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21st Century India Center

THE INDIA-CHINA CLEAN ENERGY TRADE

White Paper of the Agenda on Renewable Energy Trade between India and China (ARETIC)

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1. INTRODUCTION

Over the past two decades, both China and India have ramped up policy efforts to establish themselves in the growing global trade in goods related to the production and consumption of clean energy (CE). China's initiatives have led to positions in the markets for solar, wind, rare earth minerals, and electric vehicles (EVs) that range from strong to dominant. Meanwhile, India's efforts to establish domestic manufacturing capacity in the CE sector have met with more mixed success. For solar and wind components, China holds a share of at least 60% across all markets; India tops out at 12% in the global market for wind gearboxes (GWEC, 2023a; IEA, 2022).

However, a confluence of factors has led commentators to speculate on how this situation might change going forward. Geopolitical competition with China and a desire to diversify supply chains has led U.S. and its allies looking for alternative sources for CE-related goods. International investors are keen to find profitable projects and see India as potentially ripe for growth in this sector. Furthermore, India itself hopes to bolster the political appeal of its environmental policy by promoting an indigenous green manufacturing sector and become "self-reliant" in its clean energy transition.

Nonetheless, this speculation occurs in a current context of high levels of dependence on China for many CE goods and significant levels of investment in India by Chinese firms, raising the question of how such economic "decoupling" can occur. China is by far India's large trade partner when it comes to sectors such as solar PV and batteries. As of 2017, India was actually the top recipient of Chinese solar PV exports in the world, at roughly $3.5 billion worth of goods. On the investment side, three in four power plants in India use Chinese equipment (Krishnan, 2020). Even as policymakers have sought to nurture domestic industry to ameliorate this dependency, Indian firms become ever more dependent on China for components and raw materials.

The India-China CE trade relationship has monumental implications for global decarbonization efforts. As of 2022, China accounted for 30.62% of the world's carbon dioxide emissions, the most in the world; India accounted for 7.62% – a figure that is already the third highest in the world and is set to increase, if trends continue (Ritchie et al., 2023). The governments of both countries are responding accordingly with ambitious decarbonization targets: China plans to achieve net zero emissions by 2060; India plans to do so by 2070. India also has a set of 2030 targets that will require rapid scale-up of CE deployment. Altogether, the pace and success of global emissions reduction efforts will hinge crucially on the ability of these two countries to obtain and deploy the necessary CE technology at a massive scale.

Despite the importance of this topic for the future of India's efforts to decarbonize and for the global CE trade more broadly, there remains a dearth of data-driven scholarship on how the India-China CE trade relationship will develop. The ARETIC research initiative seeks to fill this gap, starting with this report which characterizes the state of play on CE trade between India and China.

The structure of the report is as follows. First, we characterize some of the key developments and findings in this issue area. Next, we highlight a selection of data sources for studying the India-China CE trade and present descriptive findings. Last, we identify important questions that can drive the research agenda moving forward and conclude.

2. **THE STATE OF INDIA-CHINA CE TRADE**

As CE deployment has accelerated in both India and China, the trade in CE goods between the two countries has grown apace. This section summarizes the state of India-China CE trade and discusses key trade policy efforts by the Indian government.

2.1. China dominates the global clean energy trade, leading to high dependence of India on China.

Through a combined strategy of state subsidies, market-based policies, innovation in manufacturing, and technology transfer, China has come to dominate the markets for many goods related to CE (Figure 2.1). This dominance extends to nearly every area of trade in CE, including: solar, wind, electric vehicles, rare earth minerals, and more.

China maintains a strong position in the global solar market. Growing from practically nothing in the early 2000s, China's manufacturing capacity in the solar photovoltaic (PV) market now accounts for 75%, 85%, 97% and 79% of output in modules, cells, wafers, and polysilicon, respectively (IEA, 2022). China is also the largest player in wind turbine manufacturing, accounting for 60% of global capacity (IEA, 2023). China has 7 of the top 10 wind manufacturers globally, with much of its production deployed domestically. Nonetheless, in addition to supplying the robust domestic market, Chinese wind firms are increasingly gaining a foothold in global markets (GWEC, 2023b).

Meanwhile, in rare earth minerals (REMs), China accounts for 57.57% of global production and similar shares of refining (around 50-70% of lithium and cobalt, 35% of nickel, and 90% of REM processing) (IEA, 2021). Once refined, these minerals are used to make rechargeable batteries, a market in which Chinese companies hold a 75% share (Rajshekhar, 2023a).

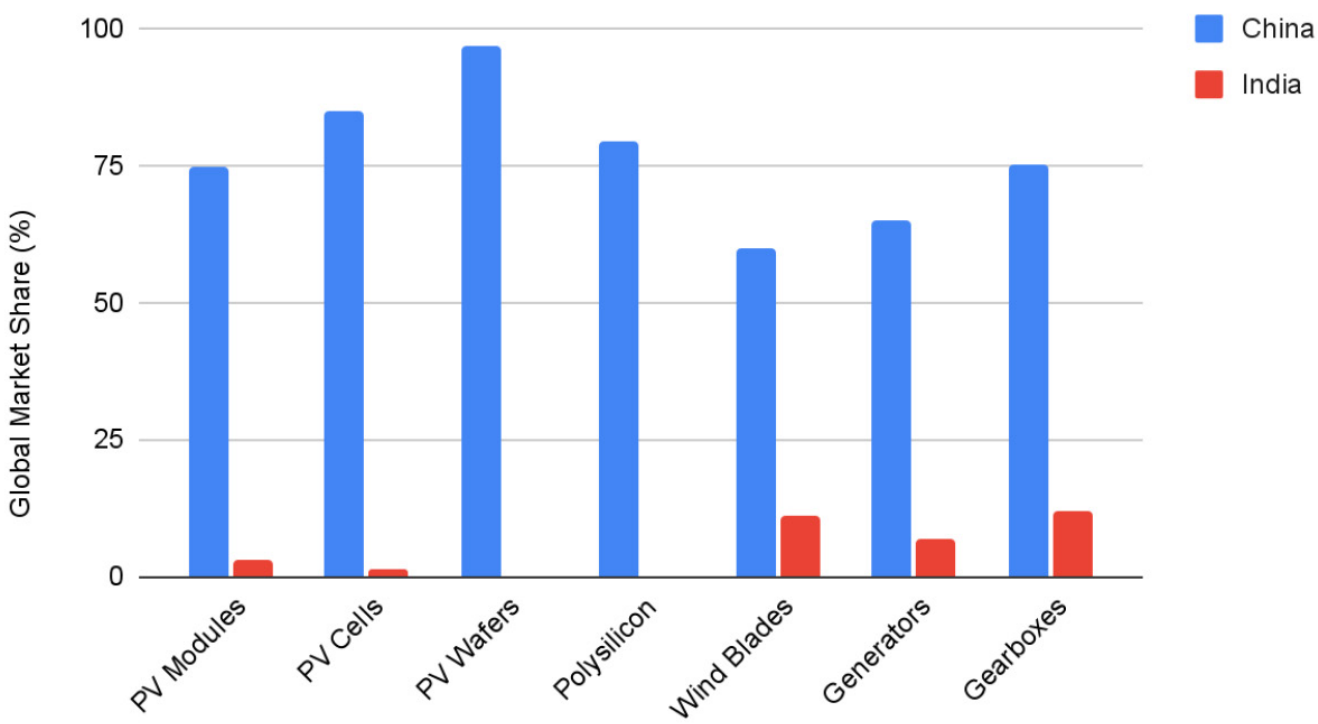

Figure 2.1.: Global Market Shares in Solar & Wind Components

Source: IEA (2022), GWEC (2023)

Despite Indian efforts to grow the competitiveness of its domestic manufacturing sector, China maintains a cost advantage in many key markets. For example, the cost to manufacture all components of the solar PV supply chain are 10% higher in India than in China (IEA, 2022). This has been attributed to "[l]onger construction and development timelines, considerable labour and material costs, the higher cost of capital, a lack of economies of scale and a dearth of knowhow in developing mega-scale PV manufacturing facilities", as well as higher industrial electricity prices (IEA, 2022, p. 85). As a result, India imported $3 billion worth of solar panels in 2021-22, 92% of which came from China (Singh & Ohri, 2023).

Meanwhile, compared to Indian turbines, Chinese turbines are 30% cheaper than turbines assembled in India with majority imported components and 60% cheaper than turbines locally manufactured in India (GWEC, 2023b). In sum, this means that like the rest of the world, India is dependent on China for many of the goods needed to facilitate a CE transition.

2.2. "De-risking" and "friendshoring" efforts signal international appetite for India to compete.

A key reason why the trade in CE goods between India and China matters is Western appetite for diversifying suppliers in the markets for these goods. Crucially, the United

States and other countries in the West perceive security risks from China's dominance in CE markets. There are also risks stemming from the concentration of CE manufacturing in so few geographies, even aside from the geopolitical elements – such high concentration makes supply chains vulnerable to shocks (CEEW, 2023).

The United States government has sought to use trade policy to diversify its trade partners and support its own domestic CE manufacturing sector. The Obama administration first enacted tariffs of 30% on solar panels from China and Taiwan in 2011. The Trump administration extended these protections to most of the world, with the argument that Chinese firms were routing their solar exports through other countries. Notably excluded from the tariffs were most GSP-eligible developing nations, which meant that they did not apply to India (SEIA, 2019). More recently, the Biden administration has characterized its approach to trade policy as "friend-shoring," in which it seeks to route supply chains through geopolitical allies.

India is uniquely positioned as the U.S. ally with the most potential to compete with China in many industries. With its low labor costs, large population, and extensive rare mineral deposits, India holds particular upside as a CE manufacturing giant. From the Indian perspective, the ongoing tensions over border disputes with China, geopolitical competition for regional influence, the desire to position itself in rapidly growing markets, and political imperatives to mitigate the impacts of climate change all underline a strategic incentive to grow its capacity in these sectors.

There have already been a few high-profile news items that might portend a shift towards more Western trade and investment with India. A crash in American investment into China, coupled with a more moderate increase in investment flowing into India, has garnered attention (Sivabalan et al., 2024). Tesla is in advanced discussions to create a factory in India, a step that Apple has already taken (Venkat, 2023). With respect to the CE trade specifically, the American firm First Solar has announced a 3.3 GW solar cell manufacturing plant in Tamil Nadu, India (ETEnergyworld, 2024).

However, it is not yet clear to what extent these examples represent evidence of a broader shift in international CE markets. China is still understood to be the dominant player in CE manufacturing.

2.3. India has ambitious domestic clean energy targets.

India is currently highly reliant on coal and other fossil fuels for energy, with coal constituting 41% of India's installed power capacity in 2023 (Administration, 2024). Yet, it has also set highly ambitious targets for CE deployment. India has a target of Net Zero emissions by 2070. By 2030, it hopes to:

- Meet 50% of energy requirements from renewable energy (RE)
- Reach a non-fossil fuel capacity of 500GW
- Reduce carbon emissions by 1 billion tons
- Reduce carbon intensity by 45% from 2005 levels

India has made significant progress towards its decarbonization goals. It has increased its installed renewable energy power capacity from about 10% of the total in 2010 to about 30% in 2023, corresponding to an installed renewable energy capacity of roughly 131 GW (Handa, 2023). However, India only installed 13.7 GW of CE capacity in 2023, whereas it needs to install 51 GW a year to meet the 500GW target by 2030 (Arasu, 2024). In order to achieve its targets, it will need to accelerate the pace of deployment.

2.4. India has sought to grow its domestic CE manufacturing industry.

Beginning with the inauguration of the National Solar Mission in 2010, India has long professed an ambition to meet its decarbonization targets via domestic manufacturing. To this end, India has implemented a range of policy initiatives to improve its CE manufacturing capacity and reduce its dependence on Chinese imports.

Figure 2.2 summarizes the frequency of policy initiatives that affect CE trade with China, using data from Global Trade Alert on CE-related HS6 codes (Alert, 2022). The counts represent the number of policy actions enacted in a given year. Indian government action on behalf of its domestic CE industry has been fairly consistent for the past 15 years, with a diverse range of policy instruments employed.

Figure 2.3 breaks down the key trade policies enacted over 2009-2023 by sector & intervention type. The solar industry has been the primary focus of the Indian government, subject to the most frequent and varied policy interventions among all CE sectors. Yet, India has applied trade protections to every CE sector in the form of tariffs, with biomass and wind also seeing interventions in the form of LCRs, anti-dumping measures, and safeguard duties. Below, we provide more detail on several of the most significant policy interventions.

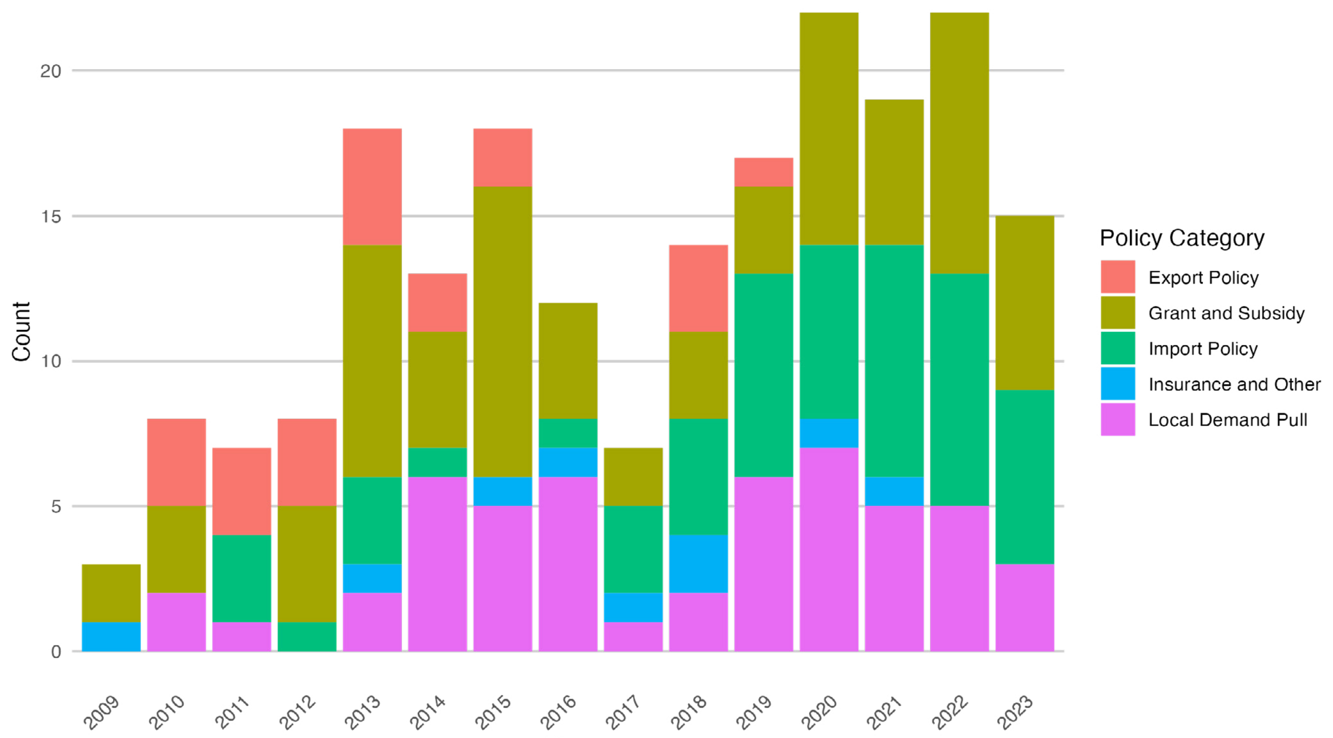

Figure 2.2.: Policy Interventions Imposed By India on China's CE Products

Source: Global Trade Alert

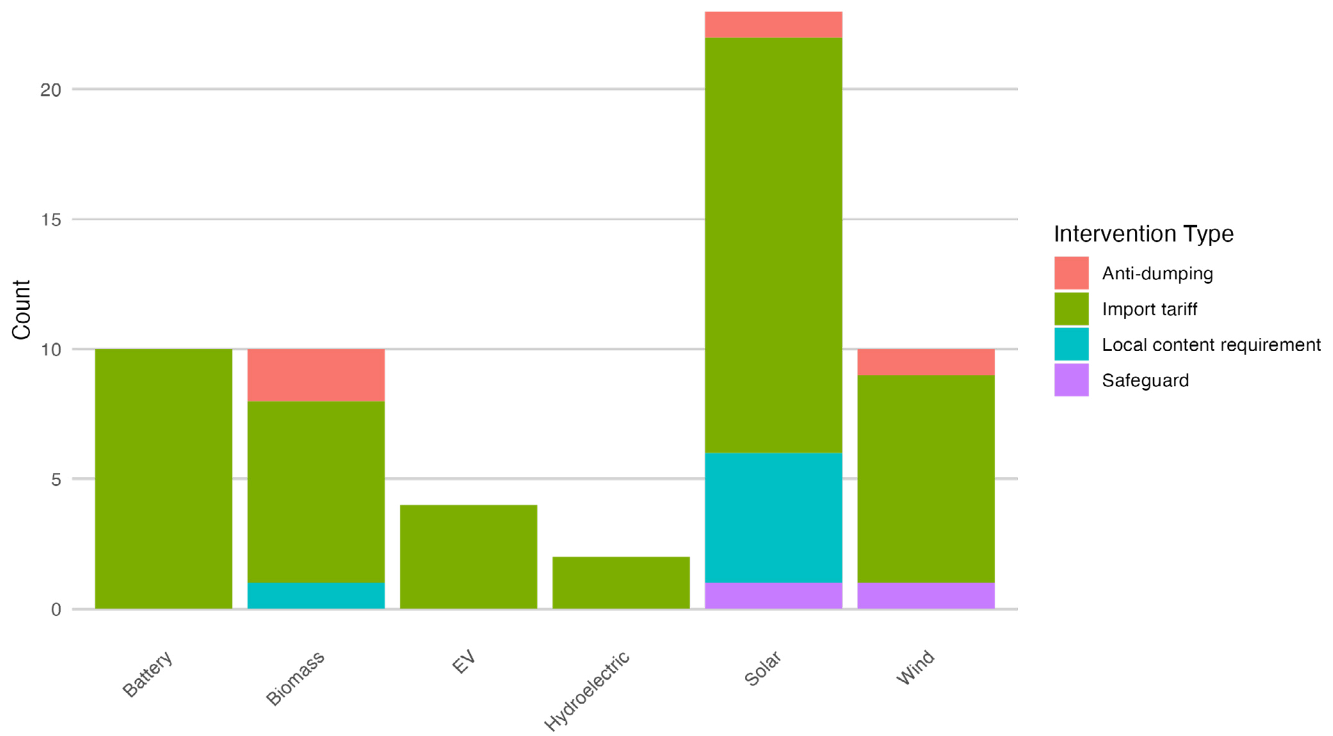

Figure 2.3.: Policy Interventions Imposed By India on China by CE Sector, 2009-2023

Source: Global Trade Alert

Local Content Requirements (LCRs) for Solar

In the National Solar Mission, the government held "reverse" auctions in which developers submitted bids to construct solar plants, stating the lowest price at which they will sell power to power distribution companies. For some auctions, bidders were required to purchase solar modules manufactured in India for crystalline silicon solar PV projects.

Production-Linked Incentive (PLI) Scheme

In 2020, the Indian government pledged $600 million to subsidize the solar PV module industry under the PLI Scheme. In this scheme, companies can apply for incentives on incremental sales.

Faster Adoption & Manufacturing of Hybrid & Electric Vehicles (FAME)

The FAME scheme employs demand-side incentives in the form of EV purchase subsidies to stimulate the creation of an indigenous electric vehicle value chain (Rajshekhar, 2023b). It applies to commercial and public sector purchases of electric three-wheelers, electric four-wheelers, and electric buses, as well as private purchases of electric two-wheelers. To be eligible for the subsidies, the products must use locally sourced components.*

Approved List of Models and Manufacturers (ALMM)

Since the conclusion of the LCR program, the Indian government has used public sector procurement to incentivize domestic solar manufacturing. Starting in 2021, the government requires that solar development projects bid out by the government source panels from the ALMM. As of March 2022, the ALMM did not include any foreign manufacturers (Minocha, 2022).

Tariffs on Solar Products

Starting in 2018, India introduced significant tariffs on solar module and cell imports. Initially, the tariffs were set at 25% and applied only to imports from China, Malaysia, and Chinese Taipei; additionally, the tariffs were scheduled to decrease over time, to 14.5% in 2021. Yet, in 2022, the tariffs were increased to 40% for solar panels and 25% for solar cells, as well as changed to a basic customs duty applying to all imports.

Remissions of Duties or Taxes on Export Products (RoDTEP)

The RoDTEP Scheme provides a 0.8% credit rebate on all wind turbine parts exported out of India. It was announced in January 2021 to replace the Merchandise Exports from India (MEIS) Scheme; when this occurred, the credit rebate for wind turbine parts was reduced from 2% to 0.8% (GWEC, 2023b). The scheme was recently extended to last until June 2024 (of Commerce & Industry, 2023).

National Green Hydrogen Mission

This program aims to develop green hydrogen production capacity of at least 5 MMT per annum, using financial incentives for manufacturing of green hydrogen and electrolysers to do so. For biomass, India recently implemented a 5% biomass co-firing requirement for its thermal power plants, effective EY2024-25 ("Revised Biomass Policy Mandates 5% Biomass Co-Firing in Thermal Power Plants from FY 2024-25", 2024).

*However, in 2021, a whistleblower revealed that companies were flouting the localisation rule and selling Chinese electric scooters as Indian-made, resulting in the suspension of the program for certain companies ("India Is Not Keen on $1 Billion Electric Vehicle Plan of China's BYD", 2023).

2.5. Research has focused on the 2014-2017 local content requirement for solar.

Research on Indian policy efforts to establish an indigenous CE supply chain has focused on the local content requirement (LCR) program that was deployed under the National Solar Mission (NSM) from 2014-2017, at which point it was discontinued as a result of a WTO dispute filed by the United States (Karttunen & Moore, 2018). The NSM LCR program was one of the earliest efforts by a national government (especially of a developing country) to use industrial policy to achieve climate goals and grow a domestic CE manufacturing sector. Given its importance, the LCR program has been the subject of significant scholarly inquiry.

The results appear somewhat mixed. Probst et al., 2020 find that projects with LCRs had the same realization rate as other projects and did not suffer delays. They also found a positive impact on domestic solar PV patenting and installed manufacturing capacity. On the other hand, they found that the projects were more expensive and that there was no effect on Indian firms' domestic or international market shares.

Scheifele et al., 2022 also find that the LCRs had no effect on solar exports in India. Münch and Scheifele, 2023 find no evidence of an effect on solar patents or sales, looking at firms that won bids. Bazilian et al., 2020 provide a descriptive assessment of the impact of Indian LCR policy on the development of local manufacturing and local companies, finding mixed success.

There has been some limited scholarly inquiry into other Indian CE policies in terms of their effect on domestic manufacturing and trade. Garg and Saxena, 2022 use a structural model to estimate the welfare losses suffered by downstream industries and consumers as a result of solar tariffs as compared to the PLI scheme. They find that tariffs are much more costly than subsidies. Krishna et al., 2023 find that various market-creation measures, including the National Solar Mission, have driven increasing local start-up activity in the "renewable energy sources" sector. In a descriptive review of the National Solar Mission, Behuria, 2020 notes that tariffs were ineffective in fostering a domestic solar manufacturing sector and would have needed to be higher to be effective.

It is clear that there are a great number of topics in the India-China CE trade that are ripe for further inquiry, which we turn to in the next section.

3. **SURVEYING THE DATA LANDSCAPE**

A main objective of the ARETIC initiative is to collect and centralize the available data in this area. There are many sources of data that can help answer outstanding questions on the effect of policy on CE trade and deployment, but there has not yet been a systematic assessment of the data landscape. Table 3.1 summarizes a selection of key data sources related to clean energy trade between India and China.[1]

As part of the data collection effort, we have collated trade volume data from the India Department of Commerce and tariff data from Indian Customs to analyze trends over time (CBITC, 2023; of Commerce and Industry, 2024). Thus far, the academic studies on India's CE trade policy have relied mainly upon the OECD and CEPII trade data (Scheifele et al., 2022) or on trade data from UN Comtrade (Garg & Saxena, 2022). Our trade and tariff data are measured at the monthly level and cover 2012-2024.

Another empirical contribution we make is to bring in more granular definitions of CE product categorizations. Scheifele et al., 2022 – building on Surana et al., 2020 and Mealy and Teytelboym, 2022, who themselves draw on lists from the OECD, WTO, and APEC – classify CE-related products at the HS6 product code level. This is because generally, tariffs and duties are assessed at the HS6 level. However, this leads to the challenge of classifying codes that encompass products with both CE and non-CE applications. For example, HS6 code 730820 includes goods in the category of "Iron or steel; structures and parts thereof, towers and lattice masts." Products in this category are important inputs to wind turbines, but it carries other uses as well. As a result, estimates of CE trade volume at the HS6 code level are likely overstated (or understated, if ambiguous codes are excluded).

To gain a more precise picture of CE trade trends, we leverage tariff and trade data at the more granular HS8-digit level. We first identified HS8 product codes that fall into one of seven CE trade categories: solar, wind, nuclear, hydroelectric, biomass, batteries, and EVs. We restrict qualifying codes to those that are clearly related to clean energy production; products with other potentially environmentally beneficial uses are not considered. We also referred to the US Energy Trade Dashboard Data Dictionary for sub-sector product descriptions. This results in a total of 102 categories of products that we identify as CE-related. Table A.2 in the Appendix contains the full list of HS8 code categorizations.

[1] A selection of clean energy datasets related to non-trade areas such as policy, deployment, and markets is provided in Table A.1 in the Appendix.

3.1. Trends in CE Trade Volume

Figures 3.1 and 3.2 summarize monthly trends in CE exports from China to India and in India's solar imports for its top 5 trading partners, respectively (the charts reflect rolling averages).
For most of the period under observation, solar is the largest traded CE sector. However, these trade flows are characterized by a very high degree of volatility. While the highest volume occurred between 2016 and 2018, the relatively lower volumes that occur after 2018 are punctuated by spikes in 2022 and 2024 (although not to the highest levels seen in 2017-2018). Although commentators have speculated that changes and general uncertainty in the policy environment affect trade volume, research investigating the reason(s) behind the striking peaks and valleys is needed.

Aside from solar, it is notable that there has been a steady increase in battery imports by India from China, reflecting their growing importance in the EV sector and for CE storage. For a period in 2022, trade volume in batteries even exceeded that of solar before it was overtaken again by solar. There has also been a slight, but noticeable increase in Indian imports of wind-related goods, which is notable since India has historically been known for having a robust domestic wind manufacturing sector. The EV and hydroelectric trades remain modest relative to the more established CE markets.

Meanwhile, Figure 3.2 shows that China is by far the largest player when it comes to India's trade in solar. It does not appear to be the case that drops in Chinese imports are offset by increases in imports from other trade partners. Rather, it appears more likely that demand is met by a combination of domestic suppliers and Chinese panels stockpiled from earlier periods, although it could also mean that lower imports correspond to a decline in the rate of solar installations. In turn, this last scenario could mean that there are shortfalls in the supply of solar components and panels stemming from supply chain or policy-related bottlenecks, or that there is simply a contraction of the solar market stemming from demand-side factors.

Next, we investigate India's CE Exports. While India's CE export sector is much smaller than China's, it is nonetheless an important player in many international CE markets. First, Figure 3.3 shows trends in India's exports to China. Comparing to Figure 3.1 shows that monthly exports from China to India greatly exceed those from India to China, sometimes by a multiple of ten or more.

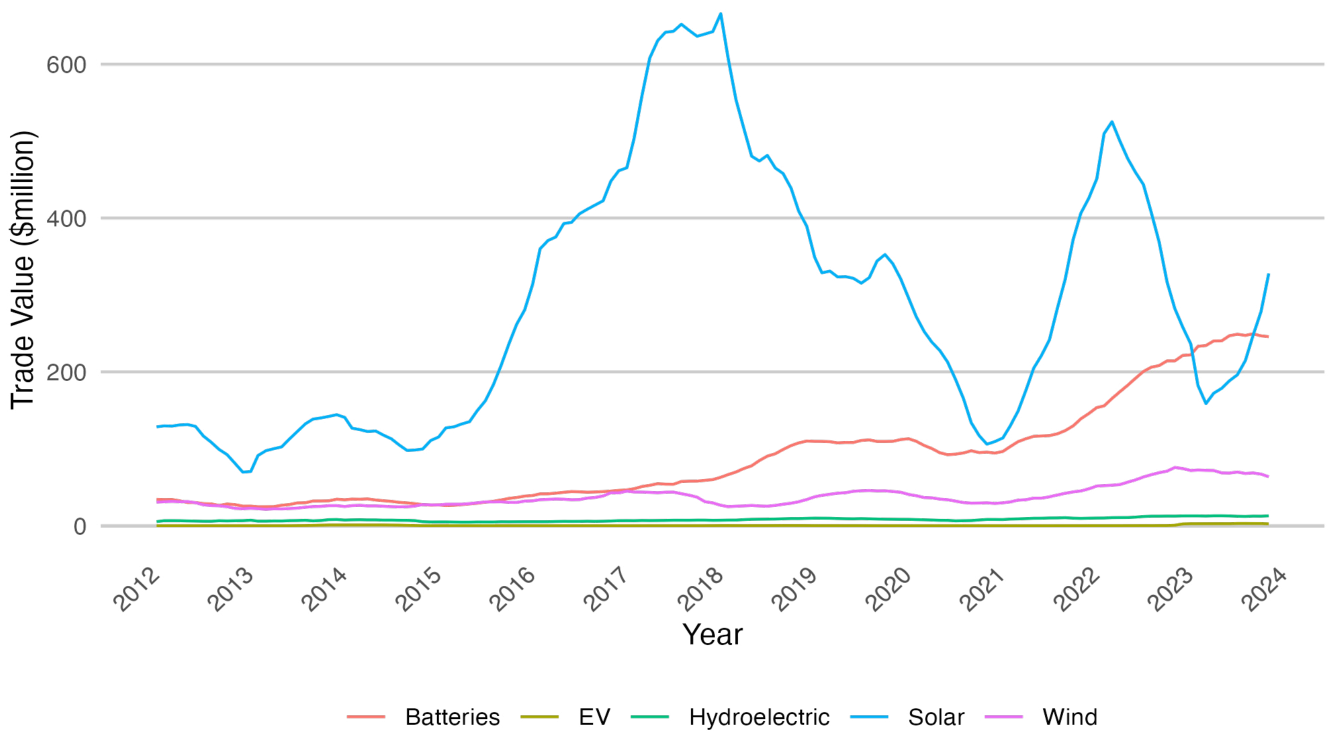

Figure 3.1.: India's CE Import Volume from China

Source: Export Import Data Bank, Ministry of Commerce and Industry, Government of India

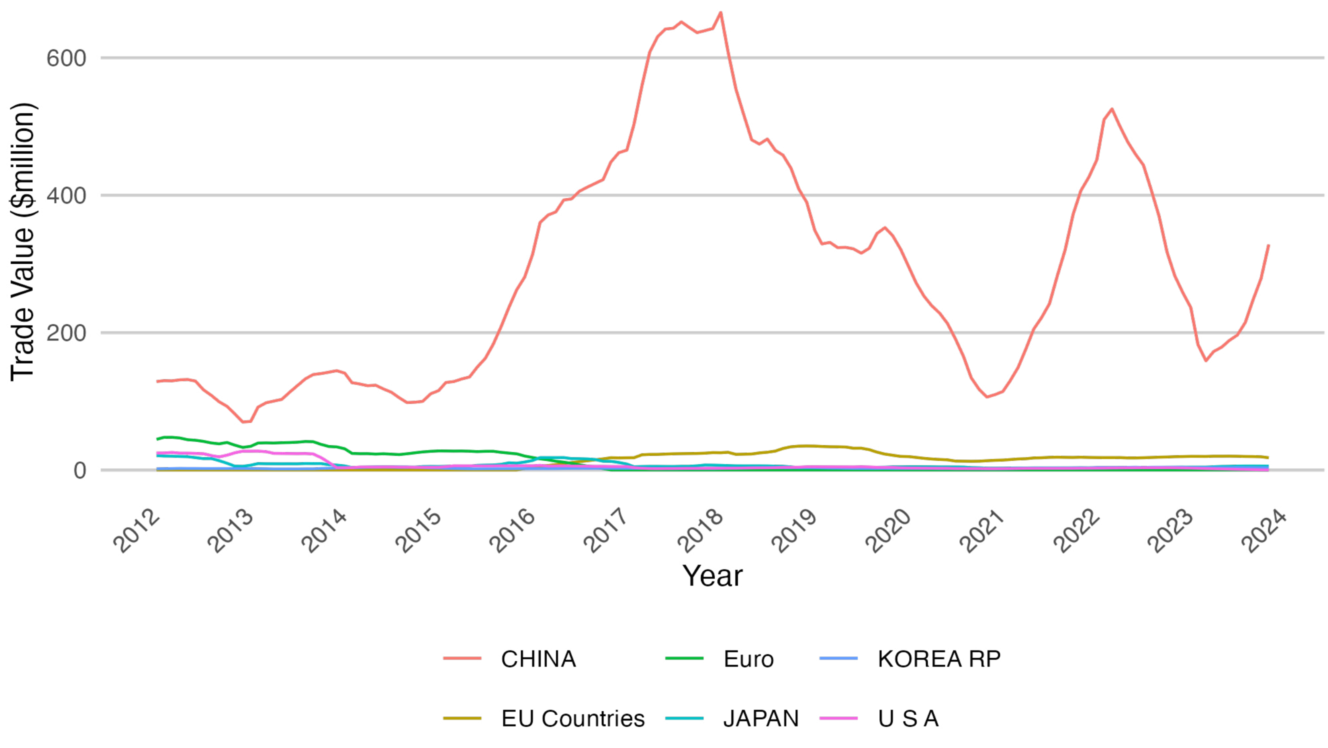

Figure 3.2.: India's Solar Import Volume from Top 5 Trade Partners

Source: Export Import Data Bank, Ministry of Commerce and Industry, Government of India

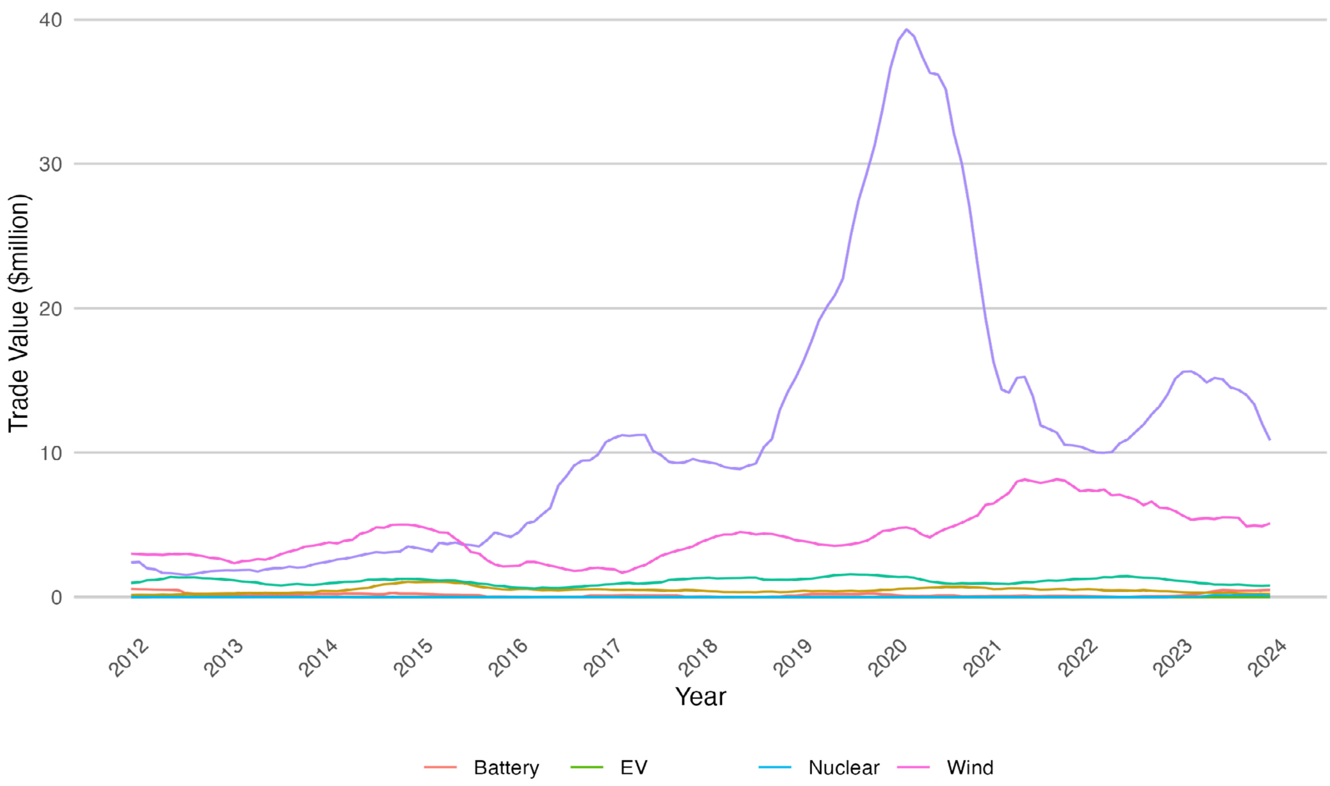

Figure 3.3.: India's CE Export Volume to China by Sector

Source: Export Import Data Bank, Ministry of Commerce and Industry, Government of India

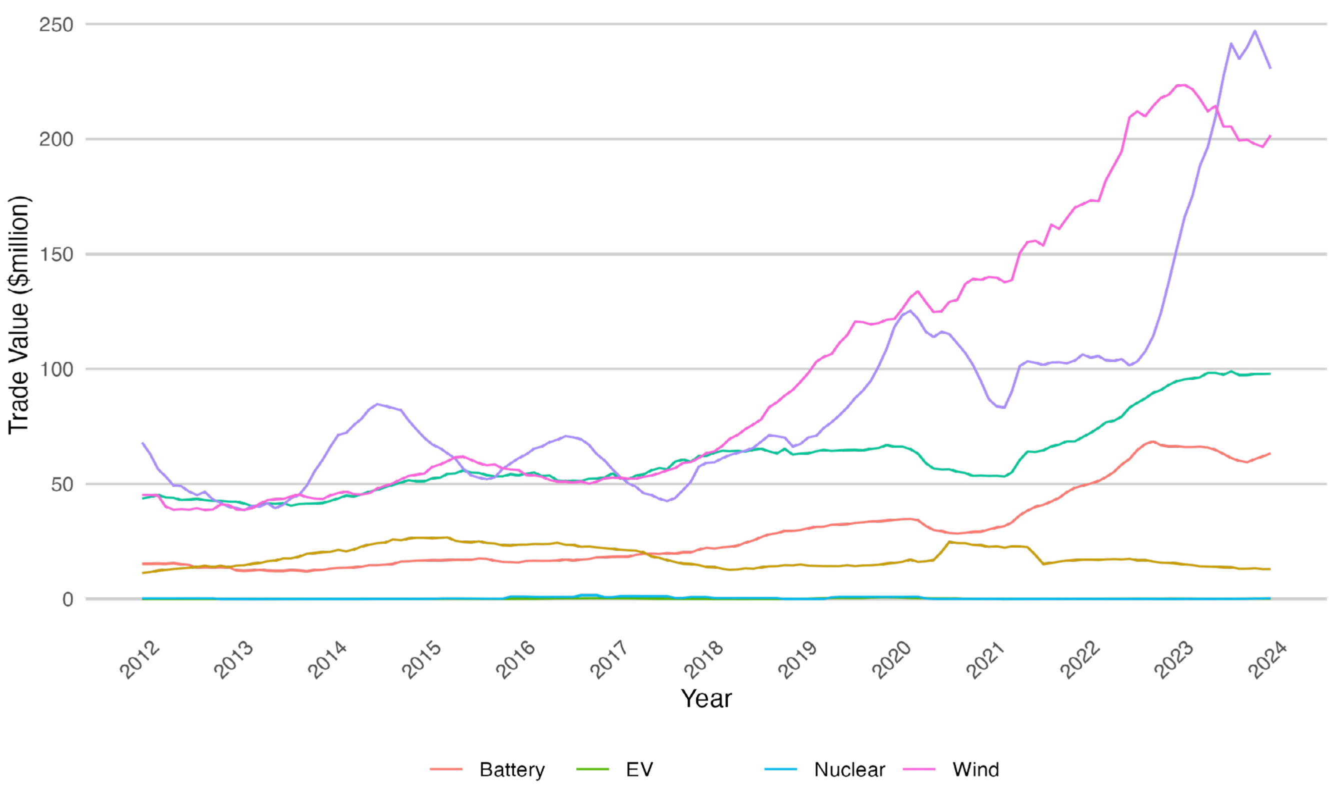

Figure 3.4.: India's Total CE Export Volume to the World by Sector

Source: Export Import Data Bank, Ministry of Commerce and Industry, Government of India

Nonetheless, there are decently sized trade flows in wind and solar markets. Solar exports from India to China saw a sharp spike in 2020, peaking at ~$40 million at one point in 2020. This peak was short-lived, however, as trade flows quickly reverted back to levels in line with the previous trends. This particular spike does not appear to have garnered a great deal of attention from the news media or researchers. One possible explanation is that it reflects changes in exports from Chinese-affiliated solar manufacturing facilities in India, which have been subject to intense political scrutiny in the last few years ("India Is Not Keen on $1 Billion Electric Vehicle Plan of China's BYD", 2023; "Reliance in Fray as MG Motor Looks to Sell India Ops", 2023).

Figure 3.4 shows trends in India's total CE exports to the world by sector. Wind and solar have consistently dueled for the spot of largest CE export sector, with solar as the largest as of the most recent data. Both sectors have seen significant growth during the period under observation, especially since around 2018-2019. Solar in particular saw a significant jump from late 2022 to early 2023. This change was not driven by exports to China, looking trends for that period in Figure 3.3.

The steady growth in India's wind exports –especially since 2018 – is notable given the prevailing perception that Indian firms used to be a significant player in international markets, but are now being out-competed by Chinese firms. Though India's total wind production capacity remains much lower than China's (GWEC, 2023b), this trend indicates that India is steadily increasing its competitiveness in international markets.

Meanwhile, India's battery and EV exports, though significantly lower in total volume than wind and solar, have also grown over the time period.

3.2. Trends in CE Tariffs

India's 30% tariff on solar panel imports from China has garnered headlines, but to what extent has this carried over to other types of trade in CE? To characterize the trajectory of India's CE trade policy, we construct figures reflecting the average tariff rate that India applies to HS8 products in a given CE sector. These data reflect the tariff rates applied uniformly to all countries with most favored nation (MFN) status vis-a-vis India; anti-dumping and safeguard tariffs that apply to specific countries or firms are not reflected.

Figure 3.5 shows the evolution of India's tariffs on CE imports over time. A few trends stand out. First, tariffs on solar components have been steadily increasing since 2018. Looking at Figure 3.6, which shows average tariffs on HS8 products by solar component group, we can see that the overall change in tariffs on solar is driven by increases to tariffs on solar cells and panels, as well as on inverters and transformers. These changes likely explain some of the fluctuations in import volume seen in Figure 3.1.

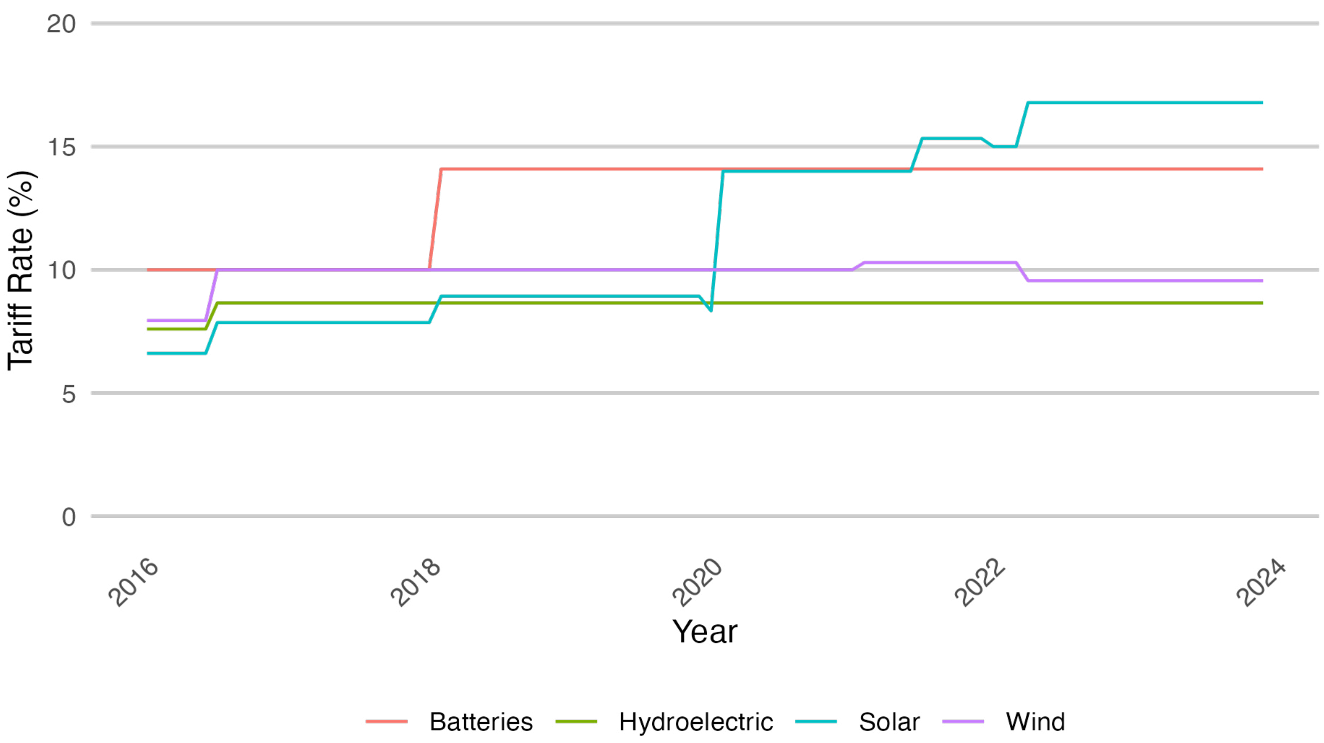

Figure 3.5.: Indian Import Tariffs by CE Sector

Source: CBIC, Department of Revenue, Ministry of Finance, Government of India

Imports of battery components have also been subject to a tariff of almost 15% that has stayed consistent since 2018. Figure 3.8 shows that this is primarily due to a tariff on lithium battery imports. Not displayed in Figure 3.5 are the extraordinarily high tariffs on EV imports, which is an artifact of high tariffs on all car imports. These tariffs range from 70-125% depending on the size, cost, and age of the car.

Figures 3.6 through 3.9 show the tariff rates of each CE sector broken into their constituent components, which themselves are aggregates of HS8-level products. The solar industry shows the most temporal and cross-component variation in tariff levels, perhaps reflecting its unique importance as a traded CE good. The EV sector is notable for its extremely high tariff levels, which again are an artifact of high tariffs on vehicle imports generally. Most components in other CE sectors see tariffs that hover in the range of 10-15%.

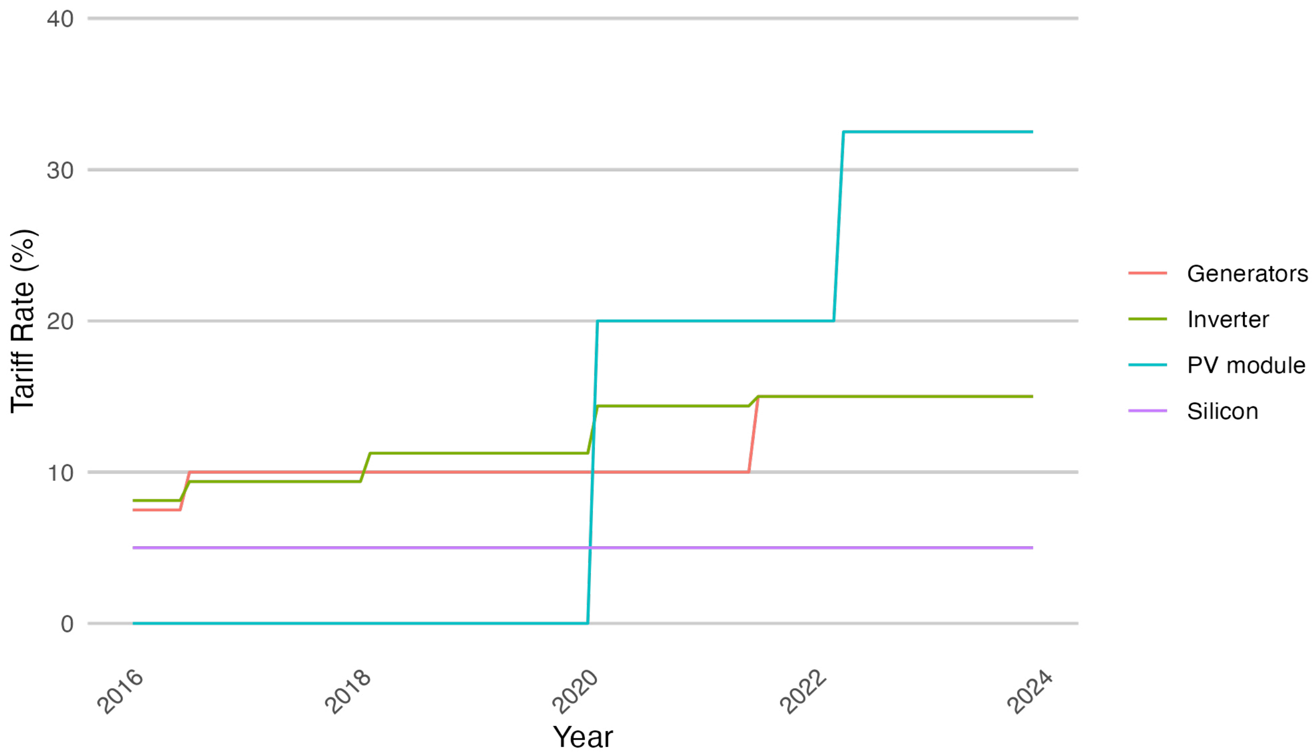

Figure 3.6.: Indian Tariffs on Solar Components

Source: CBIC, Department of Revenue, Ministry of Finance, Government of India

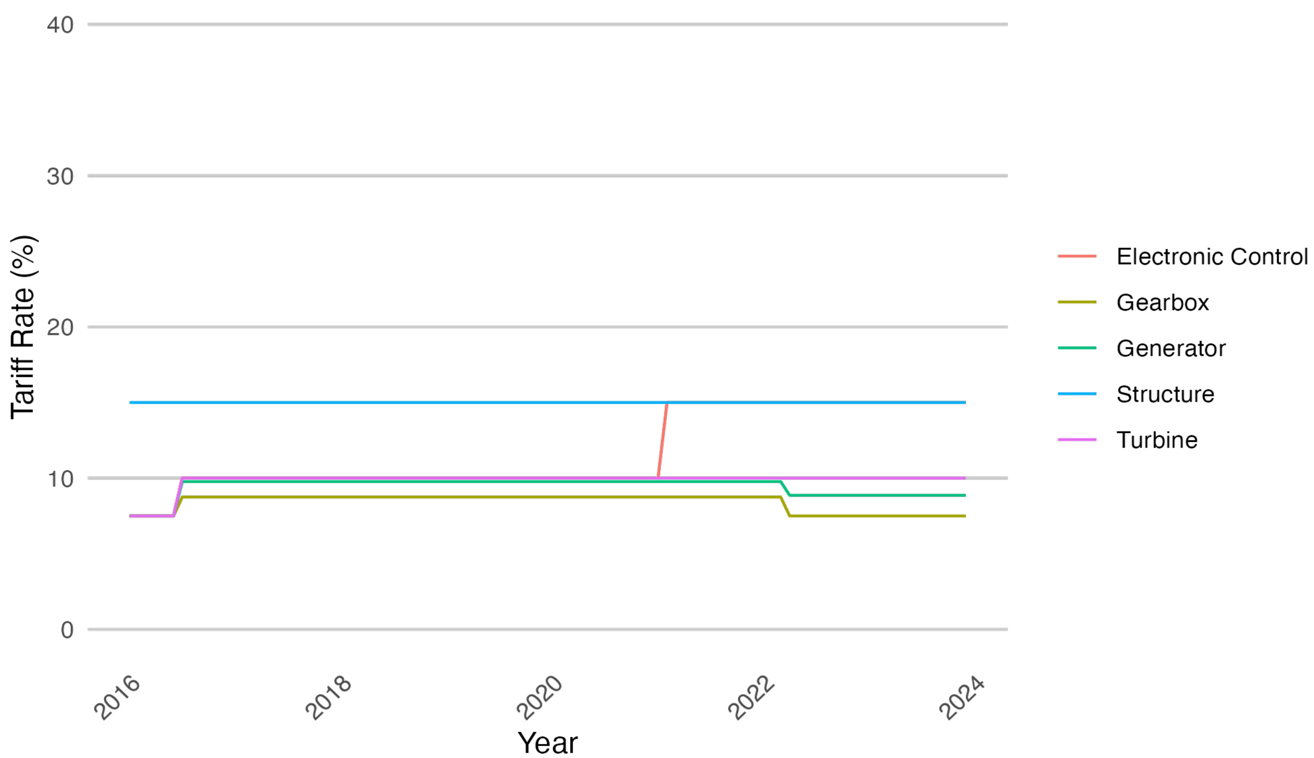

Figure 3.7.: India Import Trade Value by Component

Source: CBIC Department of Revenue, Ministry of Finance, Government of India

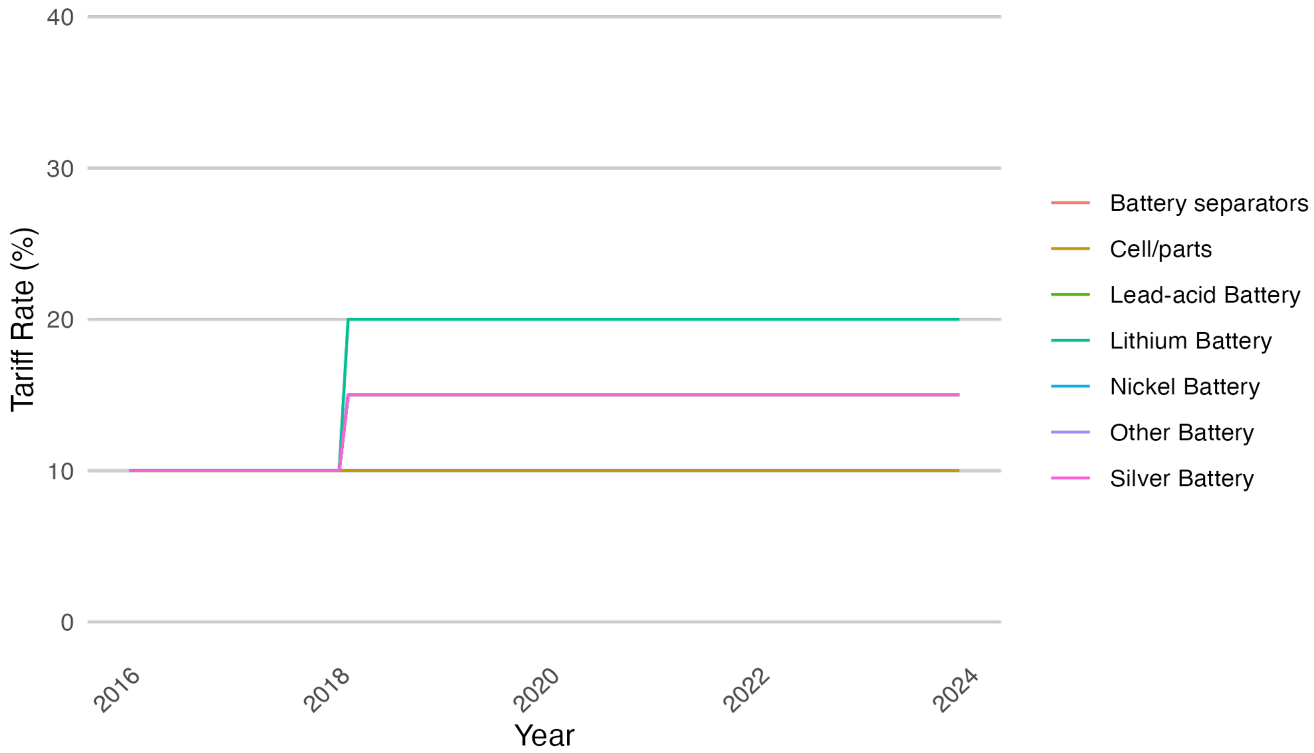

Figure 3.8.: Indian Tariffs on Battery Components

Source: CBIC, Department of Revenue, Ministry of Finance, Government of India

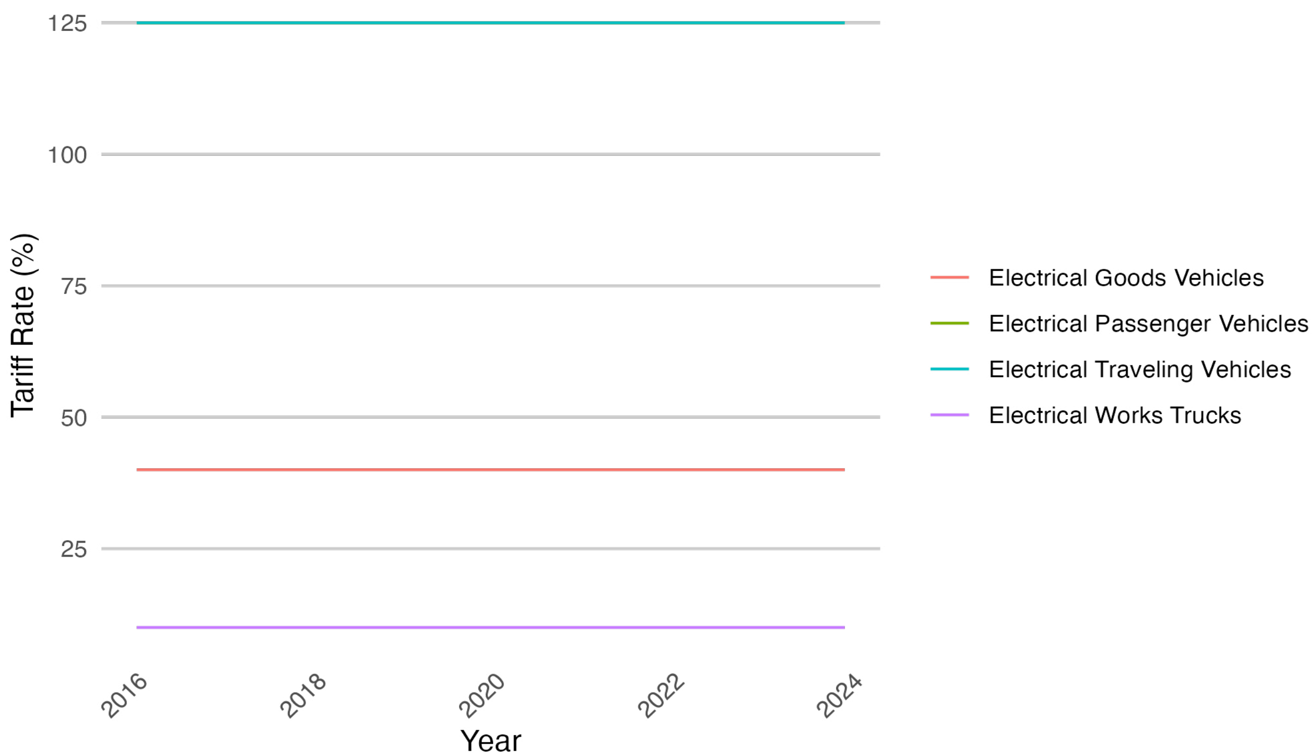

Figure 3.9.: Indian Tariffs on EV Components

Source: CBIC, Department of Revenue, Ministry of Finance, Government of India

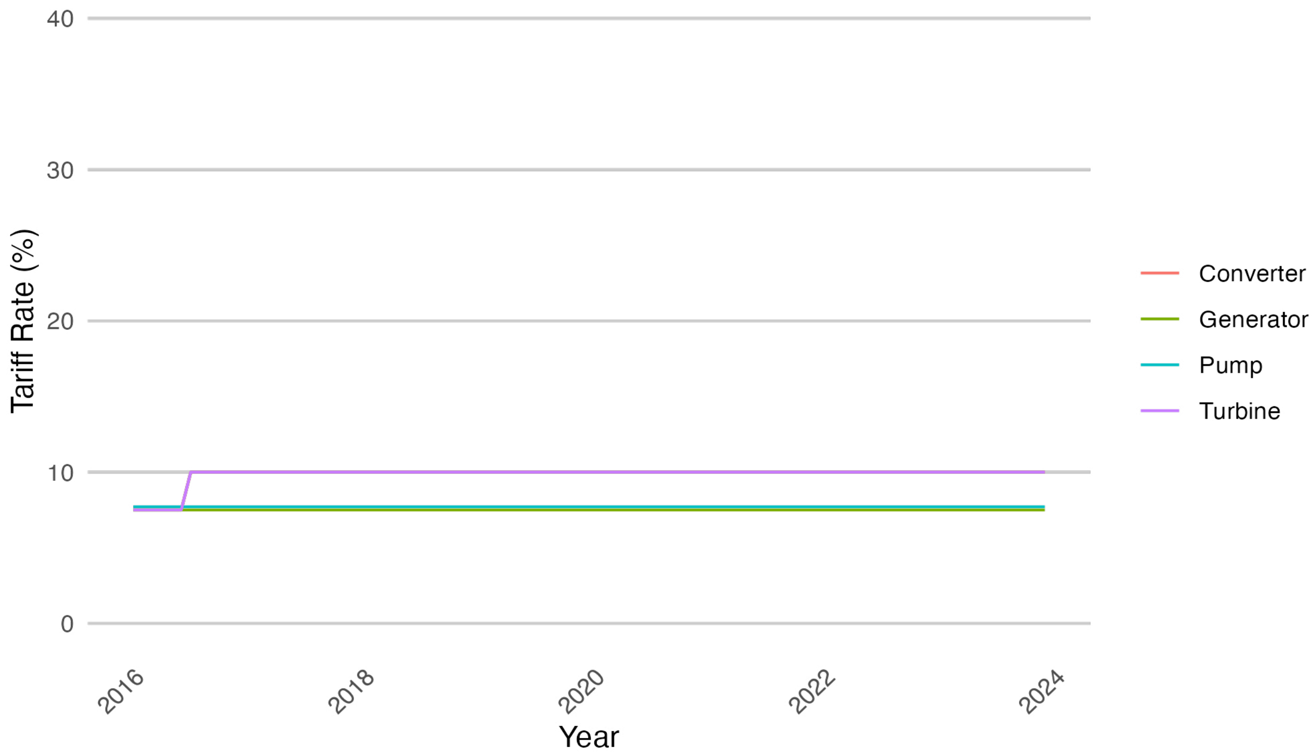

Figure 3.10.: Indian Tariffs on Hydro Components

Source: CBITC, 2023.

Name	Organization	Description	Used by:
UNCTAD TRAINS	WITS	MFN and Applied Tariff at the HS 6 digit level	
China's Customs Data	Self-collected	Custom data at firm-year level	
GTA database	Global Trade Alert	52500+ records of unilateral commercial policy interventions	
World Integrated Trade	World Bank	Product-country level trade w/ sources, destinations, & tariffs	
Solution Volza Grow Global	Volza	Global export/import data for 78+ countries	
India Solar Export Import Tracker	Mercom India	Monthly solar trade	
UN Comtrade	UN	Global annual and monthly trade statistics by product and trading partner	Garg & Saxena (2022)
ITPD-E	US ITC	Agriculture, mining, energy, manufacturing, and services trade data	
CHELLEM Trade	CEPII	Bilateral flows on all traded goods	
Trade Unit Value	CEPII	Trade unit values (in USD/ton) at year-reporter-partner-product level	
Trade in Value-Added (TiVA)	OECD	Country-level value added data	
BACI	CEPII	Bilateral trade flows for 200 countries at the 6 digit product level	Scheifele et al. (2022)
Trade Data	OEC	Trade data for 5018 products on 6-digit HS code level	Scheifele et al. (2022)
China Overseas Solar PV Database	N/A	China's overseas trade and investments in PV technology and projects	Jackson et al. (2021)
EXIOBASE	UN	Environmentally extended multi-regional input-output (EE MRIO) tables	Joseph (2021)
World Trade Flows Characterization	CEPII	Reconciled unit values at the year-exporter-importer product level	
ICIO Tables	OECD	Input, output and final demand for industries in countries	
Trade and Foreign Economy	EPS China Statistics	Monthly and yearly trade value data on product and ownership level	
Export-Import Data Bank	India DoC	Monthly and yearly trade value data	Mondal (2024)
TradeProd	CEPII	International and domestic trade flows and trade protection	

Figure 3.9.: Indian Tariffs on EV Components

4. **KEY QUESTIONS**

The combination of growing trade tensions with China, the mounting imperative to de-carbonize energy systems, and India's roll-out of policy initiatives designed to grow its domestic CE manufacturing sectors means that there are many questions that are both important and understudied in the realm of India & China's CE trade.[1] A selection of clean energy datasets related to non-trade areas such as policy, deployment, and markets is provided in Table A.1 in the Appendix.

4.1. What are the main policy & market factors driving trade patterns?

There are a host of developments in CE policy and markets that have an effect on the trade in related goods between India and China. It is crucial to understand which developments matter and in what ways. For example, the relative impact of explicitly trade- oriented policies such as tariffs versus industrial policies that target particular sectors on trade volume, domestic welfare, markets shares, innovation, and other outcomes are important and evergreen questions. We can also draw comparisons between India's and China's policy objectives to see the extent to which they are counteracting each other or working together to produce observed trends.

It is clear that markets for CE goods are changing as a result of policy and market forces. Our figures (Figure 3.1 and Figure 3.2) show the high degree of volatility in India's solar imports from China. While our data go to the end of 2022, news reports note that solar modules import from China are down 80% in the first half of 2023, totaling $2b in value (Tiwari, 2023). At the same time, in the last 2-3 months from the time of writing, solar imports from countries with whom India has free trade agreements increased by 48%.

Some reports have attributed falling solar imports to the tariffs that India has placed on solar panels and components (Gera et al., 2023). However, such evidence is purely descriptive – it is not clear if or how tariffs are actually affecting imports, and how the effect of tariffs interacts with (or perhaps, is superseded by) other policies that India has in place to incentivize domestic manufacturing.

What has been the impact of the tariffs on the volume of trade between India and China? How does this effect compare that of the range of domestic industrial policies and incentives that India has enacted?

4.2. How is Indian CE trade policy affecting product prices & the pace of deployment?

Ultimately, the CE trade matters most insofar as it affects the rate at which countries are able to achieve decarbonization. However, the role of trade policy in advancing decarbonization is nuanced.

Policymakers face a complex problem in managing the dual objectives of achieving rapid deployment of renewables and growing indigenous manufacturing capacity. While pro- viding local benefits is key to making decarbonization politically viable, the cheapest products (and thus, those that can be deployed most rapidly) are currently manufactured by China.

Attempts to tax CE imports and/or mandate that a certain proportion of components be sourced locally can thus have the effect of driving up product prices in the Indian market and slowing CE deployment. As a result, attempts to protect domestic industry from Chinese imports can help grow domestic manufacturing capacity, but may also raise costs and reduce the pace of deployment.

How are Indian policymakers managing the cross-cutting imperatives of decarbonization and supporting the domestic CE industry? Historically, Bhatia, 2023 characterizes this as a tension that was resolved in favor of "the deployment of mature CE technologies at the lowest cost over support for indigenous innovation and manufacturing" (p. 9) in the 2000s and 2010s.

Recent tariff increases on solar products, as well as the various "Made in India" policy initiatives highlighted in Chapter 1, suggest that this orientation might be changing. If so, it raises the question of how these policies have affected local prices and rates of deployment. It could be the case that changes in the policy environment are being managed so as not to affect the business of CE developers – or, it could be that prices are fluctuating and deployment is becoming more challenging.

In terms of current trends, we know that Indian solar imports from China are down recently (Tiwari, 2023). Some commentators have been quick to characterize this as evidence of an increasingly competitive Indian solar sector. However, it is not clear whether this decrease has actually been made up by increased domestic production. Other reporting notes that the tariffs may be rolled back in response to pressure from the finance ministry ("Reliance in Fray as MG Motor Looks to Sell India Ops", 2023) andthat India undershot its 2022 renewable energy installation target by 30% "amidst solar module supply shortages" (Norman, 2023).

The report also notes that solar projects in 2023 were expected to be delayed or canceled due to supply chain issues. The precise nature of the "supply chain issues" and how (or whether) they are driven by the recent tariff increases is unclear.

We can extend this question to other areas of CE trade as well. Though the traded volumes are smaller than solar, other CE sectors carry similar market dynamics where tariffs can help local manufacturers, but may result in shortfalls or decreasing deployment.

Leveraging data on trade & deployment and careful investigation into policy implementation could potentially illuminate these questions. In general, the question of how at- tempts to re-shore CE manufacturing and decrease dependence on China affect prices and rates of deployment has broad importance for India's longer-term decarbonization trajectory, as well as the decarbonization efforts of other countries. As policymakers seek to find politically viable ways to decarbonize, it will be necessary to understand which policy instruments are best positioned to meet the dual objectives of supporting domestic green industry and reducing emissions.

4.3. How is Indian CE trade policy affecting product prices & the pace of deployment?

The well-studied solar LCR policy was discontinued by the Indian government in 2017. However, our investigation into India's CE industrial policy reveals that there are a number of policies in place that seek to achieve similar ends to the discontinued LCR policy.

For example, the ALMM requires that the public sector source panels from a list of manufacturers that does not include any foreign companies. The Indian government notes that there are active solar projects that are "mandated to source their requirement of [sic] solar cells & modules from domestic sources, in a WTO compliant manner": the 12000 MW - Government Producers Scheme (CPSU Scheme), KUSUM Scheme, and New Roof-top Scheme (MNRE, 2023).

Meanwhile, "Make in India" requires that offshore wind projects source 80% of their components locally (Bazilian et al., 2020). As with the ALMM for solar, the wind sec- tor is also subject to a "Revised" List of Models & Manufacturers that are approved for manufacturing.

Have these newer iterations of LCR been effective in supporting domestic CE manufacturing? Could they potentially lead to WTO disputes in the future?

4.4. Where can India compete in international markets?

India has policies that target nearly every product area in the CE trade, and it remains to be seen which will be most effective in terms of allowing its firms to gain a global foothold. Historically, India's wind manufacturers were some of its most competitive, but its share of global manufacturing capacity has steadily eroded over time as India has lost ground to China. On the other hand, our data show that this does not mean that India's wind sector is shrinking; in fact, in total export volume, the wind sector has steadily grown (Figure 3.4).

Perhaps the most substantial policy efforts have been made in solar, where India is positioned well in terms of its manufacturing upside. Like the wind markets, Indian solar exports have grown in volume as firms appear to have benefited from U.S.-China trade tensions. But also, like wind, Indian market share remains much smaller than that of China's.

It is especially interesting where India might position itself in more nascent markets for goods such as electric two- and three-wheelers, biofuels, and hydrogen, which have all been the target of some policy intervention. In the case of electric vehicles (EVs), the FAME initiative (which we highlighted in Chapter 1) is perhaps the flagship CE policy initiative designed to under Modi's broader "Make in India" policy. Another signature program of Modi's administration is the National Green Hydrogren Mission.

Though these policies receive less attention than attempts to compete in more established markets such as solar, given that all countries are starting from a similar place on the learning curve in these nascent markets, there may well be more opportunity for India to successfully compete globally.

5. **CONCLUSION**

The clean energy trade relationship between India and China is crucial for the success of decarbonization in both countries – and by extension, the world. Each country needs to deploy massive amounts of CE technology to reduce their emissions, which will require obtaining cost effective and high-quality CE goods. As two of the largest economies in Asia, trade policy between India and China will thus be crucial in determining the trajectory of international markets and supply chains for CE goods, with massive implications for the world's ability to meet Paris climate goals.

The development of the India-China trade relationship also carries very important implications for both domestic and international climate politics. In India (as elsewhere), the political viability of decarbonization is tied to the local benefits it provides to domestic interest groups. As a result, India's ability to grow its domestic CE manufacturing sector to compete with China will shape the politics of climate policy in the country moving forward. Internationally, other countries face similar pressures to diversify CE supply chains and reduce dependence on China, for reasons of geopolitical competition and – given how dominant China is – to insure against the risk of supply shocks. Again, the trajectory of India's trade relationship with China and the effect on its domestic CE industry will have a large impact on global markets and policy.

Given the significance of the issue, both China and India have implemented a range of policy initiatives to affect the composition of CE trade. This report highlights the most important policies, gathers the available data in the area, provides descriptive findings regarding CE trade volume and tariffs, and identifies some of the most crucial policy questions going forward. Our hope is that researchers and policymakers can leverage this information to conduct further inquiry into the state of the India-China trade relationship, investigate the effects of trade policy, and provide recommendations for future policy initiatives.

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A. **APPENDIX**

4.4. Where can India compete in international markets?

Name	Organization	Type	Description	Source
UNCTAD TRAINS	WITS	Customs	MFN and Applied Tariff at the HS 6 digit level	
China's Customs Data	self-collected	Customs	Custom data on firm-year level, exports and imports	
PV Directory	ENF	CE Markets	Database of firms operating in solar industry	
Product Database	ENF	CE Markets	Solar product - firm mapping	
Directory Indian Windpower	CECL	CE Markets	Comprehensive data on wind potential sites	
Project database	Bridge to India	CE Markets	All utility scale solar and wind projects in India	Garg & Saxena (2022)
Rooftop project database	Bridge to India	CE Markets	Solar project info (size, location, etc.)	
Tender tracker	Bridge to India	CE Markets	Comprehensive record of all solar and wind tenders	Garg & Saxena (2022)
Price indices	Bridge to India	CE Markets	Solar auction tariffs and prices of all key components	Garg & Saxena (2022)
Mergent Intellect	FTSE Russell	CE Markets	All major solar PV firms active in India	
BloombergNEF	Bloomberg	CE Markets	Commodity prices, deployment & installation, policy, ESG	Garg & Saxena (2022)
Climatescope	BloombergNEF	CE Markets	Installed capacity by sector & generation by sector	
India Infrastructure Research	India Infrastructure	CE Markets	RE Market Reports	
India Solar Project Tracker	Mercom India	CE Markets	Comprehensive database of large-scale solar projects	
India Solar Tender Tracker	Mercom India	CE Markets	Large-scale solar and rooftop solar project tenders	
Renewable Power Generation Costs	IRENA	CE Markets	Global weighted average cost of solar & wind projects	
International Renewable Energy Agency	IRENA	CE Markets	Misc. RE finance & investment	
Financing and M&A	Bridge to India	Finance	M&A transactions, equity investments, etc.	
India Solar Market Share Tracker	Mercom India	Finance	Top solar players, installations, etc.	
Derwent Innovations Index	Clarivate	Patents	Information on patent activity	
Policy database	Bridge to India	Policy	RE sector policy, central and state govt	
Renewable Energy Regulatory Updates	Mercom India	Policy	Indian renewable energy regulations	
Overview of LCR in wind and solar projects	N/A	Policy	Authors' elaboration from policy documents	Scheifele et al. (2022)
GTA database	Global Trade Alert	Policy	Records of unilateral commercial policies	

Table A.1.: Clean Energy Datasets (Non-Trade)

A.2 HS8 Code Classifications by CE Sector

CE Category	HS8 Code	Component
Wind	73082020	Structure
Wind	84128020	Turbine
Wind	84128030	Turbine
Wind	84834000	Gearbox
Wind	85016100	Generators
Wind	85016200	Generators
Wind	85016300	Generators
Wind	85016410	Generators
Wind	85016420	Generators
Wind	85016430	Generators
Wind	85023100	Gearbox
Wind	85023920	Generators
Wind	85030010	Generators
Wind	85030021	Generators
Wind	85030029	Generators
Wind	85030090	Generators
Solar	90328910	Electronic Control
Solar	85013120	Generators
Solar	85013220	Generators
Solar	85013320	Generators
Solar	85044010	Inverter
Solar	85044021	Inverter
Solar	85044030	Inverter
Solar	85044040	Inverter
Solar (22-23)	85414200	PV module
Solar (22-23)	85414300	PV module
Solar	85045010	Inverter
Solar	85045090	Inverter
Solar	85049010	Inverter
Solar	85049090	Inverter
Solar (16-19)	85414011	PV module
Solar (20-21)	85414011	PV module
Solar (20-21)	85414012	PV module
Solar	28046100	Silicon
Hydroelectric	84101100	Turbine
Hydroelectric	84101210	Turbine
Hydroelectric	84101220	Turbine
Hydroelectric	84101310	Turbine

Hydroelectric	84101320	Turbine
Hydroelectric	84101390	Turbine
Hydroelectric	84109000	Turbine
Hydroelectric	84122100	Generator
Hydroelectric	84122910	Generator
Hydroelectric	84122990	Generator
Hydroelectric	84135010	Pump
Hydroelectric	84135021	Pump
Hydroelectric	84135029	Pump
Hydroelectric	84138110	Pump
Hydroelectric	84138120	Pump
Hydroelectric	84138130	Pump
Hydroelectric	84138190	Pump
Hydroelectric	84139110	Pump
Hydroelectric	84139120	Pump
Hydroelectric	84139130	Pump
Hydroelectric	84139140	Pump
Hydroelectric	84139190	Pump
Hydroelectric	85042100	Converter
Hydroelectric	85042200	Converter
Hydroelectric	85042310	Converter
Hydroelectric	85042340	Converter
Battery	85064000	Silver Battery
Battery	85069000	Cell/parts
Battery	85073000	Nickel Battery
Battery	85074000	Nickel Battery
Battery	85075000	Nickel Battery
Battery	85076000	Lithium Battery
Battery	85078000	Other Battery
Battery	85079010	Battery separators
Battery	85079090	Battery separators
Battery	85071000	Lead-acid Battery
Battery	85072000	Lead-acid Battery
EV	87091100	Electrical Works Trucks
EV	87031010	Electrical Traveling Vehicles
EV (17-23)	87039000	Electrical Passenger Vehicles
EV (16)	87039010	Electrical Passenger Vehicles
EV (16)	87039010	Electrical Goods Vehicles

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