TITLE

The Evolution and Future of the Indian Carbon Market: Challenges, Opportunities, and Policy Frameworks

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Abstract

Climate change mitigation has become a global concern and countries have adopted carbon markets, as one of the mitigation measure to address the climate change. India has also come up with its domestic carbon market in the form of Indian Carbon Market. This paper examines the evaluation of the Indian carbon market drawing lessons from international carbon markets of USA, Europe and China. The paper examines opportunities and challenges in aligning Indian carbon market with the International carbon markets. The paper examines the policy and regulatory framework, market, infrastructure, and preparedness in terms of, various stakeholders and their active involvement in the carbon market. The paper highlights some of the key requirements for stable carbon market in terms of stable regulatory environment, market trading mechanism, monitoring and verification requirements, market liquidity concerns, and aligning the Indian carbon market with international trading platforms. Findings of the paper provide favourable, insight to the policy makers in developing a domestic carbon market to align with India's decarbonisation goals.

Keywords: Carbon Markets, Decarbonization, Carbon Pricing

1. Introduction

1.1. Background

The impact of climate change has become prevalent and visible on the global stage as it manifests itself in the form of extreme weather events, water scarcity, wildfires, and high temperatures among others (Juss, 1997). NASA has reported that the past 10 consecutive years have been the warmest years to have been recorded (NASA, 2024). Greenland is losing 30m tonnes of ice in an hour and has lost a trillion tonnes of ice since 1985 from glacier retreat alone (Carrington, 2024). The global sea level has risen about 21 cm since 1880 and countries like China, Bangladesh and India are facing a threat of submergence of its coastal cities (World Economic Forum, 2024).

In response to these global threats of climate change, countries have agreed to take their shared responsibilities under the Paris agreement. The Paris Agreement is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels (UNFCCC, 2015**)**. There has been various initiatives under the Paris agreement by the countries that include aligning the country specific decarbonisation policies, adopting technology innovation and introducing a market mechanism for carbon trading. Among these, carbon trading stands out as a key policy mechanism. As a signatory in under the Paris Agreement India has also made its commitments as per the Nationally Determined Contributions (NDCs), in alignment with Article 3 of the Paris Agreement.

1.2. Importance of Carbon Markets

Carbon markets have evolved as a most promising tool for the countries in achieving their decarbonisation goals. The trading of carbon credits allows economic incentives for reducing GHG emissions. India has also attempted various policy initiatives in the form of structured policy framework to integrate market mechanisms, which help in adopting clean energy technology. Some of these initiatives have been in the form of Renewable Energy Certificate (REC), trading schemes and (Perform Achieve and Trade (PAT) schemes. Trading of carbon credit stands a promising area to promote energy efficiency and renewable energy technologies to meet India's climate change commitments under the Paris agreement. While Indian carbon market is in the nascent stage and rapidly evolving, the initial draft of Indian carbon market is

highly influenced by European Union's Emission Trading Scheme(EU-ETS), which is on the principle of cap and trade mechanism. The India's evolving carbon market requires integration with the global best practises, and come up with it's indigenous approach for balancing economic growth with environmental and sustainability.

India being one of the largest, third largest emission producer accounting for over 7% of global GHG emissions, has a critical role to play its part of contribution in GHG emission reductions. India is to reduce its emission intensity of its GDP by 33 to 35% by 2030 from 2005 levels, and will achieve 40% of its cumulative electric power from non-fossil fuel based energy resources by 2030 and has a net zero target by 2070 (Government of India, 2015). There has been many initiatives as part of its short-term medium term and long-term targets for GHG emission reduction, including governments, announcement of 500 GW renewables by 2030 (Government of India, MNRE, 2021). Drawing lessons from Europe countries and China. India is also ready with its carbon market to provide economic incentives to the projects which are reducing GHG emissions through market mechanism design in line to EU-ETS.

1.3. Research Objectives and scope

India has been second largest contributor to the UNFCCC Clean Development Mechanism (CDM) projects under These projects have played a significant role in global efforts to reduce GHG emissions (UNFCCC, 2020). There are valuable lessons available from the existing carbon markets, operating over last two decades in terms of market design, regulatory framework implementation strategies. However, there is a research gap, to address how these international experiences can be adopted in a developing country like India and align its carbon market with the International Carbon markets. This paper addresses the research gap by providing a detailed analysis of the challenges and opportunities that Indian market is expected to face during its evolving face. The paper addresses three major objectives as part of our research work, which are as follows.

A. The paper analyses the current structure and development of Indian carbon market, the existing policy framework and how it's alignment with the Global best practises.
B. The study also analyses the regulatory infrastructure and market based challenges that may affect the operationalisation of Indian carbon market.

C. The paper presents actionable insights for policymakers to enhance the design and implementation of India's carbon market in a balancing approach of development with climate goals.

2. Evolution of Carbon Markets

2.1. Genesis of Carbon Markets

Genesis of carbon market started way back in 1997 by United Nations Framework Convention for Climate Change (UNFCCC) through Kyoto Protocol ("The Carbon Market," n.d.). The Kyoto Protocol came into effect in 2005 and divided the states into two categories wherein the Annex 1 countries (having Compliance targets) and Non-Annex countries (with no compliance requirements of emissions caps). The market mechanism was known as Clean Development Mechanism (CDM) (United Nations Climate Change, 2024). India and China became the largest suppliers of carbon credits under the Kyoto Protocol CDM mechanism (Gupta, 2016).

2.2. Emergence of Regional Carbon Markets

In response to the Kyoto Protocol, in 2005, European Union launched its own European Union Emission Trading Scheme (EU-ETS) to trade between EU member countries as a cap and trade mechanism (Climate Action, 2024). In 2013 America also came up with its domestic market in the name of as California cap – and – trade system ("Cap-and-Trade Program," n.d.). Subsequently many other countries including the China also came up with their domestic carbon markets. CDM played a significant role in providing a global carbon credit trading platform as the EU ETS compliance was permitted through purchase of carbon credits from the CDM market.

2.3. Shift to Voluntary Carbon Markets

In 2012 the European union phased out its EUETS compliances through CDM which laid to the sad demise of carbon credit trading under the CDM mechanism (Kainou, 2022). This led to a global shift towards the voluntary carbon markets and the countries which were active participants in the CDM shifted towards the voluntary carbon markets. Though the Voluntary Carbon Standard (VCS) was introduced in 2007, however post 2012 most of the carbon credit trading was for voluntary compliances and market shifted from CDM to VCS as global voluntary markets. In 2016, the airline industry launched the Carbon Offsetting and

Reduction Scheme for International Aviation (CORSIA) as a part of airline industry carbon net zero aspirations (KPMG in Ukraine & United Nations Development Programme, 2022). Now many countries have their domestic carbon markets including the South Korea, China, Canada, New Zeeland etc.

The evolution of carbon market illustrate and dynamic and adaptive approach of formation of carbon trading in the countries. The learnings from CDM and VCS has played a significant role for the country specific, market mechanism development. The shift towards the voluntary carbon market and introduction of some new mechanisms such as CORSIA highlight the ongoing shift of the global carbon market from not only the International markets but the domestic markets which are aligned with regional and international trading compliances. As Indian Carbon market is in its nascent stage, the lessons learned from international experiences will be helpful in shaping the robust and effective carbon trading scheme which aligns with India's commitment to achieve net zero goal by 2070.

2.4. Emergence of Indian Carbon Markets

1.1. National Action Plan on Climate Change (NAPCC)

In 2008, Government of India launched the National Action Plan for Climate Change (NAPCC) with 8 missions which included the National Solar Mission, as well as the National for Enhanced Energy Efficiency. The aim was to address India's net zero targets through varoous initiatives. This laid the foundation of Indian Carbon Market. Under the National Solar Mission the Distribution companies were assigned Renewable Energy purchase obligations (RPO) , and Renewable Energy Certificate Trading (REC) was introduced as a market mechanism to incentivise the renewable power generators as an additional revenue stream. As part of NMEEE the GOI introduced the Perform Achieve and Trade (PAT) scheme which also laid the trading of Energy Savings Certificates (ECerts) as a market mechanism to improve the industrial sector energy efficiency through a domestic trading scheme of ECerts (BEE, n.d.).

2.5. Launch of Indian National Carbon Market

Building on the success of PAT and REC schemes, Government of India taken his significant step towards establishing the Indian national carbon market in December 2 022. The Indian

carbon market in its initial phase is focusing four sectors—iron and steel, cement, petrochemicals, and paper and pulp—to initiate carbon credit trading. The trading is expected to commence by April 2025 (Chaganti Singh, 2023). It is expected that the Indian carbon market will cover about 15% of the country's GHG emissions by 2030 and more sectors with tight regulatory forms will also be introduced. The Bureau of Energy Efficiency (BEE) is assigned the role of primary regulatory authority responsible for overall governance and implementation of the carbon market mechanism (Bloomberg, 2023).

A National Steering Committee has also been established, comprising representatives from various ministries. The role of market administrator has been assigned to the Central Electricity Regulatory Commission (CERC), which will be responsible for monitoring market transactions, ensuring transparency, and preventing market manipulation (Writer, 2023). Monitoring and verification will be carried out by State Designated Agencies (SDAs), who will ensure accurate reporting and data integrity within the carbon market.

The trading platform for carbon credits will be hosted on the Indian Energy Exchange (IEX) and the Power Exchange of India Ltd (PXIL), both of which are already facilitating the trading of Energy Saving Certificates (ESCerts) and Renewable Energy Certificates (RECs) (Ahmad & Alam, 2019). Additionally, the Government of India is exploring the possibility of linking the Indian carbon market with international markets under Article 6 of the Paris Agreement, which would enhance liquidity and promote global cooperation in carbon credit trading.

Table 1: Structure of Indian Carbon Market

Component	Role
Regulator	**Bureau of Energy Efficiency (BEE):** Acts as the primary regulatory authority responsible for the overall governance and implementation of carbon market mechanisms in India. The BEE ensures that all market participants comply with national climate policies and regulations.
Oversight Body	**National Steering Committee:** Comprising representatives from various ministries, this committee provides strategic oversight, ensuring that the carbon market aligns with India's national policy objectives and international climate commitments.
Market Administrator	**Central Electricity Regulatory Commission (CERC):** Administers the carbon credit trading scheme, monitors market transactions, ensures transparency, and prevents market manipulation. CERC also oversees the cap-and-trade mechanism and carbon offsets.
Market Participants	**Industries in Specific Sectors:** Initially, companies in the iron and steel, cement, petrochemicals, and paper and pulp sectors are obligated to participate in the carbon credit trading scheme, starting by April 2025. These industries must meet specific carbon reduction targets or purchase carbon credits.
Monitoring and Verification	**State Designated Agencies (SDAs):** These agencies are responsible for monitoring and verifying compliance with carbon market rules. They ensure accurate reporting, data integrity, and adherence to energy efficiency and carbon reduction targets.
Trading Platform	**Indian Energy Exchange (IEX) and Power Exchange India Limited (PXIL):** These platforms will facilitate the trading of carbon credits, alongside existing markets for Energy Savings Certificates (ESCerts) and Renewable Energy Certificates (RECs).
Compliance Mechanism	**Penalties and Incentives:** Companies that fail to meet their carbon reduction obligations will face penalties, while those that exceed their

	targets may benefit from financial incentives. This mechanism ensures adherence to carbon market regulations.
Linkages with Other Markets	**International Market Integration:** The Government of India is exploring the possibility of linking the Indian carbon market with international markets under Article 6 of the Paris Agreement. This would enhance market liquidity and foster global cooperation in carbon credit trading.
Carbon Pricing Mechanism	**Cap-and-Trade and Carbon Offsets:** India employs a cap-and-trade mechanism alongside carbon offsets to regulate and reduce greenhouse gas emissions. Companies in obligated sectors must either reduce their emissions or purchase carbon credits to comply with the set limits.
Legal Framework	**Energy Conservation Act (Amended) and Environmental Protection Act:** These acts provide the legal foundation for the operation and enforcement of the Indian carbon market. The legal framework ensures that the carbon market is aligned with national and international climate goals.

3. CHALLENGES FOR CARBON MARKETS

A carbon market is an essential tool in mitigating climate change, however, the design and implementation of carbon markets are subjected to several challenges (Newell, Pizer, & Raimi, 2014). These challenges, if not addressed, can undermine the effectiveness of carbon markets. This analysis explores the primary challenges and potential solutions, with a focus on the Indian context. These challenges can be broadly categorized into regulatory and policy uncertainties, market infrastructure and capacity issues, market liquidity and participation problems, linkage with global markets, public and stakeholder acceptance, Carbon pricing, and governance and regulation. For the carbon markets to be effective it is imperative that these challenges be addressed.

3.1. Regulatory and Policy Uncertainty

Carbon markets, much like stock markets, are dynamic and susceptible to fluctuations driven by changes in policy and regulatory frameworks. These changes can have a great impact on market behaviour, pricing, and overall market stability (Colby, 2000). One of the instances that can best describe the impact of policy on the carbon markets is that of the EU, in the initial phase of the EU ETS, some of the power producers received free allowances to prevent significant increases in consumer electricity prices (Newell, Pizer, & Raimi, 2014). However, many utilities passed the market price of these allowances on to their customers, leading to "windfall profits" for the companies. This introduces financial risks in the market which make the market less attractive creating uncertainty that may deter investments (Newell, Pizer, & Raimi, 2014). It is a challenging task for the Indian regulators to enforce the emission reduction compliances on the Discoms whose balance sheets are already in RED. There have been challenges to enforcing the emission reduction targets through the RPO and PAT schemes to the Discoms as we have seen in recent years. Moreover, the policy uncertainty and lack of clear guidelines not only decrease the attractiveness of carbon markets but also their effectiveness as the companies struggle to understand their obligations and opportunities in the markets. Carbon markets and climate policies continuously evolve, and we can expect the learning and evolution in Indian carbon markets as well. There is also a risk of carbon markets facing uneven compliance and resistance from businesses against investing in low-carbon technologies. The low-cost carbon credits in the market shall be most preferred by the businesses for their compliance and may lead to specific technologies that may be pursued for carbon credits. For example, the forestry carbon credits may be least preferred as the cost of these carbon credits may be high as compared to the carbon credits from Industrial energy efficiency projects. It will be challenging for the Indian government to promote all the clean energy sectors through the carbon credit as a market mechanism. The Regulatory bodies also need to balance the market-sensitive decisions to ensure that there is an equal preference provided to different technologies to maintain the market stability (Newell, Pizer, & Raimi, 2014). Another risk that policy and regulatory instability pose is the threat to the market participants who may not find most of the carbon credit project financially viable and if the trading is done mostly at the floor price, it may lead to the lack of supply of the quality carbon credits in the market.

It is difficult to justify the carbon markets with a linear relationship between a ton of CO_2 reduced and its equivalence with reference to the method of CO_2 emission reduction or removal approach. There are various challenges that have been observed over the last decade in terms of the CDM project case studies. For example, Forest sequestration projects may lead to biodiversity loss, and forest and project projects like planting fast-growing trees can deplete the groundwater very fast in regions where water is a scarce resource. Some of the reasons why projects related to biofuel or forestry related projects may lead to displacement of the local food protection [(Gerbens-Leenes, Hoekstra, & Van der Meer, 2009) AND (Cotula, Dyer, & Vermeulen, 2008)]. The risk of regional spread and diversity of the project is important to be addressed by the regulators. The idea of the carbon market is for the last mile social benefits, and these benefits need to be passed on to the wide geographies and need not be concentrated in certain developed states within the country. In the case of CDM, the majority of CDM projects were concentrated in India, China, and Brazil. However, the rest of the developing countries and least developed nations were left out as part of receiving benefits from these projects. The diversity of projects spread over larger geographies becomes a challenge. Often, it is also being argued that the carbon credit projects have failed to deliver on the local community benefits, though there is an assessment of social benefits in the project design document. However, it has been argued that the majority of social benefits associated with the carbon credit projects have been lip service (Olsen & Fenhann, 2008). The market has also been blamed for gaming of the carbon credit benefits. Many of the firms producing HFC 23 were solely producing it for the claim of carbon credit benefits projects have been blamed for this appropriate benefit due to carbon credits (Wara, 2007). If carbon offset is allowed and cheaper, carbon credits are flooded in the market. This may lead to this appropriate exploration of fossil fuel projects and easy offset of the fossil fuel emissions through such a gaming approaches(Carton & Andersson, 2017).

3.2. Market Infrastructure and Capacity

Transparency, credibility, and capability provide a strong base for the carbon market to become effective. The development of a robust carbon market necessitates significant enhancements in market infrastructure and capacity which encapsulate creating an effective Monitoring, Reporting and Verification (MRV) system since it helps in preventing fraud and ensuring that carbon credits are based on genuine emission reductions (Belenky, 2024). This, in turn, enhances

the overall transparency of the carbon market. One of the challenges that the carbon markets face is that developing these systems requires significant investment and technical expertise, which can be challenging, especially in developing countries. In India, establishing reliable MRV systems across various sectors demands substantial resources and coordination among stakeholders (Invest India, Carbon Markets Association of India, auctusESG, & National Institute of Public Finance & Policy, 2024). Trading under the PAT scheme was halted due to glitches in the PXIL in Oct 2021 which led to significant challenges to the Designated Consumers who wanted to buy EScerts for their compliance (Chunekar & Apte, 2023). Similarly, California's carbon market faced similar challenges in its initial phase with its online platform and trading of carbon credits (Bushnell, Chong, & Mansur, 2013).

It is essential that the technical standards for the carbon market are uniform as consistent and standardized methods for calculating emissions reductions are essential for not only the integrity of carbon credits but also the credibility of the carbon markets (Mehling, 2009). The Inconsistencies in the technical standards can undermine the trust of the investors and make it difficult for the domestic markets to integrate with the international standards. Different methodologies for calculating emissions reductions can eventually lead to disputes over the validity of carbon credits, affecting market credibility (Mehling, 2018).

In addition to this, effective carbon trading also requires well-established platforms which are capable of handling complex transactions. The lack of necessary infrastructure can lead to inefficiencies and reduced market confidence as the absence of sophisticated trading platforms can result in delayed transactions, increased costs, and reduced market participation (Küfeoğlu, Liu, Anaya, & Pollitt, 2019). The EU ETS saw significant price collapses due to an oversupply of allowances, highlighting faulty market design and challenges in implementing cap-and-trade systems (Ervine, 2013) The technology governing the carbon markets is also going through rapid technological advancements along with the blockchain technology to play a crucial role in the future of the carbon trading (Pan et al., 2019). It is important to develop and standardise the monitoring reporting and verification systems so that transparency can be maintained in the market. The use of Blockchain technology and other digital ledger technologies can be used to enhance the transparency and accessibility of carbon credits in order to avoid double counting.

Blockchain technologies provide transactions more secure, transparent, and tamperproof, thereby the risk of fraud and counting can be minimised (Zambrano-Monserrate & Ruano, 2021).

3.3. Market Liquidity and Participation

For any carbon market to be effective, it must maintain high liquidity and broad participation. Ensuring a sufficient number of buyers and sellers is critical for price stability and market efficiency, especially in the early stages of market development. This is so because the limited participation can result in low market liquidity which can further lead to instability in the carbon prices (Green, 2019). The instability in carbon pricing shall have a detrimental impact on the carbon market as it shall not only deter the potential participants but also create a vicious cycle of low participation and high volatility in the market making it highly ineffective(Kojima & Asakawa, 2016). Without a broad base of participants, the market may fail to reflect the true cost of carbon, undermining its ability to drive emission reduction decisions by businesses. Companies may find it cheaper to purchase allowances rather than invest in emission-reducing technologies, stalling progress towards environmental targets (Neuhoff, 2009).

The market participation can also be impacted by the diverse kinds of projects being pursued and their environmental impacts due to the regional differences. Thus, these regional and project specific challenges require a tailored approach to ensure sustainable and equitable carbon market operations.

3.4. Linkage with Global markets

It is imperative that the domestic carbon markets are aligned with International standards as it is essential for enhancing the effectiveness and credibility of the domestic markets. However, this process involves navigating significant regulatory, economic, and technical disparities (Fedosov, 2016). For the carbon markets to attract investment, it is essential that the approach towards accounting for the emissions reductions should be standardized and seamlessly integrate the domestic markets with the international markets as inconsistencies in approaches can lead to disputes and make the market less attractive for investors (Pollitt, 2016). Thus, it is crucial to ensure compatibility in the technical standards as the different emissions trading systems have varied design elements such as targets (fixed or intensity-based), accounting methods (direct or

indirect), compliance periods, banking rules, coverage, etc. This alignment of global markets with the domestic markets needs to be followed and strategized through domestic policies as the political differences can hinder the harmonization of carbon markets (Murray, Maniloff, & Monast, 2013). Effective diplomacy and international cooperation are required to align policies and standards. For instance, Indian exporters in carbon-intensive sectors like steel and cement may face additional costs due to carbon border adjustment mechanisms, impacting their competitiveness (Icwa, n.d.). The domestic markets also need to maintain competitive costs of compliance since an increased cost of compliance can be a significant barrier as it can reduce the attractiveness of the domestic carbon markets and further impact carbon pricing. Thus, determining the right carbon price that reflects the true social cost of emissions is challenging. Prices need to be high enough to incentivize emissions reductions but not so high as to cause economic disruptions. Another challenge that the linking of carbon markets might pose is that of carbon leakage wherein the industries in countries with stringent carbon pricing may face competitive disadvantages compared to those in countries with lax regulations. While this can be addressed through the implementation of border tax adjustments, however, it shall create its own set of challenges in terms of International Trade and Investment laws and administrative complexity.

Though there have been successful alignments of the international carbon markets, however, the experiences are limited for example, the European Union EU ETS scheme is well aligned with the Swiss emission trading scheme (Flachsland, Edenhofer, & Jakob, 2008). This link has required both markets to align, their rules, including cap, setting, coverage of sectors and use of monitoring and verification, systems at a common level. Similarly, the California trade program and the Québec carbon market are also very well linked in North America (Ranson & Stavins, 2016). However, developing global and uniform carbon markets across the countries face significant challenges. The CDM faced significant challenges due to inconsistencies and standards in terms of validation and verification across different countries, these inconsistencies led to the consuls about the environmental Integrities of the CDM projects. According to a UN report, 80% of the CDM projects were located in just five countries and regional concerns about the equitable distribution of the benefits of the carbon credit mechanism (Schneider, 2007). The European Union has recently introduced a carbon border adjustment mechanism (CBAM), which

also raises the requirement of linking domestic carbon markets with the international carbon markets(Cosbey, Droege, Fischer, & Munnings, 2019). Indian companies who are having compliances to make their carbon offsets with the European Union have only option presently to buy carbon credits from EU ETS (Jaspal & Miller, 2024). Hence the Indian market needs to align with EU ETS so that the stepping of carbon credits across different geography can take place. The government of India needs to explore the linkage of the Indian carbon market with the international carbon market such as ETS to facilitate the cross-border trading of carbon credits. Once the Indian carbon market is aligned with the international carbon market, it will facilitate a broad pool for carbon credits and will help Indian companies to meet the international compliance standards for carbon credits and the market liquidity will also improve.

3.5. Public and Stakeholder Acceptance

The public and stakeholder acceptance is extremely crucial for the effective implementation of the domestic carbon markets as it shall increase the participation in the market which would further decrease the volatility in the markets and increase stability (Singh & Chaturvedi, 2023). Thus, building capacity and gaining acceptance are significant challenges to the effective implementation of the global Carbon markets. The success of the carbon markets is dependent on the acceptance and effective participation of both public and private institutions including businesses, government, and non-governmental organizations (NGOs).

The lack of stakeholder acceptance can be because of various reasons and can be broadly categorized under the categories of historical trust deficit, diverse stakeholder interests, and economic and financial concerns among others. Financial institutions are an integral part of the stakeholders regulating the carbon markets. However, financial institutions like banks have been involved in financial meltdowns like the global recession of 2008 wherein the reputation of banks was significantly damaged along with the public trust in the banks. This can be addressed through increasing transparency and including comprehensive sustainability practices. In 2020, JP Morgan Chase announced its commitment to align its financing activities with the Paris Agreement goals (Segal & Segal, 2023). This included a pledge to achieve net-zero emissions across its operations by 2050 and significant investments in clean energy projects ("Sustainability Initiatives," n.d.). However, JP Morgan faced criticism for heavily investing in

the fossil fuel business. To address these concerns, JP Morgan enhanced its transparency by publishing detailed reports on its environmental impact and progress towards sustainability goals (Light & Skinner, 2021). The bank also engaged with stakeholders through public forums to discuss its strategies and gather feedback.

During the launch of China ETS, there have been several regional pilot programs before venturing into the national ETS system. This led to a wider acceptance of the stakeholders in terms of the design and implementation of the Chinese carbon market (Lo, 2013).

The diverse stakeholder opinions may be another challenge faced by the carbon markets and can lead to the non-acceptance or partial acceptance of carbon markets. This can be addressed through a transparent dialogue between all the stakeholders. In India, fostering a transparent dialogue with industries and the public about the benefits and responsibilities of participating in the carbon market can enhance its acceptance and success. The Bureau of Energy Efficiency (BEE) in India conducts stakeholder consultation workshops, but ongoing efforts are needed to ensure broad acceptance and understanding of the carbon market (Invest India, n.d.).

The economic and financial concerns of the various stakeholders including the public are crucial for the acceptance of the carbon markets and its broad-based participation. For instance, HSBC has committed $1 trillion to sustainable finance and investments by 2030, including renewable energy projects, energy efficiency initiatives, and green bonds. The bank transparently emphasizes the business opportunities and risk management benefits of investing in low-carbon businesses. They further actively engage shareholders through investor briefings and detailed financial performance reports. This approach helps in addressing the financial and economic concerns of all the stakeholders and shareholders of the bank (Light & Skinner, 2021).

3.6. Price Volatility

Price volatility is a significant concern in carbon markets as it can impact market stability and the effectiveness of emission reduction strategies (Ritz, 2020). Sudden regulatory changes can lead to rapid price fluctuations, affecting market stability (Casini & Valentini, 2019). For example, when the regulatory body tightens the emissions caps, the supply of allowances decreases, which can lead to a sharp increase in prices as companies scramble to purchase the limited allowances

available (International Carbon Action Partnership, n.d.). Conversely, relaxing emissions caps can flood the market with allowances, causing prices to drop. Similarly, in the cases where there are changes made to how the allowances are allocated, like in the case of shifting from free allocation to auctioning, there is an impact made on the prices (Aldy & Stavins, 2012). These adjustments can create uncertainty and lead to significant price swings as market participants react to the new regulatory landscape.

The carbon pricing is also impacted by economic factors like economic growth, recession, or economic depression (Chan, 2009). The country in the period of economic growth oversees an increase in industrial activities. This increase in industrial activity also leads to higher emissions which further creates an increase in the demand for carbon credits causing an increase in carbon prices. However, during the recession, there was a downturn in industrial activity which eventually led to lower emissions that led to a decrease in the price of carbon credits. When the state is going through a financial crisis the domestic carbon markets may showcase high volatility in the carbon credit prices due to the reduced liquidity and an increased uncertainty in the market. A case in point can be the 2008 financial crisis wherein the price of EU ETS allowances dropped from around €25 per tonne to about €9 per tonne due to reduced industrial activity and demand for carbon credits (Koch et al., 2014). This sharp decline highlighted the sensitivity of carbon markets to broader economic conditions (International Swaps and Derivatives Association, 2021).

The volatility in carbon pricing can be mitigated through the use of financial instruments like futures, options, and swaps [(Manera, Nicolini, & Vignati, 2013) AND (Mehling, 2009)]. The companies can also enter into long-term contracts with renewable energy projects or forestry projects to ensure a consistent flow of carbon credits at a fixed price (Mehling, 2009). This shall provide more stability and predictability to the companies and make these projects more investable.

In order to address the price volatility, the carbon markets have introduced the floor price as well as ceiling price which provides greater price stability reduces uncertainty and encourages long-term investments in low-carbon technologies (Burtraw & Palmer, 2008). The floor price and forbearance price were also introduced in the trading of RECs, in order to reduce the price

volatility (CERC, 2017). This ensured that REC sellers were getting a minimum return on their investments in renewable energy projects. The Bureau of Energy Efficiency has also addressed price volatility in the EScert market through extended trading windows multiple times for buyers to meet their compliance obligations. This helped prevent a sudden drop in the EScert prices, due to an oversupply of the unsold.

3.7. Governance and Regulation

The carbon markets to be successful need to be governed and regulated effectively which can be achieved through a specific oversight [("Carbon Market Design & Oversight," 2010) AND (Kachi, Frerk, & International Carbon Action Partnership, 2013)] Specific oversight is also crucial for preventing the fraud in cap – and – trade system. One of the cases wherein this was showcased was in the Czech Republic wherein the hackers stole 1.2 million carbon credits from the Czech Carbon Registry (Funk & Freeman, 2015). Specific oversight is extremely crucial for the functioning of carbon markets as in the absence of oversight, the market participants may engage in rent-seeking behaviour wherein the market participants may exploit the system for economic gains with no genuine emission reduction (Mehling, 2009). Thus, undermining the primary goal of the carbon markets.

The weak regulatory framework may also lead to market manipulation wherein the market participants can artificially influence the carbon credit prices for profits which can lead to market destabilization [(Adcock & Crowe, 2022) AND (National Academies of Science, Engineering, and Medicine, 2024)]. For instance, the REC scheme in India faced significant challenges due to inadequate enforcement. Discoms (distribution companies) often fail to meet their Renewable Purchase Obligations (RPOs), leading to a surplus of RECs and market distortions(Powell, Sati, & Kumar Tomar, 2024). The lack of enforcement also resulted in the banks and financial institutions not considering additional revenue from RECs in their project assessments, affecting the viability of renewable energy projects(Bansal et al., 2012).

The major success of any carbon market is dependent on the market demand for carbon credits. The carbon credit market under CDM resumed failed due to the EU ETS withdrawing their compliance requirement through buying the carbon credits under CDM and the prices over less

than a dollar per carbon credit (Australian-Japan Research Centre, n.d.). This was a significant blow, to the carbon market and most of the market shifted towards a voluntary carbon market, India is going to face the oversupply challenge of carbon credits. We have observed this during the trading of energy-saving certificates. The trading of energy-saving certificates (EScerts), has taken place typically at the floor price because of a lack of demand and it was the Discounts and fertiliser sector that did not meet their compliance targets. EScerts in PAT cycle II, about 57 lakh EScerts were issued while the target of buying was 36 Lac EScerts (Prayas Energy, n.d.). It was difficult for the regulators to enforce the Discoms and fertiliser sector compliance of buying the EScerts. The market faced the oversupply challenges of EScerts. This is going to be a significant challenge to the Indian market. If the regulators are not able to enforce the supply-demand, gap and enforcement of compliance requirements to the designated consumers.

4. Conclusion

The Indian carbon market is evolving against the backdrop of the country's target of zero as per the Paris Agreement. Achieving the climate goals of net zero by 2070 is challenging for developing countries like India. Carbon markets have internationally been treated as one of the market mechanisms to address the climate goals. India is exploring introducing carbon markets which will drive opportunities and innovations in clean technologies. The international experiences in carbon markets from EU-ETS, California cap trade, and China ETS are providing valuable lessons to the Indian authorities to develop a robust Indian carbon market. It is important to note that a successful carbon market is dependent on a stable policy framework, robust market infrastructure, market liquidity, and broader participation from the buyers as well as sellers in the market. Price volatility and the potential for market manipulation have been the challenges to the global carbon market. It is important for Indian authorities to develop strong governance and regulatory oversight to maintain market integrity, and achieve meaningful emission reduction.

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