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Clean-energy Supply Chains in the Indo-Pacific:

Prioritizing the Quad's Role

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In recognition of the Indo-Pacific region being vital to the clean-energy transition, the 'Indo-Pacific Clean Energy Supply Chain Forum' was hosted in July 2022 by Australia with support from its Quadrilateral Security Dialogue (Quad) partners. The clean-energy transition is expected to gain momentum in the coming years as regional countries race to meet climate targets and attempt to reduce energy insecurity by ceasing the import of fossil fuels. However, while this acceleration of the green transition is certainly desirable, the present clean-energy supply chains are not stable enough to facilitate the shift. The transition will only move the region's dependency onto China for energy as a consequence of Beijing's current near-monopoly over clean-energy supply chains, making them vulnerable to disruptions and weaponization for foreign policy gains. As such, this paper aims to highlight how the Quad's national drives, bilateral ties, available resources, experience and reach mean that the grouping has a unique opportunity to step up cooperation towards establishing alternative clean-energy supply chains in the Indo-Pacific. These supply chains will contribute to the region's green transition whilst also reducing energy insecurity and re-balancing geo-political power away from China.

Introduction

On July 12-13, 2022, Australia hosted the 'Indo-Pacific Clean Energy Supply Chain Forum' (also known as the 'Sydney Energy Forum') together with the International Energy Agency. The event was announced earlier this year with the support of the Quadrilateral Security Dialogue (Quad), a regional grouping consisting of the United States (US), India, Japan, and Australia, that has consistently signified clean-energy supply chains as an area of focus since the inaugural September 2021 Summit.[1] On the sidelines of the Forum, the Quad Energy Ministers met for the first time, taking an important step towards their shared vision to accelerate the green transition in the Indo-Pacific. Together they now must advance the work of the Quad Climate Working Group, responsible for clean-energy, and set in motion the development of the '10-Year Clean Energy Supply Chain Plan' announced at the May 2022 Quad Summit in Tokyo.[2] While these developments are welcome and necessary, it has taken time to get here, and they are still only preliminary steps in establishing supply chains. It is imperative that this initiative is prioritized, and progress accelerated because the transition to renewable energy is critical to the Indo-Pacific.

The Indo-Pacific region is responsible for 60 percent of the world's greenhouse gas emissions,[3] and is home to some of

the world's most vulnerable countries to climate change. Consequently, the Indo-Pacific's transition to clean-energy is vital to achieve the Paris Agreement's target to limit global warming to 1.5°C, and yet, so far progress has been insufficient. While the drop in the price of renewable energy has made it more accessible, their deployment in Indo-Pacific countries has been generally low. Current objectives will not ensure that global emissions reduce by the required 7 percent each year between 2021 and 2030 to meet the 1.5° C threshold, nor will they be conductive to achieving carbon neutrality in the Indo-Pacific by 2050.[4]

Nevertheless, the shift to clean-energy is gaining impetus. This is largely due to the vulnerability of most regional countries to the effects of climate change, and the necessity to reduce these threats by urgently augmenting national climate targets. Furthermore, the issue of energy security is currently alarming countries all around the world as they are forced to address their dependency on fossil fuels and their unreliable sources. The Russia-Ukraine War has starkly highlighted global reliance on Russian exports and in the Indo-Pacific, the economic impacts, and concerns of energy security are significant.[5] The invasion is expected to stimulate the clean-energy transition[6] as it spurs the world to look at renewable energy as a viable replacement to fossil fuels. Thus, combined with the urgency to meet more ambitious climate targets, there is likely to be a substantial push for green energy worldwide, and especially in the Indo-Pacific.

Yet, while an accelerated green transition is certainly desirable, the present clean-energy supply chains are not stable enough to facilitate the shift. In the current state, moving to clean-energy will not eliminate energy insecurity but rather just shift dependency onto China,[7] as China has a near-monopoly over the supply chains of renewable energies and is expected to continue to dominate in the coming years, making up 43 percent of global renewable capacity growth.[8] The Quad has acknowledged the geopolitical importance that supply chains hold and shares concerns over depending on China for the green transition. As the need to meet climate targets and secure energy supplies simultaneously heighten, the Quad could provide a welcome solution by endeavoring to create these alternative supply chains and re-balance geo-political power away from China. These clean-energy supply chains would increase resilience and more capably handle the urgency of the green transition that is predicted in the Indo-Pacific.

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Clean-energy Transition in the Indo-Pacific

Countries in the Indo-Pacific increasingly fear the threat to national security and regional stability that climate change presents. The Intergovernmental Panel on Climate Change identifies the Indo-Pacific as particularly vulnerable both geographically, in terms of weather hazards and rising sea levels, but also socially because of the development deficit in many areas.[9] Already the effects of climate change are manifesting themselves more frequently and will undeniably only intensify in the years ahead. The International Federation of Red Cross recorded 26 new operations in 2021 to deal with climate-related disasters in the region, affecting 57 million people.[10] The impacts of natural disasters and extreme weather conditions in the Indo-Pacific will cause destruction to human life and infrastructure. It will not only threaten food security and access to essential resources, but will generate millions of climate refugees, which has the potential to exacerbate national and ethnic tensions. Densely populated countries such as India, Pakistan and the Philippines are especially vulnerable to displacement and large-scale migration.

Figure 1 shows the major perceived threats to 20 Indo-Pacific countries in relation to climate change identified by the World Economic Forum. The most severe are recognized as the spread of infectious diseases, debt crises in large economies, employment and livelihood crises, human-made environmental damage, extreme weather events, failure of cyber-security measures, prolonged economic stagnation, asset bubble burst in large economies and the geopoliticization of economic resources.[11] The Indo-Pacific

is home to both smaller, less developed states vulnerable to climate disasters and large economies where the fallout will damage global markets. As such, it is a region poised to feel the extremities of what climate change will bring.

Figure 1[12]: Perceived climate change threats in Indo-Pacific

Risk	Number of countries that perceive it as a Top 5 national risk (20 Indo-Pacific countries)
Extreme weather events	9
Climate action failure	5
Infectious diseases	12
Debt crises in large economies	10
Failure of cyber-security measures	8
Employment and livelihood crises	10
Prolonged economic stagnation	8
Human-made environmental damage	10
Asset bubble burst in large economies	8
Geopoliticization of strategic resources	7
Digital inequality	6
Fracture of interstate relations	1
Adverse outcomes of technological advances	1
Biodiversity loss and ecosystem collapse	3
Collapse or lack of social security systems	1
Widespread youth disillusionment	1
Failure of technology governance	1
Interstate conflict	1
Failure to stabilize price trajectories	2
Breakdown of critical information infrastructure	1
Failure of public infrastructure	1

> ***Many countries are being forced to address their dependency on fossil fuels and their unreliable sources. The issue of energy security combined with climate targets is likely to lead to substantial push for green energy worldwide, and especially in the Indo-Pacific.***

Despite the pressing threat to the survival of many regional countries, the Indo-Pacific has not been at the forefront of the green transition thus far since fossil fuels still dominate. In fact, it comprises of the Top 5 major coal producers globally.[13] The indexes shown in Figure 2 reveal that advanced economies (principally wealthy European states) are, for the most part, leading the transition and therefore, that most Indo-Pacific countries are not performing so strongly. The low take-up of green energy initiatives is generally reflective of countries' overall wealth and capital constraints, along with a responsibility to satisfy the growing demand for energy. Many Asian countries are experiencing high demands for energy due to their population growth and the rise of the middle class which requires development and modernization.[14] Interestingly though, the International Renewable Energy Agency has found that a combination of increasing renewable energy and improving energy efficiency will be sufficient to meet energy demands, even with population and economic growth.[15] The Indo-Pacific is slowly transitioning to green energy, although the pace is varied across countries. It is clear that the national government's determination to prioritize decarbonization is an influential factor.

Figure 2: Status of green transition

Country	Nationally Determined Contributions (NDCs)[16] (newest version)	Climate Change Performance Index[17](2022)*	Renewable Energy Rating[18] (2022)	Energy Transition Index[19] (2021)
India	33-35% emission reduction by 2030 from 2005 levels 40% electric power from non-fossil fuel energy by 2030	69.29 (10th)	Medium	87th
US	Reduce net GHG emissions by 50-52% below 2005 levels in 2030	37.39 (55th)	Very Low	24th
Australia	Net zero emissions by 2050 Reduce emissions by 43% below 2005 levels by 2030	30.06 (59th)	Very Low	35th
Japan	Reduce GHG emissions by 46% by 2030 from 2013 levels Net zero by 2050	48.53 (45th)	Low	37th
China	Emissions peak before 2030 and carbon neutrality by 2060 Lower emissions by 65% from 2005 level, increase share of non-fossilfuels in primary energy consumption to around 25% by 2030	52.20 (38th)	Medium	68th
Philippines	GHG emissions reduction of 75% between 2020-2030	58.98 (23rd)	Medium	67th
Indonesia	Reduce emissions from 2020-2030 by 29% unconditionally and 41% conditionally	57.17 (27th)	High	71st
Republic of Korea	Reduce GHG emissions by 40% from 2018 levels by 2030 Carbon neutrality by 2050	26.74 (60th)	Low	49th

* Score calculations – GHG Emissions (40% weighting), Renewable Energy (20%), Energy Use (20%), Climate Policy (20%). (No countries received positions 1st-3rd)

China

In contrast to most Indo-Pacific countries, China has moved ahead to become the leading innovator and manufacturer[20] of green energy technologies, ranging from wind and solar power to electric vehicles. Between 2010 and 2020, China was by far the largest investor in renewable energies, spending approximately $760 billion while, in comparison, the US spent $356 billion.[21]

China's commitment to steer the production of renewable energies has arisen in conjunction with a willingness to be viewed as a global leader in combating climate change. Former President Trump's withdrawal of the US from environmental politics opened space for China to aspire to this position. The 13th Five-Year-Plan for Renewable Energy Development (2016-2020) revealed Beijing's intention for China to 'play a leading role in promoting the global

energy transformation and development' and be a 'leading power in renewable energy technology industries'.[22] China is motivated to drive the green transition for the same reasons as most countries. Firstly, its vulnerability to the effects of climate change, and most pressingly the health and economic risks that pollution poses to the population. Secondly, China's own insecurity as the largest energy importer in the world. By building their own methods of sustainable energy production and attempting carbon neutrality by 2060, Beijing is endeavoring to eliminate potentially detrimental factors to the stability and legitimacy of the Chinese Communist Party.

Quad's individual positions vis-à-vis China

United States

Relations between the US and China with regards to climate change have fluctuated significantly over the last few decades but they have mostly been at odds with one another due to conflicting perspectives. Before COP15 in Copenhagen 2009, China was not willing to agree to a formal commitment to reduce emissions because of Beijing's belief in 'Common but Differentiated Responsibilities' (CBDR) allowing the country the right to develop without restrictions. Nowadays China continues to support CBDR but has moved to simultaneously champion the transition. The historic pledge in 2014 between President Obama and Xi Jinping, in which the leaders recognized their shared critical role in addressing climate change,[23] was foundational to the success of the Paris Agreement. Yet, the Trump Presidency went on to undermine this cooperative pillar of the US-China bilateral relationship and global progress in decarbonization. While the US withdrew from environmental action, Xi Jinping accelerated China's programs. Ultimately, while the US was a bigger market for renewable energy in 2010, by 2020 it had fallen significantly behind–a development which Secretary of State Anthony Blinken has stated undermines Washington's prospects in the overarching "long-term strategic competition with China."[24]

The US and China are engaged in a global battle for influence that has permeated into the climate change arena, the hostility leading them to compete over mitigation rather than collaborate despite shared interests.[25] Since collaboration would entail the US importing Chinese equipment and resources to enable the transition,[26] President Biden's government is instead taking steps to diversify away from China. In the aftermath of Trump's exit from the Paris Agreement, Biden is seeking to re-assert the US at the helm of climate change governance, but with a conscious effort to minimize dependency on China as it does so. In February 2022, 'America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition' was released, confirming that a way to meet the expected increase in demand for renewable energies must be found without deepening reliance on China.[27] Low-carbon goods provide an opportunity to revive US leadership, stimulate the American economy, and are a secure investment as they will only continue to increase in value.[28]

> ***While an accelerated green transition is certainly desirable, the present clean-energy supply chains are not stable enough to facilitate the shift. In the current state, moving to clean-energy will not eliminate energy insecurity but rather just shift dependency onto China.***

India

On one hand, India and China have an implicit partnership as the 'leaders of the developing world'[29] in climate change negotiations, pushing for CBDR and their right to development. Most recently, India and China both argued for the COP26 deal to change its statement on coal power from 'phase out' to 'phase down'. The change was met with disappointment about their curtailing the impact of the agreement,[30] particularly as India and China are the two largest consumers of coal. However, within the wider conflicts in climate politics their move was understandable. In many ways Beijing and New Delhi are viewed as standing up for the anger and betrayal felt towards the failure of developed countries to deliver the $100 billion promised to developing countries for mitigation and adaptation.

Despite this, India and China remain locked into a multi-faceted regional battle that spans decarbonization. In India, renewable electricity is growing at a faster rate than any other major economy[31] and thus, its clean-energy transition is in competition with China. Furthermore, their relations are still very much informed by their tense ongoing border dispute. However, in this vein, the two countries actually share an even greater reason to cooperate because climate change could potentially escalate and exacerbate the dispute significantly. The 2021 report entitled 'Melting Mountains, Mounting Tensions' detailed how climate change will impact the India-China rivalry – predicting that flooding, rising temperatures, and the impacts on dam projects will sharpen tensions and increase the risk of conflict.[32]

Japan

The competitive dynamics between the US and China within the environmental arena have put Japan between these powers, each side influencing it to boost climate action. The struggle for prestige on the international stage has resulted in Sino-Japanese competition, with Tokyo attempting to match Beijing's ambitious targets.[33] Shortly after President Xi Jinping announced carbon neutrality by 2060 in China, Prime Minister Suga responded by declaring net zero carbon in Japan by 2050. Nevertheless, the wider Sino-American strategic competition has also played a role, and Japan has found it easier to cooperate with the US and the West, unveiling its 'Green Growth Strategy' just ahead of the 2021 US President election – as if trying to align itself with the future Biden administration already.[34] As the US-China climate battle prevails, Japan will undoubtedly face more pressure from the US to accelerate its decarbonization and transition to clean-energy. To achieve carbon neutrality, the new Kishida government has indicated plans to increase renewable energy, but also restart its many dormant nuclear reactors. These intentions have been met with a strong anti-nuclear public sentiment after the devastation of 2011, and international criticism, which will pose a challenge for its energy transition. Yet, in the context of the Ukraine War, notions are circulating of Tokyo gaining geopolitical power if it reduces large imports of liquefied natural gas (LNG) by switching to renewable or nuclear power and allowing the LNG to instead release Europe from its dependency on Russia.[35]

> ***The Indo-Pacific is slowly transitioning to green energy, although the pace is varied across countries. It is clear that the national government's determination to prioritize decarbonization is an influential factor. In contrast, China has become the leading innovator and manufacturer of green energy technologies.***

Australia

Currently, Australia and China are engaged in a geopolitical contest for influence over the Pacific Islands, which is arguably being shaped, to an extent, by climate change. Australia's standing with the Pacific Islands has diminished because they are frustrated and disappointed by Canberra's perceived failure to address climate change – a significant threat to their existence.[36] The Solomon Islands, one of the world's most vulnerable countries, was closely associated with Australia until recently, but it has begun to move towards China over Australia's modest emissions targets and the protection of its coal industry. In 2019 it was a contributing factor in the country's decision to downgrade its relationship with Taiwan and renormalize diplomatic relations with Beijing, turning to China in the hope of more resources for mitigation efforts.[37] Many believe it also influenced the Solomon Islands to enter into a security pact with China in March 2022. Prime Minister Sogavare has made it clear that development plays a large role in its closer relations with China, and the islands of the Pacific increasingly view climate change and their insecurity as intertwined with development.[38]Newly elected Australian Prime Minister Albanese has in part blamed the security pact and Canberra's overall loss of influence in the Pacific on Australia's "alienation" of its neighbors through empty targets and poor progress at reducing emissions.[39] Australia's concerns over the security pact are shared by all

the Quad members as the agreement holds the potential to significantly disrupt the balance of power in the Indo-Pacific, allowing for the expansion of Chinese military power into the Southwest Pacific.[40]

Geopolitical Impact of Supply-chain Dependency on China

Overall, Chinese supply chains, spanning many different markets, have been increasingly affecting world trade. This has been amply demonstrated over the last few years and will only increase as the impacts of climate change intensify. The COVID-19 pandemic, power outages, labor shortages and high consumer demand[41] have exposed the fragility of Chinese supply chains as well as the underlying issue of dependency on China for essential goods. Indo-Pacific countries have struggled with their dependency on China for goods such as semiconductors, automobiles, pharmaceuticals, and telecommunications[42] – a vulnerability that has prompted the restructuring of supply chains away from China. The India-Japan-Australia Supply Chain Resilience Initiative (SCRI) has emerged, as has the Quad agreeing to make rectifying the degree of overreliance and de-risking supply chains a top priority of cooperation. The first Joint Statement in September 2021 expressed that the Quad "will cooperate to establish responsible and resilient clean-energy supply chains."[43]

China has made itself dominant and indispensable in clean-energy supply chains, monopolizing both the export of final products, and the acquisition of raw materials for manufacturing. An examination of solar photovoltaic (PV) equipment reveals that China is the largest supplier globally making up 41 percent of exports,[44] and eight of the 10 main companies are Chinese-owned. Beijing also controls all sectors of PV production plus its vital materials, for example by producing 45 percent of the polysilicon needed and running 60 percent of wafer manufacturing.[45] Yet, even more crucial still is the near complete monopoly that China holds over the supply chains of rare earth metals[46] which are essential in most types of renewable energy, as well as other technologies like electric car batteries. China produces approximately 60 percent of all rare earths and processes 87 percent,[47] as well as dominating the refining of other essential materials such as nickel, lithium, and cobalt. Ultimately, even if countries wish to construct their own renewable energy products, they will still need to procure the material components from China, and thus, dependency on China currently exists at every stage of the clean-energy supply chain.

> ***"Between 2010 and 2020, China spent about $760 billion on renewable energies while the US spent $356 billion. Former President Trump's withdrawal of the US from environmental politics opened space for China to aspire to being the global leader in combating climate change.***

Risks of unplanned disruptions

In terms of clean-energy, decarbonization and access to suitable technology is too critical to be reliant on unpredictable Chinese-controlled supply chains.Not only could they be affected by the logistical struggles we have previously seen, but China's ability to continue producing renewable energies is itself vulnerable to disruptions caused by climate change. This is because their low-carbon technology production centers located in Southern China and neighboring South Asian countries are at risk.[48] More broadly too, supply chains are going to be subject to more challenges generated by climate change like natural disasters and the displacement of labor. Ultimately as mitigation efforts and energy insecurity boost demand for clean-energy, overreliance on China will mean that disruptions would negatively affect this transition – something the Quad should try to avoid.

Risks of intentional disruptions

Moreover, the acceleration of the green transition with the current supply chains will cause China to gain in geopolitical power as countries will increasingly need Beijing's exports. In a speech in April 2020, President Xi Jinping said

that the country "must tighten international production chains' dependency on China".[49] This direct expression of ambition demonstrates China's understanding of the power and influence that indispensability in supply chains can yield. Therefore, there is significant reason for concern over the likelihood that China will exert control over clean-energy supply chains when it suits it to do so,[50] and use them to Beijing's advantage. After all, China has already demonstrated a readiness to deploy coercive economic strategies to promote foreign policy aims[51] and exploit the deeply integrated nature of the world's economies.

A global example of this was China's furious response to Lithuania's 'Taiwanese Representative Office', unleashing its economic coercion toolkit against the European Union (EU) single market by halting imports and targeting supply chains.[52] In response, the EU launched a case against China at the World Trade Organization, which Quad members, Australia, the US, and Japan, have all requested to join, motivated by their own experiences of China's economic targeting.

In the case of Australia, Canberra's call for an independent investigation into the origins of the COVID-19 pandemic made it a target in the eyes of the CCP.[53] Accusing Australia of initiating a "political witch hunt", China introduced an unprecedented wave of sanctions on Australian trade as punishment.[54] These have continued due to China's '14 grievances' against Australia, which include interferences into Chinese affairs in Taiwan, Hong Kong, Xinjiang, and the South China Sea.[55] In January 2022, former Australian Prime Minister Morrison spoke out on China's economic coercion, warning that the Indo-Pacific region has become "highly contested" and is engendering these types of tactics from countries trying to "coerce and intimidate" others over territorial disputes.[56]

> ***In February 2022, 'America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition' was released, confirming that a way to meet the expected increase in demand for renewable energies must be found without deepening reliance on China.***

Japan and the US have experienced China's threat of restricting the export of rare earths which, as a crucial material for many essential products, is a key tool at China's disposal given its monopoly. In 2010, China restricted exports of rare earths to Japan over a territorial dispute in the East China Sea.[57] Furthermore, at the height of the China-US trade war during the Trump Presidency, it was hinted that China would halt exports of rare earths to the US as a 'counter weapon'.[58] The importance of rare earths in renewable energy means their value is constantly rising, creating a dependency Beijing is taking advantage of. Given what we have seen, there is reason for concern that China will be prepared to halt the supply of rare earths in a coercive manner over bilateral issues in the Indo-Pacific, which would disrupt transitions. Thus, the Quad needs to reduce reliance and have an alternative supply so that the grouping will continue to feel capable of standing up for the democratic, liberal, rules-based principles of a 'Free and Open Indo-Pacific' (FOIP), without damaging repercussions to its transitions.

Worries for the Indo-Pacific

Energy security is a central factor which maintains geopolitical balance, and as the green transition gains momentum it is on track to cause a structural shift in the Indo-Pacific, orienting economic and political power increasingly towards China.[59] It has been suggested that the 'transition to renewable energy puts the West at the mercy of China',[60] but in fact Beijing will possess more of a hold over the Indo-Pacific because the transition is so vital for the survival of many countries in the region.

In this way, concern for climate change has already begun to influence Indo-Pacific dynamics and geopolitical strategic competition between China and the Quad partners. For example, while the previously mentioned security deal between the Solomon Islands and China was motivated on behalf of the Solomon Islands by climate change, for China it was likely part of a wider trend of geopolitical rivalry over

the Pacific Islands. The deal is plausibly a direct result of the AUKUS agreement signed last year, largely understood to be a security deal to contain China, which has prompted Beijing to create its own sphere of influence.[61] We may begin to see an emerging trend of China targeting small states in the Indo-Pacific for power projection purposes, and these countries simultaneously moving towards China and away from traditional powers (Quad members) for gains in climate change resilience. These relationships based on mutual interest will increase Beijing's regional influence.

The Boe Declaration (2018) formalized the Pacific Islands view of "climate change as the single greatest threat" to their people[62] and, as such, they view concern for this key security issue as essential in their partners. For traditional partners such as the Quad, non-traditional security threats do not always appear as important because it is less of an immediate threat to them.[63] Rather than aiding with significant climate mitigation and adaptation, the Quad appears more preoccupied with securing the strategic value of the Pacific Islands for achieving the FOIP, and reducing the leverage that China is gaining with these islands through their 'debt-trap diplomacy' projects. Yet, for the Pacific Islands themselves, the Quad's perceived limited commitment to climate action, both at home and abroad, is problematic, while China presents an opportunity. Thus, Pacific Islands may prove more sympathetic to Beijing and its interests so as to gain infrastructure and development for mitigation and adaptation.

Additionally, the Pacific Islands mostly have little self-sufficiency and rely on imports, which makes them vulnerable to economic coercion.[64] It is plausible that other Pacific Islands and states in the Indo-Pacific with similar characteristics may begin to concede to Chinese foreign policy to gain access to clean-energy technology, especially as their situations become more desperate and the financing of their transition remains difficult. By moving closer to China, say by abstentions or neutrality over territorial claims or human rights issues, these countries would hope to avoid being at the receiving end of economically coercive tactics over supply chains that would constrain their ability to shield from climate change.

Evidently, alternative clean-energy supply chains are essential to alleviate the pressure[65] on vulnerable, less financially capable Indo-Pacific states to adhere to Chinese foreign policy to get protection from climate change. Clean-energy supply chains made by the Quad will firstly increase resilience against China's economic coercion by providing an alternative source of renewable energy, and secondly, will ensure the Quad's influence prevails over strategically important Indo-Pacific countries by demonstrating strong concern for climate change.

Quad Capabilities to Develop Clean-energy Supply Chains

The Quad has frequently expressed its intention to develop clean-energy supply chains, and for the reasons outlined, it is imperative that it be made a priority of their cooperation. Moreover, the Quad has an advantageous set of capabilities it can harness that make it an appropriate body to tackle reducing China's monopoly over supply chains and solidify the green transition in the Indo-Pacific.

National drives to establish alternative clean-energy supply chains

The Quad recognizes the vulnerability in becoming dependent on China and is willing to instigate change. This has been expressed by their joint statements but can also be exemplified in their respective regional drives to improve supply-chain resilience and the regional situation. The Quad must become leaders, both in the green transitions themselves, and in the broader regional shift.

The previously mentioned 'Strategy to Secure the Supply Chain for a Robust Clean Energy Transition' released by the US in early2022 is a solid example of the seriousness with which the current administration views the over-reliance on China for the green transition. For the Quad, the US' urgency and strategy recognizing the severity of the issue at hand will only help to reinforce any steps it takes. President Biden unveiled his new 'Indo-Pacific Economic Framework' at the Quad Summit in May, with all Quad members joining the initiative. The framework is intended to advance resilience and sustainability in the partners' economies through both supply chains and clean-energy, although not strictly together.[66]

Additionally, the most meaningful step towards regional progress in establishing new supply chains was the 'Sydney Energy Forum' in July 2022, proposed and hosted by Australia. Former Prime Minister Morrison expressed his enthusiasm for the event saying that "access to affordable, reliable, and secure clean energy is critical".[67] For new Prime

Minister Albanese, climate change has already proved a focus area for cooperation with the Quad. In Albanese's opening speech at the Quad Summit May 2022 shortly after his election, he spoke of his government's ambition to significantly increase Australia's climate action efforts, and particularly mentioned the alignment between his domestic agenda and the Quad's intention to tackle climate change and build a "stronger and more resilient Indo-Pacific region".[68] The recent Forum provided an opportunity for Albanese to once again promise a "new era" of climate action under his government.[69] The event resulted in the identification of actions to be taken by actors at different levels across the Indo-Pacific to collectively improve clean-energy supply chains and deliver on emissions reductions.

Japanese Prime Minister Kishida pledged at the 207th Session of the Diet to address clean-energy strategy through "innovation and capital investments" targeting both the supply and demand sides.[70] One of his key policies since taking office has been pushing forward the 'Economic Security Promotion Bill' (passed by the Diet on May 11) which has a strong focus on supply-chain resilience and promoting research and development of cutting-edge technology.[71] The bill reveals an intention to diversify Japanese supply chains in order to "eliminate the potential risk of supply interruption due to excessive dependence on specific countries", which has been interpreted to mean an exclusion of China.[72] In this way, the Japanese government wants to prevent key technologies entering from China, including low-carbon products of which Japan is currently a major importer.[73] Further, Kishida pledged at the Shangri-La Dialogue in June 2022 that Japan will support 100+ supply-chain resilience projects in the next five years, and he hopes to cooperate with like-minded countries on economic security.[74]

India does not currently have an established national policy targeting supply-chain resilience in the same form as its fellow Quad members, but one pillar of its agenda is diversifying to reduce its dependencies, particularly for raw materials.[75] The Quad can provide a way for India to develop and collaborate on clean-energy technology and supply chains to promote its own transition and that of the region. As a South Asian country, the decarbonization of India will be hugely impactful for the Indo-Pacific – providing a boost to the region's transition and credibility to the Quad.[76]

Access to rare earths

Over the last decade, Beijing's monopoly over rare earth production has been gradually declining as new states have developed their mining capacities, falling from approximately 92 percent in 2010 to 58 percent in 2020.[77]

Figure 3: Rare earths (2020)[78]

Country	Reserves (Million Tons)	Mining Production (Thousand Tons)	Market Share of production (%)	Market share of processing (%)
China	44.0	140	57.5	87[79]
United States	1.5	38	15.6	-
India	6.9	3	1.25	-
Australia	4.1	17	7	
Japan	1.6[80#]	-	-	-
Vietnam	22.0			
Brazil	21.0			
Russia	12.0			

Not included in further totals because currently impossible to extract.

The data in Figure 3 demonstrates the substantial reserves of rare earths that all four Quad members have – with India and Australia fifth and sixth globally. In terms of domestic production, the US and Australia are the second and fourth largest miners of rare earths, respectively, although Chinese production does exceed that of America three-fold.

Nevertheless, Australia and the US are increasing both their production and processing capabilities. Former Prime Minister Morrison expressed to the Quad leaders at the September 2021 Summit that Canberra intends to develop its role in supplying critical materials to "support technologies of the future".[81] Then, in March 2022, the Australian Federal Government announced an investment plan of A$240 million to develop its production of rare earth metals to address the dominance of China and end Australia's fears of reliance.[82] Moreover, Australia is home to the only significant rare earth processor outside of China, 'Lynas Corporation'. The US' '100 Day Review' of America's supply chains revealed its dependency on China's rare earths for achieving climate goals via clean-energy technology, vowing to un-do this.[83]As such, major investments into expanding domestic critical minerals supply chains are under way. In early 2021, a contract was signed between the US Department of Defense and Lynas Corporation to develop a rare-earth processing facility in Texas. The Pentagon has now extended the original funding of $30 million with a follow-on contract in June 2022 amounting to $120 million to make the facility operational in 2025.[84] Together, the expansion of the rare earths' industries in Australia and the US will enable the Quad to begin independent supply-chains from China and possess the ability to bypass China with regards to rare earths.

Despite having been a pioneer of the rare earth industry with large reserves, India has not been able to capitalize on its potential yet, however the government has recently suggested plans to triple rare earth production by 2032.[85] Japan's reserves are found in mud deposits below the sea, and are consequently currently inaccessible. Nevertheless, Japan is committed to reducing its reliance on critical materials from China – Kishida's economic security bill plans to secure the supply of rare earths[86] and there is a target to reduce rare earth imports to less than 50 percent by 2025.[87] Following China's weaponizing of rare earths against Japan in 2010, the 'Japan, Oil, Gas and Metals National Corporation' invested in Lynas Corporation for new supply chains (one of the reasons Lynas became the only capable processor outside of China).[88]

Therefore, while India and Japan may not imminently be in a position to contribute to the production and processing of rare earths, they will be able to switch from their current sources to investing and purchasing American and Australian rare earths. Together, the Quad could aim to match China's production of rare earths, and then form a 'monopsony'[89] to use the product in their clean-energy supply chains. For the next stage in the production of renewable energy, the Quad also has complementary assets. India, for example, has a low-cost manufacturing capacity for PV products, and the government is currently planning to expand its subsidy scheme for domestic producers.[90] Japan and the US also have significant financial and technological resources which would be key.[91]

Strong bilateral cooperation between Quad members

The commitment of Quad countries to delivering programs and initiatives to advance climate change mitigation and adaptation is also seen in their bilateral dealings. A few bilateral agreements and partnerships are listed in Figure 4 to indicate both the breadth and depth of cooperation.

Figure 4: Bilateral cooperation among Quad members

Australia - India	• Australia–India Energy Dialogue • Letter of Intent on New and Renewable Technology (2022) • India–Australia Economic Cooperation and Trade Agreement (2022)
Australia - Japan	• Australia–Japan High-Level Group on Energy and Minerals Consultations • Japan–Australia Partnership on Decarbonization through technology (2021) • Hydrogen Energy Supply Chain
India - Japan	• Japan–India Energy Dialogue • India–Japan Clean Energy Partnership (2022)
Australia - US	• Australia–US Strategic Partnership on Energy • Australia–US Strategic Commercial Dialogue • Founding members of the 'Energy Resource Governance Initiative'

India - US	• US–India Partnership to Advance Clean Energy (2009) • Annual 'US-India Energy Dialogue • India–US Strategic Energy Partnership (2018) • US–India Climate and Clean Energy Agenda 2030 Partnership (2021) • US–India Strategic Clean Energy Partnership(2021) • US–India Trade Policy Forum (2021)
US - Japan	• Japan–US Strategic Energy Partnership (2018) • US–Japan Climate Partnership (2021) • US–Japan Competitiveness and Resilience Partnership (2021)

Australia – India

Bilateral cooperation mostly occurs under the annual Ministerial level 'Australia–India Energy Dialogue', which includes a working group on 'Renewable Energy and Smart Grids', but at the Quad Summit in September 2021, Canberra and New Delhi also committed to developing a partnership on clean-energy. At the 4th Dialogue meeting in February 2022, this was realized through the signing of a 'Letter of Intent' which aims for cooperation in reducing the costs of renewable energies to increase their competitiveness.[92] The newly signed 'Economic Cooperation and Trade Agreement' is aimed at building resilient supply chains and contributing to a stable Indo-Pacific during a time of China's assertive behavior.[93]

Australia – Japan

With a strong relationship in energy trade, Australia and Japan are also close partners in clean-energy development. They have long been engaged in the 'High Level Group on Energy and Minerals Consultation' as a forum for policy developments, which has evolved to incorporate areas like renewable energy. Most meaningful though is their 'Partnership on Decarbonization through Technology' established in 2021. With a focus on the Indo-Pacific, the partners aim to cooperate to drive the transition to zero emissions technologies – supporting each other and the region to meet its growing energy needs in a sustainable way.[94]

> ***Chinese supply chains, spanning many different markets, have been increasingly affecting world trade. This has been amply demonstrated over the last few years and will only increase as the impacts of climate change intensify.***

India – Japan

From as early as 2007, India and Japan have acknowledged the need for an 'Energy Dialogue' to promote bilateral cooperation, including for renewable energy.[95] Notably though, in March 2022, Prime Ministers Kishida and Modi announced the 'India–Japan Clean Energy Partnership', designed to expand the Dialogue's collaborations and promote reliable supply chains between the partners for their green transitions.[96]

Australia – US

In 2018 the Trump Administration constructed three strategic partnerships in the Indo-Pacific with Australia, India, and Japan to aid in the US' promotion of a sustainable and reliable supply of low carbon technologies to the region.[97] To build on this, in March 2022 the inaugural 'Australia–US Strategic Commercial Dialogue' (AUSSCD) took place, recognizing their vital collaborations to secure supply chains and promote the green transition in line with the needs of the Indo-Pacific. AUSSCD aims to involve the private sector through investing in renewable energies and supply chains for critical materials.[98]

India – US

The 'US–India Energy Dialogue' has been running annually since 2005, and under the Obama era the more specific 'US–India Partnership to Advance Clean Energy' was established. While Trump did secure the 'Strategic Energy Partnership' with India, it was geared more towards energy insecurity and the promotion of renewable energy was on the backfoot. However, under President Biden, US-India cooperation on clean-energy has been

revitalized with the launch of the 'US–India Climate and Clean Energy Agenda 2030 Partnership' and the 'Strategic Clean Energy Partnership'. Together they aim to advance renewable energy research, investment, and deployment in a sustainable manner to accelerate the clean-energy transition.[99] In 2021, the 'US–India Trade Policy Forum' was also re-launched, with a focus on creating resilience and securing supply chains through cooperation.

US – Japan

Under the Biden administration, bilateral cooperation with Japan has also been expanded via the launching of the 'US–Japan Climate Partnership (on Ambition, Decarbonization, and Clean Energy)' and the 'US–Japan Competitiveness and Resilience Partnership'. These concentrate on the energy transition in the Indo-Pacific, and collaboration to support the rapid development and roll out of clean-energy in the region.[100]

Track record

In addition to the SCRI launched by India, Japan, and Australia, the Quad members have other experience in establishing clean-energy supply chains. Namely, clean-hydrogen supply chains are currently under construction and hope to be competitive against China's own rapid development of this green energy source. The world's first 'Hydrogen Energy Supply Chain' (HESC) aims to safely produce and transport clean liquid hydrogen from Australia to Japan, and recently celebrated the pilot project's success in moving hydrogen between them via tanker.[101] Additionally, in September 2021, the Quad announced the establishment of the 'Quad clean-hydrogen partnership' to scale up production whilst boosting demand by strengthening and reducing costs of the supply chain.[102] The need for this cooperation was reiterated by all members at the May 2022 Summit. If this comes to fruition, and a clean-hydrogen supply chain is devised under the Quad framework, it will reduce dependency on China and promote energy security in the Indo-Pacific.[103] China is again the current leading producer of clean-hydrogen globally, boasting the largest electrolyzer in existence today.[104] Beijing has also outlined ambitious targets to drive up production under the 'Medium and Long-term Plan for the Development of Hydrogen Energy Industry (2021-2035)', and so it is in the interest of the Quad to quickly develop a competitive alternative.

> ***China is the largest supplier globally of solar photovoltaic (PV) equipment making up 41 percent of exports. Beijing also controls all sectors of PV production, for example by producing 45 percent of the polysilicon needed and running 60 percent of wafer manufacturing.***

Moreover, the US and Australia are founding members of the 'Energy Resource Governance Initiative' (ERGI) and are working through this venture to improve supply chains of minerals essential to clean-energy. As nations with established mining sectors, ERGI members aim to uncover and promote the most sustainable methods of mining through a 'Toolkit', both within their own countries and internationally, in order to support the energy transition.[105] The Quad members also have experience cooperating on clean-energy under multilateral forums such as the Clean Energy Ministerial, G20, UNFCCC, International Solar Alliance, and formerly through the Asia-Pacific Partnership on Clean Development and Climate.

Regional reach

In terms of reach, the Quad could also extend the supply chains to involve like-minded countries of the Indo-Pacific, and possibly this could become an activity of the Quad Plus framework. The Quad Plus is a cooperative framework that has largely been mobilized to tackle transnational challenges, such as the involvement of South Korea and Vietnam in the case of the COVID-19 pandemic.[106] Therefore, climate change could be a similar area that would benefit from dialogue and cooperation with regional officials and experts.[107] In addition, given that the work will be aimed at supporting the climate targets of Indo-Pacific countries, including them in these processes as much as possible will strengthen the pluralistic and inclusive nature of the Quad's work, giving it legitimacy.

Partners may also have resources or production capabilities that would help the Quad to complete all stages of low-carbon technology development. For example, there is much potential for South Korea to work as a Quad Plus partner in promoting the transition, as a trusted like-minded partner with a shared recognition of the dangers of dependency on China at a time when the green transition is so critical. Seoul could provide welcome technological capabilities in terms of electric vehicles and battery production, and commercial opportunities[108] that would strengthen supply chains. As such, a project conducted by the German Marshall Fund exploring the Quad Plus framework suggests that cooperation between the Quad and South Korea should begin with critical materials. This is not only due to the mutual benefits it would bring to promoting the green transition, but also because it is a relatively "low-controversy" form of cooperation that could be conducive to more formal cooperation under the Quad Plus framework in the future.[109]

Actualization of Clean-energy Supply Chains

Clean-energy supply chains should be constructed in line with an adapted version of the Quad's principles of 'Critical Technology Supply Chains'– security, transparency, autonomy and integrity.[110] The most important entities for establishing these green technology supply-chains are the Quad's 'Critical and Emerging Technologies Working Group' and mostly the 'Climate Working Group' (CWG), both inaugurated in March 2021. During the CWG's first year little progress was made but at the May 2022 Summit the Quad acknowledged this and pledged to "catalyze" efforts at deploying clean-hydrogen and devising a '10-Year Clean Energy Supply Chain Plan'.[111] Nevertheless, this needs to be accelerated even further. There is a 50 percent chance the world will overshoot the 1.5° C Paris threshold in the next five years,[112] so making pathways to reduce emissions in the Indo-Pacific is imperative.

A separate expert group that combines the activities of these two working groups to specifically focus on clean-energy supply chains should be considered by the Quad. It could draw from the progress of both working groups and then apply it in this specific context, making it likely to progress faster. It currently appears that clean-energy supply chains are not a principle focus of the CWG as it has a wide spread of responsibilities including mitigation, adaptation, and climate finance.[113] Non-Quad countries should also be invited to participate in the two original working groups and within the specific clean-energy supply chain expert group.[114]

More official high-level meetings are also needed to raise this issue in the Quad's agenda. The May 2022 statement suggests that efforts will be accelerated through a meeting of the US Secretary of Energy Jennifer Granholm and the Quad Energy Ministers,[115] therefore proving that more high-level attention can ensure faster progress. Moreover, in these meetings ministers can work to bring together their overlapping individual programs and bilateral cooperation in this field to adapt and create a plan for the Quad. In this way, more partnerships such as the Quad's Green Hydrogen Partnership are necessary. Finally, the Quad needs to focus on building public-private partnerships and establishing strong investment and technical support necessary to make these supply chains function.

> ***Even more crucial is the near complete monopoly that China holds over the supply chains of rare earth metals (producing about 60 percent and processing 87 percent), essential in most types of renewable energy as well as other technologies like electric car batteries.***

Conclusion

In the coming years, the green transition will likely be catalyzed in the Indo-Pacific as countries race to meet their climate targets and attempt to diminish energy insecurity by ceasing the import of fossil fuels. However, unless coordinated action is taken, this impetus will only move the region's dependency onto China for energy due to

Beijing's near-monopoly over clean-energy supply chains. This is further cause for concern as China's supply of green energy technology is likely to be affected by disruptions and could be used in a coercive manner to further Chinese foreign policy aims.

The creation of clean-energy supply chains should be, hence, advanced by the Quad as a priority because it is very much in its interest to promote the green transition. Firstly, regional security and stability in the Indo-Pacific will be greatly upset by climate change unless significant efforts for mitigation and adaptation take place swiftly. Renewable energy is essential to meet climate targets and prevent exacerbating existing regional tensions, such as the China-India border dispute, or creating new ones. Secondly, the establishment of alternative clean-energy supply chains holds geopolitical consequences for the Quad, because it would re-balance regional control away from China and stop vulnerable countries moving into China's sphere of influence to seek protection from climate change. Moreover, the impact of the Quad will be hindered and lack legitimacy if its members are themselves dependent on China for their own decarbonization.

The Quad's realization of these systemic risks and strategic vulnerabilities means that it should act on its pledges and utilize the unique position it holds to develop alternative clean-energy supply chains. Success would emanate from the Quad's available resources, experience, bilateral ties, and national drives. In terms of reach, the Quad could also extend the supply chains to involve trusted partners of the Quad Plus framework, such as South Korea, who could expand the Quad's resources and capabilities along the supply chains. The Quad should build on the momentum generated by the recent Sydney Energy Forum to set this work in motion.

Nevertheless, there are significant challenges that the Quad will need to navigate. Between the members there are differences – domestic, strategic, political, and geographic – that determine their threat perception of climate change and thus, individual propensity to transition to clean-energy and promote it regionally. Notably, India may need significant investment from the other Quad members to replace coal and meet its energy demand through green energy.[116] Moreover, India has been increasing its imports of fossil fuels from Russia at a discounted price since the invasion of Ukraine. This does not support the view that the war is accelerating the green transition, nor is New Delhi's position of neutrality over Ukraine in line with that of the other Quad members. The Quad must not let these types of misalignments affect the progress of its work. Lastly, the speed of the transition to green energy, and how fast these new clean-energy supply chains need to be established will certainly be a challenge for the Quad.

Ultimately, green energy is only going to increase in importance. By developing alternative supply chains, the Quad will contribute to security and stability in the Indo-Pacific by reducing dependency on China and limiting the effects of climate change. Moving from statements to action, the Quad can together build sustainable, resilient, well-governed clean-energy supply chains, using this opportunity to justify it as a leading "force for good".[117]

> ***By moving closer to China, say by abstentions or neutrality over territorial claims or human rights issues, Pacific Island countries would hope to avoid being at the receiving end of economically coercive tactics that would constrain their ability to shield from climate change.***

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