CLIMATE POLICY INITIATIVE

POLICY BRIEF

Policies and Enabling Environment to Drive Private Investments for Industrial Decarbonization in India

Identifying Priority Actions for Decarbonizing Steel and Cement Sectors

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INTRODUCTION

Industrial emission accounts for about one-third of all global anthropogenic CO2 emissions and are expected to grow rapidly, with major contribution from developing economies. In India, the industrial sector is the largest and fastest-growing energy end-use sector and is expected to be the single largest source of CO2 emissions by 2040. Decarbonization of industries is one of the most critical issues that needs to be addressed to achieve global climate ambition and India's target of net-zero emissions (NZE) by 2070.

Steel and cement are the most consumed emission-intensive industrial materials, and India is the second largest producer of both these materials. Combined, they account for 15-20% of India's emissions, and in a business-as-usual scenario, emissions from these sectors are expected to increase three-fold by 2050. Massive efforts, even greater than those being employed to decarbonize the electricity sector, are needed to decouple industrial growth from emissions.

Steel and cement are also regarded as 'hard-to-abate' sectors. The sectors have significant process-related emissions and are highly dependent on fossil fuels, primarily coal in India. In addition, these sectors are highly capital-intensive, have long investment and asset replacement cycles, and have a high cost of carbon mitigation. The Mission Possible Partnership estimates that commercialization and deployment of NZE compatible technologies in the steel sector alone would require about USD 10 billion in additional investments globally between 2030 and 2050[2]. This excludes substantial investments required outside steel plants in supporting energy and technology-specific infrastructure. Different sources of capital – primarily from private sources that include companies, commercial banks, and institutional investors – would be needed to meet these investment needs.

There are several levers available to decarbonize industrial sectors, including energy efficiency, fuel switching, process modifications, material circularity and substitution, and resource efficiency. As per sectoral roadmaps of most countries, low-carbon technologies like hydrogen and carbon capture will likely play a critical role in decarbonizing the primary production processes of industrial materials. While these technologies exist, most are currently under development, commercially unviable, and uncompetitive against conventional technologies. Therefore, while decarbonization of steel and cement may be technically possible, economic viability needs to be addressed to attract private investments that can enable the shift to low-carbon production.

Transitioning these sectors would need coordinated action from the government, industry, and the financial sector. Well designed and targeted policy actions, and an enabling environment supported by effective regulation is needed to effectively address investment risks and barriers, and to create a level playing field between low-carbon and incumbent technologies. Public finance is required to support innovation and de-risk private investments. Financial sector innovation in instruments and services is needed to enable investments in innovative business models. Most importantly, early action in this decade is vital to indigenize breakthrough technologies and avoid carbon lock-in by diverting investments away from carbon-intensive assets.

Several studies have made recommendations on the policies and enabling environment (regulatory, market and financing conditions) required for industrial decarbonization. However, none have analyzed different interventions based on their potential impact on the risk-return profiles of investments and their significance in investment decisions, specifically in the context of breakthrough low-carbon technologies in a developing economy like India. **This brief aims to cover this gap. It seeks to support policymakers in making informed**

decisions and prioritize actions that can drive climate-aligned private investments to bridge the financing gap for low-carbon development of industries in India.

The rest of the brief covers the following:

- Methodology of the study
- Review of technologies and existing policies for decarbonizing steel and cement sectors in India
- Policies and enabling environment to drive private investments in breakthrough low-carbon technologies
- Conclusion and suggestions for future work

KEY FINDINGS AND RECOMMENDATIONS

1. **Early actions are needed to align industrial sectors on low-carbon pathways in the long-term.** Several low-carbon technologies required to decarbonize the largest carbon emitting industrial sectors in India - steel and cement – are currently commercially unviable and have a significant cost of abatement. A rapid increase in demand for these materials – expected to be 3-4-fold by 2050 – and long investment cycles, necessitates early actions by all stakeholder involved to ensure low-carbon capacity addition and avoid carbon lock-in. Markets alone cannot drive adoption of these technologies – effective policy frameworks and a functioning enabling environment built in coordination with the industry and the financial sector, is needed to effectively address investment risk-returns and unlock private sector investments into these breakthrough technologies.
2. **Expand policy frameworks to drive decarbonization.** India's existing industrial policy frameworks prioritize rapid growth, energy security and competitiveness. There are only a few instruments that promote decarbonization, which primarily focus on low-hanging levers (such as energy efficiency and renewable energy) and are insufficient to drive a low-carbon industrial transition. Well-designed policy frameworks that promote industrial decarbonization must include a mix of fiscal, financial, market-based, and regulatory interventions that target both the supply-side and the demand-side factors (see next point).
3. **Implement an effective policy-mix to unlock private investments in breakthrough low-carbon technologies for industrial decarbonization.** Our analysis, substantiated by private sector stakeholders, suggests that the policy instruments expected to have the highest potential impact on directing private investments towards breakthrough technologies for low-carbon production of steel and cement are:
    i. Internationally coordinated carbon pricing [Market-based, Supply-side]
    ii. Public funding for first-of-a-kind demonstration pilots [Fiscal, Supply-side]
    iii. Viability gap funding as capital expenditure subsidies [Fiscal, Supply-side]
    iv. Green public procurement of low-carbon materials [Fiscal, Demand-side]
    v. Product embodied-carbon standards in end-use sectors [Regulatory, Demand-side]
    vi. Interest subvention and/or credit guarantees [Financial, Supply-side]

4. **Strengthen efforts to create well-functioning enabling environments.** A functional enabling environment (suitable regulatory, market and financing conditions) would address investment barriers, improve the ease of doing business, and attract private investors. Our analysis, substantiated by private sector stakeholders, suggests that the enablers that have the highest perceived significance when deciding to invest in breakthrough technologies for low-carbon production of steel and cement are:

    i. Supporting infrastructure that includes CO2 and hydrogen storage and transportation, RE generation, electricity networks, and industrial hubs

    ii. Simplified, streamlined, and accelerated permitting procedures for production facilities as well as supporting technologies

    iii. Long-term contracts for the supply of raw materials (e.g., green hydrogen), and off-take of by-products (e.g., captured CO2) and low-carbon materials (e.g., steel)

    iv. Availability of concessional finance and risk mitigation instruments from international sources that include DFIs, MDBs, and multi-lateral funds

STUDY METHODOLOGY AND SCOPE

This study uses a mixed-methods approach that combines qualitative research, analysis, and stakeholder interviews.

As a first step, peer-reviewed journal articles, reports by leading organizations (including IEA, ETC and TERI) and consultations with several stakeholders were used to identify policies that are being considered and/or implemented by governments across the world, and the enablers required, to drive industrial decarbonization. This was followed by an in-depth analysis of the potential impact of each policy measure on investment risk-return profiles and the perceived significance of each enabler in investment decision-making with regards to breakthrough technologies.

Next, semi-structured interviews were conducted with companies, industry associations, lenders, technology providers, and other experts to validate and complement the analysis. Interviewees were asked to rate (on a qualitative scale) each policy instrument and enabler on its *expected impact* and *perceived significance* respectively; and explain the causal mechanism through which the intervention would influence private investments. Here we use the term e*xpected impact* of policies due to the subjective nature of the responses, and lack of context-specific evidence on actual effectiveness of, and limited stakeholder experience with, one or more instruments included in the analysis. An online questionnaire was used to record responses. **Table 1** below lists the organizations consulted as part of this study.

The scope of this brief is bound within certain contours. First, we only look at interventions targeted at industrial sectors and not individual technologies such as green hydrogen (G-H2) and carbon capture utilization and storage (CCUS).

Second, we focus on investments in technologies that are between Technology Readiness Level[3] (TRL, as classified by the IEA) 5 to 9 (large prototype to large demonstration stage), which have proven technical viability on a laboratory scale but have not been commercially deployed. The risk-return profiles of technologies at this stage are unsuitable for private investors. This excludes important decarbonization levers such as energy efficiency, material circularity (e.g., scrap-based secondary steel), and material substitution (e.g., blended cement).

Third, we focus on greenfield projects. This is primarily because, on a net present value basis, deployment of breakthrough technologies would be more economical and have a lower cost of abatement in greenfield projects than in retrofits. Furthermore, given the expected rise in demand for steel and cement in India (and low availability of scrap for secondary steel production), significant new production capacity is yet to be added, which needs to have lower emission-intensity to avoid carbon lock-in for the subsequent 20-25 years.

Table 1: List of organizations interviewed and surveyed

Sector/Technology	Organization	Type
Steel	TATA Steel	Company
Steel	JSW Steel	Company
Steel	International Energy Agency (IEA)	Inter-governmental organization
Cement	JSW Cement	Company
Cement	Global Cement and Concrete Association (GCCA)	Industry Association
Finance	ING	Commercial Bank
Finance	International Finance Corporation (IFC)	Development Finance Institution
Finance	Asian Development Bank (ADB)	Development Finance Institution
Finance	Proparco	Development Finance Institution
Green Hydrogen	ReNew	Company
Carbon Capture	Dastur	Company
Carbon Capture	Independent expert	-
Carbon Markets	EKI Energy Services	Company

LOW-CARBON TECHNOLOGIES AND EXISTING POLICIES FOR DECARBONIZING STEEL AND CEMENT SECTORS IN INDIA

Technologies required to decarbonize the steel and cement sectors are at different stages of development. The decarbonization pathway also varies by region, depending on factors such as demand growth, resource availability, policy environment, etc. **Table 2** below shows CPI's analysis of characteristics of technologies relevant to the Indian context. Several technologies which are expected to play an important role in decarbonizing these sectors are between TRL 5-9 (the focus of this brief). At this stage, technologies have relatively higher perceived risks, unproven business models, and do not offer market-based competitive returns. As per the analysis, the cost of abatement of these breakthrough technologies in India is expected to be at least 50 USD/tCO2 by 2030, and their adoption could increase the cost of production of steel and cement by up to 45% and 80% respectively. Therefore, a combination of supply-side incentives and demand-side price support would be needed for low-carbon production. In addition, industrial sectors have high capital requirements, function in volatile commodity markets, and lack sufficient resources to finance a profitable transition through technological improvements and innovation. Diffusion of breakthrough technologies cannot be left to market forces alone[4].

Governments and the development finance community have a central role to play. India's existing industrial policy frameworks currently prioritize rapid growth, energy security and enhancing competitiveness. There are only a few instruments that promote decarbonization, as highlighted in **Table 3**, and these primarily focus on low-hanging levers (such as energy efficiency and RE). Interviewees agree that existing policy frameworks are insufficient to drive a low-carbon industrial transition. Effective industrial and climate policies that include fiscal, financial, market-based, and regulatory interventions that target supply-side (e.g., regulation and financial incentives), demand-side (e.g., product carbon standards), or are cross-cutting (e.g., sectoral targets) are needed, along with development of a functioning enabling environment in coordination with industry and the financial sector. The next two sections discuss these specific interventions.

Table 2: Characteristics of low-carbon technologies for steel and cement sector decarbonization in India. The box highlighted in green indicates the scope of analysis.

Technology Readiness Level	Steel				Cement			
	Technology	Increment in LCOS (%)	Cost of Abatement (USD/tCO2)	Importance for NZE	Technology	Increment in LCOC (%)	Cost of Abatement (USD/tCO2)	Importance for NZE
TRL 1 (Initial Idea) - TRL 4 (Early Prototype)	Direct Ore Electrolysis	-	-	Moderate	Partial use of H2 in kilns	-	-	Moderate
					Electrification of kilns	-	-	Moderate
TRL 5 (Large Prototype) - TRL 9 (Early Commercial Operations)	Partial injection of G-H2 in BF	5-10%	130-150	Low	RE with BESS	Up to 5%	30-40	Moderate
	TGR-BF, Smelting Reduction (HIsarna)	5-10%	30-40	Moderate	Carbon capture with kilns	70-80%	80-90	Very High
	Carbon capture with BF / TGR-BF / HIsarna	10-20%	50-60	High				
	(Partial) G-H2 use in DRI	20-45% (for 30-100% G-H2 use)	40-90 (30-100% G-H2 use)	Very High				
TRL 10 (Commercially Competitive) - TRL 11 (Stable Growth)	Energy Efficiency (including WHR)	None	Less than 0	Moderate	Energy Efficiency (including WHR)	None	Less than 0	Moderate
	Scrap-EAF	Up to 5%	Less than 10	High	AFR	Up to 5%	30-40	Moderate
					Blended Cement	Up to 5%	Less than 5	Very High

Abbreviations: AFR = Alternate Fuels and Raw Materials, BESS = Battery Energy Storage System, BF = Blast Furnace, EAF = Electric Arc Furnace, G-H2 = Green Hydrogen, LCOS = Levelized Cost of Steel, LCOC = Levelized cost of cement, TGR = Top Gas Recycling, DRI = Direct Reduced Iron, RE = Renewable Electricity.
Note: (1) Technologies selected based on an assessment of the literature and stakeholder consultations; (2) Natural gas and biomass-based technologies were not considered due to concerns regarding dependence on international value chains and long-term availability respectively; (3) Cost calculations for G-H2 and carbon capture exclude the cost of storage and transportation; (4) Cost of abatement values represent lower bound estimates. **Source:** CPI analysis.

Table 3: Existing policies and regulations for promoting steel and cement sector decarbonization in India

Policy	Sector	Umbrella Legislation	Ministry, Agency	Details
Perform, Achieve and Trade (PAT), 2012	Industry-Wide	Energy Conservation Act, 2001	MoP, BEE	A market-based regulatory instrument (cap-and-trade mechanism) for reducing the specific energy consumption (SEC) of energy-intensive industries by allocating SEC targets and allowing trading of certificates (called Energy Savings Certificate, or ESCert).
Renewable Purchase Obligation (RPO)	Industry-wide	Electricity Act, 2003	MoP, CEA, CERC, SERC	Regulated entities - electricity distribution companies, and large power consumers, like steel and cement industries - are expected to procure a minimum percentage of the total consumption of electricity from RE sources. Renewable Energy Certificate (REC) is the tradable instrument used under the scheme.
National Carbon Market (NCM) (under development)	Industry-wide	Energy Conservation (Amendment) Bill, 2022	MoP, BEE	India is developing a national carbon market, primarily targeting high-emitting sectors like energy, steel, and cement. The scheme is proposed to be implemented in phases, starting from implementation of a voluntary market to increase demand for existing instruments (ESCerts and RECs, that would be converted to carbon credits), followed by increasing supply of credits by allowing project-based registration and issuance, and finally progress towards a compliance cap-and-trade market.
Obligations to use non-fossil sources	Industry-wide	Energy Conservation (Amendment) Bill, 2023	MoP, BEE	The central government can specify energy consumption standards, including mandating a minimum share of energy or feedstock consumption from non-fossil sources. Key sector include industries, transport and buildings.
NDC of steel sector submitted to MoEFCC	Iron and Steel		MoS	Average CO2 emission intensity of the Indian steel industry is projected to reduce from 3.1 tCO2/tcs in 2005 to 2.64 tCO2/tcs by 2020 and to 2.4 tCO2/tcs by 2030 (i.e., approx. 1% per year).
Steel Scrap Recycling Policy, 2019	Iron and Steel	National Steel Policy (NSP), 2017	MoS	Indian steel industry aims create 300 MT of demand by 2030, with a contribution of 35-40% from EAF/IF route, which requires scrap input. The main aim of this policy is to (a) promote circular economy; (b) minimize dependency on imports; (c) ensure proper and scientific handling, processing, and disposal of all types of recyclable scraps.

Policy	Sector	Umbrella Legislation	Ministry, Agency	Details
Steel Research & Technology Mission of India (SRTMI)	Iron and Steel	National Steel Policy (NSP), 2017	MoS	Set up in association with public and private steel companies to promote R&D and skill development, with an initial corpus of INR 200 Crore, contributed by MoS and by participating companies.
Solid Waste Management (SWM) Rules, 2016	Industry-wide (mainly concerns cement sector)		MoEFCC, CPCB	Sets the precedent for usage of refuse derived fuels (RDF) in cement industry. All industrial units using fuel and located within 100km from a solid waste-based RDF plant shall replace at least 5% of their fuel requirement by RDF. High-calorific wastes shall be used for co-processing in cement or thermal power plants.

Abbreviations: BEE = Bureau of Energy Efficiency, CEA = Central Electricity Authority, CERC = Central Electricity Regulatory Commission, CPCB = Central Pollution Control Board, MoS = Ministry of Steel, MoP = Ministry of Power, MoEFCC = Ministry of Environment, Forest and Climate Change, SERC = State Electricity Regulatory Commission, tcs = tonne of crude steel. **Source:** CPI analysis.

POLICIES TO DRIVE PRIVATE INVESTMENTS IN BREAKTHROUGH LOW-CARBON TECHNOLOGIES

Well-designed policy frameworks can effectively improve the risk-return profile of investments, attracting private investments. However, the mechanism and the degree of impact of different policy instruments vary.

This section presents our analysis (validated through interviews) and findings from the survey of private sector stakeholders, on the impact of policy instruments on private investments in breakthrough technologies for the Indian steel and cement sectors.

We categorize the instruments as having a ***high***, ***moderate***, **or** ***low*** **degree of impact on investment decisions** (relative to others). For each measure, we discuss its function and the mechanism of impact on investment risk and returns. **Table 4** lists and classifies the instruments analyzed in this study.

Table 4: Classification of policy instruments based on instrument type (row headings) and intervention stage in the value chain (column headings).

		Value chain target		
		Cross-cutting	**Demand-side**	**Supply-side**
Instrument type	**Fiscal and Financial**	–	• Green Public Procurement	• Public funding for demonstration pilots • Direct public investments • Capex subsidies • Opex subsidies • Investment / Production tax credits • Interest subvention / credit guarantees
	Regulatory	• Sustainable finance taxonomy / climate-aligned investment principles	• Product embodied-carbon standards • Certification of low-carbon materials and labeling of products	• Technology mandates
	Market-based	–	–	• Carbon pricing
	Others	• Long-term sectoral targets	–	• International collaboration for technology transfer • Public funding for R&D / Private R&D incentives

HIGH IMPACT INSTRUMENTS

CARBON PRICING

Putting a price on carbon, either through a cap-and-trade mechanism or a carbon tax, can be a highly effective tool for driving decarbonization across sectors. India is in the process of transitioning from an energy-intensity-based cap-and-trade mechanism – the Perform, Achieve and Trade (PAT scheme) – to a carbon emissions-based national carbon market (NCM)[5]. Therefore, here we limit the discussion to market-based carbon pricing.

This instrument is technology-neutral and provides market-driven incentives to shift to the least-cost low-carbon alternatives. Carbon pricing can act as a cornerstone of climate policy and needs to be complemented with other instruments that target the supply-side, demand-side, and also the financial sector - enabling increased lending to these sectors.

For carbon pricing to be effective, stringency (supervision and compliance) and stability (demand and functioning carbon markets) are key. The carbon price would need to be sufficiently high – at least 50 USD/tCO2 by 2030 – to support deep decarbonization technologies applicable to the industrial sectors. However, the carbon price under the NCM, as approximated from the present PAT scheme, would be around 5-6 USD/tCO2. At low price levels, the NCM is unlikely to make a shift in heavy industries without additional subsidies or price support for production of low-carbon materials.

Price stability and confidence in the carbon markets can be achieved through regulatory interventions, such as the market stability reserve (MSR) for the EU-ETS[6], and policy instruments, like Carbon Contract for Difference (CCfD). CCfD can address political and market risks, and lower financing and carbon mitigation costs by guaranteeing carbon revenues for companies[7]. For internationally traded commodities like steel, an internationally coordinated sectoral carbon price may be required to ensure trade competitiveness. Carbon border adjustment mechanisms (CBAM) are also being considered by regions with high carbon prices to avoid cross-border carbon leakage, however unresolved questions remain around its impact on international trade and political acceptance. Lastly, in addition to regulated and voluntary carbon markets, companies can also adopt internal carbon pricing (ICP) as a tool to guide their investment decisions based on life cycle emissions and climate risks, to prepare for the imminent transition[8].

FUNDING FOR DEMONSTRATION PILOTS

Several large Indian steel and cement companies are considering pilots of breakthrough technologies. Public funding for first-of-a-kind commercial-scale demonstration pilots directly reduces costs for companies. Effectiveness would depend on the quantum of funding (share of cost coverage). It can be highly important in the early stages of market development to address risks (e.g., technology risk), prove the technical and commercial viability of new technologies and promote learning-by-doing, which drives down production costs.

CAPITAL EXPENDITURE (CAPEX) SUBSIDIES

Breakthrough emission technologies for the steel and cement sector are capital-intensive and entail very high upfront costs - a 1 million tons per annum H2-DRI steel plant can cost nearly two times as much as a traditional BF-BOF plant of the same capacity. Viability gap funding in the form of capex subsidies can (partially) cover the incremental investment cost of shifting to low-carbon production routes. This financial incentive directly addresses the returns from projects. Capex subsidies may be awarded based on a competitive bidding process to minimize the public cost of implementing the policy.

PRODUCT EMBODIED-CARBON STANDARDS

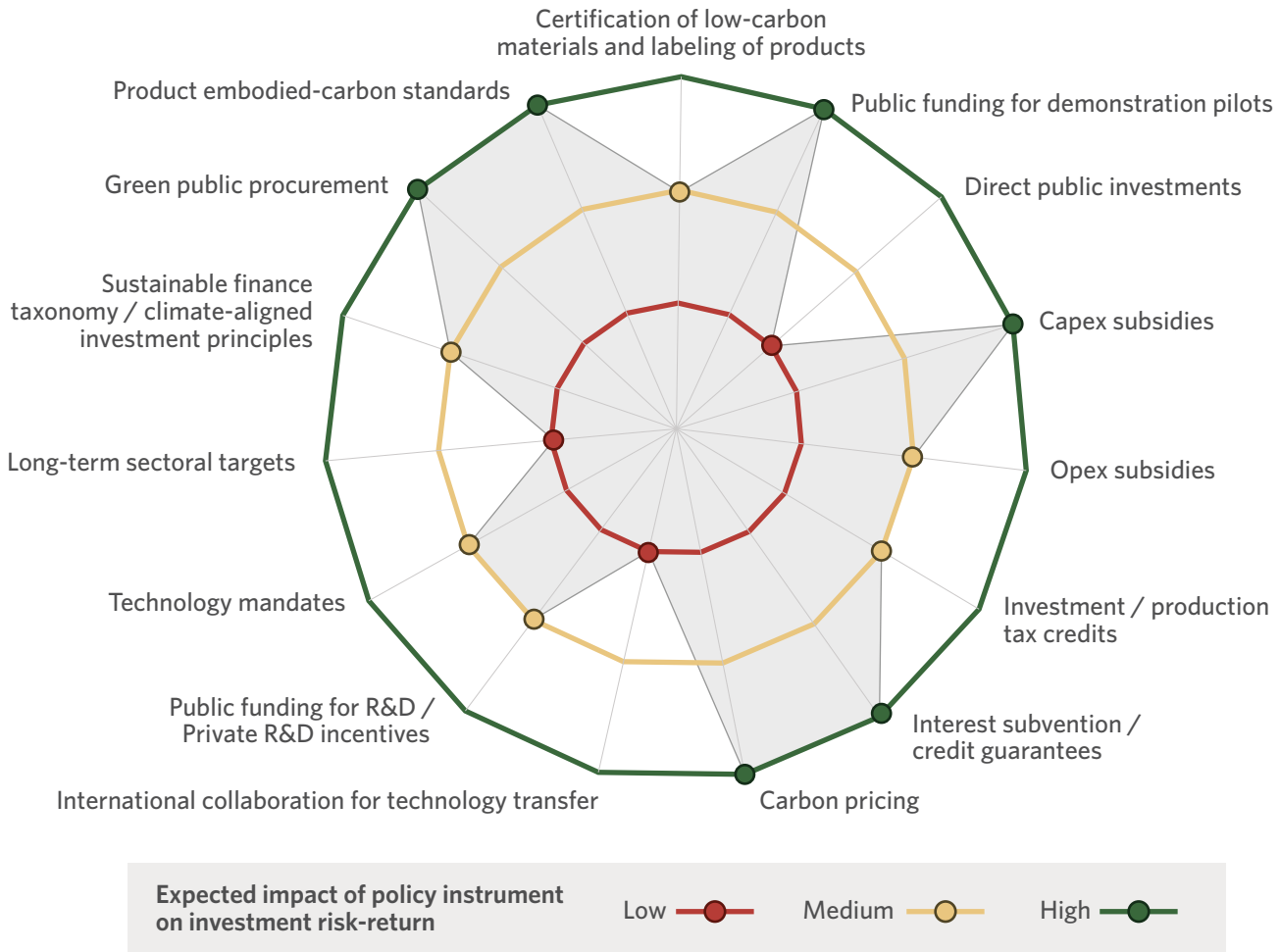
Defining embodied carbon standards for products and the built environments (e.g., cars, buildings) based on consistent and verifiable life-cycle emission methodologies can create large-scale demand for low-carbon materials[9]. It sends a strong signal to producers to meet specific minimum emission intensity targets, which can be made more stringent with time.

GREEN PUBLIC PROCUREMENT (GPP)

Governments can help create initial lead markets for low-carbon materials by mandating the use of, or preferential purchase of, materials based on their carbon content. Off-take combined with a price support guarantee (as green premium) stimulates market demand, improves economic viability, and thereby incentivizes investments in low-carbon production facilities.

India spends around 20% of its GDP on public procurement[10] and this purchasing power can be a highly impactful driver of the decarbonization of the steel and cement sectors. In 2021, India and the UK in coordination with UNIDO launched the Industrial Deep Decarbonization Initiative (IDDI)[11], which seeks to bring together multiple stakeholders to create markets for low-carbon industrial materials.

Figure 01: Expected impact of policy instruments on private investments in breakthrough low-carbon technologies.



INTEREST SUBVENTION OR CREDIT GUARANTEES

Both these instruments help reduce the overall cost of debt for companies, which can be especially impactful in developing countries where the cost of financing is relatively higher. By reducing the debt burden, subsidized loans help improve the return to equity investors. On the other hand, guarantees address higher credit risk, which encourages the participation of lenders and unlocks capital available in the market[12].

MODERATE IMPACT INSTRUMENTS

INVESTMENT / PRODUCTION TAX CREDITS

It is a popular policy tool for supporting investments in new technologies in several countries. Through tax deductions of investment costs, this tool can indirectly fund the viability gap which improves profitability and returns on equity. However, its impact may be limited when the gap in the production cost and profitability of the low-carbon technology and the emission-intensive alternative is high, which is the case with most breakthrough technologies in the steel and cement sectors. The existing PLI (Production Linked Incentive) scheme in India could also be used to incentivize greenfield investments in decarbonized industrial production facilities.

OPERATIONAL EXPENDITURE (OPEX) SUBSIDIES

Raw materials (e.g., G-H2, CO2 absorbent, etc.) and electricity (e.g., for operating CCUS modules) add significant Opex to production of low-carbon materials. Opex subsidies can bridge the viability gap by covering such incremental expenses and guaranteeing long-term revenue streams. However, due to significant uncertainties around future costs of raw materials and technology learning rates, the cost of implementing Opex subsidies can be highly variable. It also tends to create long-term dependencies and promote operational inefficiencies. Therefore, it may not be as economically efficient (or even desirable) in driving private investments as capex subsidies or investment tax credits, which are more favorable from the perspective of historical experience, political acceptance, and ease of implementation in India. To overcome these issues, financial incentives may be given directly at the fuel/feedstock production stage, as has been proposed under the National Green Hydrogen Mission[13] of India.

TECHNOLOGY MANDATES

Production facilities can be mandated to adopt certain technologies (e.g., G-H2) for producing low-carbon materials. This can be an effective measure in driving the transition if the mandate applies to all producers across the sector, and if the incremental cost of low-carbon alternative, relative to the conventional technology, is feasible from the perspective of profitability and competitiveness of the domestic industry. A high degree of technology-specificity and picking winners at early stages of market development should also be avoided to prevent lock-in of inferior technologies and to ensure market-driven economic efficiency.

CERTIFICATION OF LOW-CARBON MATERIALS AND LABELING OF PRODUCTS

Certification schemes based on internationally-aligned science-based standards (such as those being developed by ResponsibleSteel, IEA, SBTi, ArcelorMittal, and others for the steel sector) and complementary labeling programs for end-user products enable consistency and transparency in calculations and reporting of emissions data, tracking of progress in carbon intensity against targets, creation of differentiated

markets for greener products, pricing of green premiums. They also raise public awareness and acceptance (especially important in the cement sector where end-user awareness plays a key role in the adoption of differentiated products), prevent greenwashing, and helps in the implementation of other policies such as product standards, GPP, and sustainable finance taxonomy. Alignment between various certification schemes is needed.

SUSTAINABLE FINANCE TAXONOMY/CLIMATE-ALIGNED INVESTMENT PRINCIPLES

A taxonomy/voluntary investment principle (such as the Sustainable STEEL principles[14]) would enable financial institutions to measure and track the climate-alignment of their portfolios. From an investor's perspective, principles based on sector-specific methodologies are likely to be easier to adopt and more effective to implement than broad-scoped taxonomies. Combined with assessment, disclosure, and appropriate pricing of climate-related risks, this measure should incentivize the allocation of capital and improve the availability of finance for sustainable activities, in the long term. In the short term, while decarbonization technologies are economically unviable, having a taxonomy or principles that are too stringent or ambitious, and do not consider the country's development context, may negatively impact financial flows in the sector. Ministry of Finance is working towards the development of a sustainable finance taxonomy for India.

LOW IMPACT INSTRUMENTS

LONG-TERM SECTORAL TARGETS

Developing long-term targets and associated decarbonization pathways is usually the first important step taken by governments to signal the market, set expectations regarding the future policy direction, and align the interests of companies and their investors regarding long-term strategic plans. However, usually, these targets are non-binding and have an indirect impact, if any, on investment risks and returns, and find limited consideration in investment decisions.

PUBLIC FUNDING FOR R&D/PRIVATE R&D INCENTIVES

Public R&D grants and private sector R&D incentives (e.g., tax credits) can foster innovation by startups, help address very early-stage technology risks and decrease the overall cost of innovation for companies in technologies that are further away from commercial readiness and drive continuous efficiency improvements and cost reductions in proven technologies. However, it does not directly address investment risks or returns for commercial-scale projects and therefore has limited impact as a financial incentive.

DIRECT PUBLIC INVESTMENTS

Direct investments by Public Sector Undertakings (PSUs, e.g., Steel Authority of India) or state-owned investment banks into breakthrough technologies can help build a track record of performance. PSUs can be the first movers and help develop investor confidence in the market. However, this does not directly affect co-investors or investors and lenders of other projects[12]. Moreover, there is often a lack of ownership from PSUs in developing and proving new technologies. Therefore, this measure has a limited potential impact on driving sector-wide investments.

INTERNATIONAL COLLABORATION FOR TECHNOLOGY TRANSFER

Early adoption of new and breakthrough technologies is likely to be undertaken by large steel and cement companies that have sufficient internal resources and can access both domestic and international technology providers. Moreover, companies have highlighted underlying barriers to effective collaboration such as international competition, issues related to the transfer of intellectual property rights, and the high cost of technology transfer. This measure does not seem to have a significant impact on directing investment decisions.

Note: It is important to note that certain technologies like RE with BESS, G-H2, and CCUS have applications across multiple sectors and there is a high degree of confidence in their potential role in decarbonizing the Indian economy. Therefore, the selection, design, implementation, and governance of policy frameworks for industrial sectors need to be coordinated and aligned with technology and application-specific policies (i.e., future policies for the steel sector would need to align with instruments used under the National Green Hydrogen Mission to support the uptake of G-H2 for steelmaking).

ENABLING ENVIRONMENT TO DRIVE PRIVATE INVESTMENTS IN BREAKTHROUGH LOW-CARBON TECHNOLOGIES

Enabling environment consists of regulations, market-making interventions, natural and human capital, and directed use of public finance, that can improve the ease of doing business, and thereby catalyze private investments in the country and targeted sectors. The lack of a functional environment due to the absence of these conditions can form sector-specific investment barriers.

This section presents our analysis (validated through interviews) and findings from the survey of private sector stakeholders, on sector-specific enablers necessary to drive private investments in breakthrough low-carbon technologies for Indian steel and cement sectors. We first categorize enablers as having ***high*, *moderate*, or *low* degree of perceived significance in investment decisions** (relative to others). Then, for each enabler, we discuss how its presence (or absence) can catalyze (or be a barrier to) private investments.

HIGH SIGNIFICANCE ENABLERS

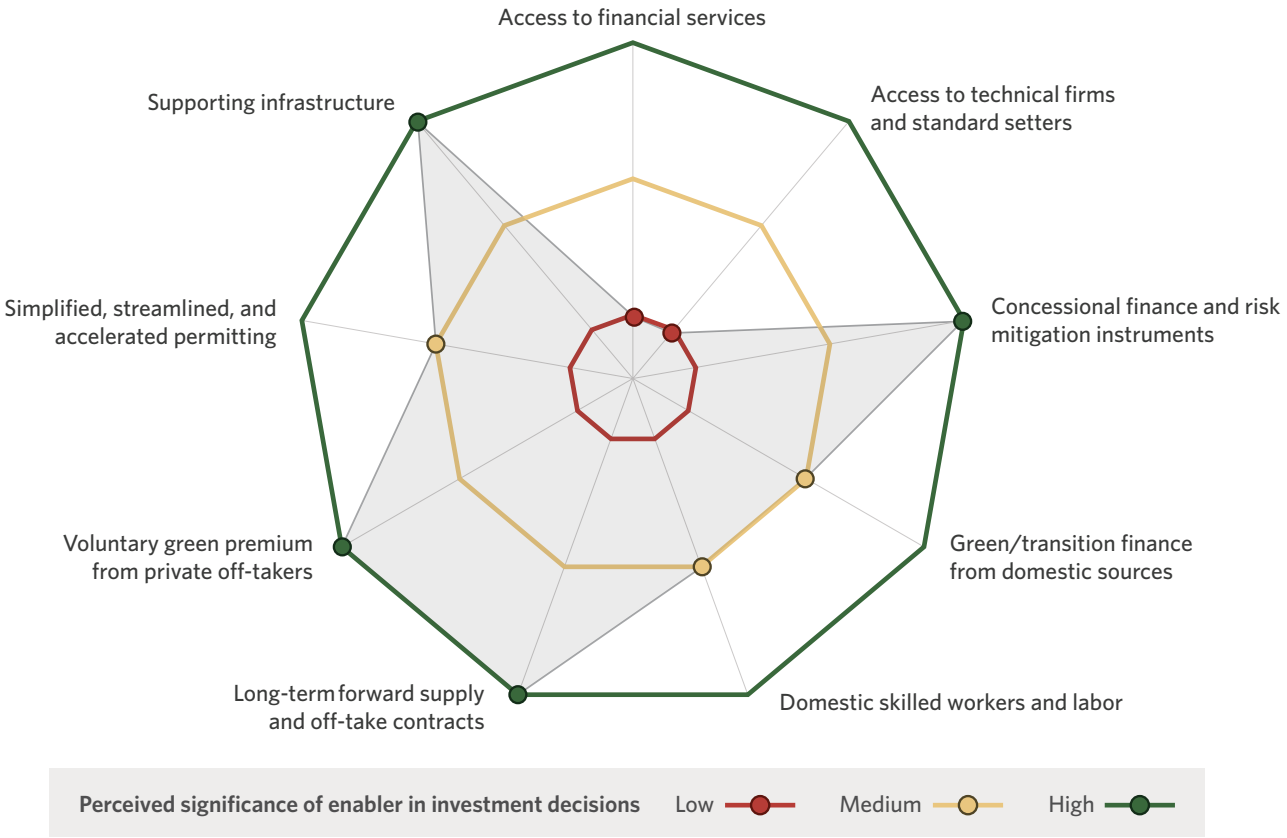
SUPPORTING INFRASTRUCTURE

Investments in infrastructure for CO2 and hydrogen storage and transport, RE generation, modern electricity networks, and industrial hubs would account for a significant share of all investments needed to achieve NZE in the steel and cement sectors[15,16]. Early policy support and major public and private investments are therefore needed to develop this infrastructure and remove barriers to investments in breakthrough technologies. Public-private partnership models and a consortium of private players (across the value chain) investing in shared infrastructure can reduce total investment costs and reduce the cumulative green premium required for low-carbon industrial transitions.

VOLUNTARY GREEN PREMIUM FROM PRIVATE OFF-TAKERS

The bulk of the market for steel and cement comprises private companies in the transport, buildings, and consumer goods sectors. Increasingly, these companies are setting targets to reduce their Scope III emissions (e.g., by signing up for SBTi). Voluntary commitments from these companies to pay a premium for long-term procurement of lower-carbon steel or cement could add significant volumes to demand. This can support existing producers and innovative startups in addressing business models and market risks, and improve bankability leading to increased access to finance (e.g., H2GreenSteel, a Swedish startup, was able to pre-sell more than half of its planned green steel production volume at a premium and recently secured commitments for EUR 3.5 billion in debt[17]). Currently, in India, there is no proven willingness to pay a green premium. The SteelZero[18] initiative is working to stimulate private sector demand for low-carbon steel, both at global and India-level.

Figure 02: Perceived significance of enabling conditions on private investments in breakthrough technologies.



LONG-TERM FORWARD SUPPLY AND OFF-TAKE CONTRACTS

Long-term contracts (more than 5 years) for the supply of raw materials (e.g., G-H2 as feedstock in DRI units), off-take of by-products (e.g., captured CO2 sold for utilization), and forward purchase of low-carbon materials (particularly in the steel sector) are needed to develop business models with high certainty of cost and revenue streams and to mitigate future price risk. However, to enable corporates to enter into long-term agreements in nascent markets, the high-cost differential between green and conventional products needs to be reduced through policy interventions. Green premiums could be built into the off-take contracts for low-carbon materials. Contracts could also be underwritten by the government to further mitigate off-taker risk[9]. Finally, aggregation of G-H2 and CO2 supply, and demand could play an important role in providing flexibility of supply and managing demand from multiple off-takers in different end-use sectors.

CONCESSIONAL FINANCE AND RISK MITIGATION INSTRUMENTS

Grants, concessional loans, and risk-mitigation instruments (e.g., credit guarantees, political risk insurance) from development finance institutions, multi-lateral development banks, and multi-lateral funds can provide technical assistance to develop a pipeline of bankable opportunities and create blended finance structures and risk-sharing mechanisms that reduce the overall cost of financing, as well as the green premium required for economic viability. Steel and cement producers in India have conveyed a strong demand for support from the international development finance community, especially to undertake large-scale demonstration pilots where risk perception is high. Recently, Climate Investment Funds (CIF) announced its

Industry Decarbonization program[19] at COP27 in Egypt, one of the first multi-laterals to offer support for the development and financing of projects in developing economies.

MODERATE SIGNIFICANCE ENABLERS

PERMITTING

Streamlined, simplified, and accelerated permitting procedures for supporting infrastructure and demonstration projects is needed to minimize lead times, reduce overall project costs, and support faster deployment of low-carbon projects, as well as supporting technologies, not only in industrial, but all major economic sectors.

GREEN/TRANSITION FINANCE FROM DOMESTIC SOURCES

Domestic commercial banks and (to a lesser extent) capital markets are key sources of finance for steel and cement companies in India. Availability of green/transition finance – which is earmarked for specific activities or linked to specific objectives and is more suited for long-term investments (because of features such as lower cost of debt, longer tenor, and grace period) – would help unlock substantial private investments in low-carbon projects. However, for large steel and cement companies in India, which will be potential first movers to invest in low-carbon projects, this is not a critical factor since they have access to foreign capital markets and cheaper sources of finance, which reduces their reliance on domestic sources. This factor is more important for smaller producers which face constraints in accessing international sources of finance.

DOMESTIC SKILLED WORKERS AND LABOR

Given the nascency of breakthrough technologies and the high technological complexity of industrial sectors, the domestic availability of skilled workers and labor is an important factor in determining the ability of a company to innovate, develop large-scale projects, and remain competitive. Large steel and cement companies in India consider this to be an important factor but not a major barrier to project execution since they have considerable resources and a reputation to attract skilled workers. However, this could be a significant barrier for smaller companies.

LOW SIGNIFICANCE ENABLERS

ACCESS TO TECHNICAL FIRMS AND STANDARD SETTERS

Steel and cement companies would need to work with technology providers (for access to innovative technologies), engineering procurement and construction firms (for EPC services and independent certification and verification of underlying technologies), and standard setters (e.g., ResponsibleSteel for certification of low-carbon materials). While access to these services would be critical, it does not pose a significant investment barrier since large companies have long-standing business relationships and are well-integrated with the ecosystem to access these services.

ACCESS TO FINANCIAL SERVICES

Financial services such as risk insurance for technology / engineering, construction, storage, and transportation by insurance companies, inflation and forex hedging facilities, and credit insurance by export credit agencies can be key instruments to address various investment risks (such as technology risk, credit risk, currency risk) and reduce overall costs borne by the developer[4]. Access to these financial services can be a critical factor in implementing innovative business models. However, most large companies in India have access to these financial services. Unless these financial services are unavailable in the market, it will likely not be a significant investment barrier.

CONCLUSIONS

This brief discusses the findings of a CPI research that studied the potential impact of different policy instruments and enabling environment factors on private investments into breakthrough low-carbon technologies for decarbonizing steel and cement sectors. Based on the degree of impact on investment risks and returns, as well as the mechanism of impact delivery, certain priority actions have been identified that can be taken by governments, policymakers, industry, and the financial sector, to unlock private investments for industrial decarbonization in India.

Firstly, a well-designed policy mix that includes different types of instruments – fiscal, financial, market-based, regulatory and others – and addresses both the supply-side and demand-side issues is required to effectively improve the risk-return profile of investments in breakthrough technologies. Policy recommendations for driving private investments are carbon pricing, funding for first-of-a-kind demonstration pilots, green public procurement, capex subsidies, product embodied-carbon standards, interest subventions and credit guarantees.

In addition to an effective policy framework, an enabling environment that consists of supporting infrastructure, accelerated permitting processes, long-term forward supply and off-take agreements, and availability of concessional financing and risk-mitigation instruments is crucial to address underlying investment barriers and catalyze private investments.

SUGGESTIONS FOR FUTURE WORK

Future research can build on this study by undertaking:

1. Evaluation of policy choices to compare the different instruments relative to their sector-specific impact on private capital mobilization, carbon abatement, public cost of implementation, and additional impacts related to just transition.
2. Deep dive into the design of policies in the Indian context to understand how policy effectiveness can be maximized. Design features include generic characteristics (e.g., stringency, predictability, credibility) and policy-specific characteristics (e.g., specifications of fuel consumption under technology mandates).

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