June 2026

Institute for Energy Economics and Financial Analysis

Environmental Defense Fund

Potential drivers of carbon price formation in the CCTS

Design and market dynamics in the Indian carbon market

Saurabh Trivedi, Lead Specialist, Sustainable Finance & Carbon Markets, South Asia
Subham Shrivastava, Climate Finance Analyst, South Asia
Saloni Sachdeva Michael, Lead Energy Specialist, South Asia

Acknowledgements

We are grateful to the team at IIT Roorkee, led by Dr. Tarun Sharma, for their continued support and collaboration. This report is the second output of an ongoing initiative to develop scenario-based insights and design recommendations for India's Carbon Credit Trading Scheme.

We also thank Vibhuti Garg for her valuable inputs during the review process. Special thanks are due to Aastha Manocha (editor) and Janhvi Saini (designer) for their contributions to the editing and formatting of this report.

The views expressed in this report are those of the authors alone, and any errors or omissions remain the authors' responsibility.

Contributing authors: We extend our deepest gratitude to Suzi Kerr, Pedro Martins Barata, Hisham Mundol and Shuchi Malhotra from the Environmental Defense Fund (EDF) for their close engagement throughout the development of this discussion report. Their expert insights, strategic guidance, and detailed feedback at every stage have been instrumental in shaping the framing, analytical depth, and overall quality of this work. The report has benefited significantly from EDF's deep expertise in carbon market design and implementation.

Contents

Figures and tables

List of acronyms

B&C - Baseline and Credit
BEE - Bureau of Energy Efficiency
BM - Bharat Methodologies
Capex - Capital Expenditure
CCER - Chinese Certified Emission Reductions
CCR - Cost Containment Reserve
CCTS - Carbon Credit Trading Scheme
CCUS - Carbon Capture, Utilisation and Storage
CDM - Clean Development Mechanism
CERC - Central Electricity Regulatory Commission
CO_2/CO2 - Carbon Dioxide
CO_2e/tCO_2e - Carbon Dioxide Equivalent (tonne of)
COP - Conference of the Parties
Discoms - Distribution Companies
ECBC - Energy Conservation Building Code
EITE - Emissions-Intensive Trade-Exposed
EPA - Environmental Protection Agency (US)
ESCert(s) - Energy Saving Certificate(s)
ETS - Emissions Trading System
EU-ETS - European Union Emissions Trading System
EV - Electric Vehicle
FAME - Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
FY - Financial Year
GDP - Gross Domestic Product
GEI - Greenhouse Gas Emissions Intensity
GHG(s) - Greenhouse Gas(es)
ICAP - International Carbon Action Partnership
ICM - Indian Carbon Market
IEA - International Energy Agency
JI - Joint Implementation
K-ETS - Korea Emissions Trading System
KRW - South Korean Won
LNG - Liquefied Natural Gas
LRF - Linear Reduction Factor
MAC(s) - Marginal Abatement Cost(s)
MC - Marginal Cost
MCP - Market Clearing Price
MNRE - Ministry of New and Renewable Energy

MoEFCC - Ministry of Environment, Forest and Climate Change
MoP - Ministry of Power
MR - Marginal Revenue
MRV - Monitoring, Reporting and Verification
MSR - Market Stability Reserve
MtCO_2e - Million tonnes of Carbon Dioxide Equivalent
N_2O - Nitrous Oxide
NDC(s) - Nationally Determined Contribution(s)
NSC-ICM - National Steering Committee for the Indian Carbon Market
OBA - Output-Based Allocation
PAT - Perform, Achieve and Trade
PFCs - Perfluorocarbons
PLI - Production-Linked Incentive
PPA(s) - Power Purchase Agreement(s)
PSAM(s) - Price or Supply Adjustment Mechanism(s)
RCO(s) - Renewable Consumption Obligation(s)
REC(s) - Renewable Energy Certificate(s)
RGGI - Regional Greenhouse Gas Initiative
RPO - Renewable Purchase Obligation
SDAs - State Designated Agencies
SERCs - State Electricity Regulatory Commissions
SO_2 - Sulphur Dioxide
TIER - Technology Innovation and Emissions Reduction (Alberta)
USD - United States Dollar

Key findings

In India's intensity-based system, output growth can generate both credit supply and credit demand depending on which firms drive growth. This makes benchmark calibration the central mechanism for shaping the price signal. Output-based allocation also mutes the transmission of carbon costs into product prices, weakening demand-side signals even when the carbon price is positive. Credible, pre-committed tightening trajectories and rule-based supply adjustment mechanisms are essential to sustain scarcity.

Covered sectors differ meaningfully in abatement options, capital cycles, trade exposure, and ability to pass through carbon costs. The power sector's initial exclusion removes the single largest emission source, the primary fuel-switching channel, and a class of participants that trade continuously. Future integration will need to address how carbon costs interact with India's electricity regulatory framework, particularly dispatch and merit-order decisions. Without a credible integration roadmap, the CCTS will lack the primary channel through which carbon pricing shapes energy investment.

Instruments such as ESCerts, RCOs, PLI schemes, and the National Green Hydrogen Mission affect emissions in covered sectors independently of the carbon price. Without periodic baseline revisions reflecting their cumulative impact, the resulting surpluses can depress prices and blur what the CCTS price signals about in-sector abatement costs. International experience, particularly the EU-ETS waterbed effect, underscores the importance of dynamic baseline revision and unified registries to prevent double counting.

Ex-post credit issuance, the exclusion of financial intermediaries, and capital-intensive industrial abatement mean both supply and demand will remain relatively inelastic in the early years, with trading likely to cluster around settlement deadlines. Communicating clear long-term targets and a predictable path for benchmark tightening is particularly important given that industrial investment decisions span 15 to 30 years. Forward guidance and well-designed stability mechanisms can help firms integrate carbon costs into long-term planning.

Executive summary

This report analyses how carbon prices will take shape in India's forthcoming Carbon Credit Trading Scheme (CCTS), an intensity-based emissions trading system covering energy-intensive industries.

Price formation in the CCTS reflects the interaction of regulatory design, firm-level abatement decisions, macroeconomic conditions, and companion policy dynamics. These forces interact through feedback loops that will determine whether the CCTS produces a carbon price capable of guiding the capital-intensive, long-term investments that India's industrial decarbonisation requires.

Supply, demand, and the role of benchmark design

The CCTS regulates emissions intensity rather than imposing an absolute cap like in the European Union-Emissions Trading System (EU-ETS), meaning aggregate allowable emissions will scale with output. This accommodates India's industrial growth trajectory but creates a structural tension at the heart of price formation. Output expansion simultaneously generates carbon credit supply from efficient firms outperforming their benchmarks, and credit demand from less-efficient firms falling short. Whether the market tightens or loosens in any period depends on which firms are driving growth and how regulators calibrate benchmarks relative to realised sectoral performance. Output-based allocation (OBA) also mutes the transmission of carbon costs into product prices, weakening demand-side signals for material efficiency and substitution even when the underlying carbon price is positive.

As the system issues credits only after verified performance against facility-level benchmarks, tradable supply enters the market with a lag. Banking behaviour, verification timelines, and firms' willingness to sell all create a gap between what the system can generate and what reaches the market. This makes benchmark design the primary lever through which regulators control scarcity. In jurisdictions where benchmark-setting has relied too heavily on industry-provided estimates without independent verification, allocations have consistently been more generous than necessary.

Credible scarcity requires pre-committed tightening trajectories reinforced by transparent, rule-based supply adjustment mechanisms. The EU-ETS recovered meaningful price signals only after structural reforms, notably the Market Stability Reserve (MSR), replaced ad-hoc interventions with automatic supply correction. India's CCTS will need equivalent mechanisms to anchor expectations and sustain the forward-looking participation that stable price signals depend on.

Power sector, liquidity, and energy price transmission

The strength of these price signals depends not only on benchmark design, but also on who participates in the market and how actively they trade. The initial exclusion of the power sector is pragmatic but narrows both dimensions considerably. It removes the single largest source of carbon emissions and eliminates the fuel-switching channel, specifically the coal-gas merit-order dynamics that have been among the strongest determinants of allowance demand in systems like the EU-ETS.

It also removes utilities, which are a class of participants that in other markets trade continuously to hedge emissions exposure alongside energy prices. Demand concentrates instead among industrial firms whose compliance requirements evolve more slowly and whose trading may cluster around settlement deadlines, weakening the informational content of periodic market-clearing prices.

Any future power sector integration will need to address the statutory tariff determination process under the Electricity Act 2003, which lacks an established framework for treating carbon compliance costs as a legitimate, automatic pass-through. Carbon cost recognition would need to be coordinated across the Central Electricity Regulatory Commission (CERC) and state electricity regulatory commissions (SERCs) to avoid competitive distortions between generators and inconsistent price signals across states. The power sector also differs from typical Emissions-Intensive Trade-Exposed (EITE) sectors in that it faces limited carbon leakage risk given its largely domestic nature. This creates a different set of design questions over time, including how allocation approaches might evolve, and how any associated revenues could be deployed in ways that support the broader energy transition, including the financial sustainability of the distribution segment.

That said, without a credible integration roadmap, the CCTS will continue to operate without the primary transmission channel through which carbon pricing shapes energy investment decisions.

Companion policies and early-stage market conditions

The absence of the power sector in CCTS places greater weight on industrial sectors covered therein to sustain meaningful compliance demand, and on companion policy coordination to preserve the integrity of the carbon price signal. Instruments such as the Perform, Achieve and Trade (PAT) scheme, Renewable Consumption Obligations (RCO), Production-Linked Incentives (PLI) schemes, and the National Green Hydrogen Mission directly affect emissions intensity and output decisions in the sectors covered. When these policies reduce emissions independently of the carbon price, they lower compliance demand and create surpluses without any change to CCTS baselines. If baselines are not periodically revised to reflect these effects, it results in a price depression, blurring what the CCTS price signals about in-sector abatement costs. The risk is compounded when firms receive overlapping subsidies alongside carbon credit revenue, potentially driving their net marginal abatement cost below zero and shifting investment decisions away from the carbon price signal entirely.

These coordination challenges intersect with structural market conditions that are inherently difficult in the formative years. Both supply and demand are likely to remain relatively inelastic. Industrial abatement is large and uneven and capital-intensive, short-run fuel-switching options are limited. Production decisions are governed by asset cycles rather than marginal carbon costs.

The initial exclusion of financial intermediaries, who account for roughly 65% of secondary market activity in the EU-ETS, further constrains liquidity and continuous price discovery. In this scenario, even small differences between benchmark stringency and actual reductions can lead to significant price fluctuations. This uncertainty makes it difficult for firms to incorporate carbon costs into their investment decisions over the next 15–30 years.

This report also lays the analytical groundwork for subsequent work on international market linkages, Article 6 engagement, and the design of price and supply adjustment mechanisms (PSAM) for the CCTS.

1. Introduction

The carbon price, in any emissions trading system, is the central economic signal facilitating decarbonisation at the lowest cost. It reflects the marginal cost of emissions reductions aligned with policy targets, guiding firms to reduce emissions where their internal costs fall below the market price and to purchase compliance instruments otherwise. For this signal to influence long-term, capital-intensive investment, it must be predictable and credible over time. Weak or erratic prices raise financing costs, distort investment timing, and favour short-term compliance over durable low-carbon transitions.

At the firm level, output-linked crediting creates differentiated incentives. Efficient producers may earn credits that they can sell as output expands, while less efficient facilities face rising compliance liabilities that can discourage production. Similar incentives also arise in cap-and-trade systems that rely on OBA. What distinguishes intensity-based systems is that these effects extend to the aggregate level, allowing total emissions to move with output even as emissions intensity improves.

Banking, expectations of future policy tightening, and anticipated technology costs influence price paths in the CCTS through inter-temporal dynamics similar to other carbon markets. The interaction of these dynamics with ex-post credit issuance and periodic market clearing can affect early liquidity and price discovery. In addition, sectoral coverage and sequencing, including the initial exclusion of the power sector, shape how energy price movements and macroeconomic shocks affect compliance demand.

Price formation in the CCTS is best understood as the result of familiar forces operating in a distinctive institutional setting. This includes regulatory scarcity shaped by intensity benchmarks, firm-level optimisation under uncertainty, market clearing through trading, and expectations about future constraints. The challenge is not in abandoning standard economic intuition, but in applying it carefully in a context characterised by growth uncertainty, evolving institutional capacity, capital-intensive technologies, and rapid technological change.

This report analyses these dynamics in India’s CCTS. After a brief conceptual framing in Section 2, it examines supply drivers (Section 3) and demand drivers (Section 4) specific to India’s design, before turning to the role of offsets and external credits (Section 5), supply-demand elasticities and early market dynamics (Section 6), and the potential effects of direct and indirect policy interactions on carbon price formation (Sections 7 and 8). Throughout, the report translates economic concepts into concrete implications for how India’s carbon market will function in practice, particularly in its formative years. While cap-and-trade systems are extensively documented, practical guidance for intensity-based baseline-and-credit (B&C) systems remains limited. This report aims to fill part of that gap, drawing on India’s CCTS as a case study with relevance for the growing class of comparable systems globally.

1.1. How carbon markets create price signals: The foundations

1.1.1. The economic problem carbon markets address

Greenhouse gas emissions (GHGs) are a classic externality: the costs they impose, such as adverse health outcomes, reduced agricultural yields, and losses from extreme weather fall on society rather than directly on the firms that emit them. Without regulation, emitters have no financial incentive to account for these damages. Economists have estimated the social cost of carbon between USD140 and USD380 per tonne of carbon dioxide (tCO_2) (EPA, 2023)[1], with many analysts converging on a central estimate of around USD230 per tonne, a stark contrast to the zero cost that unregulated emitters face.[2]

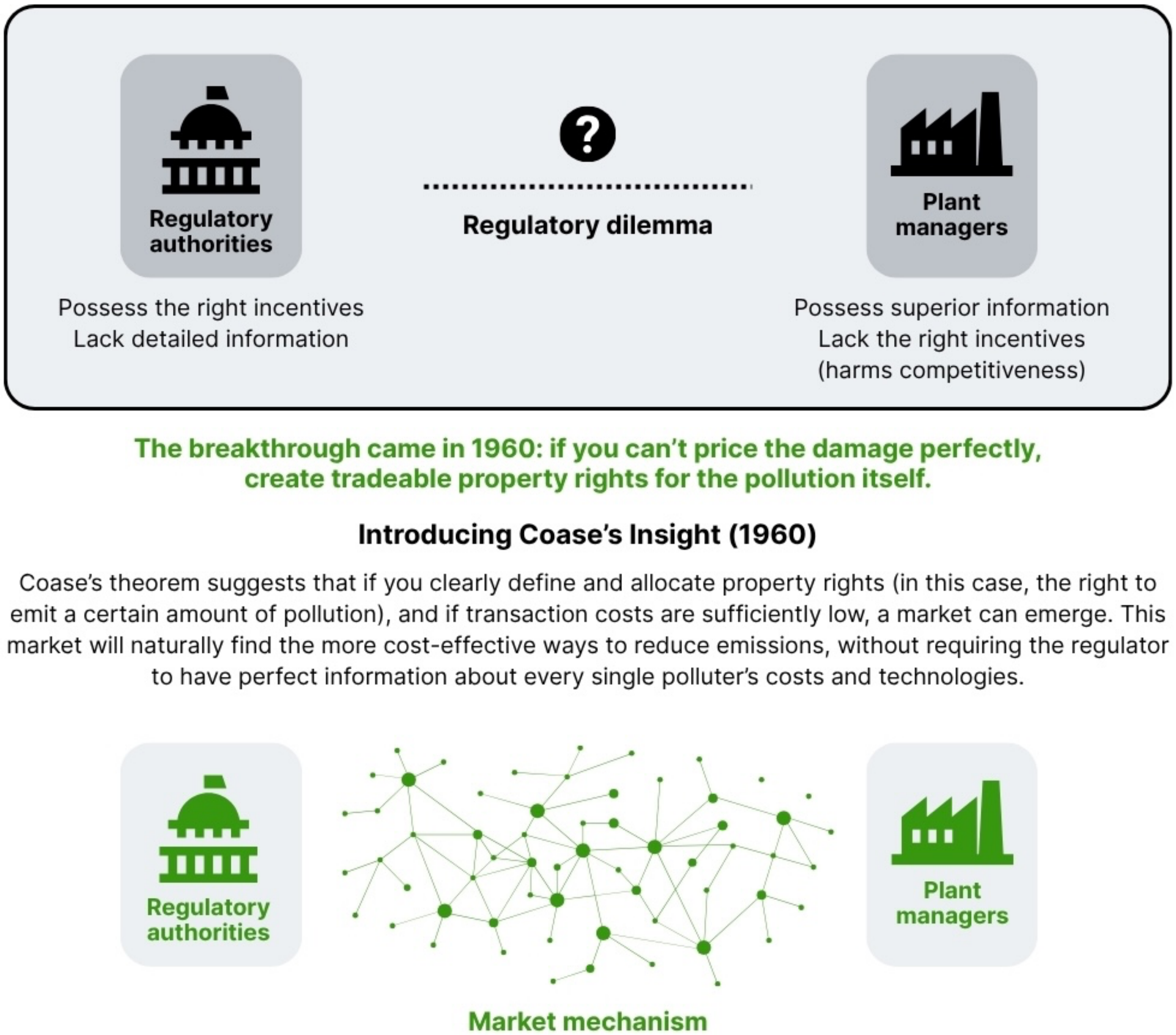
The question is not only whether to regulate, but how to. The command-and-control approach, mandating specific technologies or uniform emission limits, suffers from a fundamental information problem: regulators lack the granular knowledge of abatement costs that individual firms have. Moreover, in sectors where abatement technologies are still evolving, even plant managers may initially lack reliable cost information. In such cases, carbon pricing creates direct financial incentives for firms to discover and act on this information themselves, using their operational expertise to find the most cost-effective abatement pathways.

> **Carbon markets exist because greenhouse gas emissions create costs that fall on society rather than the emitters**

The theoretical foundation for this approach draws on two complementary insights. Coase (1960) showed that when directly pricing environmental damage is difficult or politically unfeasible, governments can instead create tradeable property rights over emissions. Trading then happens among firms; those with low abatement costs reduce more and sell credits and those with high costs buy. The government sets the environmental limit and the market finds the least-cost way to meet it. Separately, the Pigouvian tradition argues for directly pricing the externality through a carbon tax, offering price certainty but no guarantee on the quantity of emissions reduced. Emissions trading systems reverse this trade-off: they constrain quantities and let price discovery emerge through the market. India's choice of an emissions trading system reflects the global trend, such systems now cover 28% of global emissions and generate over USD100 billion annually, and the specific appeal of quantity certainty for a country with binding decarbonisation commitments.

[1] EPA. EPA report on the social cost of greenhouse gases: Estimates incorporating recent scientific advances. Nov 2023
[2] RMI. Getting the social cost of carbon right. Feb 2021

Figure 1: Command & control vs Market mechanism for carbon pricing



1.2. The architecture of a carbon market

Carbon markets vary along two independent design dimensions—the type of emissions constraint and the method of credit or allowance allocation—each with distinct implications for price formation.

1.2.1. Emissions constraint: Absolute cap vs. intensity-based target

An absolute cap fixes the total quantity of emissions permitted across covered sectors, regardless of economic activity. Before the compliance period starts, the government issues a corresponding number of allowances and firms must surrender allowances equal to their actual emissions. This offers certainty about aggregate environmental outcomes but means that firms facing output growth must obtain additional allowances, affecting prices.

An intensity-based target, by contrast, expresses the emissions limit per unit of output. Aggregate allowable emissions adjust automatically with production volumes, so the constraint scales with economic activity. This design accommodates growth more readily but provides less certainty about absolute emission levels. It is particularly suited to rapidly industrialising economies where penalising output growth would be politically and economically difficult.

1.2.2. Allocation method: Pre-allocated allowances vs. performance-based credits

Under cap-and-trade with pre-allocated allowances, units are distributed to firms before the compliance period. Trading can begin immediately, enabling early price discovery and liquidity.

Under a B&C approach, credits are issued only after the compliance period ends, based on verified performance against assigned benchmarks. Firms that outperform their benchmarks earn credits they can sell; those that underperform must purchase credits to meet their obligations. This ex-post issuance means liquidity develops gradually as the first verified credits enter the market, a feature that shapes early price dynamics in India's CCTS.

India's CCTS combines an intensity-based emissions constraint and a B&C allocation approach. The rationale for this design choice and its implications for price formation in India's specific institutional and economic context is examined in detail in Section 2.

1.3. How firms decide to buy, sell or abate: The logic of carbon pricing

Carbon market prices emerge through the interaction of multiple participants making individual optimisation decisions based on their costs, expectations, and regulatory obligations. The aggregate of these decisions, combined with direct government intervention, determines market-level supply and demand, and in turn establishes the equilibrium price. In this respect, carbon markets resemble competitive commodity markets: demand and supply determine prices, and individual firms try to maximise profit by responding to prevailing market prices rather than setting them.

1.3.1. Firm-level decisions and the marginal abatement cost curve

Within a carbon market, each firm determines its internal emissions reduction and its position regarding buying or selling credits. This is not a binary choice: most firms have a portfolio of abatement options at varying costs, so they typically engage in both internal abatement and some trading. The key decision variable is the marginal abatement cost (MAC), which rises with increased abatement. A firm will reduce emissions till the point its MAC equals the prevailing market carbon price. Any remaining compliance obligation will then be met by purchasing credits. Conversely, firms with low abatement costs may reduce emissions beyond their benchmark and sell surplus credits.

The switching point between being a credit demander and a credit supplier is specific to each firm and fluctuates with market prices.

1.3.2. How carbon markets differ from commodity markets

Carbon markets share the competitive pricing principles of other markets but differ in one fundamental respect: scarcity is created and maintained by government regulation, not physical constraints. The value of carbon credits derives from regulatory compliance requirements. Policy design choices, particularly the stringency of firm-level benchmarks and targets, directly determine whether firms become net credit suppliers or demanders. A generous benchmark enables firms to generate credits without meaningful abatement, potentially transforming them into a net supplier. A stringent benchmark does the opposite. Critically, not all price dynamics trace purely to regulatory design. Macroeconomic conditions, energy prices, interest rates, and broader economic shocks all shape firms' responses to market signals.

To understand who becomes a credit supplier or demander, it is important to recognise that credit generation depends on a firm's absolute emission intensity relative to its target, not its rate of improvement. A firm producing 2 tonnes of CO_2 equivalent (tCO_2e) per unit with a 3 tCO_2e target generates one credit per unit regardless of whether this reflects recent improvement or longstanding efficiency. Conversely, a firm that has cut intensity from 6 to 3.6 tCO_2e still faces compliance deficits if its target is 3 tCO_2e. Infrastructure investments that permanently lower absolute emission intensity creates lasting credit generation potential across multiple periods, while operational abatement mainly affects current performance. Any doubts about regulatory commitment or changes to policy frameworks can instantly shift market fundamentals irrespective of current supply-demand conditions.

1.3.3. Banking credits: Why today's decisions shape future prices

Banking provisions allow firms to save unused credits from one compliance period for future use. This creates an important intertemporal dimension to price formation. Current prices are driven primarily by expectations about future benchmark stringency rather than just present supply-demand balance. A credible signal that benchmarks will tighten significantly in future compliance periods can push current prices up even when the market is currently in surplus. Banking transforms credits into a financial asset whose value depends on anticipated future scarcity.

This dynamic produces a fundamental relationship known as the Hotelling rule. Banking creates intertemporal arbitrage opportunities. Firms capable of outperforming their benchmarks can generate excess credits early and bank them for future sale as constraints tighten and prices rise. Firms anticipating future compliance deficits can purchase and bank credits today to hedge against future price increases. Firms remain indifferent between selling credits today at price $P(t)$ or banking them for future sale at $P(t+1)$, provided $P(t) = \delta \times P(t+1)$, where δ is the risk-adjusted discount factor. In equilibrium, credit prices tend to rise at approximately the risk-adjusted rate of interest over time.

2. Who shapes carbon pricing and how: Multi-agent interactions

Carbon price formation is the aggregate outcome of decisions made by multiple interdependent agents. Government policymakers, enterprises, energy and technology markets, and financial institutions each make decisions that interact through connected transmission pathways to determine market prices, liquidity, and environmental outcomes. Figure 2 illustrates this framework for India's B&C, intensity-based system.

Government: Primary architect of market structure

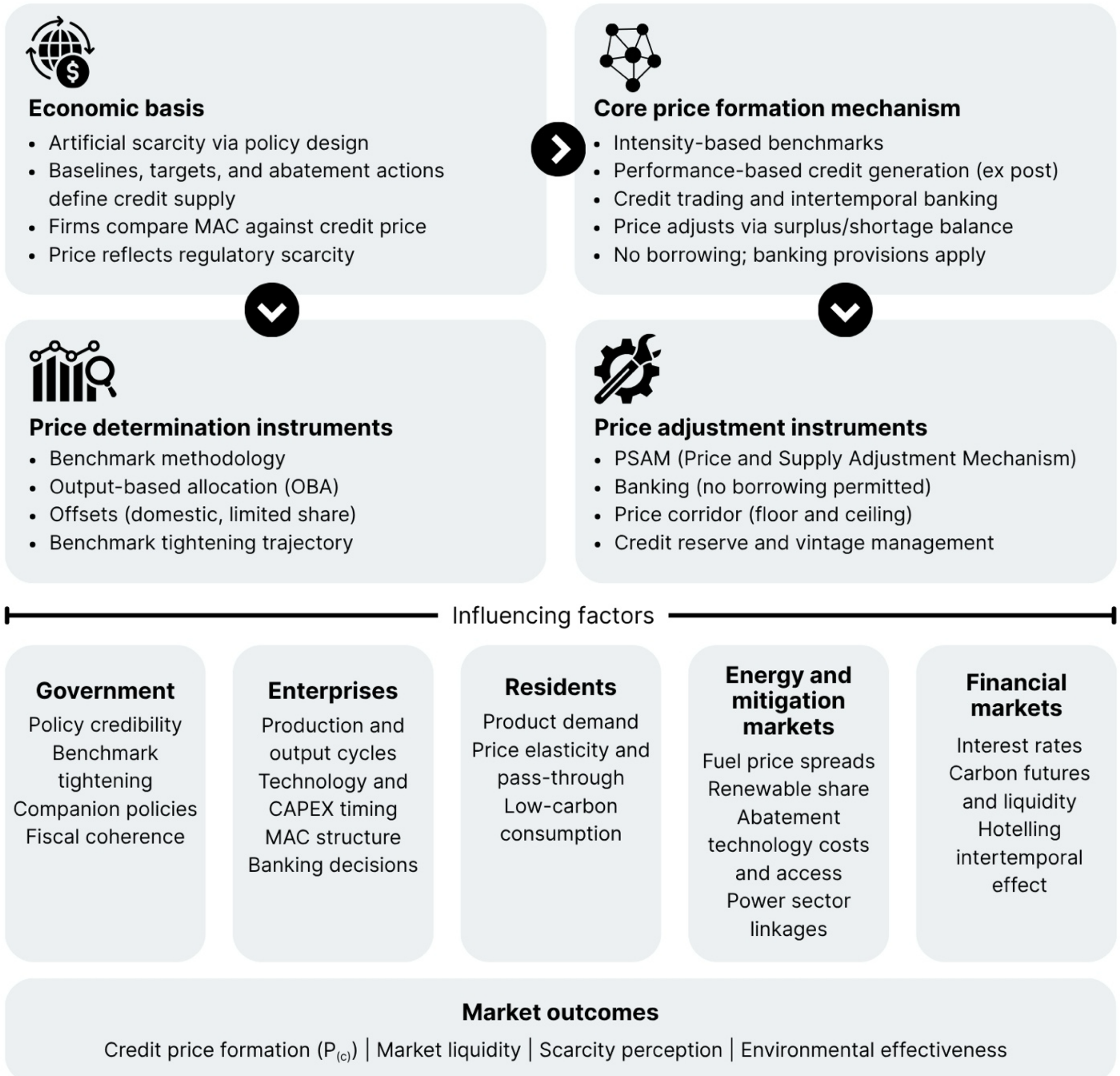
Government is the foundational architect of the carbon market. Its most direct intervention is the setting of baselines and targets, the mechanism that determines whether firms become net credit suppliers or demanders. This, combined with the legal definition of credits (their fungibility, bankability, traceability, and transferability) and enforcement of firms' regulatory obligations, forms the core architecture of price formation.

Beyond baseline and target design, governments shape markets through price limits, banking provisions, market supervision, and rule-based supply management. PSAMs are a central element of this toolkit. By providing an automatic response to sustained surplus or scarcity conditions, PSAMs help align credit supply with underlying abatement demand in a predictable manner. Broader policy coordination also matters. Companion policies, renewable energy mandates, efficiency standards, and fuel subsidies influence firms' mitigation decisions outside the market and can reinforce or undermine the carbon price signal.

Enterprise: Making abatement decisions

Production decisions affect market balance differently depending on firm efficiency. Firms operating below their intensity benchmarks generate surplus credits when output rises, increasing supply. Firms above their benchmarks face larger compliance deficits as output grows, increasing demand. The net effect depends on which firms drive growth. Under India's intensity-based design, aggregate allowable emissions scale with total output, moderating price swings during economic cycles. This differs from cap-and-trade systems with OBA, where total supply remains fixed—higher production-linked free allocations reduce auctioned volumes to maintain the cap. India's approach provides flexibility to accommodate growth but offers less certainty about absolute emission outcomes.

Figure 2: Formation of carbon market price mechanism and influencing factors



Source: IEEFA, Jing-Ji et al., 2018[3]

> **Carbon prices emerge from firm-level abatement decisions meeting market-level clearing, shaped by policy-created scarcity, expectations, and intertemporal choices.**

[3] Springer Nature. Research on carbon market price mechanism and influencing factors: a literature review. 26 February 2018

Energy markets
Energy markets influence carbon price formation through multiple channels. Volatility in fossil fuel prices shapes firms' fuel-switching decisions and compliance costs. For instance, industrial firms covered under India's CCTS face fuel-switching choices within their operations like switching between coal and natural gas for process heat. Consequently, their electricity costs reflect the grid's fuel mix. Carbon prices, therefore, tend to move in tandem with the gap between coal and gas prices. A wider gap makes switching less attractive while a narrower gap increases it. This adjustment in switching behaviour also influences marginal cost of abatement.

Looking ahead, renewable energy is the key long-run abatement pathway for many covered sectors, both through direct on-site generation and through a progressively greening grid. Shocks in international energy markets can transmit into domestic carbon prices, creating volatility that lies outside domestic policy control.[4]

Financial markets: Market makers, risk managers, and intermediators
Financial markets, if allowed to participate, create another layer of interaction between compliance entities and governmental policies, shaping how carbon prices emerge and evolve. Banks and investment firms don't just provide capital; they actively participate in price discovery by facilitating trading between entities with different compliance needs and risk tolerances.

This intermediation proves essential for efficient price formation. Evidence from the EU-ETS shows financial actors comprise around 65% of secondary market participants, creating a deep liquidity pool that allows compliance entities to trade when needed rather than being forced to transact at unfavourable moments.[5] Banks facilitate arbitrage between spot and forward markets, ensuring price signals flow efficiently across different time horizons and market segments.

India's CCTS follows the approach of other recently established Asian markets, South Korea and China, in initially excluding financial institutions. This reflects two considerations. First, the administrative infrastructure required for financial participation is not yet in place, along with the clear regulatory status of Carbon Credit Certificates. Second, there could be a policy preference for ensuring that early price formation is anchored to industrial firms' actual MACs rather than driven by speculative investor behaviour. South Korea's experience illustrates the typical consequences of exclusion: severe liquidity constraints and limited trading activity that eventually required policy adjustments to broaden participation. India should expect similar early-stage challenges. However, concerns about speculation are not a permanent barrier to financial participation and can be addressed through well-designed market-making rules and appropriate oversight frameworks.

[4] Current coverage includes aluminium, cement, chlor-alkali, pulp and paper, petroleum refining, petrochemicals, and textiles. Targets for iron and steel will be released later in 2026.
[5] European Parliament Policy. The role of financial operators in the ETS market and the incidence of their activities in determining the allowances' price. December 2022

Building this regulatory groundwork early will be important for expanding participation and increasing liquidity as the market develops.[6]

2.1. India's CCTS design choices: Intensity-based caps and B&C system

This section examines how India's specific design choices shape mechanisms such as carbon price formation and the multi-agent dynamics that drive it in practice. India's CCTS does not simply adopt a standard emissions trading template. It combines intensity-based targets and a B&C architecture to reflect the country's economic realities and institutional context. They also create price formation dynamics that are quite different from the cap-and-trade systems that dominate the existing literature on the subject. Understanding these choices is the foundation for everything that follows in this report.

2.1.1. Why India opted for B&C plus intensity-based ETS

Intensity-based targets: Managing growth uncertainty
Choosing an intensity-based emissions trading framework reflects India's pragmatic response to economic uncertainty, industrial heterogeneity, and the regulatory capacity constraints typical of rapidly developing economies. Unlike absolute cap-and-trade systems, intensity-based emissions trading systems do not impose a fixed limit on aggregate emissions ex ante. Instead, they imply a notional emissions ceiling that scales with output and the assigned intensity benchmark. As production expands, the allowed amount of emissions rise proportionally, preserving compliance feasibility during periods of economic growth. However, this flexibility is not open-ended. By tightening benchmarks over time, regulators retain control over emissions trajectories, allowing aggregate outcomes to be steered gradually as better information on technology costs, sectoral performance, and growth patterns becomes available. In this sense, intensity-based emissions trading systems embody a bounded rationality approach to regulation, enabling emissions governance under uncertainty while avoiding the rigidity of hard quantity caps in the early stages of market development.

B&C: Administrative and compliance considerations
The B&C structure appears driven by administrative continuity and compliance assurance rather than economic efficiency. This maintains PAT's ex-post verification model, leveraging Bureau of Energy Efficiency's (BEE) existing institutional capabilities.[7,8] The approach addresses potential regulatory constraints—BEE operates within an ex-post framework rather than issuing tradable instruments upfront. Critically, B&C prevents facilities from over-selling credits early in the compliance period and later defaulting, since credits materialize only after verified performance.

[6] Council on Energy, Environment, and Water Issue Brief. Role of Financial Players in the Indian Carbon Market: Learning from Existing Markets and Stakeholder Perspectives October 2024
[7] The PAT scheme, administered by BEE since 2012, is a mandatory energy efficiency programme covering energy-intensive industries that rewards overperformance through tradable ESCerts.
[8] BEE serves as the CCTS's formal market administrator under the Energy Conservation Act, 2001 (as amended in 2022)

However, this prudence trades market liquidity for compliance certainty. Lagged issuance of credits reduces early price discovery and increases compliance uncertainty until verification concludes. Pre-allocated systems enable immediate trading but require stronger upfront regulatory infrastructure.

> **The intensity-plus-B&C combination reflects India's institutional context. It leverages existing capabilities, manages growth uncertainty, and ensures compliance integrity at the cost of reduced early-stage liquidity.**

2.1.2. Intensity-based caps: System-level dynamics

At the system level, intensity-based emissions trading schemes regulate emissions relative to economic activity rather than through fixed ex-ante limits. The result is determined by how the output changes over time, and environmental goals are achieved by gradually tightening benchmarks. This design is used in China's national ETS and Alberta's Technology Innovation and Emissions Reduction (TIER) Regulation programme.

It is important to distinguish system-level intensity targets from OBA at the firm level. For example, the California's cap-and-trade programme operates under a fixed aggregate cap while allocating some allowances on an output basis, while the EU-ETS uses benchmarking within a traditional fixed-cap framework. Intensity-based systems differ fundamentally as they lack a fixed system-wide cap.

From a theoretical standpoint, absolute and intensity-based caps can yield identical outcomes under perfectly predictable growth. The distinction becomes meaningful when actual growth deviates from expectations.

3. What determines credit supply in CCTS?

The supply of tradable credits in an emissions trading system reflects the deliberate regulatory choices that create the supply and markets' response to them. Therefore, the strength of the price signal depends on two interacting sets of drivers. First, the **regulatory supply drivers**, which stem from design decisions such as baseline methodologies and allocation rules. Second, the **market supply drivers**, which arise from firm behaviour, technological progress, and broader economic conditions.

3.1. Regulatory supply drivers

Baseline methodology lies at the core of regulatory supply. The baseline determines what counts as "business-as-usual" and, therefore, defines the number of credits to be issued for a given level of performance. Generous baselines issue credits for reductions that would have happened regardless, flooding the market and depressing prices. This is akin to the experience of EU-ETS Phase I where data asymmetry and lenient estimates drove allowance prices to near zero. Conversely, overly stringent baselines choke supply, raise compliance costs, and risk triggering political resistance.

> **Baseline methodology and allocation rules determine potential issuance and the first-order scarcity signal.**

3.1.1. Comparing baseline approaches

Different approaches to setting baselines embody distinct trade-offs between administrative simplicity, efficiency incentives, and risks of oversupply or political pushback. To illustrate these dynamics, it is useful to compare the main approaches that emissions trading systems have taken to baseline setting.

a) Historical baselines (Grandparenting)

Historical allocation ties crediting or allowances to an entity's past emissions. This approach is administratively simple and provides continuity, but it carries structural risks. Where historical emissions are high, the resulting allocations can embed excess supply. Coming back to phase I of the EU-ETS, caps derived from bottom-up estimates with naturally imperfect data overshot actual needs, which in turn drove allowance prices down.[9]

Historical approaches can also weaken incentives for early action. Firms with higher historical emissions may face less stringent reference levels, enabling compliance with limited operational change. In cap-and-trade systems, this effect was compounded by free allocation: firms received assets with market value that they did not pay for, leading to windfall profits once allowance prices were passed through to product prices.

However, a B&C system like India's CCTS, follows a different mechanism. Credits are not pre-allocated; they are generated only after firms outperform their assigned targets ex post. The relevant risk here arises when intensity targets are set too loosely relative to what firms would have achieved in any case, allowing them to generate credits for business-as-usual performance without undertaking genuine additional abatement. At the aggregate level, this inflates credit supply, depresses prices, and undermines the market's environmental integrity.

b) Benchmarking (Fixed or output-based)

Benchmarking is an allocation method which replaces facility-specific history with a performance standard usually expressed as emissions per unit of output. Benchmarks can be fixed to historical output (specific past production data) or dynamically linked to actual production. They often are the

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[9] ICAP. PMR. World Bank. Emissions Trading in Practice: A Handbook on Design and Implementation. 2021

key tool used to provide free allocation of allowances. Broadly there are two versions of benchmarking -

- Fixed benchmarking highlights an inherent structural feature of advanced emissions trading systems, which is that installations operating near the efficiency frontier often face steep marginal abatement costs for further reductions. These firms are typically compensated through more generous free allocation, which can result in surplus allowances and value transfers. The remaining abatement options tend to involve capital-intensive and operationally disruptive measures such as fuel switching, process redesign, electrification, or carbon capture.[10] As fixed benchmarks do not depend on outputs, additional production does not generate additional free allocation, meaning growth cannot offset these higher marginal costs. Benchmarking simultaneously rewards high performance and highlights the genuine technological and economic challenges of deep decarbonisation at the frontier. It also avoids penalising firms for their previous efficiency.

- Output-based allocation (OBA) adjusts to actual production and maintains strong incentives to improve emissions intensity. It also mitigates carbon leakage risks by aligning credits with output growth, making it particularly relevant for a fast-growing economy like India. However, setting benchmarks too generously or excessively differentiated by technology, as in parts of China and Kazakhstan's emissions trading systems, can create perverse incentives.[11,12] In the short to medium term, this can reward continued output from carbon-intensive facilities rather than encouraging a switch to cleaner fuels, thereby locking in higher emissions production pathways.

c) Intensity-based

Benchmarking and OBA apply performance standards at the facility level, but intensity-based caps extend this logic to the whole system. Credits increase with actual output against an intensity benchmark so that aggregate emissions can rise with growth while intensity declines over time. The trade-off (which is by design) reduces certainty about absolute emissions outcomes. However, to maintain environmental credibility and create scarcity, dynamic baselines must incorporate **automatic tightening rules** [aligned with ambitious Nationally Determined Contribution (NDC) commitments and realistic abatement potential]. For example, the EU-ETS's declining benchmark values in Phase IV show that intensity threshold becomes more ambitious each cycle.[13]

Intensity-based caps make systems more resilient to shocks such as economic cycles. By linking credits to intensity, they prevent "windfall" surpluses or deficits that arise under fixed allocation when output or energy mix changes unexpectedly. Complementary tools like a PSAM can further align supply with demand during shocks. In practice, OBA is the common thread, through benchmark

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[10] While CCUS is often cited as a decarbonisation option, its track record remains limited, with high costs, scalability challenges, and frequent project underperformance raising concerns about its viability as a core mitigation pathway. Refer to IEEFA's analysis on CCUS - https://ieefa.org/ccs

[11] In China, coal plants were assigned more generous benchmarks than gas plants, meaning that relatively efficient coal units could earn surplus allowances by outperforming their high benchmark, effectively receiving a production subsidy.

[12] The World Bank Group, ICAP, IEA, ESMAP, PMI. Carbon pricing in the power sector. 2024

[13] ICAP. PMR. World Bank. Emissions Trading in Practice: A Handbook on Design and Implementation. 2021

crediting at the facility level and an intensity-based cap at the system level. India's CCTS follows this model.

Box 1: OBA: Balancing industrial competitiveness and the strength of the carbon price signal

OBA protects competitiveness but changes how the carbon price transmits through the economy. As free credits are linked to output, firms face a lower effective carbon cost per unit of production. This preserves incentives to improve emissions intensity but weakens the extent to which carbon costs are reflected in product prices. As a result, consumer-facing signals for material efficiency, substitution, and demand reduction are muted, even when the underlying carbon price is positive.[14] The strength of this effect varies across sectors depending on market structure and price regulation. In sectors such as steel and cement, where demand is relatively inelastic and firms have some pricing power, carbon costs would normally be expected to pass through to prices. Critically, if these sectors do not face intense international competition, they lack the 'trade-exposed' characteristic of EITE industries and do not require the protection of OBA to prevent carbon leakage. In these cases, OBA can unnecessarily dampen price pass-through and weaken demand-side incentives for material efficiency and substitution. In contrast, in sectors where prices are set internationally (such as aluminium) or are tightly regulated (such as fertilisers), pass-through is limited regardless of allocation design. In these cases, OBA primarily functions as a competitiveness and cost-containment measure rather than a channel for transmitting carbon price signals to consumers.

Each baseline approach embodies trade-offs between simplicity, credibility, and environmental ambition. Setting benchmarks is often framed as a technical exercise in accurately reflecting firms' costs and protection needs, but international experience suggests the reality is more nuanced. There is no objectively correct level of benchmark stringency: the choice involves a genuine trade-off between the degree of competitiveness protection offered to firms and the public revenue forgone through free allocation.

These trade-offs are ultimately political, even if informed by technical analysis. A further consideration is the variety of firms within various sectors. When a single benchmark is applied across various firms with widely varying efficiency levels, a benchmark set to protect the least efficient firms will generate gains for the most efficient ones. Some degree of this outcome is inherent in applying uniform standards across a heterogeneous sector. What matters most in this context is transparency—making trade-offs explicit, cross-referencing against internationally

[14] From an industrial-organisation perspective, cost pass-through depends on market conduct and demand characteristics rather than on carbon pricing design alone. In imperfectly competitive markets, pricing power is often discussed using standard Cournot-type frameworks, where markups are related to demand elasticity. However, while such frameworks are useful for understanding the scope for markups, they do not by themselves determine cost pass-through, which also depends on demand curvature and the nature of the cost shock. In the context of OBA, the key effect is that firms' effective marginal cost increase is reduced, which dampens pass-through regardless of competitive structure.

available benchmarking data, and building in regular review so benchmarks can be tightened as performance data accumulates.[15] Where benchmark setting has drawn too heavily on industry-provided estimates without independent verification, the experience across various emissions trading systems has been of overly generous benchmarks that erode scarcity and weaken the price signal. India's CCTS should guard against this pattern through transparent, rules-based methodology.

3.2. Credible scarcity: The foundation of a functioning carbon market

A carbon market's strength ultimately depends on credible scarcity. Allowances hold value only when limited, and this scarcity drives investment and behavioural change. Dynamic baselines, while useful for accommodating growth, can also weaken this foundation unless automatic tightening rules are credibly pre-committed. As output expands, total emissions may rise despite intensity gains, eroding confidence in long-term prices. Technology- or fuel-specific benchmarks, while politically convenient, risk locking in incremental efficiency rather than driving structural shifts such as coal-to-clean transitions. If firms doubt that regulators will maintain or strengthen scarcity, they discount future prices and delay transformative investment. Systems with predictable tightening, such as the EU-ETS's Linear Reduction Factor (LRF), show how credible scarcity anchors prices and sustains decarbonisation momentum.[16,17]

Beyond baseline design, allocation levels themselves shape market outcomes. There is no universally correct volume of free or total allocations; governments must balance credibility, affordability, and political acceptance. High allocations ease transition costs but risk windfall gains and long-term surplus, while low allocations preserve scarcity but can provoke non-compliance or industrial pushback. Most emissions trading systems therefore begin with generous allocations and tighten gradually, making transparency in this tightening rule central to market confidence.

> **A durable price signal depends not on scarcity being imposed today, but on firms believing it will be sustained and will credibly tighten over time.**

To sustain credible scarcity, regulators increasingly rely on supply adjustment mechanisms that correct imbalances between issued and required credits. Other design features such as price corridors alone do not alter market fundamentals unless paired with automatic supply responses when price triggers are reached; scarcity must be genuine, not engineered. Instruments such as the

[15] Tightening can also be driven by diminishing leakage concerns, more stringent overall targets, or the growing value of auction revenue relative to competitiveness protection, paving the way for an eventual shift to auctioning.
[16] The EU-ETS LRF was set at 1.74% per year for Phase III (2013–2020), corresponding to a reduction of roughly 38 $MtCO_2e$ annually, and was increased to 2.2% for Phase IV (2021–2030) to accelerate the decline in the overall cap.
[17] Pietzcker, R. C., Osorio, S., & Rodrigues, R. Tightening EU-ETS targets in line with the European Green Deal: Impacts on the decarbonization of the EU power sector. Applied Energy, 293, 116914. 2021

EU's MSR and the price-containment reserves in California Cap-and-Trade and Regional Greenhouse Gas Initiative (RGGI) automate this correction by withdrawing or releasing allowances in response to market conditions. These experiences underscore why India's CCTS will also need a PSAM to maintain scarcity and credibility over time.[18]

3.3. Market supply drivers

Even when regulatory design establishes the conditions for credit generation, the volume of credits reaching the market can differ substantially from what the system can produce. In a cap-and-trade system, regulatory supply is bounded by the fixed allowance budget. In an intensity-based B&C system like India's CCTS, there is no such ceiling, potential credit generation depends on realised output and emissions performance, both of which are endogenous. What matters for price formation is therefore not theoretical generation capacity, but what firms release into the market. Credit generation does not automatically create liquidity and firms may bank units, particularly when prices are low or future scarcity is possible. Credits can be issued following verification yet be withheld from trading, meaning the market does not adjust even when there appears to be ample issuance.

> **Even with generous issuance, realised supply can be thin if firms bank credits. Liquidity depends on willingness to sell, not just ability to generate.**

3.3.1. Intertemporal flexibility: Banking, borrowing, and the stock of allowances

- **Banking as scarcity management:** Firms manage supply primarily through banking. By saving credits for future use, they tighten current scarcity and smoothen price fluctuations, preventing collapses even during downturns. However, when initial allocation is excessive, banking can create persistent surpluses. After 2008, the EU-ETS exemplified this dynamic. The stock of banked allowances grew so large that speculation on policy intervention, rather than expectations about emissions relative to the cap, became the main price driver.[19]

- **Borrowing as a supply advance:** Borrowing allows firms to use future allowances for current compliance, expanding present supply and improving short-term cost efficiency. However, it shifts risk forward, encourages delayed abatement, and invites pressure to weaken future targets. Most emissions trading systems therefore prohibit or strictly limit it. China's ETS allowed limited borrowing (up to 50% of shortfalls) only during the COVID-19 period. India's CCTS disallows it, preserving credibility in an intensity-based system.

- **Timing Rules:** Timing rules, through vintages, compliance periods, or holding limits, govern how supply shifts across time. Vintaging lets regulators pace credit entry, curb surplus build-

[18] IEEFA. Strengthening India's Carbon Market: The Case for a Stability Mechanism in India's CCTS. 30 October 2025
[19] ERCST, Wegener Center, BloombergNEF, & Ecoact. (n.d.). State of the EU-ETS Report. 2021

up, and maintain flexibility. It refers to rules that limit the use of credits or allowances for compliance to specific issuance periods or compliance cycles, determining when units become eligible and how long they can be carried forward. Systems like California Cap-and-Trade and RGGI achieve similar effects via longer compliance periods, but vintaging aligns credit usability more transparently with tightening benchmarks.[20]

3.3.2. External credits: Offsets and linking

- **Offsets as conditional supply instruments:** External crediting mechanisms expand supply by allowing reductions outside the emissions trading system's boundary to count toward compliance. If poorly governed, such inflows can swamp markets as seen in EU-ETS Phase II, where large volumes of Clean Development Mechanism (CDM) and Joint Implementation (JI) credits depressed prices and raised integrity concerns, prompting later bans.[21] Note that in the current CCTS design, offsets are not allowed into the compliance market, and may later be included with sectoral limits.

- **Well-governed liquidity:** High-quality offsets can expand mitigation opportunities beyond the compliance boundary and, if well governed, deepen market liquidity driving supply. China's recent relaunch of the Chinese Certified Emission Reductions (CCER)[22] programme intends to do this. It broadens economy-wide participation in emissions reduction and provides a supplementary compliance option of up to 5% of allowance obligations.[23] By adding an alternative pool of credits, CCER can ease compliance bottlenecks when emitters hoard allowances near deadlines. This pattern was observed in China's ETS where it has been driven primarily by limited pricing transparency and supply uncertainty, which leads firms to over-accumulate as a precaution. The relaunched CCER programme addresses this by expanding the pool of tradable instruments, broadening participation, and reducing the compliance pressure created by concentrated hoarding.

3.3.3. Strategic and financial market behaviour

- **Liquidity provision:** In most emissions trading systems, financial intermediaries, banks, funds, and traders sustain liquidity by market-making and offering hedging tools. South Korea formalised Market Makers backed by reserve allowances, while the EU-ETS used futures and forwards for risk management and intertemporal liquidity.[24]
  India's CCTS, however, will rely on periodic Market Clearing Price (MCP) sessions on power exchanges. Without intermediaries or derivatives, its liquidity will hinge on whether obligated firms release credits into each clearing round.

- **Liquidity constraints:** The absence of continuous order-book trading alters how liquidity risks occur in the CCTS. Rather than appearing as wide bid-ask spreads, constraints are more likely to appear as thin participation in periodic clearing sessions, delaying price discovery and weakening the MCP's informational value.

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[20] Center for Climate and Energy Solutions. California Cap and Trade - Center for Climate and Energy Solutions. September 2025
[21] Clean Development Mechanism (CDM) and Joint Implementation (JI) were international offset mechanisms under the Kyoto Protocol
[22] Emission reduction credits generated by the National Voluntary Greenhouse Gas Emission Reduction Trading Market in China
[23] EDF. China's carbon emissions trading system: Past, present and future. July 2025
[24] Park, H., & Lee, M. Factors determining firms' trading decision in the Korea ETS market. Environmental Economics and Policy Studies, 23(3), 557-580. 2021

If covered entities treat trading primarily as an end-of-period compliance exercise, clearing volumes may remain shallow. This contrasts with the EU-ETS, where a large share of trading volume is driven by utilities that hedge emissions exposure continuously alongside energy prices.
In predominantly industrial systems like the CCTS, where compliance needs evolve more slowly, firms may rationally adopt a more passive trading posture unless credits are integrated into broader risk-management or financial strategies. The credibility of the MCP as a market reference will therefore depend on whether participation extends beyond compliance-driven trading to include intertemporal transactions, liquidity provision, and value storage, supported by sufficient market depth and confidence in the system.

- **Perceptions of scarcity:** Expectations about future benchmark stringency are a primary driver of whether firms release credits into the market or withhold them. When firms expect benchmarks to tighten credibly in future compliance periods, they have an incentive to bank surplus credits today, anticipating that their value will rise as scarcity increases. This can keep liquidity thin even when credit generation is ample.
  Conversely, when future stringency lacks credibility, for example when firms expect benchmarks to remain loose or to be softened under political pressure, the incentive to bank weakens. Experience across multiple emissions trading systems shows that credible, pre-committed tightening trajectories are therefore essential not only for long-term price formation but for near-term trading behaviour. Without them, the market cannot sustain the forward-looking participation that underpins stable and meaningful price signals.

3.3.4. Policy feedback through supply adjustment mechanisms

- **Automatic corrections:** To counteract the structural imbalances created by market behaviour, most mature emissions trading systems deploy supply adjustment tools. The EU-ETS's MSR withdraws allowances when banking exceeds thresholds and re-introduces them under scarcity, directly aligning supply with observed behaviour.

- **Price-responsive measures:** The California Cap-and-Trade programme and RGGI use reserves triggered by price thresholds, ensuring that neither speculative spikes nor collapses undermine credibility.

Such mechanisms recognise that market behaviour is endogenous–firms, financial actors, and shocks constantly shift effective supply. Adjustment tools restore the perception of scarcity, anchoring long-term expectations without resorting to ad hoc interventions.

3.4. Balancing regulatory design and market dynamics

Ultimately, credit supply reflects the interplay of regulatory design and market dynamics. Regulators decide the rules of the game through baseline methodologies, allocation volumes, and adjustment mechanisms. Firms then respond with abatement, trading, banking, and investment choices that shape realised supply. Both oversupply and undersupply create different kinds of risks: the former depresses prices and credibility, while the latter can destabilise competitiveness and political support.[25] The task of policymakers is therefore not to seek the "perfect" allocation, but to manage this balance in a way that preserves environmental integrity, maintains scarcity sufficient for meaningful price signals, and sustains the system's political and economic viability over time.

> **The task is not a "perfect" allocation, but credible rules that preserve scarcity while maintaining political and industrial viability.**

Table 1: Supply scenarios and price implications

Scenario	Implications for prices and incentives	Risks to competitiveness and integrity	Relevance for India's CCTS
Excessively stringent (Effective scarcity)	• Generates higher credit prices, strengthening incentives for abatement and efficiency improvements. • Accelerates investment in lower-carbon technologies where feasible.	• Higher compliance costs may strain firms with limited short-run abatement options. • Risks of output contraction or compliance stress in EITE sectors if adjustment is too rapid.	• In an intensity-based trading system like that of India, over-stringency does not imply facility-level infeasibility. Trading reallocates mitigation across entities. The relevant risk here arises if system-wide baseline tightening outpaces the overall availability of abatement and output adjustment across the market, leading to insufficient aggregate credit generation ex post. • In such conditions, firms may build precautionary buffers or delay sales, reinforcing scarcity dynamics early on. • Without adequate flexibility or adjustment mechanisms, excessively stringent scenarios could undermine industrial and political support.
Excessively generous (weak scarcity)	• Leads to abundant credit supply and persistently low prices. • Weakens incentives for abatement and delays low-carbon investment.	• Excess credits dilute scarcity and reduce environmental credibility. • Surpluses may persist across periods if banking is allowed.	• When system-wide intensity targets are set too loosely relative to realised sectoral performance, the result is abundant credit generation without meaningful economy-wide emissions reductions. This is a risk common to the design of any emissions trading system. Persistently low prices follow, weakening incentives for abatement and delaying low-carbon investment. • Facility-level windfalls may also generate political backlash or distort

[25] Particularly in EITE sectors and may trigger financial distress for firms with limited pass-through ability

			production incentives, even if compliance appears technically successful.

4. What drives compliance demand in CCTS?

In India's CCTS, credit demand is not an independent force distinct from supply, it is the mirror image of it. At the firm level, both credit supply and credit demand arise from the same underlying variable: realised emissions intensity relative to assigned targets. Facilities operating below their benchmark generate credits and supply them to the market while those operating above it create compliance shortfalls and demand credits. Aggregate demand, therefore, reflects the negative side of aggregate supply.

This symmetry is central to understanding price formation. As carbon prices rise, the relative attractiveness of internal abatement versus credit purchases shifts. A facility that initially demands credits may reduce emissions and move below its target, becoming a supplier. Conversely, when prices are low, firms with modest abatement costs may prefer purchasing credits to investing in mitigation, expanding demand. The same drivers, interpreted through the lens of marginal abatement cost relative to the target, determine whether a firm supplies or demands credits at any given price.

At the aggregate level, credit demand represents the sum of compliance deficits across covered entities. These deficits are shaped by production levels, fuel choices, operational efficiency, and technology adoption decisions. In an intensity-based system, the emissions constraint scales with output, meaning that production affects both sides of the market simultaneously. When output expands economy-wide, total allowable emissions increase, but so do realised emissions, and the dispersion of firm-level performance around benchmarks. The net effect on demand depends on which firms are expanding. Growth concentrated among higher-emission or less-efficient facilities increases aggregate compliance deficits and therefore demand. Growth driven by efficient producers tends to generate supply instead.

4.1. Economic activity

4.1.1. Growth, output, and credit demand

Empirical evidence from other carbon markets shows that macroeconomic activity is a primary driver of carbon prices and that industrial output and growth directly influence emissions and compliance demand. In an OBA system such as India's CCTS, higher output creates more allowances but also greater liabilities. The net price effect depends on benchmark stringency and the composition of growth. Expansion led by efficient, low-intensity producers adds little to credit demand, while growth driven by older, high-emission plants raises it sharply.

The EU-ETS illustrates this relationship clearly, with allowance prices tracking industrial production indices and commodity prices in sectors such as steel, cement, and paper. As the EU-ETS operates under an absolute cap, changes in output directly affect demand against a largely fixed supply, strengthening the observed price-activity relationship. In India, where both Gross Domestic Product (GDP) and electricity demand are projected to grow rapidly,[26] the link between economic activity and credit demand is likely to be structurally weaker than under an absolute cap. This is because credit supply adjusts with production. However, the impact will still be significant depending on stringency of the benchmark and sectoral composition.

4.1.2. Output-linked allocation and structural tension

Output-linked allocation preserves competitiveness, reducing the direct link between compliance costs and production decisions. However, it creates a structural tension for price formation. As growth expands both credit demand and its potential generation, scarcity is no longer an automatic outcome of rising economic activity. Instead, price strength increasingly depends on benchmark calibration and the composition of growth. If benchmarks are insufficiently tight, or if expansion is led by relatively efficient producers (as is expected), credit supply can outpace demand even in high-growth periods, weakening the carbon price signal. Managing this tension requires benchmark trajectories that tighten in line with expected growth and abatement potential. Without them, rapid industrial expansion can coexist with declining market stringency and progressively weaker incentives for decarbonisation.

4.1.3. False gains from trade and behavioural asymmetry

This dynamic reveals a fundamental distortion in how well-functioning OBA systems generate trading opportunities. Even when demand for credits rises among underperforming firms, the output-linked allocation creates what can be termed “false gains from trade”.[27] Unlike systems where gains from trade arise solely from differences in marginal abatement costs, OBA allows trading volumes to be influenced by output responses and abatement decisions, expanding the trading pool without a commensurate increase in absolute emissions reductions. It is also worth noting that many cap-and-trade systems also incorporate OBA, so this dynamic is not unique to B&C designs.

The mechanism does not rely on strategic manipulation. It arises mechanically from how output-linked allocation interacts with firm-level performance relative to targets. In an intensity-based OBA system, credits are determined by the gap between actual emissions intensity and the benchmark, multiplied by output. This means credit supply can increase either through deeper reductions in emissions intensity, or through higher output at an unchanged performance gap. At the same time, firms operating above their targets experience the opposite effect. Each additional unit of output increases their compliance deficit, since the gap between realised intensity and the benchmark

[26] Recent IMF forecasts project a 6.6% GDP growth for India in 2025-26, while the Reserve Bank of India (RBI) predicts a 6.8% growth
[27] Resources for the future. Rebating environmental policy revenues: Output-based allocations and tradable performance standards. 2021

scales with production. Low-emission firms, therefore, face weaker effective carbon costs at the margin and may expand output while remaining credit suppliers. High-emission firms face stronger effective costs and may restrain output or increase credit purchases. Trading activity, thus, reflects not only differences in marginal abatement costs, but also differential output responses induced by target design.

India's CCTS includes progressively stricter benchmarks to limit any supply-demand imbalance, yet two challenges remain. First, initial targets are relatively easy to meet (as it is for most emissions trading systems that are starting out), meaning that later tightening must balance early surpluses. Second, if output expands faster than anticipated, credit supply can still grow despite stricter benchmarks. The price collar[28] may compound this effect: where the price floor is set above the equilibrium price, it may mask oversupply, delaying correction. Without a responsive supply mechanism, such as a PSAM, credit demand and prices may increasingly mirror administrative settings rather than real economic scarcity. This blurs the link between growth, compliance pressure, and the carbon price signal.

4.2. Energy prices

Energy prices and market conditions are powerful drivers of compliance demand.[29,30] Shifts in relative fuel costs influence dispatch decisions in the power sector and input choices in industry, altering both emissions intensity and total credit needs. When coal is cheaper than gas, production locks into more carbon-intensive pathways, raising demand for credits, and when gas becomes competitive, fuel switching reduces it. In the EU-ETS, such merit-order shifts have been among the strongest determinants of allowance demand and price movements. In India, where energy prices are volatile and gas infrastructure remains limited, these dynamics are equally relevant. However, their impact on the CCTS will be indirect in the near term since the thermal power sector, the single largest emitter, responsible for roughly 40% of national emissions, is initially excluded. This limits the fuel-driven transmission mechanisms that dominate allowance demand in systems like the EU.

The CCTS reflects energy price signals only partially: Greenhouse Gas Emissions Intensity (GEI) targets can drive efficiency improvements in industries under its purview such as steel, cement, and petrochemicals. However, they do not influence electricity generation or demand in excluded sectors such as buildings and transport. Even if the power sector was included, effective carbon price transmission would still require competitive electricity markets with price discovery and flexible dispatch. These conditions are absent where tariffs are administratively set. However, carbon pricing can shape decisions around generation mix even without direct consumer price pass-through—gas becomes more competitive relative to coal, and efficient generators relative to inefficient ones.

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[28] In the context of the regulator-controlled exchange trading band under CCTS
[29] Aatola, P., Ollikainen, M., & Toppinen, A. Price determination in the EU-ETS market: Theory and econometric analysis with market fundamentals. Energy Economics, 36, 380-395. 2013
[30] Wilson, I. G., & Staffell, I. Rapid fuel switching from coal to natural gas through effective carbon pricing. Nature Energy, 3(5), 365-372. 2018

China's ETS illustrates that when this was established ahead of broader energy market reform, it still influenced dispatch decisions despite modest early price signals. It is now deepening as reforms advance. The lesson is not that carbon markets must await energy market reform, but that each must be designed with the other in mind.

4.2.1. Compliance demand and exclusion of power sector

Excluding the power sector from the CCTS carries important distributional and macroeconomic implications. A key advantage is that it avoids directly raising wholesale electricity prices, limiting immediate consumer impacts and reducing inflationary spillovers. It also prevents electricity from bearing a carbon cost burden that other fuels in excluded sectors such as transport or household heating do not face. This preserves carbon cost neutrality across energy carriers and maintains the attractiveness of economy-wide electrification.

Power sector has other impacts too -

- It weakens the link between volatile energy prices and compliance demand. For industries covered under the CCTS, fuel and electricity input costs still matter. Cheaper coal or oil increases emissions liabilities, while higher fossil prices or cheaper substitutes reduce them. However, these effects remain narrower than in systems anchored in the power sector.
- The absence of utilities, which are typically large and active market participants, reduces potential liquidity and trading depth. Demand may become concentrated in industrials who may only transact around compliance deadlines[31], limiting price discovery and reinforcing the risk of thin, volatile markets.

While India's power sector represents the single largest source of carbon emissions, its inclusion would raise fundamental regulatory challenges as electricity tariffs in India are determined through a statutory process under the Electricity Act 2003, and carbon cost recovery by generators is subject to regulatory approval.

Unlike in some regulated markets where carbon costs are routinely recognised as a legitimate cost item and passed on to consumers, India's tariff determination process is more sensitive, and does not yet have an established framework for treating carbon compliance as an automatic cost pass-through. This makes carbon cost pass-through structurally uncertain. Importantly, this uncertainty pertains primarily to pass-through into retail tariffs. The more consequential channel for emissions outcomes is the incorporation of carbon costs into dispatch and merit-order decisions. This can shift generation toward lower-emitting plants without raising consumer prices, which is an outcome that is desirable on both electrification and equity grounds. Korea's recent reforms (see Table 2) illustrate this distinction. Carbon costs were initially absent from both tariffs and dispatch, but reforms from

[31] Evidence from the Korean Emissions Trading System (K-ETS) shows that trading activity has been concentrated around compliance deadlines, with limited secondary market participation and low liquidity constraining continuous price discovery.

2022 onward have sought to embed them in dispatch decisions even where retail pass-through remains constrained. For India, the practical question is therefore narrower than full tariff pass-through. The question is if and how carbon costs can inform dispatch within the existing scheduling and power purchase agreement (PPA) framework.

Importantly, electricity generation is largely a domestic, non-trade-exposed sector. Unlike EITE industries, it does not face international competitiveness pressures that justify free allocation on carbon leakage grounds. This makes it a structurally significant potential revenue source under an auction-based design, if introduced later. Consumer impacts from any price pass-through could be addressed through targeted rebates, tariff design, or fiscal recycling mechanisms, rather than through continued OBA. Any future inclusion would therefore require careful design choices, rather than simply replicating models adopted elsewhere.

By excluding the power sector, the CCTS omits the primary channel through which carbon pricing in other systems has transmitted energy market volatility into compliance demand. Fuel price movements will continue to drive India's overall emissions trajectory, but their influence on credit demand within the market will remain partial. This weakens price signals, constrains liquidity, and limits the system's ability to guide investment decisions.

Addressing this requires regulators to set sufficiently ambitious targets for covered industries to sustain meaningful compliance demand in the absence of power sector fuel-switching. It also requires a credible integration roadmap that accounts for India's regulated tariff structure, so that the largest single driver of carbon price dynamics can eventually be brought within the market without creating unresolved conflicts between carbon compliance obligations and electricity price regulation.

> **Importantly, electricity generation is largely a domestic, non-trade-exposed sector. Unlike EITE industries, it does not face international competitiveness pressures that justify free allocation on carbon leakage grounds. This makes it a structurally significant potential revenue source under an auction-based design if introduced later.**

Table 2 summarises how power-sector inclusion shapes compliance demand across an emissions trading system, with carbon price movements closely tied to fuel-switching behaviour where energy prices are market-linked.

Table 2: Power sector inclusion and fuel price linkages across major emissions trading systems

Emissions trading system	Power sector inclusion	Energy price-carbon price relationship
EU-ETS	**Yes.** Power sector included since Phase I in 2005. Electric power and heat generation were also immediately covered under the cap.	**Strong fuel-switching effect.** Carbon prices move with coal-gas spreads. High gas prices shift generation to coal, raising allowance demand, while cheap gas lowers it.[32]
Korea ETS	**Yes.** Power sector included since its 2015 launch. Korea's ETS covers electricity generation along with other major sectors, though initially carbon costs in power were not reflected in electricity pricing.	**Historically weak.** In the early phases, Korea's carbon market had no significant fuel switching in power generation because carbon costs were not passed through to generation dispatch.[33] The ETS carbon price remained low [South Korean Won (KRW) ~8–10k, or <USD10] and was relatively decoupled from coal or Liquefied Natural Gas (LNG) price fluctuations.[34] Recent market reforms (from 2022) aim to incorporate carbon costs into dispatch merit order, which could strengthen the link between fuel prices and K-ETS carbon prices going forward. This highlights a key lesson for India and its energy market.
California Cap-and-Trade	**Yes.** Covers electricity generation (in-state power plants **and** imported electricity) from the outset (first compliance period in 2013). The programme expanded to cover transportation and heating fuels in 2015.	**Moderate (managed by design).** Carbon costs are embedded in the cost of California's gas-fired power generation, but allowance prices have been largely policy-driven (for example, influenced by an auction price floor and overall cap trajectory). With almost no coal in California's mix, there is little direct coal-to-gas switching. Instead, high allowance prices encourage a shift from natural gas to renewables or efficiency. Overall, fuel price volatility has had limited effect on the carbon price compared to programme design elements such the minimum auction price and banking of allowances.[35]

[32] Bertrand, V. Carbon and energy prices under uncertainty: A theoretical analysis of fuel switching with heterogenous power plants. Resource and Energy Economics, 38, 198-220. 2014
[33] South Korea operates an open wholesale electricity market with regulated retail prices
[34] International Energy Agency. Implementing Effective Emissions Trading Systems: Case Studies. Paris: 2023
[35] Columbia SIPA. Lessons for Structuring India's Carbon Market to Support a Cost-Efficient Energy Transition. 2024

China National ETS	**Yes.** The national ETS began in 2021 focusing **only** on the power sector (covering large thermal power plants). Other industries (steel, cement, aluminium) are slated to be phased in over time, as announced in March 2025.[36]	**Weak but evolving link.** As the market is intensity based and the power sector remains regulated, carbon prices have shown little correlation with fuel prices. Gas-fired generators are fully covered by free allowances, while coal plants face a capped shortfall (up to 20%), limiting any fuel-switching response. As a result, early carbon prices [Yuan (¥)40–¥60/tCO2e or USD6–8] were largely policy-driven rather than market-responsive. However, as allowance stringency increases and power market reforms advance, the link between fuel costs and carbon prices is expected to strengthen. By late 2024, prices had already risen to nearly ¥100/t (USD14).[37] Notably, the Chinese government recently announced that it intends to transition toward an absolute cap on its ETS. This shift would reduce reliance on OBA in the power sector and is expected to strengthen the link between carbon prices and fuel-switching decisions.

4.3. Technology and investment cycles

4.3.1. Technology

Technology adoption in the obligated sectors will play a decisive role in shaping credit demand under the CCTS. As baselines and targets have already been notified at the entity level,[38] compliance obligations are fixed for the first cycle. What remains fluid, however, is how each firm's technological pathway interacts with these targets, shifting the balance between internal abatement and credit purchases.

Two dynamics shape credit demand. **First, efficiency gains and process optimisation can rapidly shift firms' marginal abatement costs.** Upgrades such as waste-heat recovery in cement, energy management systems in refineries, or digital controls in aluminium represent relatively low-cost abatement activities. Such upgrades make in-house reductions potentially more cost-effective than buying credits, depending on the prevailing carbon price. For firms with capital or technology constraints, however, credit purchases will remain essential. India's PAT experience illustrates this: low-cost efficiency options and lenient initial targets led to widespread overachievement, especially in cement, creating a buyer's market and depressing Energy Saving Certificate (ESCert) prices. The

[36] EDF. China's carbon emissions trading system: Past, present and future. July 2025
[37] Ministry of Ecology and Environment of the People's Republic of China. Progress report of China's national carbon market. 2024.
[38] With final notifications for 7 sectors covering 490 obligated entities

CCTS faces a similar risk given the targets. With entity-specific baselines and varying access to low-cost abatement, early target calibration will determine whether credit demand stays strong or collapses as firms abate rather than buy.

Second, heterogeneity across firms matters. As every obligated entity faces a different starting point and technological frontier, their marginal abatement curves are uneven. Early movers adopting best-available technologies may generate surplus credits, while late movers with older, carbon-intensive assets may remain structurally short. Aggregate demand will, therefore, reflect the distribution of technologies across firms and sectors, not just sector averages. If adoption is clustered among a few firms, credit demand could stay elevated, but market liquidity would be thin. Conversely, if adoption is widespread and rapid, demand could weaken and prices soften.

4.3.2. The “lumpy” nature of industrial abatement through technology adoption

Abatement in industry is often described as “lumpy”, reflecting the discrete, stepwise nature of major technological upgrades rather than a smooth cost curve. While efficiency and optimisation measures such as energy management refinements, digital controls, or operational tuning can deliver continuous, incremental gains over time, the larger transitions tend to come in steps.

In steel, firms first exhaust low-cost measures such as gas recovery or furnace efficiency, before taking the leap to options like electric arc or hydrogen-based processes. Cement follows a similar pattern with affordable steps like waste heat recovery preceding costly transitions to carbon capture or new chemistries. These step changes create long plateaus of inelastic credit demand that persist until prices rise enough to unlock the next technology tier.

A separate but related constraint relates to measures that appear to have low, or even negative cost, on paper. Unlike lumpiness, this phenomenon arises from implementation barriers such as financing constraints, operational risk, downtime requirements, organisational inertia, or misaligned incentives. The persistence of such barriers reflects structural constraints rather than a lack of price signal, meaning the introduction of a carbon market does not automatically activate them. Together, lumpiness and negative-cost barriers explain why credit demand in India’s industrial sectors is likely to remain more inelastic than smooth marginal abatement cost curves would suggest.

Capital intensity, asset lock-in effects, and sectoral investment cycles

Credit demand in India’s industrial sectors is shaped by the capital-intensive and cyclical nature of low-carbon transitions. Major emissions cuts require large, indivisible investments in new or retrofitted plants that align with sector-specific replacement cycles. This creates temporal clustering of abatement and produces sharp, discontinuous shifts in credit demand. Between these investment windows, firms remain locked into high-emission assets, sustaining credit demand regardless of price signals. Premature retirements risk stranded assets, so even significant carbon price increases may not curb demand until the next capital turnover opportunity.

The pace and rhythm of these investment cycles vary widely across sectors. Refineries can make frequent efficiency upgrades during regular turnarounds, while cement kilns and blast furnaces lasting 30–50 and around 40 years, respectively, remain locked into emissions for long periods. Each kiln rebuild or furnace reline defers low-carbon upgrades and locks in future credit purchases for decades, while timely transitions sharply reduce compliance costs. Aluminium smelters, on the other hand, face a different pattern, with credit demand shaped more by PPAs and grid decarbonisation than by internal upgrades.

India's current industrial expansion amplifies these dynamics. For example, a large share of the country's blast furnace fleet is relatively young, meaning much of the capacity added or relined in the 2010s and 2020s will remain operational well into the 2040s.[39] This locks in emissions and creates a durable source of credit demand that will persist regardless of short-term price movements. Conversely, when capital replacement windows align with favourable technology economics, supported by predictable carbon prices or policy measures that lower transition risk, firms accelerate investment in low-emission capacity. This surge in investment leads to sharp contractions in credit demand.

Overall, credit demand in the CCTS will fluctuate not only with immediate price signals but with the timing of sectoral investment cycles. With much of India's industrial capital stock, especially in steel, still mid-life, investment decisions made over the next decade will define credit demand patterns through the 2030s and beyond. Policy interventions at critical decision nodes, such as kiln rebuilds, furnace relining, and long-term power contracts, will shape medium-term market dynamics far more than carbon price adjustments alone. Importantly, future growth and new facilities represent a distinct and potentially more elastic segment of demand. Greenfield investments can adopt best-available technology from the outset, making incentive design for new capacity a critical lever for shaping long-term credit demand trajectories.

4.3.3. Capital expenditure (Capex) cycles

4.3.3.1. Growth-driven investment and compliance implications

India's industrial expansion is driven predominantly by capacity additions rather than asset replacement, meaning that current investment decisions will shape emissions trajectories for decades. Under the CCTS's output-based allocation framework, compliance outcomes scale with production. As targets are benchmarked against the lowest GHG intensity in each sub-sector—with individual targets calibrated by the gap to that frontier—the interaction between capital stock age, technological efficiency, and facility-level targets becomes central. New plants operating at frontier performance are more likely to remain below their assigned intensity levels and generate credits,

[39] Global Energy Monitor. Why India's 'build now, decarbonize later' approach to achieving a net-zero steel industry will fail. March 2025.

while older or less efficient facilities face larger compliance gaps as output expands.[40] As a result, medium-term credit demand increasingly reflects the pace of capital stock turnover and the distribution of new investment across technologies, not solely marginal abatement effort.

Although India's targets are defined at the facility level rather than through a single transparent sector-wide benchmark, the economic logic remains similar. That is, tighter performance standards naturally push less-efficient facilities to improve, while making it comparatively easier for new, efficient ones to comply. Introducing explicit separate rules for old and new assets risks delaying retirement of inefficient facilities, complicating implementation. The more robust approach is to gradually align facility-level targets towards common performance standards and steadily increase overall stringency. This way, Capex cycles become a critical determinant of credit demand in the medium term. Expanding efficient facilities can increase credit supply and moderate prices, while continued operation or growth of less efficient facilities sustains structural demand.

4.3.3.2. Price predictability and investment incentives

The effectiveness of Capex cycles in response to carbon price signals relies on the credibility and predictability of these signals over investment periods of 15–30 years. Industrial firms evaluating major capacity additions need assurance not only that carbon pricing will continue, but that stringency will increase, aligning with the economics of long-term assets. In India's CCTS, uncertainty may stem from broader questions about the future trajectory of benchmark tightening, policy durability, infrastructure readiness, and complementary support mechanisms for low-carbon technologies. In sectors such as steel, where breakthrough routes like hydrogen-based production require significant ecosystem investments, firms may prioritise short-term compliance through credit purchases if long-term carbon price signals and policy alignment remain uncertain.[41]

At the same time, capital investment cycles can cause structural shifts in credit demand. Large-scale efficiency upgrades or coordinated technology adoption across sectors could permanently reduce aggregate compliance deficits. This would lead to sustained downward adjustments in credit prices. Conversely, delayed investment or continued reliance on legacy technologies can entrench persistent demand and support higher price levels.

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[40] Under the CCTS, individual targets for obligated entities are set with reference to the lowest GHG emission intensity within each sub-sector, with each entity's specific target calibrated by its performance gap relative to this benchmark and the sectoral trajectory aligned with India's NDC commitments. This best-performer benchmarking approach is broadly consistent with international practice, such as the EU-ETS, which sets benchmarks based on the average of the 10% most efficient installations. However, the methodology for assigning baselines and targets to new entrants, plants commissioned after the start of a compliance cycle and therefore lacking historical performance data, has not yet been specified. This remains an important open design question, since the treatment of new entrants will materially shape credit-generation dynamics from new capacity additions and, by extension, medium-term demand in the market.

[41] India has introduced several initiatives to support low-carbon steelmaking, most notably the National Green Hydrogen Mission, which funds pilot hydrogen-based steel projects, and the Green Steel Mission under the Ministry of Steel. Recent experience in advanced markets underscores these risks. For example, Thyssenkrupp's ongoing investment in a hydrogen-based steel facility in Germany has highlighted the challenge of operating-cost uncertainty, with public reporting indicating concerns over the long-term viability of hydrogen routes even under a mature ETS and substantial policy support. This illustrates that uncertainty around fuel costs, infrastructure readiness, and carbon price trajectories can delay or complicate large-scale Capex decisions, reinforcing wait-and-watch behaviour among firms.

4.3.3.3. Financial constraints and development context

Cleaner technologies usually require high upfront capital costs, while access to affordable, long-term financing for low-carbon industrial projects remains limited. This constraint is most acute for smaller firms and project-financed structures, where financing costs can be much higher than in advanced economies. Even large, well-funded industrial groups, such as integrated steel or cement majors, encounter structural barriers like weak long-term contracting frameworks, limited off-taker creditworthiness, and regulatory uncertainty over carbon price trajectories. This makes it difficult to underwrite the returns on large, irreversible low-carbon investments.[42] As a result, even firms that are financially strong may favour incremental efficiency improvements or credit purchases rather than making investments in transforming their processes.

These constraints are amplified by broader structural risks like limited creditworthiness of off-takers, regulatory uncertainty, and weak long-term contracting frameworks, all increasing uncertainty about future returns. During rapid demand growth, industrial firms often choose technologies and configurations with lower execution risk, shorter lead times, and clearer financing options. While low-carbon solutions can support energy security and competitiveness, their adoption relies on de-risking instruments and credible long-term policies. In such conditions, carbon pricing alone is unlikely to trigger large-scale industrial emissions reductions. Complementary measures, including green financing, risk-sharing instruments, revenue recycling from future auctions, and credible long-term price guidance, are therefore essential to align Capex cycles with the CCTS's decarbonisation goals and unlock the demand-reducing potential of the complementary measures.

4.3.3.4. Strategic implications for market evolution

Capex cycles will drive distinct phases of credit demand. Demand may rise initially if firms prioritise expanding capacity over efficiency, particularly under weak or uncertain price signals. If investment leans towards high-emission assets, structural compliance deficits may remain, keeping prices high and solidifying carbon-intensive capital.

However, as benchmarks tighten and cleaner technologies become more commercially viable, coordinated efficiency upgrades could quickly reduce aggregate deficits, leading to steady downward shifts in credit demand and prices. Policymakers, therefore, need to ensure that tightening measures are credible and predictable across investment cycles. Early price weakness risks locking in inefficient capital, while unmanaged structural demand reduction later could discourage investment just as low-carbon technologies scale up. Forward guidance on benchmark tightening and complementary measures that de-risk clean investment is essential to ensure that Capex cycles support, rather than disrupt long-term decarbonisation signals.

[42] IEA. Renewables: electricity. 2023.

5. Offsets and external credits

Offsets represent verified emission reductions or removals achieved outside the compliance boundary of an emissions trading system that can be used in lieu of emissions reduced by covered entities. Each unit is issued as equivalent to one tCO_2e, but this equivalence reflects certification rules and policy design rather than a precise physical identity. Within a domestic system, the government aims to ensure that even with the use of offsets, net emissions remain consistent with overall targets, rather than guaranteeing exact one-for-one additionality at the project level.

Allowances authorise emissions within the system's cap, but offsets extend carbon pricing to sectors like agriculture, waste, forestry, or transport. This mobilises mitigation in areas that are otherwise hard to regulate due to administrative or distributional challenges. For example, in India, this could potentially link CCTS with national infrastructure priorities such as those under the National Infrastructure Pipeline. Well-designed offset frameworks, particularly standardised or programmatic ones, can support projects in areas such as logistics efficiency, grid modernisation, waste management, and urban energy systems that are otherwise outside early-phase compliance coverage. Predictable carbon revenue streams from offsets can improve project cash flows, enhance creditworthiness, and provide a form of risk mitigation or credit enhancement, lowering the cost of capital and bringing in private investment alongside public expenditure.

Globally, jurisdictions have used offsets to bring investment to uncovered sectors, achieve co-benefits such as land restoration or rural livelihoods, and reduce compliance costs. However, experience shows that poorly governed offset inflows can undermine market credibility. Under the Kyoto Protocol, systems like the EU-ETS imposed formal quantitative limits such as CDM and JI credits. However, even these capped inflows represented a significant share of overall mitigation and contributed to surplus conditions, particularly when combined with generous caps and weak demand. The resulting price depression weakened domestic abatement incentives and accelerated reforms. [43,44] This experience prompted a structural shift and mature systems such as the EU, California, Québec, China, and Korea now prioritise domestic offsets with stringent monitoring, reporting, and verification (MRV), buffer reserves to manage permanence risk, and have tight quantitative limits (typically 3–10% of compliance). Domestic programmes such as those in New Zealand retain local co-benefits, build institutional capacity, and align carbon finance with national development goals.[45]

India is following this trajectory by developing "Bharat Methodologies" (BM) under the Indian Carbon Market architecture.[46] These methodologies are proposed to be in line with Article 6.4 guidance and

[43] Koch, N., Fuss, S., Grosjean, G., & Edenhofer, O. (2014). Causes of the EU-ETS price drop: Recession, CDM, renewable policies or a bit of everything? New evidence. Energy policy, 73, 676-685.
[44] Leining, C., & Kerr, S. Managing Scarcity and Ambition in the NZ ETS. 2019
[45] New Zealand's inclusion of domestic forestry as a carbon sink successfully mobilised large-scale afforestation, built a functioning domestic carbon market. However, the programme also illustrates the risks of an insufficiently managed domestic offset supply—forestry unit supply grew to a point where it dominated the scheme.
[46] Bureau of Energy Efficiency. Detailed Procedure for Offset Mechanism under CCTS (Version 1.0). New Delhi, India. 2025

will cover 10 sectors including energy, industry, waste, agriculture, forestry, and transport, and emphasise additionality, permanence, and double-counting safeguards.[47]

Authorised export credits will be labelled with corresponding adjustments, ensuring alignment with Paris Agreement accounting. Non-labelled units without corresponding adjustments can still be traded internationally, with reductions counted toward India's NDC.[48]

In the short term, offsets remain non-fungible with CCTS compliance credits, and this separation is prudent. The primary risk to early price discovery is structural oversupply from generous allocation and unlimited banking. If the compliance price is already a weak indicator of in-sector abatement costs for this reason, introducing offsets compounds the problem. However, premature offset integration introduces another complication. If cheap abatement from non-covered sectors replaces in-sector effort before a credible compliance price is established, it becomes harder to read what the CCTS price actually signals about abatement costs in the sectors covered. Offsets do reveal some cost information, but it is about sectors and activities outside the CCTS purview. Mixing these signals too early risks blurring the informational foundation needed to tighten future benchmarks.

A three-phase integration is therefore envisaged, as follows:
Phase 1: No offsets permitted, allowing the compliance market to establish a credible signal for in-sector abatement costs.
Phase 2: Limited high-integrity domestic offsets of 3–5% of compliance obligations become available once the sectoral marginal abatement cost curves stabilise.
Phase 3: Selective access to Article 6 credits is permitted under strict quantity and quality limits, after the domestic market reaches a mature stage.[49] However, this would be a very long-term design element given that India's abatement costs will likely be below global levels in the near future and the strategic opportunity of Article 6 participation remains forward-looking. A more detailed discussion will be included in the next report.

In each phase, the value of offsets will be determined primarily by the CCTS compliance price and the binding nature of any quantitative limit, not by external corporate climate standards. This sequence ensures that flexibility complements rather than dilutes scarcity within the CCTS.

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[47] The Detailed Procedure for the Offset Mechanism under CCTS (BEE, Version 1.0, 2025) requires that Bharat Methodologies shall comply with the latest Article 6.4 mechanism methodology standards. In practice, the extent to which approved methodologies reflect this requirement—as opposed to drawing on CDM frameworks—will become clearer as the methodology pipeline develops.
[48] Section A7.2.3 of the Detailed Procedure for Offset Mechanism under CCTS (BEE, Version 1.0, March 2025)
[49] The growing interest in international carbon credits among major emissions trading systems' jurisdictions reinforces the strategic relevance of this third phase for India. The EU has now agreed to allow up to 5% of its legally binding 2040 climate target to be met through high-quality Article 6 credits—its first formal re-engagement with international offsets since phasing them out in 2020. In China, the relaunched CCER programme (January 2024) now allows covered entities to offset up to 5% of emissions trading systems' obligations using domestic certified credits. China is exploring Article 6 participation as its domestic market matures, though its formal engagement remains contingent on sufficient policy clarity at the international level. COP29 finalised the Article 6 rulebook, including the transition of the CDM to the Paris Agreement Crediting Mechanism.

Figure 3: Offset use across major emissions trading systems

Jurisdiction	
California Cap-and-Invest Program	Domestic compliance offset credits allowed, with both qualitative and quantitative limits. Credits must originate from projects located in the United States, with additional eligibility for credits issued under linked jurisdictions (currently Québec, Canada). Covered entities may use offsets to fulfil up to 4% of their compliance obligation annually for 2021–2025, rising to 6% for 2026–2030 emissions.
China ETS	Domestic offsets allowed, with quantitative limits. Covered entities may use CCERs generated from projects not covered by the national ETS for up to 5% of their verified annual emissions.
EU ETS	Offset credits are currently not permitted for compliance use.
Japan Green Transformation (GX) ETS	Both domestic offsets (J-Credits) and international credits under the Joint Crediting Mechanism (JCM) are allowed, subject to quantitative limits. Combined offset use is capped at 10% of an entity's total compliance obligation.
New Zealand ETS	Offset credits are not currently permitted. Units issued under the Kyoto Protocol were eligible until June 2015 and are no longer accepted for compliance.
RGGI	Offset credits are currently allowed, subject to qualitative and quantitative limits. Usage is capped at 3.3% of an entity's compliance liability. No RGGI offset allowances will be awarded after 2027.
Korea ETS (Republic of Korea)	Domestic offset credits—Korean Offset Credits (KOCs)—were permitted from Phase 1 (2015-2017). International offset credits, subject to qualitative limits, have been permitted from Phase 2 (2018-2020). All offsets, whether domestic or international, must be converted into Korean Carbon Units (KCUs) before use for compliance.

Vietnam Pilot ETS	Both domestic and international offset credits are permitted, subject to qualitative and quantitative limits. Entities may use offsets to cover up to 30% of their compliance obligation per allocation period.

6. Supply-demand elasticities

In theory, supply and demand in a B&C system mirror each other. The same drivers—abatement costs, technology adoption, carbon prices, and output decisions—determine whether a firm generates surplus credits or faces a compliance deficit. Target allocation categorises firms across the two sides of the market, but the underlying behavioural calculus remains symmetrical. In practice, however, they differ due to structural, institutional, and behavioural issues.

6.1. The credit generation friction: Timing, discretion, and liquidity

The theoretical symmetry can be moderated in practice by institutional and timing frictions within the CCTS. Firms in both cap-and-trade and B&C systems should make deliberate abatement decisions, monitor and verify emissions, and actively participate in the market if they want to sell surplus units. Ultimately, the fundamental behavioural calculus—comparing marginal abatement costs to carbon prices—remains the same. The key distinction in a B&C system lies in the timing and issuance of tradable units. Credits are generated ex post, after verified performance relative to assigned baselines, which limits firms' ability to sell surplus units before compliance. In contrast, cap-and-trade systems allocate allowances upfront, allowing earlier intertemporal positioning.

This difference in issuance timing can influence supply responsiveness. In a B&C system, firms operating below their baseline may anticipate future tightening or higher prices and choose to defer additional abatement or delay market participation until credits are formally issued. On the demand side, however, compliance deficits must ultimately be resolved within the settlement period. While both buyers and sellers face strategic choices, the ex-post nature of credit issuance can dampen early liquidity and create short-term asymmetries in how supply and demand respond to price signals, even if the underlying economic incentives remain symmetric.

6.2. Output effects and participation bias in intensity-based systems

Output-linked allocation can amplify behavioural differences through scale effects. Since credit generation scales with production, even small efficiency gains can yield large credit volumes for high-output firms, making participation attractive despite modest price-cost gaps.

Smaller firms with similar abatement costs face disproportionate challenges in credit monetisation burdens, such as third-party verification costs and the lack of in-house trading or legal expertise that larger firms absorb internally. This discourages their participation and creates a **supply-side bias**, with large, efficient producers dominating the market.[50] Companies incur transaction costs, including verification, registration, and compliance reporting, regardless of when credits are sold or banked, effectively setting a minimum threshold for engagement. When targets are already close to cost-effective abatement levels, trading gains are limited and even modest participation costs deter engagement, reinforcing uneven market depth.

The European experience in the cement sector illustrates this: for over a decade, cement producers kept emissions close to their allocated limits, even as overall emissions declined annually. This suggests that allocation design, rather than arbitrage incentives, had a major role in influencing compliance behaviour.

6.3. Determinants of supply and demand elasticity in India's CCTS

Supply elasticity, or flexibility, depends on the distribution of firms below baseline and their capacity to reduce emissions further, as well as the potential profitability of expanding output while staying compliant. If many already outperform targets and have low-cost ways to reduce emissions such as fuel switching or process optimisation, supply will be elastic. In this case, even a small increase in prices could lead to significant new credit generation. On the other hand, if most firms are close to their targets or face steep marginal costs, supply will remain inelastic.

Demand elasticity operates through two channels: abatement and output. Higher prices may cause firms above baseline to reduce emissions rather than buy credits, or to curb production if costs cannot be passed through. Yet in early-stage systems like India's, short-term demand responsiveness is limited. Major emitters in industries such as steel, cement, and aluminium have few immediate abatement options, and production is largely influenced by capital cycles and product demand.

The volatility matrix: Elasticity combinations and price stability
The interaction between supply and demand elasticities leads to various scenarios for price volatility in India's carbon market, as shown in Table 3. However, two important sources of volatility sit outside this framework and should be read alongside it. First, uncertainty around policy and about the direction or pace of future benchmark tightening can cause large, rapid price changes entirely independent of physical supply-demand conditions.

Second, banking creates a form of effective elasticity by allowing changes in banked credit through additions and withdrawals that require no change in real-economy behaviour. Shifts in expectations can produce sharp price movements even when production, abatement, and compliance behaviour are unchanged. The table below captures the physical elasticity aspect, while policy credibility and banking dynamics complement it.

[50] While baseline compliance reporting obligations apply equally to all covered entities, the additional costs specific to actively trading surplus credits fall disproportionately on smaller participants, effectively setting a minimum scale threshold below which trading is financially unattractive even when emissions have been abated.

Table 3: Price elasticity scenarios

Supply elasticity ↓ / Demand elasticity →	**Elastic demand**	**Inelastic demand**
Elastic supply	**Balanced and moderately stable** • Price swings dampened by responsive supply and demand. • Represents mature, well-functioning market with adaptive mechanisms (MSR, CCR). • *Ideal long-run scenario.*	**Asymmetric volatility** • Rising prices trigger extra supply, moderating spikes. • In downturns, both production and credit generation tend to fall, so oversupply is not automatic. The risk arises if banked credits are released as firms liquidate stocks, or if output falls disproportionately among surplus generators while deficit firms maintain production. • *Likely medium-term risk for India.*
Inelastic supply	**Transitional stability** • Demand adjusts to prices, cushioning volatility. • Requires firms with flexible abatement portfolios and responsive output decisions. • *Unlikely in India's early phase.*	**High volatility and institutional stress** • Neither side adjusts easily to price signals. • Small shocks cause large price swings. • *Most probable in early CCTS years; underscores need for stability mechanisms.*

6.4. Early-stage realities and design implications

The intensity-based design creates a specific early-market risk that is analytically different from the elasticity dynamics discussed above but directly shapes them: there might not be enough credit supply to meet aggregate demand. This can happen if targets prove more stringent than anticipated, or if output growth in sectors that demand credits exceeds expectations, generating fewer surplus credits than deficit firms require. The practical consequence plays out in one of two ways. First, some firms that would otherwise purchase credits may reduce emissions even beyond cost-effective levels to avoid non-compliance risk. This over-abatement is driven by two factors: firms do not know whether there will be sufficient credits in the market, and they do not know what the carbon price will be, which means they cannot identify the cost-effective level of abatement in the first place.

Second, even firms that engage in precautionary over-abatement may still not be able to avoid compliance shortfalls if aggregate credit generation falls short, leaving some firms non-compliant simply because the system did not generate enough credits to clear the market.

Both outcomes—inefficient over-abatement and potential non-compliance—constrain trading activity and delay price discovery. However, the first compliance cycle operates under acute uncertainty about whether the system will generate sufficient credits to clear the market, a reality that policymakers and market participants should plan for explicitly.

As oversupply tightens, elasticity considerations become increasingly important. In India's CCTS, both supply and demand are likely to remain relatively inelastic. Many abatement options are lumpy and capital-intensive, while regulated electricity markets and limited short-run abatement flexibility constrain demand changes. This means even small mismatches between target stringency and actual abatement can lead to pronounced price swings, a risk that grows as the system matures and benchmarks become more stringent. A further asymmetry arises because credit generation in an output-linked B&C system scales with both intensity improvements and production volumes, allowing large producers to gain substantial surpluses from small efficiency improvements while smaller firms face participation thresholds that limit engagement. This results in a concentrated supply base that can worsen buyer-seller imbalances and hide the market's overall inelasticity. These dynamics suggest that early market design must do two things simultaneously:

- Prevent credibility loss from oversupply by using banking rules and signalling pathways towards stricter future targets.
- Establish stability mechanisms and supply adjustment measures that will become critical once oversupply conditions shift to tighter balances and higher volatility.

7. Direct policy effects on market development

Carbon markets are intentional policy constructs. Emissions trading requires governments to create transferable rights to emit within defined scarcity limits. Governments are not the regulators, but the architects of this market, setting participation rules, allowance quantities, and price formation mechanisms. Without these decisions, there is no scarcity, value, or trade. From the US SO_2 programme (Acid Rain Programme) to EU and China's ETS, experience has shown that market performance depends on the precision, coherence, and credibility of design. Weak rules, such as over allocation or excessive offsets, have repeatedly caused price collapses.

An emissions trading system thus follows a policy lifecycle, not a single design moment. Each phase, from preparation to evaluation, requires active state involvement to translate environmental and economic goals into operational rules. Choices on coverage, baseline setting, allocation, and stability mechanisms jointly determine cost effectiveness and integrity. Seeing the development of an emissions trading system as a continuum of policy intervention underscores that sustained governance, not one-time design, is what makes carbon trading function. Table 4 maps this lifecycle in full, identifying the required government interventions at each of the 10 stages from preparation to implementation and review.

Table 4: Policy interventions across different stages of establishing a carbon market (adapted from ICAP)

Lifecycle step	Intervention area	Required government actions
1. Preparation	Objectives & strategy	• Define the emissions trading system's role in the broader climate policy mix (such as, cost-effective mitigation, fairness, investment signal). • Identify and remove countervailing policies unless strategically justified. • Select assessment criteria (robustness, predictability, flexibility).
	Policy interactions	• Map overlaps with existing policies (for example, renewable subsidies, efficiency mandates). Ensure complementarity rather than conflict.
2. Stakeholder engagement & capacity building	Coordination	• Establish inter-ministerial coordination (energy, environment, industry, finance). • Appoint clear executive leadership.
	Engagement & communication	• Develop consultation and communication strategies to build credibility and public support.
	Capacity building	• Invest in regulatory and technical capacity for MRV, allocation, and market oversight. • Provide training for obligated entities.
3. Scope demarcation	Coverage	• Determine the sectors (for example, power, industry, transport) and gases (such as CO_2, N_2O, PFCs) to be included.
	Regulation	• Select point of regulation (upstream, midstream, downstream). • Balance accuracy with administrative feasibility.
	Entities & thresholds	• Set thresholds to exclude low emitters while maintaining coverage integrity.
4. Cap or baseline setting	Ambition & type	• Choose between absolute caps or intensity-based trajectories. • Establish ambition aligned with NDCs.
	Trajectory & governance	• Define long-term reduction path (for example, Linear Reduction Factor in EU-ETS). • Legislate governance structures for cap-setting and adjustment.
	Allowance/Credit issuance	• Establish total number of units issued annually, ensuring scarcity is credible.
5. Allowance distribution or credits	Allocation method	• Decide between auctioning (revenue generation) and free allocation (transition management, leakage prevention). • Establish transparent auction platforms.
	Free allocation rules	• Apply benchmarking or historical emissions ("grandparenting") with clear eligibility rules.
	New entrants & closures	• Design reserves for new entrants

6. Setting up a functioning market	Temporal flexibility	• Set rules for banking, and whether borrowing is allowed.
	Price/supply adjustment	• Introduce PSAMs such as floor/ceiling prices, MSRs, or Cost Containment Reserves. • Define transparent, rule-based triggers.
	Market participation	• Specify participants (for example, only compliance entities, or financial intermediaries too). • Define holding limits to prevent concentration.
7. Compliance & oversight	Legal framework	• Enact legislation and regulations establishing rights, obligations, and penalties.
	MRV system	• Develop rigorous MRV protocols. • Approve and supervise third-party verifiers.
	Registry	• Establish an electronic registry to track unit issuance, transfers, banking, and surrender.
	Enforcement	• Impose penalties that are effective, proportionate, and dissuasive (for example, EU's €100/tCO_2e fine plus make-good).
8. Establish offsets usage	Offset role & type	• Decide whether offsets are allowed; specify eligible project types (domestic, international, sectoral scope).
	Limits & quality	• Impose qualitative criteria (and permanence) and quantitative limits (for example, percentage of compliance).
	Governance	• Establish rules for baselines, methodologies, and accrediting verifiers (such as India's CCTS offset mechanism).
9. Linkages	Partners & type	• Identify potential linkage partners, decide on bilateral, multilateral, or unilateral linkage.
	Compatibility	• Align key programme elements (cap type, PSAMs, offset rules). • Ensure environmental integrity is not diluted.
	Governance	• Create institutions for joint auctions, registry links, and contingency planning for de-linking.
10. Implementation, evaluation & improvements	Implementation timing	• Phase in sectors, cap stringency, or allocation methods. Pilot if needed to build capacity.
	Reviews & evaluation	• Establish periodic reviews (every 3–5 years). • Track progress toward environmental and economic objectives.
	Policy adjustment	• Design predictable, transparent processes for amending rules. • Communicate adjustments transparently to reduce regulatory uncertainty.

8. Indirect policy effects on market development

While direct policy choices define the CCTS's structure, its effectiveness depends equally on how the wider policy environment interacts with it. Fiscal, energy, industrial, and financial policies can either reinforce or dilute the carbon price signal. Fossil fuel subsidies, rigid power tariffs, or overlapping efficiency mandates can weaken scarcity and suppress prices. Conversely, transparent power pricing, carbon-consistent fiscal incentives, and green finance norms can amplify market impact and deepen participation.

8.1. India-specific risks from indirect policy instability

The CCTS's credibility will depend on consistent political and regulatory commitment across a multi-tiered institutional structure.

While the BEE and the National Steering Committee for the Indian Carbon Market (NSC-ICM) provide central direction, state designated agencies (SDAs), state regulators, and large public sector enterprises will shape how rules are implemented and enforced in practice. This layered structure introduces coordination and sequencing risks that can affect price discovery and investor confidence.

Policy instability can also emerge from overlapping or inconsistent regulations. PAT's experience demonstrated that timely verification, predictable compliance cycles, and transparent enforcement are essential to sustain participation. In the CCTS, uncertainty around baselines, banking, or credit issuance could discourage trading and limit liquidity. Also, frequent adjustments to renewable targets, fiscal incentives, or industrial support schemes could lead firms to adopt a wait-and-watch approach rather than commit to investments in curtailing emissions. The interaction with the power sector will be particularly important once it is brought under the CCTS. Electricity generation and pricing fall within the concurrent list, meaning both central and state regulators influence how carbon costs transmit through the system. The CERC and SERCs would need a common framework to ensure carbon costs are recognised as a legitimate change in law and transparently reflected in merit-order and tariff decisions. Without such coordination, carbon costs risk being absorbed inconsistently across states, weakening the price signal and creating competitive distortions between generators.

Political economy risks add another layer of complexity. Many of India's largest covered entities, National Thermal Power Corporation (NTPC), Indian Oil Corporation Limited (IOCL), and Steel Authority of India Limited (SAIL), are public sector enterprises whose investment and production decisions are influenced by fiscal and policy priorities, rather than just profit maximisation. Subsidy reforms, tariff freezes, or delayed cost pass-through during election cycles could neutralise the carbon signal and discourage long-term investment.

International experience underscores the importance of depoliticising these decisions.[51] For India, credible implementation will depend on transparent rule making, predictable baseline trajectories, and clear alignment between carbon pricing and companion energy policies. Establishing a standing regulatory working group under the NSC-ICM to harmonise state-centre coordination in the power sector could provide an early institutional safeguard. Stability in both policy and regulation will ultimately determine whether the CCTS evolves into a reliable price signal that guides India's energy transition or remains constrained by administrative and political uncertainty.

8.1.1. What impacted the policy stability in EU-ETS?

Carbon markets like the EU-ETS rely on expectations about future scarcity of emissions allowances. If firms believe the cap will tighten over time and that enforcement will be strong, they will value permits more and begin abatement investments earlier. However, if government signals are unclear or inconsistent, firms cannot form reliable expectations. Faced with this level of uncertainty, firms are less likely to integrate carbon prices into business planning. Instead, they may treat the market as a short-term policy experiment subject to reversal, delaying abatement or even locking in carbon-intensive pathways.

Not all reforms have had an equal impact on price stability in the EU-ETS. Incremental or temporary measures had a limited effect, while structural, rule-based reforms restored confidence and influenced long-term price trajectories.[52] An empirical study by Koch et al. (2014)[53] analysed 50 major EU-ETS policy announcements between 2005 and 2014 and found that only 24 had a statistically significant price effect. Supply-side measures such as cap adjustments and auction volume changes produced the strongest and most consistent impacts, while restrictive signals raised prices more reliably than supportive interventions. Markets also frequently reacted in anticipation of announcements, reinforcing the central role of expectations and forward guidance. For example:

- **Backloading (2012–2014):** The EU temporarily postponed the auction of 900 million allowances to address oversupply. This signalled willingness to intervene but was seen as a stop-gap measure, with limited impact on sustained price levels.
- **MSR, adopted 2015, effective 2019:** By creating an automatic, transparent mechanism to adjust allowance volumes in response to surpluses or deficits, the MSR provided a durable solution. This reform restored credibility and reduced long-term variability. It also led to a sustained recovery in carbon prices, as participants regained confidence that future scarcity would be enforced.

[51] In South Korea, restrictions on power price pass-through by the state-owned utility blunted the incentive effect of its ETS, and in the EU, political hesitation to tighten the cap delayed price recovery until automatic stability mechanisms were introduced. Papathanasiou, D., Sara, J., The World Bank, ICAP, & IEA. Carbon pricing in the power sector. 2024
[52] Fan et al. What policy adjustments in the EU-ETS truly affected the carbon prices?. 2017
[53] Koch et al. The European Emissions Trading System: Ex-Post Analysis, The Market Stability Reserve. 2014

The EU-ETS experience also highlights that periods of uncertainty during reforms amplified volatility. Prolonged political debates and delays in finalising measures created speculation, weakening the market signal.

Table 5: Lessons from EU-ETS

Policy environment factor	EU-ETS experience	Lesson for India's CCTS
Credible, rule-based reforms	MSR restored confidence; backloading had limited impact	Structural mechanisms needed to manage supply and anchor expectations
Ad-hoc or uncertain interventions	Political debates and delays increased volatility	Avoid sudden changes; consultative rule-setting builds trust
Transparent communication	Clear implementation timelines reinforced market signals	Advance notice of changes supports planning and investment
Clear baseline evolution	Clear tightening of caps was key to regaining market confidence	Stable trajectories for B&C rules are essential
Built-in supply mechanisms	MSR adjusted supply automatically based on surplus thresholds	CCTS design should include structured, predictable supply adjustment rules

8.2. Interaction with other energy policies

Carbon markets operate within a wider policy ecosystem, and their performance depends on how they interact with companion measures in India's climate and energy framework. Major schemes that affect emissions in CCTS-covered sectors (across compliance and offset) include the PAT scheme mechanism, RCOs, energy efficiency codes, and national subsidy missions such as PLI, Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) India scheme, and the National Green Hydrogen Mission. Smaller sector-specific or state-level incentives will also interact with the CCTS but are likely to have a more limited effect on overall price formation.[54,55]

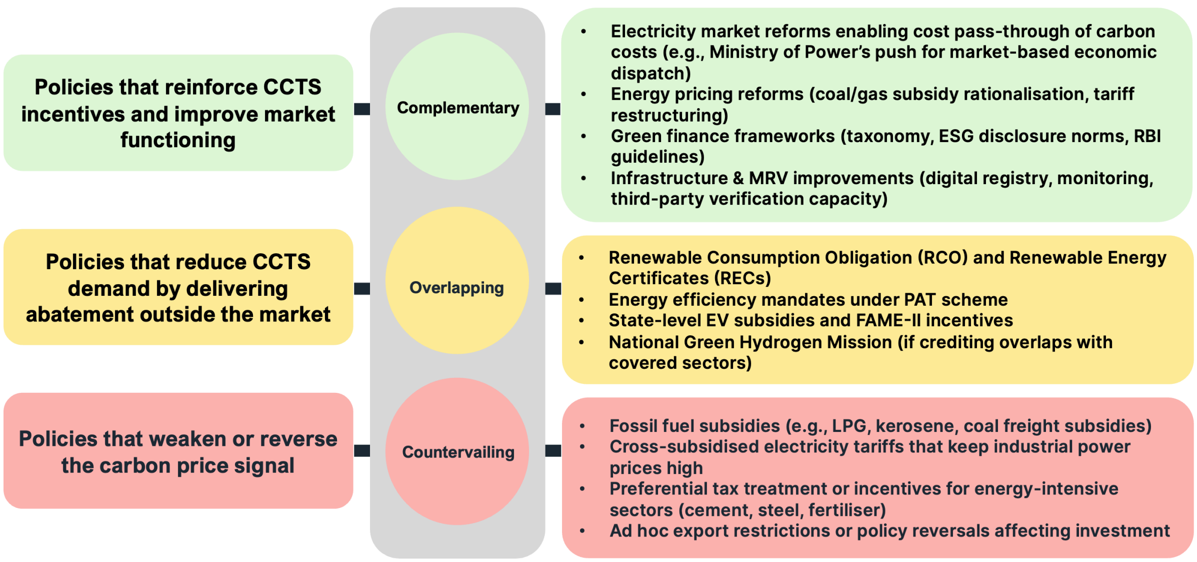
The CCTS should function as the keystone of India's climate policy architecture, with companion policies designed to reinforce rather than substitute its price signal. Some programmes, like PLI and the National Green Hydrogen Mission, promote *directed technical change* by subsidising research, demonstration, and early deployment of clean technologies. Such support helps internalise the social benefits of innovation that the carbon price alone cannot capture. As technologies mature and costs fall, these incentives should gradually phase down, allowing the CCTS to guide long-term decarbonisation through market signals.

In intensity-based systems, companion policies can influence market balance through both emissions intensity and output effects. As each unit of production carries an implicit allowance tied to the

[54] The Renewable Purchase Obligation (RPO), previously defined under the Electricity Act 2003, was superseded by the RCO under the Energy Conservation Act, 2001, with binding targets effective from FY 2024–25 onwards.
[55] The PAT scheme also interacts with the CCTS, though in a more indirect and transitional manner.

baseline, policies that lower average emissions or stimulate output can expand the system's aggregate baseline allowance and reduce scarcity, even without changes to the CCTS itself. This mechanism shows how overlapping measures can create hidden surpluses, weaken prices, and blur the system's environmental signal. Conversely, well-aligned fiscal and regulatory measures can strengthen scarcity and improve credibility. Coordinated calibration of baselines, renewable targets, and fiscal incentives will therefore be essential to maintain a stable and effective carbon price. Figure 4 depicts these interactions.

Figure 4: Types of companion policies and their interaction with CCTS



8.2.1. Aligning carbon pricing with companion policies

For carbon pricing to serve as the central policy instrument, companion policies must complement rather than substitute for its price signal. Effective alignment requires adjusting baselines in light of overlapping policies, coordinating implementation timelines. It also involves using non-market instruments to address barriers such as technology lock-ins or infrastructure gaps that the price signal alone cannot resolve.

Without this alignment, companion policies can undermine the CCTS by distorting supply-demand dynamics. Specifically, when firms receive overlapping subsidies and can simultaneously sell carbon credits, their net marginal abatement cost may turn negative. They will then respond to subsidy incentives rather than the carbon price, weakening the CCTS as the central price-setting mechanism.

Key companion policies that will interact with the CCTS include:

- **PAT scheme:** Administered by BEE, the PAT scheme sets energy efficiency targets for industries such as steel, cement, and fertilisers, rewarding overperformance through tradable

ESCerts. Under India's transition, entities will not receive dual targets. Instead, sectors graduate sequentially, moving to the CCTS only after completing their PAT cycle. The challenge is therefore not overlap but strategic timing. Some firms may adopt a stop-at-target approach, meeting but not exceeding PAT goals in anticipation of more valuable CCTS credits later. Others may defer deeper efficiency investments to match future carbon targets. These dynamics can influence early CCTS price formation. If firms delay abatement, near-term credit demand may rise while supply lags, amplifying volatility at the point of transition. Strong monitoring, transparent transition criteria, and predictable timelines are therefore essential to ensure PAT serves as a stepping stone rather than a drag.

- **RCO framework:** This framework and the associated Renewable Energy Certificates (RECs) require power distribution companies (Discoms) and large consumers to source a fixed share of electricity from renewable generation. As renewable energy penetration increases, the emissions baselines of covered entities may fall even without market incentives, reducing credit generation or compliance demand. If CCTS baselines are not periodically adjusted to reflect RCO impacts, persistent oversupply and price depression could follow the same dynamic that undermined EU-ETS Phase I prices before the MSR intervened. Close coordination between renewable policy trajectories and CCTS baseline revisions is, therefore, critical.

- **PLI schemes, FAME (for EV adoption), and the National Green Hydrogen Mission:** These subsidy programmes can drive emissions reductions well beyond what the carbon price alone would incentivise, particularly in hard-to-abate sectors. While essential for overcoming technology adoption barriers, they risk crowding out carbon market participation when subsidy support is high enough to make abatement financially attractive without any reference to the CCTS price.

- **Energy Conservation Building Code (ECBC), vehicle emission norms, and sector-specific efficiency standards:** These measures contribute to lowering India's overall emissions trajectory, but their cumulative impact on CCTS-covered sectors must be monitored. If they achieve significant reductions, compliance demand and prices could fall. Periodic baseline revisions that account for this cumulative effect will help ensure these instruments reinforce rather than dilute the carbon price signal.

8.2.2. Insights from the EU and China ETSs and their companion policies

8.2.2.1. EU-ETS

- **Waterbed effect:** When companion policies reduce emissions covered by the ETS, they also reduce the demand for allowances, which then leads to lower carbon prices and no net additional emission reduction unless allowance supply is adjusted. This is called the waterbed effect and has been a major concern in the EU-ETS. It was particularly pronounced in the first two phases of the EU-ETS, amplifying price volatility since allowance prices then become more sensitive to economic fluctuations and to under/over-performance of companion policies, undermining forward-looking investment signals.[56]

- **Overlap and price depression:** Generous companion policies—particularly subsidies for renewable energy and energy efficiency—depressed allowance prices, undermining the emissions trading system's role in guiding long-term abatement investments. Studies show that the bulk of emissions reductions during Phases I and II of the EU-ETS came from these companion policies and not from the emissions trading system price signal itself.

- **Policy reforms:** In response to these challenges, the EU implemented a series of reforms. MSR dynamically adjusts auction volumes based on market surplus levels. From 2023, allowances in excess stored in the MSR are permanently cancelled, addressing the waterbed effect. The Phase IV reform also tightened the cap trajectory and introduced new funding mechanisms for innovation and modernisation.

8.2.2.2. China

Unlike the EU-ETS, which is a classic cap-and-trade system with an absolute emissions cap, China's ETS is based on intensity targets (emissions per unit of output), with OBA and no absolute cap (at least initially). This means allowance supply adjusts with output, partially insulating the system from the waterbed effect caused by companion policies that reduce production.[57]

However, despite the intensity-based structure, China's ETS is not completely immune to the waterbed effect. Policies that improve emissions intensity (such as efficiency standards or fuel switching) do not automatically trigger adjustments in the benchmarks used for allowance allocation. Similarly, renewable energy expansion can reduce indirect emissions (for example from power consumption) without affecting benchmark values, leading to allowance oversupply.[58]

8.2.3. Implications for India

Experience from the EU and China shows that success of the carbon market depends not only on design but also on alignment with companion policies. Poor coordination can weaken price signals and deter investment, while well-calibrated measures can correct market failures and strengthen the carbon price as the core driver of decarbonisation.

To avoid the pitfalls observed in other jurisdictions, India should consider the following:

- **Align policy objectives:** In the EU, many companion policies pursued multiple goals (energy security, innovation, pollution control) but blurred the role of the ETS. India must clarify the distinct purposes of CCTS versus other schemes. For example, in the short-term, the PAT scheme could remain focused on energy efficiency, while CCTS should exclusively reward

[56] IEA. Managing Interactions Between Carbon Pricing and Existing Energy Policies. Guidance for Policymakers. 2013
[57] Verde et al. The EU-ETS and its companion policies: any insight for China's ETS?. pp. 306–307. 2021
[58] Relevant once industries are covered.

verified GHG reductions. Explicit delineation will reduce duplication and strengthen credibility.

- **Revise baselines dynamically:** The EU's failure to adjust allowance supply in response to renewable subsidies created large surpluses, collapsing prices in Phases I–II.[59] China's intensity-based benchmarks similarly risk oversupply if not updated when companion policies improve efficiency.[60] For India, CCTS baselines must be periodically revised to capture the impact of RPOs, RECs, and technology mandates (for example, EV adoption, green hydrogen). Without this, oversupply will depress prices and weaken investment signals.

- **Avoid double counting:** Overlapping instruments create opportunities for strategic gaming, as seen in China's ETS where firms could manipulate benchmarks to gain more allowances. In India, overlaps between PAT and CCTS or between RECs and CCTS may allow the same abatement to be credited twice. A unified registry and MRV framework are therefore essential to preserve environmental integrity and investor confidence.

- **Build stabilisation mechanisms:** The EU eventually restored market credibility through the MSR and permanent cancellation of surplus allowances. Buffers, price floors, and cancellation rules can be explored to reduce volatility from companion policy interactions. India should incorporate similar stabilisation mechanisms into CCTS design from the outset to avoid price collapse during the early years.

- **Ensure institutional coordination:** Governance challenges in both the EU (decentralised implementation) and China (central-provincial tensions) demonstrate the risks of fragmented oversight. For India, coordination between the Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Power (MoP), Ministry of New and Renewable Energy (MNRE), CERC, and the wider set of sectoral ministries and regulators with stakes in CCTS-covered industries will be vital.[61] Scheduled reviews and a clear division of responsibilities should be institutionalised to adapt the CCTS as companion policies evolve.

India's CCTS should be the core of its carbon market, with companion policies that reinforce it. To avoid issues like the EU's oversupply or China's benchmark rigidity, the scheme must clearly define policy scope, update baselines to reflect overlaps, and prevent double counting through integrated registries. Built-in stability mechanisms, strong inter-ministerial coordination, and regular reviews will be vital for coherence. When aligned, these measures can sustain a credible carbon price that supports India's path to net zero by 2070.

9. Future research

This report has set out the conceptual and institutional foundations of carbon price formation in India's CCTS. In doing so, it has also surfaced a number of questions that the existing literature and available data cannot yet answer—questions that will need to be addressed through research,

[59] Koch et al. The European Emissions Trading System: Ex-Post Analysis, The Market Stability Reserve. 2014
[60] Verde et al. The EU-ETS and its companion policies: any insight for China's ETS?. 2021

regulatory development, and early market observation. This section identifies the most important of these open questions and links them to the agenda for the next paper in this series.

This report looks at how companion policies interact with the CCTS at a conceptual level, identifying the waterbed effect, and the sequencing between PAT and the CCTS. What is also required is a policy-by-policy analysis of each instrument's likely impact on CCTS credit supply and demand. These questions require sector-specific modelling that traces the emissions and compliance implications of each policy individually and in combination. Without this analysis, CCTS baseline revisions will remain intuitive rather than evidence-based, and the risk of market imbalance would remain.

Alongside this, a deeper understanding of how Indian firms will act in the market is essential. Much of the behavioural evidence in this report is drawn from international experience in the EU, Korea, and China.

It remains to be seen how Indian industrial firms, including large public sector enterprises whose investment and production decisions are influenced by factors other than just profit maximisation rationale, will respond to CCTS incentives. Whether they will bank or trade, whether they will treat credits as financial assets or purely compliance instruments, are not yet clear. Early trading data from the first compliance cycle will be invaluable in answering these questions, and building the analytical capacity to interpret that data in real time should be a priority for researchers and regulators alike.

As the market matures and the institutional groundwork develops, thinking carefully about how the power sector can be brought in the CCTS ambit over time, in a manner that is consistent with India's electricity regulation framework and supportive of its energy transition goals, will be an important area of ongoing policy development. Similarly, as India's BM framework matures and bilateral Article 6 agreements begin to take shape, understanding how domestic and international carbon prices will interact will become increasingly important for market credibility and India's positioning in the global carbon economy.

Together, these questions point to a research and policy development agenda that is as much about institutional capacity and regulatory coordination as it is about economic analysis. The CCTS is not simply a market. It is a policy instrument embedded in a complex institutional ecosystem like all emissions trading systems, and its success will depend on the quality of governance, the coherence of the surrounding policy mix, and the credibility of the rules that underpin it.

The next report in this series will take up several of these threads, particularly examining how India's carbon market can be connected to international mechanisms and positioned as a durable instrument for the country's long-term decarbonisation journey.

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About the authors

Saurabh Trivedi

Saurabh Trivedi, PhD, is Lead Specialist, Sustainable Finance & Carbon Markets at the Institute for Energy Economics and Financial Analysis (IEEFA), specialising in the Indian and Australian sustainable finance markets. With a PhD focused on Climate Finance from Macquarie University, he brings deep expertise in sustainable financing mechanisms. His experience spans research, policy analysis, and financial instrument design, developed through his work with organizations like the Climate Policy Initiative and its India Innovation Lab for Green Finance. strivedi@ieefa.org

Subham Shrivastava

Subham Shrivastava is a Climate Finance Analyst at IEEFA, where he works at the intersection of finance, climate policy, and data modelling to support India's energy transition. His research spans sustainable finance, zero-emission mobility, and carbon markets, with a focus on analysing energy and climate policy through financial and systems perspectives. subhams@ieefa.org

Saloni Sachdeva Michael

Saloni Sachdeva Michael is Lead Energy Specialist, India Clean Energy Transition at IEEFA. Saloni focuses on accelerating and sustaining the clean energy transition through policy, technology, and financial interventions. She has worked with national and several state level organisations including energy departments, distribution companies, think tanks and civil society organisations to understand the pulse of the Indian power sector. ssachdeva@ieefa.org