First Movers Coalition

WORLD ECONOMIC FORUM

Surfacing Supply of Near-Zero Emission Fuels and Materials in India

WHITE PAPER

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Preface

The goal of the Paris climate agreement to reduce greenhouse gas emissions to net zero by 2050 will only be possible by bringing the right technologies to commercial scale within the next decade. This is especially the case for seven of the hardest-to-abate sectors – aluminium, aviation, chemicals, concrete, shipping, steel and trucking – responsible for more than one-third of the world's carbon emissions.

Breakthrough technologies to decarbonize these industries exist – from clean hydrogen to sustainable aviation fuel to carbon capture and storage – but they remain expensive and niche. Without sufficient demand from the private sector or policy support from the public sector, these technologies will not scale up in time to deliver the decarbonization the world needs by mid-century.

The focus of the First Movers Coalition (FMC) is to leverage the collective purchasing power of the private sector to send a clear demand signal to technology suppliers, enabling them to finance, develop and scale up the climate technologies essential for the net-zero transition. The FMC sets the bar high: the only technologies within its scope are those capable of delivering near-zero emission processes that reduce the carbon footprint of these industrial sectors by 85-100%.

Launched jointly by John Kerry, the US President's Special Envoy for Climate, and Børge Brende, President of the World Economic Forum, at COP26 in November 2021, the FMC has to date garnered 106 commitments from 85 member companies totalling more than $12 billion of aggregate demand. Mindful that global challenges often have local solutions, the coalition is holding a number of regional workshops in Asia, Africa and South America with the aim of both demonstrating demand for and surfacing supply of critical near-zero emission technologies. These workshops bring together all the key stakeholders, including businesses, banks and financial institutions, technology developers, intermediaries, governments, academia and civil society.

This white paper reports on the outcomes of the India workshop, which took place on 11-13 July 2023 and focused on three sectors: aviation, cement and concrete, and steel. The workshop's aims were threefold: to identify the existing potential within India to scale up the supply of these technologies; to analyse the challenges and barriers to increasing both demand and supply of these near-zero emission solutions; and to fashion the outcomes of the workshop into recommendations for a way forward.

Executive Summary

Significant levels of risk-tolerant international capital and ambitious domestic policy measures are needed to decarbonize India's hardest-to-abate industrial sectors.

Nearly 20% of India's emissions come from the steel, cement and aviation industries. Decarbonizing these sectors is crucial to meet the country's Nationally Determined Contribution (NDC) commitment to reduce GDP emissions intensity by 45% by 2030 and achieve net-zero emissions by 2070 at the latest.

In July 2023, the First Movers Coalition (FMC) convened an in-country workshop to encourage domestic suppliers of steel, cement and aviation fuel to accelerate their decarbonization efforts by demonstrating demand from FMC members for low- and zero-carbon products. The workshop also engaged with government and financial actors to identify priority actions to accelerate the market for these climate-critical technologies.

Steel

Surging domestic demand for steel will triple the industry's CO_2 emissions to 800 million tonnes per year (Mtpa) by 2050, without efforts to decarbonize. Barriers to scaling up near-zero emission steel include the uncertain availability of essential upstream technologies, such as renewable energy, clean hydrogen, carbon capture, utilization and storage (CCUS), and efficient scrap recycling. Market dynamics also play a role: Indian buyers are reluctant to pay a green premium, economies of scale favour the traditional and highly carbon-intensive blast furnace method of production, and domestic investors face high borrowing costs.

Nevertheless, three Indian companies – Mahindra & Mahindra, ReNew and Bharat Forge – in addition to international companies with manufacturing activities in India, have committed to the FMC's steel target to ensure at least 10% of their steel purchases will be near-zero emissions (0.1-0.4 tonnes of CO_2e per tonne of crude steel produced) by 2030.

Cement

Emissions from cement are expected to double to around 440 Mtpa by 2040, driven by India's ever-increasing demand for housing and infrastructure, without efforts to decarbonize. The industry has already reduced its emissions intensity by 36% since 1996 to 720kg CO_2e/t. Its plants are more thermally and electrically efficient than in the US. The industry also makes better use of supplementary cementitious materials (SCMs)

to replace carbon-intensive clinker. But the FMC's threshold for near-zero emission cement of 184kg CO_2e/t is seen as unrealistic by some workshop participants as it is dependent on CCUS technologies. Nevertheless, India's RMZ has committed to FMC's cement target.

Barriers to scaling up near-zero emission cement include uncertain supply of two key technologies to decarbonize the sector: commercially viable CCUS and sufficient SCMs. The SCMs the industry currently uses are fly ash and blast furnace slag, but as these are by-products of carbon-intensive industrial processes, FMC puts them out of scope after 2035. Nevertheless, workshop participants highlighted that these by-products are likely to play an important role for the sector beyond 2035, given the country context. Other barriers include lack of demand, inertia around building codes and practices, and the high cost of capital.

Aviation

While aviation in India currently emits around 25Mt of CO_2 a year, this figure could soar as the country's air traffic is set to triple by 2040. Domestic actors – including Indian Oil, IndiGo and Vistara airlines, and the Indian Air Force – are piloting the use of sustainable aviation fuel (SAF), but none is yet approaching the carbon abatement performance required by FMC, to reduce lifecycle greenhouse gas emissions by 85% or more (SAF 85).

Barriers to scaling up near-zero emission aviation include the high cost of SAF 85 production (two or three times the cost of jet fuel in India today), fragmented supply chains for the feedstocks that SAF needs (e.g. agricultural residues, municipal solid waste), uncertain access to green hydrogen, limited domestic expertise in SAF 85 production technologies, and lack of demand.

Financial measures

Decarbonizing steel, cement and jet fuel entails major upfront capital investment and ongoing production premiums, compared to incumbent fossil-powered alternatives. The International Energy Agency (IEA) estimates that $160 billion per year is needed across India's energy economy between now and 2030 to hit its net-zero goals. That is three times today's investment levels. Access to low-cost, long-term capital, blended finance and risk management mechanisms from international sources will prove critical. There are five principal barriers to financing near-zero emission technologies: traditional finance is not sufficient, the green premium is a major challenge, the cost of capital is too high for most micro, small and medium-sized enterprises (MSMEs), India has no carbon market, and there is a lack of investor confidence.

Workshop participants identified several priority actions:

- Collaboration between public, private and philanthropic actors can provide the blended capital needed to reduce risks and unlock flows of private capital (e.g. the World Bank's recent $1.5 billion loan to accelerate India's low-carbon transition).
- Third-party financing options (e.g. green bonds, sustainability-linked loans) can provide companies and governments a lower-cost alternative to deploying internal capital.
- Investors could take a portfolio approach to risk and return by balancing long-term, high-risk bets in evolving technologies with short-term, lower-risk investments.
- Risk-sharing mechanisms such as insurance or first-loss loan policies need to be established.

Policy measures

The Indian government has already taken ambitious strides towards a low-carbon future. It has set a target to more than double its renewable energy capacity to 450GW by 2030. And it recently announced the National Green Hydrogen Mission, backed by a $2 billion incentive plan, to deliver 5 Mtpa of production by the end of this decade.

Workshop participants called on India's government to accelerate production of near-zero emission steel, cement and aviation in four key areas:

- Support increased availability of essential upstream technologies via clear regulations, subsidies and project approval processes for green hydrogen, CCUS, renewable energy and consolidation of biomass waste feedstocks.
- Invest in innovative R&D, competitive pilots and demonstration projects, through collaboration across ministries and with external partners from business, finance and philanthropy.
- Adopt clear definitions and targets for near-zero emission goods and services, aligned with international standards.
- Develop a cross-sectoral industrial cluster strategy to support the growth of CCUS and green hydrogen, learning from best practices in other countries such as the US and Norway.

Additional policy measures could include: putting a price on carbon (e.g. the forthcoming Indian carbon market could incorporate near-zero emission steel, cement and SAF), allowing 100% FDI into low-carbon sectors, and prioritizing low-carbon steel, cement and aviation in public procurement.

Introduction

Decarbonizing steel, cement and aviation – which contribute nearly 20% of emissions – is crucial if India is to meet its NDC commitments to reduce GDP emissions intensity by 45% by 2030 and become net zero by 2070.

Emerging economies such as India are critical players in the low-carbon transition towards a pathway that can limit global warming to 1.5°C, in line with the goal of the Paris climate agreement. As these economies develop, their growth is especially dependent on energy-intensive industries like cement, steel and aviation. The challenge facing such countries is to decarbonize these hardest-to-abate industries in ways that meet their greenhouse gas (GHG) reduction targets, while boosting economic growth to support a just transition.

The emissions data on these industries is daunting. India's steel sector emitted an estimated 250 million tonnes of CO_2 in 2021, accounting for 10% of the country's total GHG emissions. Given the surging domestic demand for crude steel, by 2050 the industry's CO_2 emissions are expected to more than triple to 800 million tonnes per year (Mtpa), without significant attempts at decarbonizing the sector. Carbon dioxide emissions from cement – 219Mt in 2019 – are expected to double by 2040, driven by the ever-increasing demand for housing and infrastructure. And while aviation accounts for just 25Mt of India's carbon footprint, domestic passenger traffic grew at 15% per annum in the five years before the COVID-19 pandemic, fuelled by a rapidly expanding middle class.

Decarbonizing these three sectors – which together contribute nearly one-fifth of the nation's total emissions – is crucial if India is to meet its Nationally Determined Contribution (NDC) commitment of reducing the emissions intensity of its GDP by 45% by 2030 (compared to 2005) and its ambition to become a net-zero economy by 2070. The technologies to clean up these industries exist in pilot form, but none are yet available in India at the scale or cost needed to make them commercially viable.

The obstacles to scaling up these clean technologies are complex and interconnected. With a GDP per capita of $2,256 in 2021,[1] India sets a high priority on minimizing the cost of its economic development. Reducing the green premiums for near-zero emission steel, cement and aviation fuel is therefore critical to decarbonizing these sectors. Concessionary or blended finance tools have a key role to play, as do measures to de-risk private capital. The government has many potential policy levers to hand, including incentives, mandates, procurement and streamlined regulation. To help the technology gain commercial traction, collaboration between demand- and supply-side actors through advance offtake agreements will prove crucial.

In July 2023, the World Economic Forum's First Movers Coalition (FMC) convened an in-country workshop with two main objectives: to demonstrate demand from FMC's member companies for near-zero emission products showcasing their purchasing commitments to local suppliers; and, through such demand signals, to identify potential local suppliers and accelerate the uptake of clean technologies and production of near zero emission steel, cement and aviation fuel. The workshop convened not only FMC member companies, but also domestic suppliers, technology providers, policy-makers, financial institutions and civil society organizations to share knowledge and experiences around the nascent clean technologies available in India, identify best practices and develop shared solutions.

This white paper analyses the India-specific context for these three sectors, summarizes the barriers and opportunities in transitioning each sector towards near-zero emission processes, and concludes with two sections that present cross-cutting financial and policy measures to accelerate the uptake of these climate-critical technologies in India. The report is informed by situation analysis reports on each sector provided by FMC's knowledge partner, Boston Consulting Group (BCG), as well as by the detailed discussions and priorities raised during the FMC workshop.

1 Steel

India's economic growth will triple demand for steel by 2050, driving up emissions to 800 million tonnes per year, unless the sector can significantly decarbonize.

1.1 Overview of steel landscape in India

“ 250 million tonnes – annual CO_2 emissions from India’s steel sector: expected to more than triple to 800Mt by 2050 without efforts to decarbonize.

The Energy and Resources Institute (TERI)

India is the second-largest producer of steel in the world, yet 95% of the sector’s 154 Mtpa capacity[2] is consumed by the domestic market.[3] India has a huge appetite for this most versatile of building materials: by 2050, demand is expected to soar to 500 Mtpa.[4] Over the same period, the sector’s CO_2 emissions – currently around 250 Mtpa, or 10% of India’s total emissions[5] – are expected to more than triple to 800 Mtpa, without significant efforts to decarbonize.[6]

To service this demand, the Indian government has set a goal of 300 Mtpa of steel production capacity by 2030.[7] Indian steelmakers have responded with plans for 205 Mtpa of new capacity, of which 85% uses existing blast furnace-basic oxygen furnace (BF-BOF) technology. This method is the most widespread and cost-effective in the country. It is also the most carbon-intensive, generating at least 2.2 tonnes of CO_2 for every tonne (t CO_2/t) of steel produced. This planned new BF-BOF capacity alone would add nearly 400Mt of carbon dioxide-equivalent (CO_2e) to India’s annual greenhouse gas footprint.

India’s steel industry is dominated by a handful of major players, most of whom have begun to move towards reducing the emissions intensity of their production. Tata Steel has declared it will become net zero by 2045; it has already begun to explore decarbonization technologies such as injecting hydrogen into its blast furnace in Jamshedpur.[8] Jindal Steel and Power (JSP) has announced a memorandum of understanding (MOU) with renewables developer Greenko Group to deliver 1,000MW of carbon-free energy for its steel facility in Odisha.[9] Meanwhile, JSW Steel, India’s second-largest private sector steel company, recently earmarked $1.3 billion for decarbonization initiatives, with an emissions-intensity target of 1.95t CO_2/t of crude steel.[10]

1.2 Status of technologies, supply and demand for near-zero emission steel

The First Movers Coalition (FMC) requires its members to commit to a target that at least 10% (by volume) of all steel purchased per year will be near-zero emissions by 2030. The FMC’s benchmark sets a stringent threshold for near-zero emission steel of <0.4t (0% scrap inputs) to <0.1t (100% scrap inputs) of CO_2e per tonne of crude steel produced.

BOX1: **FMC’s targets for near-zero emission steel and technologies**

At least 10% (by volume) of all steel purchased per year will be near-zero emissions by 2030

Emitting <0.4t (0% scrap inputs) to <0.1t CO_2e (100% scrap inputs) per tonne of crude steel produced

There are two principal technologies capable of delivering near-zero emission steel:

1. Carbon capture, utilization and/or storage (CCUS) to capture process-related emissions at source, used in conjunction with existing fossil-fuel-powered processes such as BF-BOF.
2. A fossil-free process known as H_2-DRI-EAF, which uses a combination of green hydrogen (H_2) for direct reduction of iron ore (DRI), plus an electric arc furnace (EAF) powered by renewables or nuclear to produce the steel.

To date, there are no projects in India capable of producing steel that clears this threshold. India’s government policy to promote green steel up to 2030 focuses on energy and resource efficiency, but this will not deliver the level of decarbonization envisaged by the FMC. Although the government plans to focus on green hydrogen and carbon capture from 2030-2047, there are no details available on when near-zero emission steel will begin production in India.[11]

Capital expense is the major challenge. Whether decarbonized or not, steelmaking is expensive. Building a new BF-BOF plant in India costs $400-

670 million per megatonne of annual capacity. However, the cost of converting a large plant to produce near-zero emission steel can run to well over $1 billion, before even considering the cost of additional upstream infrastructure.[12]

Indian companies that have already committed to the FMC's steel target include Mahindra & Mahindra, ReNew and Bharat Forge. By signing offtake agreements to purchase near-zero emission steel at a premium upon delivery in 2030, these companies are providing producers with bankable advance contracts to help them raise the capital required for decarbonized steel production. But far more demand for this kind of steel production in India is needed to drive change.

1.3 Seven key barriers to scaling up near-zero emission steel

There are seven principal barriers to scaling up near-zero emission steel supply in India, based on BCG's situation analysis report. Four relate to the uncertain availability of critical upstream technologies: renewable energy, green hydrogen, scrap metal and CCUS. Three relate to market dynamics: uncertain demand, cost-effectiveness of existing processes and the high cost of capital for new investment.

According to the situation analysis report, while any one of these dynamics would create a significant challenge, together they can create a feedback loop of uncertainty and risk that prevents action that might spur market development. Alternatively, momentum in one or two areas could create a cycle that unlocks the market.

Uncertain availability of upstream technologies

1 Renewable energy

Low-carbon steel production needs huge amounts of renewable energy to power its green electrolysers and electric arc furnaces. If India were to use the near-zero emission H_2-DRI-EAF pathway to produce the 300 Mtpa of steel it has targeted for 2030, it would need to double its target of 450GW of installed renewable energy capacity by the end of this decade.[13]

In October 2022, the capacity of India's renewables sector stood at 165GW. As an indication of the huge amount of investment required, the financing needed to deliver the 250GW of targeted incremental wind and solar development in India totals around $223 billion between 2022 and 2029.[14]

"$223 billion – the financing needed to deliver India's goal of 250GW of incremental wind and solar power by 2030."

Bloomberg NEF

While plans announced by Indian renewable energy developers are broadly aligned with the national ambition, such a massive increase in funding needed before 2030 may prove challenging, especially in a rising interest environment.

2 Green hydrogen

Green hydrogen will play a critical role in decarbonizing ironmaking, given its potential to replace coking coal as a reduction agent in the direct reduced iron (DRI) process. But the production of green hydrogen at scale itself requires major investments in renewable energy and electrolyser capacity.

On the positive side, India's government recently announced its National Green Hydrogen Mission, backed by a $2 billion incentive plan to deliver 5Mt of production per year by 2030.[15] The question, however, is whether sufficient green hydrogen will be produced in time to support the decarbonization of steel.

One transition technology is to use natural gas instead of hydrogen for DRI facilities. While this approach falls outside the FMC's definition of near-zero emission steel, natural gas can be replaced in the DRI process by green hydrogen once it is available. That said, the current share of natural gas in India's energy mix is just 6%.[16]

"India's government recently announced its National Green Hydrogen Mission, backed by a $2 billion incentive plan to deliver 5 million tonnes per year by 2030."

Ministry of New and Renewable Energy of India

3 Scrap metal

Scrap metal can reduce the volume pressure on primary iron production. Scrap inputs provide an important alternative transition pathway, by replacing the highly carbon-intensive blast furnace phase of producing iron from iron ore. When combined with an EAF process (powered by renewables) to produce steel, the scrap-EAF approach can deliver low-carbon steel. The use of scrap to help solve India's near-term steel demand could therefore enable the sector to delay deployment of new capacity until green hydrogen is ready to be used for steelmaking.

However, India's steel recycling rate is believed to fall significantly below the global average of 85%.[17] Despite a National Steel Scrap Recycling Policy published in 2019, significant investment will be required to develop the scrap supply chain.

4 Carbon capture, utilization and/or storage (CCUS)

Given the current dominance in India of the highly carbon-intensive BF-BOF production process, CCUS will be critical for decarbonization of any relatively new BF-BOF plants. To date, however, carbon capture technology remains at pilot stage. Government think tank NITI Aayog recently published a CCUS roadmap for India to reach 750 Mtpa of capacity by 2050, but it remains unclear when the policy changes and substantial investments required to deliver CCUS at scale will materialize.

According to the situation analysis report, India's current regulatory positions are unlikely to provide operators with the clarity needed for sizeable investments. What is lacking is a clear process for project approvals, long-term liabilities provision and geological storage regulation. Unlike green hydrogen and renewables, there is currently no current government incentive driving CCUS deployment in India.

> "Unlike green hydrogen and renewables, there is currently no government incentive driving CCUS deployment in India."
> BCG

Market dynamics

5 Uncertain demand

Indian buyers have yet to demonstrate a clear willingness to pay the green premium required for near-zero emission steel. The emphasis remains on minimizing the cost of economic growth and consequently domestic demand for low-carbon steel is limited. The cost base for Indian steel producers is already 5-10% higher than the global average, due to high capital, logistics and infrastructure costs.[18] This puts Indian steel exports at a disadvantage even before factoring in the green premium. Local demand will therefore prove especially important for developing the near-zero emission steel market. The construction and infrastructure sector, which consumes 68% of India's steel, will be a critical source of demand.

> "The construction and infrastructure sector, which consumes 68% of India's steel, will be a critical source of demand."
> BCG

6 Economies of scale favour BF-BOF

India's rapidly growing steel industry is built upon the existing BF-BOF production process. These carbon-intensive plants have a greater capacity than the near-zero emission alternatives and therefore bring considerable economies of scale.

Building alternative DRI-EAF plants will prove costly. Meanwhile, CCUS requires significant investments not only in the facilities themselves, but also in transportation and storage. These costs can be too large for any single company to pay.

7 High cost of capital

India's high cost of capital prevents investments that would be viable in other markets. In 2020, its economy-wide cost of debt was around 7% higher than in the US.[19] Research by the OECD finds that a 1% change in the cost of debt can drive a 5% decrease in the levelized cost of energy from offshore wind.[20] The government has a key role to play in providing policy support such as incentives, subsidies and coherent regulations, which can both increase capital flows and reduce the cost of that capital.

1.4 Steel sector priorities identified by FMC's India workshop

Workshop participants focused on the challenge presented by the green premium for breakthrough technologies capable of producing near-zero emission steel, especially in the Indian context of a developing economy and a steel sector that features many micro, small and medium-sized enterprises (MSMEs).

The FMC's workshop participants identified the following priorities for decarbonizing India's steel sector:

1. Collaboration

The various stakeholders in the steel sector need to create stronger collaborations and partnerships to develop a pipeline of near-zero emission steel projects in India. This will take a high degree of willingness on both supply and demand sides. One example of collaboration would be to negotiate forward purchase agreements at an initial premium offer.

2. Awareness and demand

Collective action is needed across the value chain to raise awareness among buyers and the public of the need for sustainable materials and to generate demand for decarbonized steel in India. The government, industry players and financial institutions should collaborate, with the government taking the lead in implementing policies and providing incentives. Creating industry clusters and involving MSMEs would help with the widespread promotion and adoption of low-carbon technology.

3. Incentives for MSMEs

Joint efforts from both the government and financial institutions are essential to provide comprehensive, affordable financial support for MSMEs in achieving their decarbonization goals in all sectors, including steel. The government plays a crucial role in creating a supportive policy environment, through implementing measures such as loan interest subvention schemes and tax incentives. Simultaneously, financial institutions can collaborate by offering specialized financing products and services tailored to the needs of MSMEs, to help them adopt low-carbon technologies and products in the steel sector.

4. Innovative pilots

The government and major steel manufacturers should focus on innovative pilot projects and increasing research and development (R&D) spending to ensure the availability of breakthrough technologies in India for decarbonizing steelmaking. The government can provide support through funding, policy incentives, and creating a conducive environment for research and innovation. At the same time, major steel manufacturers can invest in R&D and collaborate with research institutions to develop and deploy advanced technologies that enable decarbonization. Joint efforts from the government and industry are important to drive the development and adoption of transformative technologies in the steel sector.

5. Policy measures

The government could support industry decarbonization through the following policy measures:

- Efficient carbon market
- Government funding (e.g. for capital expenditures)
- Tax credits (e.g. for green hydrogen production and CCUS)
- Public procurement for near-zero emission steel
- Streamlined permitting (e.g. single-window clearance) and enhanced land availability

6. Financial sector measures

Considering the scale and scope of financing required, it is crucial for public, private and multilateral financial institutions to take the lead in developing specific incentives and mechanisms to support the decarbonization of the steel sector in India. These measures should include blended finance to lower the cost of capital in India. One example is the World Bank's announcement on 29 June 2023 of a $1.5 billion loan to support India's low-carbon transition.[21] Another is the International Monetary Fund's long-term financing tool, the Resilience and Sustainability Trust (see section 4.4).

7. Definitions and standards

As the regulatory authority responsible for setting standards and promoting sustainable practices, the central government, in collaboration with relevant stakeholders, should spearhead the effort to establish a clear, comprehensive definition for near-zero emission steel, aligned with the international community. By taking the lead in defining and promoting this standard, the government can provide clarity and guidance to the industry, investors and consumers, facilitating the adoption and market acceptance of green steel.

8. Industrial clusters

Major steel manufacturers, supported by government, should take the initiative to develop an industrial cluster approach that can leverage shared infrastructure and transition the cluster towards near-zero emissions. This collaborative effort would enable a coordinated and integrated approach across multiple sectors, including steel, cement and aviation fuel. By involving both the government and key industry players, the cluster approach can ensure the alignment of policies, resources and technological advancements necessary to achieve the desired transition towards near-zero emissions, fostering sustainable development and economic growth in India.

9. Scrap steel market

Major steel manufacturers should take the lead in improving scrap availability and collection, along with support from the government. As scrap plays a crucial role in achieving low-carbon emissions in the steel industry and reduces the reliance on primary steel production, it is in the best interest of steel manufacturers to prioritize and invest in scrap collection and recycling infrastructure. However, government support is essential in terms of creating favourable policies, regulations and incentives that encourage and facilitate efficient scrap collection and supply chain management. Collaboration between industry and government can drive the necessary improvements in scrap availability and collection, contributing to a more sustainable and environmentally friendly steel production ecosystem.

10. Renewables

India's industrial sectors, especially steel, face a growing need for locally sourced renewable energy. Addressing this demand involves identifying opportunities to enhance renewable energy generation capacity and developing policies, regulations and incentives that promote the adoption and integration of renewables within the industrial sector. This requires a collaborative effort between the government and relevant stakeholders, such as renewable energy providers, industry associations and policy-makers to establish a conducive environment for renewable energy deployment, facilitate investment in renewable infrastructure, and enable renewable energy production and distribution networks.

2 Cement

Annual emissions from India's cement production could double to 440 million tonnes of CO_2 by 2040. Public procurement and private sector leadership are essential to accelerate demand for decarbonization.

2.1 Overview of cement landscape in India

“ 219 million tonnes – annual CO_2 emissions from India’s cement sector: expected to double by 2040 without efforts to decarbonize.

International Energy Agency

As it is for steel, India is the second-largest producer of cement in the world, with annual production topping 391 million tonnes in 2022-2023.[22] More than half the demand is driven by the country’s burgeoning housing sector. The International Energy Agency (IEA) notes that most of the buildings that will exist in India in 2040 have yet to be built. So, cement production is expected to grow nearly 150% by 2040. Emissions – which were an estimated 219Mt or 8% of India’s total emissions in 2019 – will in turn double, without efforts to decarbonize the sector.[23]

While the FMC’s target is for concrete and cement, this report focuses on the cement industry for two reasons. First, the majority of emissions in concrete come from cement production. Second, the Indian market is uniquely reliant on bagged cement, which accounts for 75-80% of all cement sold, compared to just 5% in the US.[24] Unlike with centrally mixed concrete, bagged cement impacts the industry’s ability to optimize cement use.

Another key challenge is the localized nature of the cement market – a feature of the industry across the world, given the high cost of transporting such a heavy material. India’s cement supply is fragmented across 210 large cement plants, with an average capacity of around 2 Mtpa each.

India’s cement industry has already managed to reduce its emissions intensity by 36% between 1996 and 2017, to 720kg CO_2 per tonne of cement produced. Its cement plants are more thermally and electrically efficient than in the US. And the industry makes better use of supplementary cementitious materials (SCMs) to replace the clinker binding agent which is so carbon-intensive to produce. The FMC’s threshold for near-zero emission cement is 184kg CO_2e/t. However, some industry partners attending the India workshop felt this target is unrealistic, as it depends on CCUS technologies. Even to drive the carbon intensity of Indian cement down to 350kg CO_2e/t by 2050, for example, would take $29-50 billion of investment, according to the Reserve Bank of India.[25]

“ The FMC’s threshold for near-zero emission cement is 184kg CO_2e/t. To drive down the carbon intensity of India’s cement industry to 350kg CO_2e/t by 2050 would take $29-50 billion of investment.

Reserve Bank of India

India’s cement industry is dominated by 10 producers who control two-thirds of capacity. Many have made net-zero commitments by 2050, though most pledges are in line with a 2-degree Celsius rather than 1.5-degree Celsius scenario. Dalmia, for example, has pledged to become carbon negative by 2040, with supporting commitments to achieve 100% renewable energy by 2030, 100% fuel substitution by 2035, and adoption of CCU and other technologies by 2035.[26] Meanwhile, leading supplier UltraTech, which controls 22% of all production, has implemented an internal carbon price of $10/t CO_2 and is targeting SCMs to get its clinker ratio down to 70%.

2.1 Status of technologies, supply and demand for near-zero emission cement

The FMC requires its members to commit to a target that at least 10% (by volume) of all cement/concrete purchased or procured per year will be near-zero emissions by 2030.

The FMC's threshold of 184kg of CO_2e per tonne of cement requires an 80% reduction in embodied carbon compared to the industry average in the US.

BOX2: **FMC's targets for near-zero emission cement and technologies**

At least 10% (by volume) of all cement purchased per year will be near-zero emissions by 2030

Emitting <0.184t CO_2e per tonne of cement produced

Excludes fossil-based SCMs by 2035

There are two principal technologies capable of delivering near-zero emission cement:

1. Carbon capture, utilization and/or storage (CCUS) to capture process-related emissions at source
2. Clinker substitution using non-fossil-based SCMs (i.e. not fly ash or ground granulated blast furnace slag)

Indian cement producers are on the right decarbonization path, through their initial focus on improving operating efficiency and using supplementary cementitious materials (SCMs).

Boston Consulting Group

Indian cement producers are on the right decarbonization path, through their initial focus on improving operating efficiency and using supplementary cementitious materials.

Despite India's leadership in driving down emissions intensity in cement production, it will be tough for local producers to achieve the FMC threshold, for a number of reasons. The sector is localized, commoditized and capital-intensive. Concrete use is highly regulated by building codes that still favour clinker-based Portland cement. And more than half of cement's carbon footprint comes from emissions associated with producing that clinker. That means electrification or switching energy sources cannot prevent these emissions. They have to be captured with CCUS or avoided through finding alternatives to clinker.

Nevertheless, Indian cement producers are on the right decarbonization path, through their initial focus on improving operating efficiency and using SCMs. Meanwhile, several companies have committed to purchase near-zero emission cement, including India's RMZ and multinationals such as Consolidated Contractors, ETEX, GM, Orsted and Vattenfall. However, more localized Indian demand will be needed to accelerate the commercialization of the market.

2.3 Five key barriers to scaling up near-zero emission cement

There are five principal barriers to scaling up near-zero emission cement supply in India. Unlike with steel, the challenge to decarbonize cement does not directly depend on scaling up renewables or green hydrogen. However, it does depend on the availability of two critical upstream technologies: CCUS and SCMs. The three other barriers relate to market dynamics and regulation: uncertain demand, building codes and practices and the high cost of capital.

Uncertain availability of upstream technologies

1 Carbon capture, utilization and/or storage (CCUS)

Decarbonizing traditional cement production relies principally on using CCUS to capture the process emissions inherent in producing clinker – the critical binding agent in Portland cement. Greater detail on the availability of CCUS in India can be found

in the preceding section on steel. India does have some strategic advantages when it comes to scaling up CCUS. Its offshore oil and gas industry can provide carbon storage capacity. And its non-fossil energy industry, which is expected to grow to around 450GW by 2030, remains relatively low-cost. Meanwhile, the Global Cement and Concrete Association (GCCA), whose members have committed to achieve net zero by 2050, is trying to pull forward CCUS with its Innovandi programme;[27] but it remains far from commercially viable on a global basis.

2 Supplementary cementitious materials (SCMs)

The only other technologically proven process to decarbonize cement production is to replace carbon-intensive clinker with alternative binding agents. The two most common SCMs are fly ash or ground and granulated blast furnace slag (GGBS). Fly ash is a by-product of coal-fired power plants, while GGBS is waste from the blast furnaces that make iron. Consequently, supply of both these SCMs is expected to decline in the long term as blast furnaces and coal-fired power plants phase out.

To ensure that its commitment leads to pulling forward new technology, FMC puts fly ash and GGBS technologies out of scope after 2035. FMC clearly recognizes the critical role that these fossil-based SCMs will play in the broader decarbonization path, in India particularly. However, their wider role is to accelerate the adoption of other near-zero emission technologies.

> If limestone calcined clay became the dominant way to make cement, it could reduce the sector's emissions by 30-40%.
>
> LC3.ch

The most promising alternative SCM is calcined clay, derived from a naturally occurring material found across the Global South. Cement and concrete manufacturing is a very localized process, given the expense of transporting such a heavy material. So being able to source an abundant, alternative feedstock like calcined clay in the geographies where concrete consumption is predicted to peak could be a game-changer. Some estimates suggest that if this material became the dominant way to make cement, it could reduce the sector's emissions by 30-40%.[28]

Market dynamics

3 Uncertain demand

There is no avoiding the fact that, under current market conditions, most near-zero emission cement is going to cost more than regular Portland cement. The purpose of the FMC is to encourage buyers to send tangible demand signals that acknowledge the price premium producers need to make their investments economically viable.

Three factors hamper the market's capacity to aggregate demand across India for decarbonized cement that is sufficiently strong and bankable to support the major investments necessary. First, cement production is a very localized industry. Second, the Indian market is highly fragmented, due to its high dependence on bagged cement. Third, the majority of demand is coming from housing projects for lower income citizens.

The best opportunity to build demand is through public procurement, which is responsible for 40-60% of global concrete sales and can leverage policy to ensure a broad application of decarbonization targets. Leading private companies should also send demand signals – this will not only encourage producers to invest, but may also prompt government agencies to make the necessary reforms to regulation.

4 Building codes and practices

The Bureau of Indian Standards clearly specifies which types of cement are appropriate for which applications, as well as defining maximum permissible proportions for the different types of SCMs. To reduce the carbon footprint of cement production, in the absence of CCUS, would require the agency to either raise the proportion of SCMs permitted or expand the approved uses of different cement types. However, inertia around updating building codes to embrace new carbon-free technologies is hampering investment and progress.

Architects, engineers and building contractors are often slow to adopt new products and processes, which is appropriate when safety is a factor. Contractors may struggle to embrace the different approaches and timescales needed to ensure that cement made using SCMs cures to the appropriate strength. India's highly variable climate adds to the complications.

5 High cost of capital

As seen in the section on steel above, the high cost of capital in India – roughly 7% higher than in the US in 2020 – acts as a significant brake on the investments needed to decarbonize the cement sector.

2.4 Cement sector priorities identified by FMC's India workshop

The cement and concrete sector in India is facing the challenge of decarbonizing its operations while ensuring a just transition that takes into account the country's economic and social context. The sector has already achieved significant improvements in efficiency, clinker factor optimization and SCM utilization, andhas the potential to lead the global transition with innovative technologies and practices.

The FMC's workshop participants identified the following priorities for decarbonizing India's cement and concrete sector:

1. Cost-effective abatement options

Both cement suppliers and demand-side actors or off-takers (e.g. real estate developers, construction companies) need to identify and implement the most cost-effective measures to reduce its emissions, such as renewable energy, alternative fuels and raw materials, low-clinker cements and nature-based solutions. The workshop discussed the trade-offs and synergies between these options and their implications for the sector's competitiveness and profitability.

2. Collaboration for demonstration

The larger suppliers and off-takers need to enhance their business-to-business collaboration and develop stronger partnerships. For example, cement and concrete producers could work with construction and real estate companies to demonstrate the use of low-carbon cement and concrete in real-life projects. Workshop participants emphasized the need for collaboration from project inception to execution and demonstration, as well as the role of design and construction standards in enabling the adoption of low-carbon products.

3. Criteria for green finance

The sector must be able to access adequate and affordable financing sources to support its decarbonization efforts, such as green bonds, loans, grants and subsidies. The workshop explored the opportunities and challenges of green finance for the sector. An important priority for the finance sector and policy-makers is to clarify the criteria and indicators that could be used to assess the environmental performance of cement and concrete projects and how these criteria influence access to green finance.

4. Awareness and demand

Cement sector actors need to increase the demand – as well as the willingness to pay – for low-carbon cement and concrete, by raising awareness among customers and stakeholders about the benefits and value proposition of these products. The workshop highlighted the need for communication and education campaigns, as well as tools such as environmental product declarations (EPDs), labels and certifications to help customers make informed choices. Currently, the use of such tools does not lead to increased sales.

5. Diversification of SCMs

Workshop participants highlighted that a one-size-fits-all approach will not work. Local cement and concrete producers will continue to rely on the use of fossil fuel-based SCMs (e.g. GGBS, fly ash), but this does not compromise the environmental integrity of their products. The process also prevents the creation of additional waste streams from other sectors. The workshop underlined the importance of the sector as a best practice example when it comes to waste management and recyclability of these materials, as well as their potential contribution to circular economy principles. Nevertheless, the sector needs to increase investment into non-fossil-based SCMs, such as calcined clay, and alternative cement chemistries.

6. Nature-based solutions (NBS)

The sector needs to consider the role of NBS (e.g. afforestation, reforestation, soil carbon sequestration, etc.) in its decarbonization pathway. The workshop examined the potential co-benefits and trade-offs of these solutions for the sector's emissions reduction, biodiversity conservation, water management and so on.

7. CCUS feasibility and monetization

Cement sector actors need to explore the technical and economic viability of CCUS technologies, which are essential to achieve net-zero cement and concrete. Workshop participants called for more collaborative research and development of CCUS technologies, especially on the utilization of captured CO_2 and the monetization of the molecule that could offset the large capex-related costs of this technology.

8. Public procurement and policy

The workshop highlighted the importance of green public procurement, and the role policy could play in building consensus around the definition of low-carbon cement across different regions and markets. The sector needs to engage with policy-makers and regulators to create a conducive environment for its decarbonization, such as setting clear targets, standards, incentives and penalties that could drive innovation and investment in low-carbon products.

9. Building code reform

More funding is needed for research to support safe building code reform, such as adopting more efficient building techniques and alternatives to Portland cement. In turn, the Bureau of Indian Standards could raise the proportion of SCMs permitted in cement or expand the approved uses of different cement types.

3 Aviation

By 2040, India's air traffic could triple and set emissions soaring. The technology to cut aviation's carbon footprint is unlikely to take off without major policy support.

3.1 Overview of aviation landscape in India

By 2040, Indian aviation will cater for 430 million additional air passenger journeys to, from and within India, compared to 2019.

International Air Transport Association

In 2022, India carried around 123 million passengers on internal flights, making its domestic civil aviation sector the third-largest in the world. Meanwhile, Indian carriers flew a further 43 million passengers on international routes.[29] Asia will experience the highest air traffic growth in the coming decades and, as the world's most populated country, India will play a critical role.

By 2040, the International Air Transport Association (IATA) expects Indian aviation to cater for 430 million additional air passenger journeys to, from and within India, compared to 2019. Both Boeing and Airbus predict that India will be the world's fastest-growing aviation market, with 7% annual growth until 2040.[30]

India's aviation market faces several key challenges. Jet fuel – produced mainly by domestic public sector refiners – costs 40% more than the global average. Fuel accounts for 30-40% of operating costs for domestic airlines – their single biggest expense. Meanwhile, the industry has come under financial stress recently from low fares, high fuel taxes and intense competition, exacerbated by the COVID-19 pandemic.

Aviation in India emits around 25 million tonnes of CO_2e per year, accounting for roughly 1% of the country's total emissions (2018 data).[31] However, given the sector's predicted growth, these emissions could reach alarming levels if left unabated.

3.2 Status of technologies, supply and demand for near-zero emission aviation

Indian aviation's decarbonization efforts to date have focused mainly on efficiency measures to reduce consumption, which will reduce operating expenses but will not deliver more than around 30% of emissions reductions.

By contrast, FMC's target is to accelerate the commercial viability of technologies that can deliver 85-100% abatement. Alternative propulsion technologies, such as battery-electric or hydrogen-powered aircraft, can deliver this level of decarbonization but remain nascent. However, the FMC's aviation demand commitment also embraces scaling up sustainable aviation fuels, especially those that can reduce lifecycle emissions by 85% or more – known as SAF 85. If India met FMC's 2030 target to replace 5% of all jet fuel consumption with SAF 85, that would reduce the industry's footprint by around 2 million tonnes of CO_2e every year.

If India met FMC's target to replace 5% of all jet fuel consumption with SAF 85, it would reduce aviation's emissions by 2 million tonnes of CO_2e a year.

BOX3: **FMC's targets for near-zero emission aviation and technologies**

By 2030, replace at least 5% of conventional jet fuel with SAF that reduces lifecycle greenhouse gas emissions by 85% or more

Zero-carbon alternative propulsion technologies also in scope

There are three principal propulsion technologies capable of delivering near-zero emission aviation:

1. SAF 85 made through the Gasification Fischer-Tropsch (GFT) or Power-to-Liquid (PtL) processes, both of which require green hydrogen and renewable electricity to be near-zero emissions
2. Battery-electric power – if generated by non-fossil means
3. Green hydrogen – direct combustion in turbine or hydrogen fuel cell

India already exhibits a high level of technology readiness in the field of SAF, with significant advancements in biofuel production techniques, conversion technologies and refining processes, contributing to the feasibility of establishing a robust and domestic SAF industry.

Not all existing SAF processes are sustainable – especially those that rely on processing crops like rapeseed, soy, palm oil, sugarcane, or corn to create jet fuel, as that can bring the industry into conflict with other land uses, including food production.

Two sustainable, near-zero emission SAF technologies are the Gasification Fischer-Tropsch (GFT) and Power-to-Liquid (PtL) processes. PtL combines green hydrogen (produced by renewable power) with CO_2 from direct air capture (DAC) air to create a synthetic fuel also known as "e-kerosene" – a virtually fossil-free power source that requires no arable land or biological feedstocks. But given the low maturity of the DAC sector, PtL is likely to be a longer-term option.

Meanwhile, GFT can turn a wide range of non-food feedstocks – municipal solid waste, switchgrass, residues of forestry and agriculture – into jet fuel that delivers 90-100% CO_2 abatement. Given the abundance in India of both agricultural residues and municipal solid waste, the GFT process could potentially yield 16-20 Mtpa of SAF – more than enough to meet the entire jet fuel needs of the sector by 2030.[32] This makes GFT the most promising of the SAF technologies to help India decarbonize its aviation sector and deliver on the FMC's 2030 target.

SAF production could also bring India significant co-benefits. FMC's target of 5% SAF blending by 2030 could potentially create 60,000-80,000 new jobs across the supply chain, improve farmers' incomes by 10-15%, open up new export opportunities, and reduce local air pollution by providing incentives for managing waste that is otherwise disposed of by open-air burning.[33] In addition, a SAF industry based on domestically available feedstocks would reduce India's reliance on crude oil imports, helping address concerns around energy security.

In terms of supply, SAF production in India is still at a nascent stage. Domestic actors – including Indian Oil, IndiGo and Vistara airlines, and the Indian Air Force – are piloting projects to demonstrate the viability of SAF, but none is yet approaching the carbon abatement performance of SAF 85. From a demand perspective, IndiGo is so far the only Indian airline with a stated ambition of using SAF (up to a 10% blend) in their operations by 2030.

3.3 Five key barriers to scaling up near-zero emission aviation

There are five principal barriers to scaling up near-zero emission aviation in India: four are related to the complexity and cost of manufacturing SAF 85, while the fifth is a lack of demand for SAF.

1 High cost of SAF 85 production

The production costs of SAF options most likely to meet FMC's 85% carbon abatement target – such as GFT and PtL – range between $1,400 and $3,000 per tonne. This is two or three times the average cost of jet fuel in India today.[34] The purpose of the FMC is to demonstrate demand for the purchase of high-performing SAF at the green premium currently required to produce it. Nevertheless, given the commercial realities of India's domestic aviation market, the introduction of government mandates or incentives could accelerate demand for SAF and reduce that premium.

2 Fragmented supply chains and limited feedstock access

While the feedstocks for the GFT approach to producing SAF 85 are plentiful in India, the infrastructure needed to collect, sort, transport and store these materials in a cost-effective way remains underdeveloped. For agricultural residues, India lacks supply chain that can account for crop seasonality, coordinate with thousands of farmers, transport bulky residues and store them without deterioration. For municipal solid waste, more work is needed to remove the impurities (metals, stones, packaging) from the useful components (bio-waste and plastic).

3 Uncertain access to green hydrogen

All SAF production pathways typically require large amounts of green hydrogen to minimize their climate footprints.[35] Although India is working on scaling up its green hydrogen capacity to at least 5 Mtpa by 2030, it is not yet known which sectors will be prioritized for the end use of this much in-demand resource.[36]

4 Limited access to SAF 85 production technologies

India currently lacks domestic suppliers able to produce SAF 85. A key goal of the FMC's in-country workshop is to stimulate supply by inviting existing Indian fuel producers to participate along with demand-side players. One solution may be for domestic companies to collaborate with international project developers or licensors with expertise in SAF 85 production.

5 **Lack of demand**
SAF production and consumption remain in their infancy in India. There is some progress: IndiGo airlines has pledged to use SAF by 2030, while the national fuel producer Indian Oil has trialled SAF manufacture. An important goal of the FMC's in-country workshop is to encourage more domestic companies to demonstrate stronger demand-side commitments to purchasing SAF.

3.4 Aviation sector priorities identified by FMC's India workshop

Workshop participants agreed that the SAF industry in India is gaining prominence due to the growing pressure to decarbonize and the projected growth of the aviation market in India. However, to date there are just two pilot SAF plants being built in India.

The workshop identified the following priorities for decarbonizing India's aviation sector:

1. Domestic SAF mandate

A domestic SAF mandate (starting at 1% blending) could play a crucial role in accelerating the establishment of a SAF industry in India. Such a mandate would provide a clear and strong market signal, encouraging investment and industry growth. It would incentivize the establishment of SAF production facilities, infrastructure and supply chains across the country, leading to the creation of a robust domestic SAF industry.

2. Policies to secure feedstocks

India is blessed with abundant sustainable feedstock sources, such as agricultural residues, municipal solid waste and other organic waste materials, providing a reliable resource base for the production of SAF. It is in India's interest to have policies in place to ensure that the feedstocks necessary to scale up industrial production of SAF remain in the country and are not exported to other countries that have feedstock incentives. The government could ensure this through, for example, a cross-border tax mechanism that levels out the costs of feedstock, avoiding market disruptions. In the near future, policy-makers will also need to agree a framework to determine how feedstocks are allocated across hard-to-abate sectors.

3. Differential tax structures

The government should offer tax reductions for SAF, especially given that value-added tax currently constitutes 45% of airlines' operating costs. More broadly, there is an urgent need to rationalize taxes (e.g. value-added tax, incentives, excise duties) to encourage SAF production across India.

4. Emphasize co-benefits of SAF industry

Workshop participants highlighted that having a domestic SAF industry would not only contribute to reducing emissions, but also generate numerous co-benefits, including economic growth, waste reduction and creation of green jobs. In addition, India's aviation industry relies heavily on imported jet fuel, which is often expensive and subject to price fluctuations. Developing a domestic SAF industry could enhance energy security and reduce the sector's exposure to imports and volatile global markets. This would also contribute to cost stabilization and potentially make SAF more affordable in the long term.

4 Financial measures to accelerate the transition

Investments in zero-emission technology are exposed to high capital and operational risks. Public-private cooperation has a vital role to play in de-risking these sectors.

4.1 Overview

India is particularly well-placed to become a global leader in low-carbon technologies, including green hydrogen, which could create a market worth up to $80 billion in India by 2030, according to International Energy Agency Executive Director Fatih Birol and NITI Aayog Chief Executive Officer Amitabh Kant. Writing in January 2022, they said: "Support from the international community is essential to help shift India's development onto a low-carbon path. To reach net-zero emissions by 2070, the IEA estimates that $160 billion per year is needed, on average, across India's energy economy between now and 2030. That's three times today's investment levels. Therefore, access to low-cost, long-term capital is key to achieve net zero."[37]

The innovative industrial processes required to decarbonize steel, cement and jet fuel entail both major upfront capital investment and an ongoing production premium, compared to the incumbent fossil fuel-powered alternatives. Financial support is therefore critical in each of these sectors, which are among the hardest-to-abate of all industries. However, in addition to funding at economically viable rates, another type of financial support is needed: risk management.

4.2 Five financial barriers to scaling up near-zero emission technologies

There are five principal financial barriers to scaling up the technologies needed to deliver near-zero emission steel, cement and jet fuel in India: traditional finance approaches are not sufficient, the green premium remains a major challenge, the cost of capital is too high for most MSMEs, India does not have a carbon trading market, and there is a lack of investor confidence.

1 Traditional finance is not sufficient

One of the main challenges in financing the commercialization of near-zero emission steel, cement and SAF technologies is that decarbonization ambitions cannot be funded by traditional finance alone, due to strict payback periods, narrow investment criteria and limited internal capital. Instead, scaling up investments requires blended financial instruments and innovative business models that reimagine capital allocation for decarbonization.

2 Paying the green premium

India is a very price-sensitive market. Government procurement for steel, cement and concrete does not encompass paying green premium, but instead prefers low-cost high-carbon footprint products. So it is unclear who should cover the green premium risk in the value chain.

3 Cost of capital

India's supply chain is fragmented in these industrial sectors. Abating emissions from the cement and concrete sector, or from the biomass producers of feedstock for SAF, entails working with highly decentralized production and fragmented regulation. The MSME sector comprises of nearly 63 million enterprises, which contribute 30% to India's GDP. Many of these MSMEs do not have access to formal credit and are unable to secure the financing they need to decarbonize, despite playing an important role in India's net-zero ambitions.

4 No carbon trading

India has not, to date, had an explicit carbon price or a market-based mechanism such as cap-and-trade. Carbon markets operate on the key idea that trading carbon emissions will lead to the most effective way of reducing overall emissions. They aim to encourage industries and participants facing higher costs in reducing emissions, while providing financial support to those who can do it more efficiently. As a result, carbon markets drive a gradual shift towards greater efficiency in all sectors and among all players involved.

In March 2023, India's Ministry of Power released a draft of the Carbon Credit Trading Scheme (CCTS), which establishes the institutional frameworks and mechanisms of an Indian carbon credit market. If implemented successfully, this carbon market could help lower the cost of achieving India's NDCs and net-zero goals, while at the same time promoting innovation and technological advancements.

5 Lack of investor confidence in off-takers

A major issue facing foreign investment in India is off-taker risk. This is partly inherited from the renewable energy market, where public sector distribution companies were in some cases unable to make payments on time for the procurement of power. Given the short history of renewable energy development in India, investors often lack access to records on the past performance of off-takers. The required data or performance indicators are either not available or only partly available. This increases the perception of risk among those in the banking system, which in turn pushes up the cost of capital.

> **"To reach net zero by 2070, $160 billion per year is needed across India's energy economy between now and 2030. That's three times today's investment levels. Access to low-cost, long-term capital is key.**
>
> International Energy Agency and NITI Aayog

4.3 Financial sector priorities identified by FMC's India workshop

Workshop participants prioritized the following cross-cutting opportunities and recommendations for financing India-based technologies able to produce near-zero emission steel, cement and jet fuel. For additional sector-specific priorities, see the relevant sections 1.4, 2.4 and 3.4 on each sector.

1. Blended capital to de-risk high-capex transition

The climate-critical technologies needed to produce near-zero emission fuels and materials not only have high capital needs, but they are also high risk. Typically, first-of-a-kind projects bring higher technology and delivery risks than most investors are used to. Unlocking capital flows requires overcoming this tension between venture-like risk and infrastructure-sized cheques. Concessional capital and de-risking mechanisms are needed to open the way for private capital to enter and scale up this market.

Collaboration is needed to bring different sources of public, private and philanthropic capital together. Capital providers must each play a unique role, consistent with their risk-return frameworks and financing objectives. Ultimately, the greatest returns both in terms of carbon reductions, operational risk mitigation and financial management often require external financing or partnerships between anchor investors, multilateral development banks and institutional investors to unlock capital more quickly and de-risk investments.

The recent approval of a major loan by the World Bank to India demonstrates the role of multilateral finance in de-risking the transition (see Box 4). Taking part in the FMC's workshop was Surbhi Goyal, Senior Energy Specialist at the bank, who said: "The World Bank is supporting India's energy transition — towards meeting global climate mitigation efforts — through a multi-pronged strategy. The recently approved $1.5 billion development policy operation will support the country in decoupling its economic growth from emissions by accelerating development of low-carbon energy solutions, including green hydrogen."

> **"The World Bank is supporting India's energy transition. The recently approved $1.5 billion development policy operation will support the country in decoupling its economic growth from emissions by accelerating development of low-carbon energy solutions, including green hydrogen.**
>
> Surbhi Goyal, Senior Energy Specialist, World Bank

BOX 4: **World Bank loan stimulates investment into low-carbon energy in India**

On 29 June 2023, the World Bank approved a $1.5 billion loan to the Government of India to accelerate the country's low-carbon transition. The financing is focused on helping India to scale up renewable energy, develop its green hydrogen sector and encourage climate finance for low-carbon energy investments.

The programme will support the successful implementation of the National Green Hydrogen Mission that aims to stimulate $100 billion in private sector investment by 2030. The loan will also support the government in its work to:

- Harmonize standards and regulations
- Issue policies on energy storage obligations and guidelines to offshore wind
- Create a Production Linked Incentive (PLI) scheme for solar manufacturing
- Initiate a carbon credit trading scheme (CCTS) to value the externalities of fossil fuel-based products
- Identify the demand sectors (e.g. steel, export products)
- Introduce incentive schemes and tenders
- Work on carbon capture and the just transition in relation to the coal industry

Source: World Bank[38]

2. Sustainability-linked bonds and loans

Such third-party financing options could include green bonds or sustainability-linked loans. These instruments may offer companies a lower-cost alternative to deploying internal capital, while aligning their corporate finance activities with their sustainability goals. In India there has been a substantial uptake in these products in the past two years (see Boxes 5 and 6). The space still needs clarity. The International Capital Market Association (ICMA) recently published some sustainability-linked bond principles.[39] Targets need to be very ambitious, verifiable and measurable.

BOX 5: **First from India: JSW Steel's $500m sustainability-linked bond**

In September 2021, JSW Steel, one of India's leading steel producers, raised $1 billion on the capital markets, split equally between a $500 million five-year bond priced to yield 3.95% and a $500 million 10-year sustainability-linked bond (SLB) priced to yield 5.05%.

The transaction was the first SLB to be sold by the global steel industry as well as the first from a high-yield Indian company. The company will pay a 37.5bp coupon step-up if it fails to meet its performance target to reduce its CO_2 emissions intensity by 23% by 2030, from a 2020 baseline.

Source: IFR Extra[40]

BOX 6: **First from India: Government's 80-billion-rupee green bond issue**

In January 2023, the Indian government issued its first pair of green bonds, joining a growing list of countries to issue sovereign thematic bonds. The Reserve Bank of India sold 40 billion rupees of five-year bonds at a coupon rate of 7.10%, five basis points below the sovereign yield of similar tenure. Another 40 billion rupees of 10-year bonds were sold at 7.29%, six basis points below comparable government securities. Taken together, the bonds raised approximately $980 million for the government to fund green investments such as solar power, wind and small hydro projects, as well as other public sector projects to help reduce the economy's carbon footprint.

Source: Reuters[41]

3. Transformative business models

Transformative business models are essential to enable industry participants and capital providers to work together in ways that establish new contracts and collaborations to increase the probability of commercial success. For example, companies may need to introduce demand and supply-side contracts, with some sectors moving away from spot pricing. Business models will need to proactively de-risk the areas of greatest innovation risk and co-develop solutions with stakeholders across the climate ecosystem.

4. Portfolio approach to risk and payback

Investors should calculate the least-cost pathways to achieve full potential. Private capital must redefine its appetite for risk and create a balanced portfolio with investments that entail the right balance of long-term, high-risk bets in evolving technologies and short-term, lower-risk decarbonization levers.

From the point of view of returns, a portfolio approach to evaluating investments in decarbonization projects seeks to blend projects with short and long payback periods to unlock funding for projects that might otherwise not meet the investment criteria on a standalone basis. For example, investors should consider extending the payback period of projects to five years or more.

5. Strategic policy intervention

The following policy interventions by the public sector would create an enabling environment and energize private capital flows:

- Carbon pricing with revenue recycling: the proceeds generated from a carbon tax could be earmarked to steer funds towards green spending initiatives. This requires close collaboration between federal and state governments. In India, for example, individual states own their natural resources, but pricing and taxation are decided by the central government.
- Government procurement of near-zero emission fuels and materials, plus collaborative requests for proposals (RFPs), could create economies of scale and absorb some of the green premium.

6. Financial support for MSMEs

Micro, small and medium-sized enterprises need financial support to help them with the low-carbon transition. The barriers to MSMEs accessing commercially available finance include stiff lending policies with high collateral security requirements, small project ticket sizes and high transaction costs. This is particularly relevant for suppliers of cement.

In the absence of immediate and viable financial solutions, MSMEs need government intervention to get sustainable debt at a reasonable rate. A way forward would be to establish a platform where MSMEs could access green bonds. The proceeds of green bonds could pass through financial institutions that would lend to eligible MSMEs with clear environmental KPIs. These loans could be structured as term loans, revolving lines of credit or any other type of debt instrument.

4.4 Multilateral cooperation to provide affordable finance and de-risk the transition

International governments, multilateral financial institutions and development banks, philanthropists, business leaders and international NGOs need to collaborate to de-risk the financing of near-zero emission steel, cement and aviation in India.

Speaking to workshop participants, Shubhashis Dey, Director of Climate Policy and Climate Finance at the Shakti Sustainable Energy Foundation, said: "In order to mainstream climate finance, a new approach towards financial risk rating, climate risk reporting and collaboration between economies is required. Philanthropies can play a catalytical role by creating evidence, developing cross-border partnerships and supporting the formation of cleantech unicorns."

> **Philanthropies can play a catalytical role by creating evidence, developing cross-border partnerships and supporting the formation of cleantech unicorns.**
>
> Shubhashis Dey, Director of Climate Policy and Climate Finance, Shakti Sustainable Energy Foundation

Some options to de-risk the transition to near-zero technologies include the following:

- Finance feasibility studies in the green hydrogen, steel, cement and jet fuel value chains.
- Provide more blended financing to lower the cost of capital.
- Provide access to cheap debt for green projects with guaranteed off-takes.
- Provide loan guarantees through export credit agencies.
- Establish risk-sharing mechanisms such as insurance or first-loss loan policies – the political risk insurance offered by the World Bank's Multilateral Investment Guarantee Agency (MIGA) is one example
- Set up a programme for government-backed green bonds.
- Consider issuing "green masala bonds" denominated in the Indian rupee, thereby reducing currency risks and making it easier to pay back debt.[42]

For example, the International Monetary Fund (IMF) has established a long-term financing tool, the Resilience and Sustainability Trust (RST),[43] to finance green public-private frameworks for Costa Rica, Barbados, Rwanda, Bangladesh and Jamaica. By seeking long-term financing at concessional rates, these countries are making progress in addressing the challenge posed by climate change.

Access under RST is limited to 150% of a country's IMF quota or up to SDR 1 billion.[44] The loans have a long maturity of 20 years with a grace period of 10.5 years and are provided on highly concessional terms. Lower middle-income countries pay a higher interest margin than lower-income countries. The RST is funded through voluntary contributions of Special Drawing Rights (SDRs) by developed countries. It can also be funded by loans and grants provided in SDRs or any freely usable currency.

As the global financial community becomes more active in climate finance, a growing number of sources are making pools of capital available. Some are listed in Box 7.

BOX 7: | **Global funding sources**

Legislative/ international

- European Commission's Global Gateway (€300 billion by 2027)[45]
- Funds from the Japan International Cooperation Agency (JICA)
- US government's Development Finance Corporation ($60 billion investment limit)[46]

Multilateral/ development banks

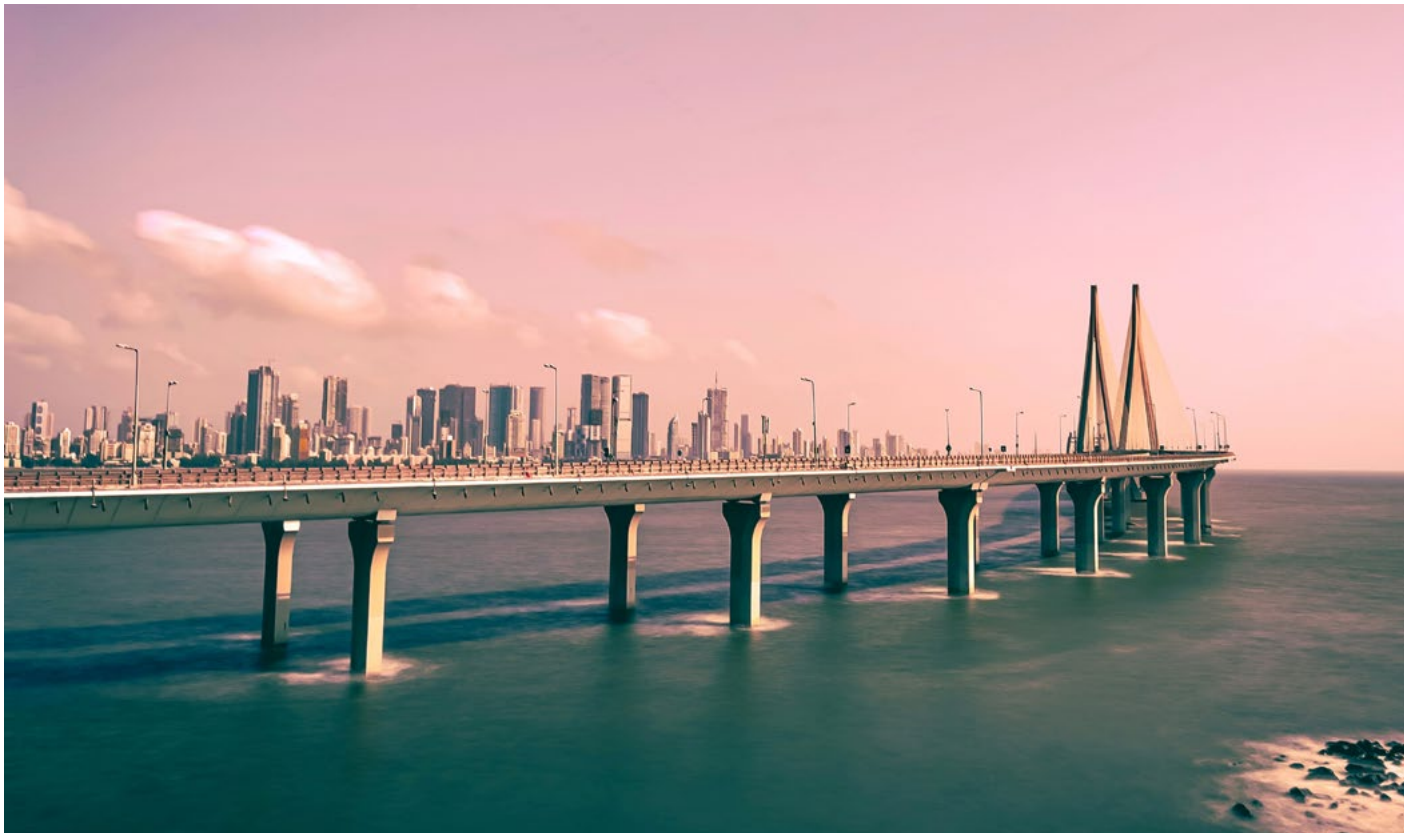
- Asian Development Bank ($100 billion from 2019-2030)[47]
- Climate Investment Funds (CIF) ($11.1 billion committed)[48] – Industry Decarbonization Program[49]
- European Hydrogen Bank – international pillar[50]
- International Monetary Fund (IMF) – Resilience and Sustainability Trust (RST)
- Partnership for Global Infrastructure & Investment ($600 billion)[51]
- World Bank's Climate Change Action Plan ($32 billion in 2022)[52]

Private sector

- Glasgow Financial Alliance for Net Zero (GFANZ) members ($7.1 trillion assets under management)[53]
- Private equity funds (e.g. BlackRock, TPG Rise Climate, Brookfield, KKR) and pension funds (e.g. CPP)

Philanthropic

- Bezos Earth Fund ($10 billion by 2030)
- Bloomberg,
- Breakthrough Energy[54]
- Hewlett Foundation
- Laurene Powell Jobs
- MacArthur Foundation
- Packard Foundation
- Resnick



5 India-specific policies to accelerate near-zero emission fuels and materials

Technologies essential for India's net-zero goal are held back by huge cost disparities with incumbent carbon-intensive processes – government measures to bring down the green premium are an urgent priority.

The priority in India for cost-efficient growth to meet the burgeoning needs of the world's most populous nation makes the economics of near-zero emission steel, cement and jet fuel extremely challenging. Through its India workshop, the FMC brought together private sector actors from both demand and supply sides, along with policy-makers and financiers, to identify barriers and drive the change needed. Host governments can play a key role in accelerating the market for these climate-critical technologies by introducing supportive policies and mandates.

While many of the challenges to the development, financing and adoption of climate technologies are shared across continents and industries, the policy solutions are typically country-specific. The FMC in-country workshop discussed a number of potential policy measures that could help accelerate the development and supply of near-zero emission solutions for India's steel, cement and aviation sectors. For additional sector-specific priorities, see the relevant sections 1.4, 2.4 and 3.4 on each sector.

Potential policy measures, cutting across the steel, cement and aviation sectors, fall into six broad areas:

1. Invest in critical upstream technologies
2. Put a price on carbon
3. Ease the price of low-carbon alternatives
4. Invest in pilot projects and infrastructure
5. Set mandates for public procurement and for the private sector
6. Streamline regulatory measures

5.1 Invest in critical upstream technologies, using industrial clusters

Carbon capture, utilization and/or storage (CCUS)

CCUS is an essential technology for decarbonizing both steel and cement production. It is used to capture emissions from existing highly carbon-intensive processes, such as blast furnaces to extract iron from iron ore and roasting limestone to extract clinker, the key binding agent for cement.

The top priority policy action discussed at the workshop in relation to accelerating the commercial viability of critical upstream technologies was to develop and implement a cross-sectoral industrial cluster strategy to support the growth of CCUS and green hydrogen in a way that facilitates collective action. An industrial cluster approach can learn from best practices in other countries such as the US, Sweden and Norway, which also offer insights for India's biomass and waste management supply chains.

Green hydrogen

Green hydrogen is an essential technology for the zero-emissions process of decarbonizing steel production known as H_2-DRI-EAF, which uses green hydrogen instead of coking coal for the direct reduction of iron ore. Green hydrogen is equally essential for the industrial manufacture of sustainable aviation fuels that can reduce lifecycle GHG emissions by 85% or more (SAF 85).

The Indian government has launched a $2 billion incentive plan to deliver 5Mt of green hydrogen production per year by 2030. A lack of green hydrogen availability for either near-zero emission steel or SAF production could severely limit their technical and economic feasibility. However, any decision on reserving green hydrogen for specific end uses needs to be weighed against other demands for the limited supply of green hydrogen, such as for fertilizer production or shipping.

Policy actions discussed at the workshop included the following:

– Incorporate explicit steel demand for green hydrogen into the National Hydrogen Mission.

– Incorporate explicit SAF production demand for green hydrogen into the National Hydrogen Mission.

– Develop and implement an industrial cluster strategy to support growth of CCUS and green hydrogen (as noted above).

Renewable energy

As highlighted in a previous section, the impact of the renewables financing challenge on steel decarbonization should not be understated. The more the Indian government invests in developing its renewable energy capacity, the lower the risk becomes for the private sector looking to invest in decarbonization technologies that are dependent on concurrent renewables development.

Indian policies support green foreign direct investment (FDI) into renewable energy, including 100% FDI under the automatic route, production incentives and waivers of inter-state transmission charges.[55] International finance is available – for example, in May 2022, Germany committed 10 billion euros to help India meets its ambitious goal of generating 500GW of power from non-fossil fuel sources by 2030.

However, given that in April 2022 renewable sources accounted for roughly 165GW of India's 393GW of power-generation capacity, far more international finance will be needed. It will take about $223 billion to reach India's ambitious 2030 goal for renewables – three times the amount of investment over the last seven years.[56]

Policy actions discussed at the workshop included the following:

– Focus on massive investment into the renewables industry before 2030, to ensure low-cost carbon-free power is available to produce the green hydrogen needed to decarbonize the hardest-to-abate industrial sectors.

5.2 Put a price on carbon

Fossil-fuel intensive industries to manufacture steel, cement and jet fuel remain cost-competitive across the world for the simple reason that their impacts on climate and nature – so-called "negative externalities" – are not priced into their production. This puts more innovative, climate-friendly technologies at a clear cost disadvantage. FMC member companies have highlighted that it would help them meet their demand commitments if government partners adopted a price on carbon.

The 2022 amendment to India's Energy Conservation Act allows the near-term establishment of a domestic carbon market. The government's proposed Indian Carbon Market (ICM) will be a national framework with the objective of decarbonizing the Indian economy by pricing greenhouse gas emissions through the trading of carbon credit certificates.

"The ICM will enable the creation of a competitive market that can provide incentives to climate actors to adopt low-cost options by attracting technology and finance towards sustainable projects that generate carbon credits. It can be a vehicle for mobilizing a significant portion of investments required by the Indian economy to transition towards low-carbon pathways," according to a speech by Abhay Bakre, Director-General of the Indian Bureau of Energy Efficiency, in May 2023.[57] As well as emphasizing the need for rigorous monitoring, reporting and verification (MRV) guidelines, Bakre envisaged the parallel development of a voluntary carbon market to encourage GHG reductions from "non-obligated sectors".

Carbon markets can create additional revenue streams for producers and end users of low-carbon commodities including steel, cement and SAF. Such mechanisms can also enable, for example, aviation stakeholders to offset their emissions by investing in SAF projects, thereby creating market demand.[58]

Policy actions discussed at the workshop included the following:

– Consider incorporating near-zero emission steel, cement and SAF into the forthcoming Indian Carbon Market.

– Carbon pricing with revenue recycling – with the proceeds generated from a carbon tax earmarked for green spending initiatives.

5.3 Ease the price of low-carbon alternatives

Tax incentives and subsidies

Along with imposing a price on carbon, the government can also work in a different, complementary direction – by easing the cost of low-carbon alternatives. For example, policy incentives such as tax breaks and subsidies have proved to be game-changing for the zero-emissions technology sector in the US, following the introduction of US President Joe Biden's Inflation Reduction Act in August 2022.

There are precedents for this in India. The government has a successful track record in incentivizing climate technologies such as solar PV and semiconductor manufacturing under the Production Linked Incentive (PLI) scheme.[59] Extending the scheme to incorporate the manufacturing of near-zero emission steel, cement and SAF could boost those sectors while reducing India's heavy reliance on crude oil imports. Such an approach also aligns with the Indian government's "AatmaNirbharBharatAbhiyan" initiative to strengthen the country's self-reliance in the aftermath of the COVID-19 pandemic.[60]

Policy actions discussed at the workshop included the following:

– Establish and increase tax incentives such as accelerated depreciation, carbon tax revenue recycling and preferential funding for near-zero emission initiatives.

– Explore providing tax benefits or subsidies for domestic production of near-zero emission steel, cement and SAF under the PLI scheme.

Cheap debt and concessional lending

The government and the Reserve Bank of India (RBI) have other policy options around easing the price of low-carbon technologies, including the following:

– Increase bank loan limits associated with the Priority Sector Lending policy to facilitate funding of larger renewable energy projects.

– Provide access to cheap debt for green projects with guaranteed off-takes; RBI could provide credit guarantees to de-risk this debt.

– Set up a programme for government-backed green bonds (discussed more in the previous section).

5.4 Invest in pilot projects and infrastructure

The capital costs for establishing near-zero emission production of steel, cement or jet fuel are often too significant for any one company to bear and require government support. The government can help finance the critical early-stage development of new technologies from piloting through to commercial viability.

One suggestion from BCG's situation analysis report is that the government could open up 100% foreign direct investment (FDI) into near-zero emission technologies, as it already does for the renewable energy sector. For example, foreign companies with expertise in producing SAF 85 or PtL fuels could invest in India via 100% FDI under the automatic route. This is already permitted for foreign investment in aviation projects to develop greenfield and brownfield airports, as well as for ground handling services, maintenance, repair and training institutes.

The co-benefits of investment in new climate technologies reach beyond the abatement of carbon dioxide. Such investment would create many thousands of new jobs in the emerging energy transition economy. It would generate incentives to reduce the health impacts of environmental and air pollution – through, for example, the efficient processing of municipal waste and agriculture residues for sustainable aviation fuels. It would reduce India's reliance on crude oil imports and instead open up new export opportunities.

Policy actions discussed at the workshop included the following:

– Invest in pilot projects to develop the feasibility of GFT and PtL processes for the production of SAF 85.

– Invest in pilot projects for CCUS and hydrogen-reduced iron technologies.

– Provide financial support in the form of grants, subsidies or low-interest loans to help develop the infrastructure required for SAF, such as agricultural residue and municipal solid waste collection facilities, downstream production plants and distribution networks.

– Provide financial support for infrastructure needed for the collection and sorting of scrap iron and steel.

– Government financial support to incentivize production of green cement could include waiving electricity tax on the power used during production and reducing GST (goods and services tax) on the final product.

5.5 Set mandates for public procurement and private sector

One of the best opportunities to accelerate decarbonization of the cement and concrete sector, for example, is through public procurement, which is responsible for 40-60% of all global concrete sales. The government can set mandates for the public procurement of near-zero emission steel and jet fuel, as well as for cement. As shown in the section on finance, government procurement of these low-carbon fuels and materials, plus collaborative RFPs, could create economies of scale and absorb some of the green premium.

The government could also set mandates for the private sector – something it is already considering in the aviation sector. A successful example of policies helping in this regard is India's 2025 ethanol mandate, which has strengthened the overall biofuels value chain and created new opportunities for suppliers. Drafted by NITI Aayog, the mandate states that the target of 20% blending of petrol in the country by 2025 appears feasible and within reach.[61]

One multilateral initiative, known as the Clean Energy Ministerial Industrial Deep Decarbonisation Initiative (IDDI), is a collaboration of public and private sector players to stimulate demand for low-carbon industrial materials. One of IDDI's key goals is to encourage a minimum of 10 governments to make public procurement commitments for low-carbon steel and cement within the next three years. According to the host organization, the United Nations Industrial Development Organization (UNIDO), green public procurement commitments are essential in signalling to the market: "If you make it, we will buy it,"[62] FMC is proud to support IDDI's efforts.

"Green public procurement commitments are essential in signalling to the market: "If you make it, we will buy it."

UN Industrial Development Organization

Given that an estimated 80% of cement and 90% of steel is produced in around 10 key countries, the adoption of green public procurement commitments in even a handful of these countries would make a significant impact on reducing emissions.[63]

Policy actions discussed during the workshop included the following:

- Make a level four IDDI commitment (the most ambitious level possible) to procure near-zero emission steel and cement.
- Mandate usage of near-zero emission cement and concrete by key players in the public sector (similar to the green H_2 mandate in the National Hydrogen Mission).
- Prioritize the use of SAF in the Indian Air Force (IAF), building on the flight of the IAF's AN-32 aircraft, carrying mixed bio-jet fuel, over Raj Path in New Delhi during the 2019 Republic Day celebrations.
- Mandate the use of SAF in domestic aviation, which progressively increases over time. The Indian government is currently in the exploratory phase of putting together an advisory to blend 1% SAF by 2025, 2% by 2026, and 5% by 2030.[64] Formalizing this as soon as possible will help create demand which in turn will incentivize SAF producers to strengthen supply.

5.6 Streamline regulatory measures

Permissions and licensing

As discussed in the section on steel, India's current regulatory positions around CCUS are unlikely to provide operators with the certainty needed for sizeable investments. Clear regulations on carbon capture could make it more worthwhile for international capital and expertise to come to India. Among other things, there needs to be a clear process for streamlined CCUS project approvals. In addition, licensing of buildings can be made contingent on environmental performance.

By leveraging platforms like the Quad and the Indo-Pacific Economic Framework (IPEF), India can enhance collaboration on H_2 standards, infrastructure development, and H_2 trading, which will not only attract international investments but also bolster the country's efforts towards sustainable and cleaner energy solutions.

Policy actions discussed during the workshop included the following:

- Encourage state-wide adoption of single-window clearance systems (e.g. the Tamil Nadu system) to expedite green development projects.
- Expand on programmes requiring environmental performance (e.g. around the carbon footprint of cement or steel) as an essential indicator impacting permitting and licensing for building development.

Definitions and standards

The unambiguous definition of what constitutes near-zero emission materials is important for sending a clear signal to the market. Alignment between Indian and global standards is essential.

Speaking to workshop participants, Ruchika Drall, Deputy Secretary, Climate Change, at the Ministry of Environment, Forests and Climate Change of India, said: "There is a need to define green products to help buyers make informed choices. The establishment of a domestic carbon market can facilitate investment in the industrial sector supporting required transitions."

❝ There is a need to define green products to help buyers make informed choices.

Ruchika Drall, Deputy Secretary, Climate Change, Ministry of Environment, Forests and Climate Change of India

One area in need of alignment is "book and claim" in the aviation industry. A major challenge is that supplies of SAF are not yet available in many airports, leaving carriers that want to refuel their aircraft in a bind. Book and claim is an innovative approach that permits an aircraft that cannot refuel with SAF to pay for another equivalent flight to fuel up from an airport that does have SAF. The airline paying for the sustainable fuel can then claim the CO_2 reduction it brings against its net-zero pledges. Book and claim is a very promising solution, but it needs international standardization to harmonize approaches.

Policy actions discussed at the workshop included the following:

- Adopt clear definitions and targets for near-zero emission steel, cement and jet fuel, aligned with the international community.
- Align with global standards around book and claim for SAF, to mitigate near-term logistical constraints and catalyse market development.
- Update building codes and practices to allow for the use of SCMs in low-carbon cement and concrete.

BOX 8: **Top government policy priorities highlighted by FMC's India workshop**

Support increased availability of essential upstream technologies via clear regulations, subsidies and project approval processes for green hydrogen, CCUS, renewable energy and consolidation of biomass waste feedstocks.

Invest in innovative R&D, competitive pilots and demonstration projects, through collaboration across ministries and with external partners from business, finance and philanthropy.

Adopt clear definitions and targets for near-zero emission goods and services, aligned with international standards.

Develop a cross-sectoral industrial cluster strategy to support the growth of CCUS and green hydrogen, learning from best practices in other countries such as the US and Norway.

Conclusion

The technologies to clean up India's carbon-intensive steel, cement and aviation sectors exist, but they remain nascent and expensive. It will take an urgent and collaborative effort to develop the financial tools and policy measures needed to make these low-carbon processes commercially viable – especially in an emerging, price-sensitive economy such as India's. Incremental measures taken by individual actors will not deliver the near-zero emission processes these sectors need in time for them to make a difference. Bold collective action by public and private stakeholders is essential.

In July 2023, the First Movers Coalition (FMC) convened an in-country workshop that aimed to demonstrate demand from FMC's member companies for near-zero emission steel, cement and aviation fuel in India and, through such demand signals, to identify and encourage domestic suppliers of those materials and fuels. The workshop also provided a chance for demand- and supply-side actors to interact with representatives from government and finance to discuss the barriers, opportunities and solutions these three sectors face in decarbonizing in India.

This white paper presents the outcomes from the FMC's India workshop, supported by situation analysis from the Boston Consulting Group. Financial solutions discussed at the workshop gravitate around ways to reduce the green premium through incentives and carbon pricing, as well as strategies to address the risk-reward imbalance through blended finance and risk management. Policy solutions include measures to increase the availability of upstream technologies essential for the transition, such as carbon capture, green hydrogen and renewable energy, as well as developing a cross-sector industrial cluster strategy to promote collaboration and economies of scale.

The FMC is planning similar workshops in South-East Asia, Africa and South America over the next 12 months, which will provide opportunities for additional sharing of solutions and lessons learned across regions and especially in emerging markets.

Done right, the low-carbon transition in India will generate not costs but opportunities for new jobs, exports and green growth in what to date have been some of the country's dirtiest industries. And there will be co-benefits for India's people too – from cleaner air and better health to sustainable livelihoods in sectors of the economy with a long-term future.

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