suspended rather than dismantled these tools, so the threat persists. Third, the clean-energy sector is collateral as well as target. Many controls were aimed at semiconductors or defence, yet they hit the same minerals that solar panels, batteries and wind turbines require. The energy transition has become entangled in a security competition that was not

designed with climate outcomes in mind.

IMPLICATIONS FOR GLOBAL CLIMATE GOVERNANCE

The Cost Mechanism: A More Expensive and Less Certain Transition

The Paris Agreement depends on clean technology getting cheaper, so countries can achieve and update their targets. Trade conflict works against this in two ways. Firstly, it directly raises prices: tariffs and sourcing rules make clean technology more expensive in protected markets, and export controls threaten suppliers elsewhere. The IEA estimates that if China's October 2025 controls were fully applied, about US\$6.5 trillion of yearly production outside China could be at risk (IEA, 2026).

Second, and more importantly, it creates uncertainty. Minerals make up only about 3 per cent of an electric car's price, so small price increases are not a big problem. But the real problem is the risk of supply stoppages, as happened when China's April 2025 controls affected some car factories. Investors in batteries, magnets, and power grids now have to account for this political risk. This makes borrowing more expensive and slows the building of clean energy, especially for projects that last for decades.

The Fragmentation Mechanism: Rival Blocs within the Regime Complex

Keohane and Victor (2011) thought the loose structure of climate governance was useful as it makes cooperation flexible. But trade conflict is turning this flexibility into division. The United States and its allies have created their own groups, such as the Minerals Security Partnership and the G7 Critical Minerals Action Plan, and US tax credits now refuse support for products linked to China. Meanwhile, China is strengthening its own ties with developing countries through the Belt and Road Initiative and by selling them most of their clean technology.

As a result, two partly separate clean-energy systems are gradually forming; each has its own rules for where to buy materials, its own standards, and its own source of money. But building new refineries outside China is expensive and time-consuming. It also moves decision-making away from the UN climate system, where every country has a voice, towards small groups of countries that care mainly about security, not climate. As a result, fighting climate change may become less important than keeping alliances strong.

The trust mechanism: losing the anchor partnership

US-China cooperation was the hinge of the Paris era. The 2014 joint announcement made Paris possible, and as recently as November 2023 the

two countries issued the Sunnylands Statement on enhancing cooperation to address the climate crisis (US Department of State, 2023). The securitization of clean technology has hollowed out this partnership. When solar panels and batteries are framed as national security threats, joint climate initiatives become politically costly in Washington, and China has less incentive to treat climate as a protected area of cooperation.

Cooperation between the US and China was the key to global climate action. Their joint announcement in 2014 helped make the Paris Agreement possible, and even in November 2023 they signed the Sunnylands Statement to work together on climate change. But now clean technology is being treated as a national security issue, and this has emptied the partnership of real meaning. When solar panels and batteries are described as security threats, working with China on climate becomes politically risky in the US, and China has less reason to keep climate separate from the wider rivalry.

Distributional effects: the Global South on the spokes

The heaviest costs of weaponization fall on countries that control neither hub. Developing countries have driven much of the recent growth in solar adoption, largely by importing cheap Chinese panels. Pakistan's solar boom, which lifted solar to about a quarter of its utility electricity in early 2025, rested almost entirely on Chinese modules (Ember data via Arab News, 2025). These countries face three risks. Chinese export controls on upstream inputs could disrupt the supply of components they rely on. US sourcing rules could make their own exports ineligible for American markets if they use Chinese inputs. And pressure to choose sides could complicate development finance, technology partnerships and access to climate funds.

This distributional dimension matters for climate justice. The Paris framework relies on developing countries raising their ambition, supported by finance and technology transfer. If great-power rivalry raises their transition costs while finance from the United States shrinks, the gap between the pledges developing countries can make and what the 1.5 °C goal requires will widen.

POLICY PATHWAYS: FIREWALLING CLIMATE-CRITICAL TRADE

If US-China relations rivalry continue to affect trade and technology , the policy question is not how to restore the pre-2018 order but how to limit the spillover of rivalry into climate outcomes. There are Five pathways follow from the analysis.

1. Protecting Climate Cooperation in US-China Agreements

The Busan arrangement shows that both sides can pause harmful trade measures when costs become high. In Future agreements, both countries could agree not to restrict core clean-energy inputs and finished products destined for third countries.

2. Inclusive Minerals Clubs

Minerals partnerships should be open to countries who import and produce. Especially in Global South, developing countries should be allowed to join these partnerships. Such partnerships should focus on shared environmental and social standards instead of excluding countries based on where their minerals come from.

3. Storing and Recycling Important Minerals

Countries should store important minerals, such as rare earths, gallium, and graphite, to reduce their dependence on any single supplier. Recycling and material substitution, also find new alternative materials, including magnet designs that use fewer heavy rare earths, reduce the chokepoint effect in the long run.

4. Diversified Midstream Investment in Developing Countries

Countries which are rich in minerals should build their own factories to process and refine these minerals themselves, instead of exporting them in raw form. This would definitely create new jobs, increase local income, and help developing countries to gain more benefits from their natural resources.

5. Hedging Strategies for Spoke States

Countries like Pakistan can reduce dependence on one country by buying materials from diverse supplier. Pakistan should also work with both powers the US and China on specific issues instead of choosing sides between them.

CONCLUSION

This article has examined how the weaponization of clean-energy supply chains by the United States and China is affecting the global climate governance. The analysis has shows that the energy transition relies on a hub-and-spoke network in which China plays a central role in processing and refining, while both powers have used their economic interdependence to advance their strategic interests. China has built a formal export-control regime over critical minerals, while the United States has used tariffs and subsidy conditions to reduce its clean-energy sector reliance on Chinese inputs. The Busan truce of 2025 has suspended the strictest measures but kept the

tools available. The analysis has identified three mechanisms through which this rivalry affects climate governance: first, higher costs and uncertainty for decarbonization, secondly, fragmentation of the regime complex into rival blocs, and last, the erosion of the US-China partnership that once anchored multilateral agreement. These effects fall hardest on developing countries, which depend on Chinese clean technology but have little voice in the rules that govern it.

Theoretically, this article extends weaponized interdependence beyond finance and information networks to physical commodity chokepoints, where China plays a central role rather than the United States. It also shows that the climate regime complex is vulnerable to dynamics originating outside it. The flexibility that Keohane and Victor saw as a strength becomes a weakness when its components can be captured by security competition.

Future research could pursue three directions: quantitative estimates of how export controls and tariffs affect clean-energy deployment costs; comparative studies of how spoke states such as Pakistan, Indonesia or Brazil hedge between the two hubs; and analysis of Russia-China cooperation on critical minerals and energy under Western sanctions, which may create a third pole in this contested network. As the one-year suspension of China's October 2025 controls approaches expiry in November 2026, the question of whether climate-critical trade can be firewalled from great-power rivalry has become one of the most urgent in international political economy.

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