February 2026

INNOVATION, ECONOMIC DEVELOPMENT AND INDUSTRIAL DECARBONISATION

GREEN ARTHA

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This report is developed with support from the Sustainability, Equity and Diversity Fund (SED)

Contents

Executive Summary

India's economic development will be the defining variable in the trajectory of global emissions and climate change.

With rapid economic growth driven by industrialisation, India has the potential to transform into a developed nation by 2047. Achieving this goal requires embracing green industrial innovation—not as an alternative to growth, but as the engine of growth.

India is already aggressively pursuing green growth. The country has exceeded 50% renewable energy integration and is accelerating the reduction of its GDP emissions intensity. Yet climate change poses a significant risk to achieving India's full economic potential. The current approach addresses only part of the problem—and not the most critical part.

Inclusive of energy use, industry is the largest contributor to India's emissions. As one of the 10 countries most vulnerable to climate impacts, India faces a dual imperative: grow its economy while transforming how that growth occurs. This requires a paradigm shift in decarbonisation—an approach built for industrialising economies pursuing development, not post-industrial developed economies.

The Innovation Imperative

Innovation is the key to unlocking this transformation. With its world-class innovation ecosystem, India stands among the few countries capable of demonstrating a different path—a better path—where innovation powers clean economic development.

Innovation across three dimensions—technical, business model, and financial—provides the foundation for India to achieve low-carbon growth while simultaneously managing climate risk, ensuring supply chain security, and capturing trade and export benefits.

India's innovation advantage is both broad and deep. Its entrepreneurs are developing breakthrough solutions across hard-to-abate sectors, core industries including textiles, pharmaceuticals, and automotive, and high-growth areas like data centers. These innovations target industrial energy, materials, and processes—the fundamental inputs that make everyday products green. Critically, these solutions succeed not merely because they reduce emissions, but because they deliver superior products that outcompete high-emission incumbents on performance and economics.

The impact potential is exceptional. These innovations offer both high unit impact and massive scale deployment opportunities. Proof points already exist: companies like Cancrie, Brisil, Smart Joules and Indra Water demonstrate that this approach is both viable and scalable.

Critical Actions To Accelerate Innovation

Unlocking India's innovation potential requires five strategic interventions:

- Prioritise clean industrial innovations as the cornerstone of India's decarbonisation strategy, recognising that industry—not just energy or transport—drives India's emissions profile
- Fund accelerated commercialisation, not merely additional R&D and reports. The critical gap lies in bridging innovation to market adoption
- Innovate how capital is deployed by adapting financial instruments to industrial innovation realities. This includes de-risking first-of-a-kind plants, underwriting novel business models, and structuring financing appropriate for asset-intensive clean technologies
- Provide specialised support to accelerate startup market entry. Facilitate partnerships between innovators and industry to align business expectations, navigate complex commercialisation cycles, and overcome integration barriers
- Foster strategic partnerships with industry that enable businesses to access innovations they cannot develop internally within the required timelines, while providing startups the customer engagement critical for commercial success

The Path Forward

India possesses the capability to become the global beacon of clean economic development. To convert growth from a climate challenge into a climate solution, we must commit to prioritise, fund, and accelerate the clean industrial innovations that will define India's—and the world's—economic and environmental future.

About Us & Authors

Green Artha is a climate innovation and investment firm founded with the purpose of accelerating the speed and scale of the adoption of impactful climate technologies.. Green Artha (GA) operates by proving models that leverage a systemic approach to address market gaps and enable the larger ecosystem. GA specifically focuses on climate technologies that have the ability to displace high-emission incumbents, in high-growth sectors, based on economic superiority – industrial energy, materials, resource efficiency, and process optimisation for hard-to-abate and rapidly growing sectors (auto components, textiles, data centers).

Apart from investing in transformational technologies, its work mobilises new capital, creates a continuum of capital and helps extend the climate capital stack.

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Maya Chandrasekaran is founding partner at Green Artha, leading impact, ecosystems and operations. Maya Chandrasekaran is an expert at scaling companies that change lives, and supports portfolio companies in building operational excellence. As one of the early members of Menterra Venture Advisors, she led the Education and Skilling investment practice, building on her work at Villgro Innovations Foundation. Maya was part of the founding leadership that scaled Babajob.com into India's largest tech-enabled livelihoods platform, securing meaningful work for 10 million people in 7 years. She is co-founder of the 500 member strong Women in Investing Network, global jury member for the Cartier Women's Initiative, and serves on the Project Frame Steering Committee.

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The Opportunity

India's Defining Role in Global Climate

India is the country that will have the greatest impact, positive or negative, on climate change and the livability of the planet in the coming 25 years.

As the world's fastest-growing major economy, India's growth is driven by its increasing prominence in global supply chains, a demographic dividend and soaring domestic consumption. The economy is projected to reach US$30 trillion by 2050, with annual growth of 6.7%.

This presents a time-sensitive opportunity to integrate climate technologies into the country's high-growth sectors, preventing the adoption of costly, long-life carbon-intensive assets. As one of the 10 most impacted countries, climate change poses a significant risk to India achieving its full economic potential. A failure to take significant action could have devasting impact on India’s prospects and global planetary health. On the other hand, a focus on transitioning the means and modes of production through economical industrial decarbonization systemically addresses the dual requirements of socio-economic development and climate impact.

India's Green Growth Progress

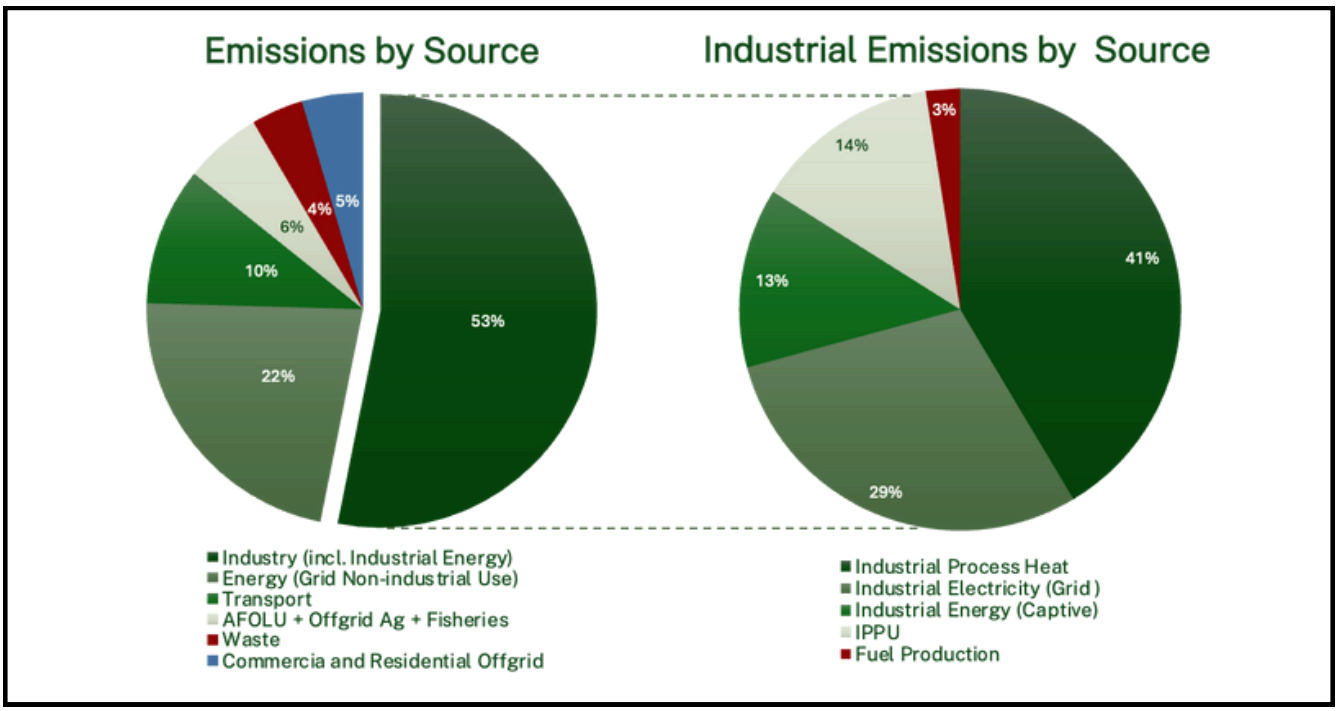
India is aggressively pursuing green growth, with it’s decarbonization plan largely modeled after those of post development economies with primary focus on grid and transport. Rapid adoption of renewable energy and energy efficiency have resulted in India, already exceeding 50% renewable capacity and rising from 30th to 10th rank in the annual Climate Change Performance Index in 10 years.

The government has made ambitious 2030 commitments to reduce the emissions intensity of its GDP by 45%, transition to a minimum 50% renewable energy, and create carbon sinks. In the face of changing global commitments to climate action, India remains steadfast in its efforts to achieve green economic development.

India's Unique Emissions Profile

As the world's 3rd largest emitter (2.8 Gt), India's transition plan mirrors developed economies, with prioritisation of grid energy transition and transport decarbonisation. This overlooks India's largest and fastest-growing emissions source – industry inclusive of its energy use.

India's emissions profile reflects its stage of economic development. Understanding the composition and drivers of these emissions is essential to designing an effective transition strategy.



Why Industrial Energy is Different from Grid Energy

Industrial energy use in India differs fundamentally from developed economies—in scale, in purpose, and in the energy sources required. These differences demand a differentiated approach to decarbonisation, one that addresses industry's needs rather than as an extension of grid transition.

Industry requires consistent, affordable, stable power—and often needs high voltage or process heat unachievable with grid energy alone. Industrial power procurement from the grid costs INR 6-17 per kWh depending on state, while captive coal delivers energy at INR 2-4 per kWh and simultaneously meets industrial heat requirements more efficiently.

Since 2019, Indian industry has increased captive power plants by 25% to manage costs, maintain stable electricity supply, and achieve necessary temperatures. This rapid adoption—through service models and capex investment—demonstrates industrial price sensitivity and the inadequacy of grid electricity alone.

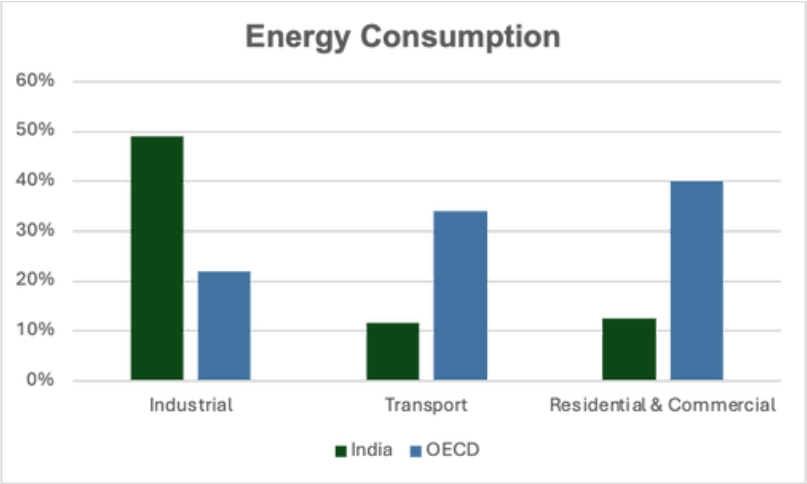
Beyond the price of energy, electrification requires significant equipment or process changes that can impact cost or quality, creating additional barriers to transition and need for innovation.

The challenge extends beyond heavy industry. Even within service industries—the easiest to electrify—39% of energy still derives from coal, oil, or gas. Inclusive of captive solar, electricity comprises only 20% of the industrial energy mix.

The Fundamental Difference from Developed Nations

India's energy consumption patterns differ fundamentally from developed economies. Industrial energy consumption accounts for 53% of India's total energy use, compared to just 21-24% in OECD countries.

In contrast, OECD countries' energy consumption is driven by personal use, with residential, commercial, and transport sectors accounting for over 70% of total energy consumption. Transport alone represents 34% of energy use in OECD countries, while in India it accounts for only 11.7%.



Despite its significant and growing industrial intensity, India maintains the lowest per capita emissions among major economies at 1.9 tCO_2/cap—60% below the global average, and 75% below the G20 average – due to low individual consumption.

These distinctions reflect fundamental differences in economic development stages. India's growth is primarily driven by industrial expansion, while developed nations are largely post-industrial, with knowledge and service sectors leading economic contribution. This creates vastly different emissions trajectories and necessitates different decarbonisation approaches—one focused on building industrial infrastructure right from the start, rather than retrofitting existing post-industrial economies.

The Paradigm Shift Required

Understanding this difference is an opportunity to directly address industrial emissions and implement an India-specific transition that will result in accelerated emissions reduction. An India-specific or industrialization-specific transition plan would place heightened importance on the role of industry, and particularly new industrial development in decarbonization.

Building right—with energy efficiency, affordable and stable clean energy, lower carbon supply chains, and circularity—as a core tenet of economic development is necessary for effective decarbonization.

Decarbonization models which focus on electricity and transport, while suitable for developed markets, cannot address the requirements of a rapidly industrializing country like India.

The Innovation Imperative

Industrial decarbonisation requires innovation. Current technologies and business models are insufficient to meet the ambitious goals of the Paris Agreement or the requirements of industrial customers. If commercially viable solutions already existed, the transition would be further along.

Innovation is needed across the full spectrum—industrial energy, materials, equipment, and processes. Widespread adoption becomes possible when solutions not only reduce emissions, but also improve profitability, integrate easily with existing infrastructure, maintain or enhance output quality, and strengthen supply chain stability.

India's World-Class Innovation Ecosystem

India possesses a unique advantage in addressing its decarbonization challenge: it is the 3rd strongest innovation ecosystem globally, with a reputation for frugal innovation. Indian climate entrepreneurs can deliver globally competitive innovations that match the technological benefits of global R&D labs, using commonly available equipment and materials. This reduces costs, improves scalability, and eliminates lag time for expensive specialty equipment or hard-to-procure inputs.

With its world-class innovation ecosystem, India stands among the few countries capable of demonstrating a different path—a better path—where innovation powers clean economic development.

Cost Advantage	Speed to Market	Scale Ready Mindset	Robust Startup Ecosystem	Talent Density
60-70% lower costs than Western equivalents without compromising performance	Market-ready innovations in 6-18 months vs. 3-5 years for traditional R&D	Designed for modular deployment and rapid scaling	Startup successes in other sectors cross-pollinate	1.5 million engineering graduates annually with technical expertise and affordability focus

Innovation as the Engine of Growth

Innovation is the key to unlocking India's transformation. Innovation across three dimensions—technical, business model, and financial—provides the foundation for India to achieve low-carbon growth while simultaneously managing climate risk, strengthening supply chain security, reducing import dependencies, and capturing economic and trade benefits.

As India embarks on rapid industrial expansion, the adoption and scale up of clean innovations can prevent the lock-in of emissions associated with long-life incumbent technologies.

By focusing on industrial decarbonisation, it becomes possible to create systemic change. In the following case studies, Brisil replaces traditional silica with green silica, enabling premium footwear brands to economically transition existing product lines to lower-carbon versions. This has a larger and more lasting impact than new green brands that depend on behavior change for adoption. Cancrie's nanocarbons create climate and economic benefits for manufacturers while delivering a better more affordable battery for consumers, driving decarbonisation in price-sensitive markets.

Carbon Negative Silica from Waste

The Innovation: Brisil's patented process produces high-quality precipitated silica using significantly less energy than traditional production. The chemically identical, drop-in replacement serves premium applications including performance footwear, pharmaceuticals, personal care, food, paints, tires, and coatings.

The Business Model: Premium pricing as compared to commodity silica, with lower production costs. Long-term step-up contracts with Fortune 500 customers support factory scale-up. Exports to Southeast Asia, Japan, Europe, US, and Brazil validate market demand.

The Impact:

- 7,500 tonnes annual capacity serving major global brands
- 10,000 kg CO2e and 2,000 kg toxic ash dumping reduced per tonne
- 50-75% lower GHG emissions and 35% less energy vs. conventional
- Target: 30,000+ tonnes silica production by 2025

Why It Works: India generates 2-3 million tonnes of rice husk ash annually, causing severe air pollution, while traditional silica production destroys riverbeds through sand mining. Brisil's drop-in replacement solves both problems at competitive economics. For manufacturers with ESG commitments, lower carbon footprint and elimination of environmental damage make adoption compelling.

Scalability: Global precipitated silica market is $7 billion growing at 5.5% CAGR. India imports significant quantities despite abundant rice husk feedstock. Current penetration is negligible, representing massive growth potential as green tire demand and sustainable manufacturing accelerate.

Turning Waste into Battery Performance

The Innovation: Cancrie's patented technology transforms agricultural waste into advanced nanocarbons that significantly boost battery performance. The drop-in additive delivers 25% longer battery life and 25% higher energy density across multiple chemistries (lead-acid, lithium-ion, sodium-ion and flow batteries).

The Business Model: Direct sales to battery manufacturers as a premium additive that reduces costs, improves performance, increases profitability by reducing warranty returns and reduces consumer lifetime $/kwh. The solution requires zero manufacturing changes, enabling rapid adoption..

The Impact:

- 200,000+ batteries deployed across inverter,erickshaw, automotive, offgrid, and renewable energy
- 0.25kg CO2e reduced per battery that uses Cancrie, 0.5 Gigatonne CO2e abatement over 10 years
- 30-40% cost reduction for end users vs. conventional batteries

Why It Works: Battery manufacturers face a critical gap—commodity carbons provide adequate performance but aren't sustainable, while advanced carbons (graphene, carbon nanotubes) are commercially unviable due to extreme costs. Cancrie delivers high performance at feasible prices.

Scalability: ndia's battery market is projected to grow from $16.77 billion to $27.70 billion by 2028. Current penetration is negligible, representing massive growth potential as India's energy storage requirements reach 82.37 GWh by 2026-27 and government PLI schemes allocate ₹18,000 crores for advanced battery chemistries.

The Breadth of India's Innovation Advantage

Emerging innovations exist across the spectrum, targeting hard-to-abate sectors, core industries (including textiles, pharmaceuticals, and automotive), and high-growth areas like data centers. The potential is exceptional, offering high impact and massive scale deployment opportunities.

These innovations are not theoretical—proof points already exist, demonstrating viability and scalability:

Industrial Energy and Efficiency

- Specialized desiccants to reduce data center cooling by 70% and energy consumption by 50%
- Energy efficient cooling systems deliver 20-30% energy cost reductions for industrial clients
- Electrolysers that can use untreated waste and sewage to produce green hydrogen with lower water consumption and higher energy efficiency

Industrial Process /Heat Innovations

- Heavy Industry AI solutions reducing heat and process waste by 15-25% (direct coal reduction)
- Advanced heat pump technologies achieving temperatures <180°C at costs 40% below electric resistance heating
- New boiler designs achieving 85-90% efficiency vs. 70-75% for conventional systems

Materials Innovations

- Green chemicals achieving cost parity with traditional alternatives while eliminating toxic byproducts
- Bio-based alternatives to petroleum products reducing carbon footprint by 60-80%
- Advanced composites matching strength of conventional materials at 30% lower embodied carbon
- Bio-tech ad-mix to reduce cement, enable self-healing, lower cost and extend concrete life

Water Treatment Innovations:

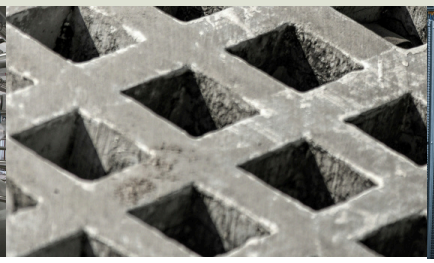
- Water treatment solutions that reduce costs by 30-40% while improving quality
- Zero-liquid discharge systems at 50% of traditional capital costs
- Modular designs enabling rapid deployment and scaling

Business Model Innovations

- PAYS models increasing adoption rates by 300% compared to traditional capex purchases
- Product-as-a-service reducing customer risk perception by 70%
- Lease-to-own structures enabling SMEs to access technologies previously beyond their capital constraints

*Each noted innovation describes an active startup






> These innovations succeed not merely because they reduce emissions, but because they deliver products that meaningfully outcompete high-emission incumbents on performance and/or economics.

Innovation's Strategic Value Beyond Emissions

India's climate innovations deliver benefits that extend far beyond carbon reduction, creating strategic advantages for the nation's economic development:

Manufacturing Security and Supply Chain Resilience - Reduced dependence on imported fossil fuels and materials strengthens India's industrial base:

- Local sourcing of materials reduces geopolitical and supply chain vulnerabilities
- Bio-based materials replacing petro-chemicals reduce exposure to volatile global oil markets
- Energy price volatility poses risk to manufacturing competitiveness
- Domestic renewable energy solutions reduce coal and natural gas imports, enhancing energy independence

Export Competitiveness - As global markets increasingly demand low-carbon products:

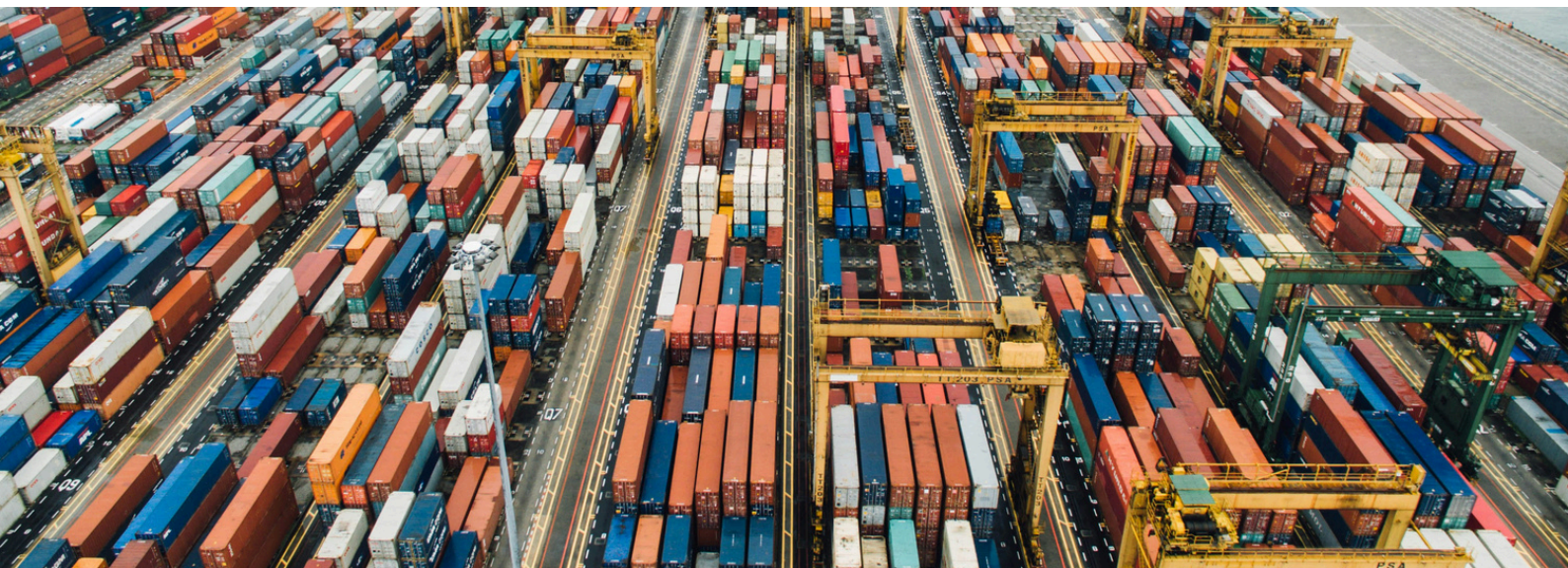
- Indian manufacturers adopting clean technologies gain preferential access to premium markets
- Major buyers (Apple, Unilever, Nike, and others) require suppliers to meet emissions reduction targets in response to consumer demand, economics and share price benefits.
- European Union's Carbon Border Adjustment Mechanism (CBAM) will impose costs on high-carbon imports
- "Made Clean in India" can become a competitive advantage, not just a compliance requirement

Technology Export Opportunity - India's cost-effective climate innovations are designed for emerging market conditions:

- Solutions developed for Indian constraints are ideal for other developing economies
- India can become an exporter of climate technologies to Southeast Asia, Africa, Latin America
- Estimated addressable market of $6.5 trillion in climate tech exports
- Positions India as a climate innovation hub, not just a manufacturing center

Employment and Skills Development - Climate innovation ecosystem creates high-value jobs:

- 35 million premium green jobs projected in next 10 years
- Multiplier effects across manufacturing, installation, maintenance
- Upskilling opportunities in emerging technologies
- Positions India's workforce for global climate economy



The Scale of Transformation Ahead

India is expected to achieve 16x industrial growth, resulting in doubling of energy demand, massive increase in material requirements, and an explosion of new buildings and infrastructure to be built.

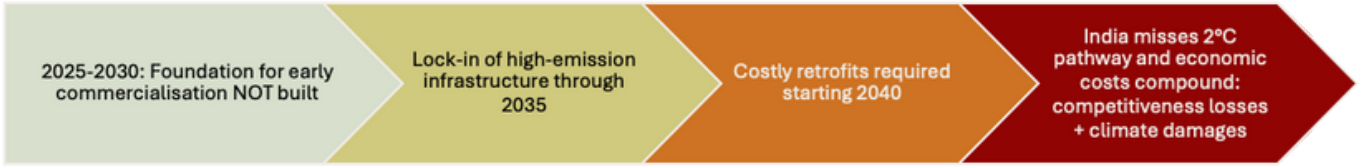
Growth of this magnitude will require significant capital investment in long-term assets. If this investment is into high-polluting legacy technologies, increased pollution will be locked in for 10-70 years, depending on the projected useful life of the asset, potentially increasing India's annual emissions by 30%.

Near-term industrial expansion will be substantial – the capacity built over the next five years is projected to constitute 30-40% of its 2050 target. Demonstration of climate smart industrial development now, will shape 2030-2050 transformation by establishing business confidence and informing policy frameworks.

An example noting the lifespan of typical industrial builds and the impact implications of a singular plant and at scale, demonstrates the multiplying benefits across duration of impact and speed of market diffusion.

Compounding Benefits of Accelerated Adoption

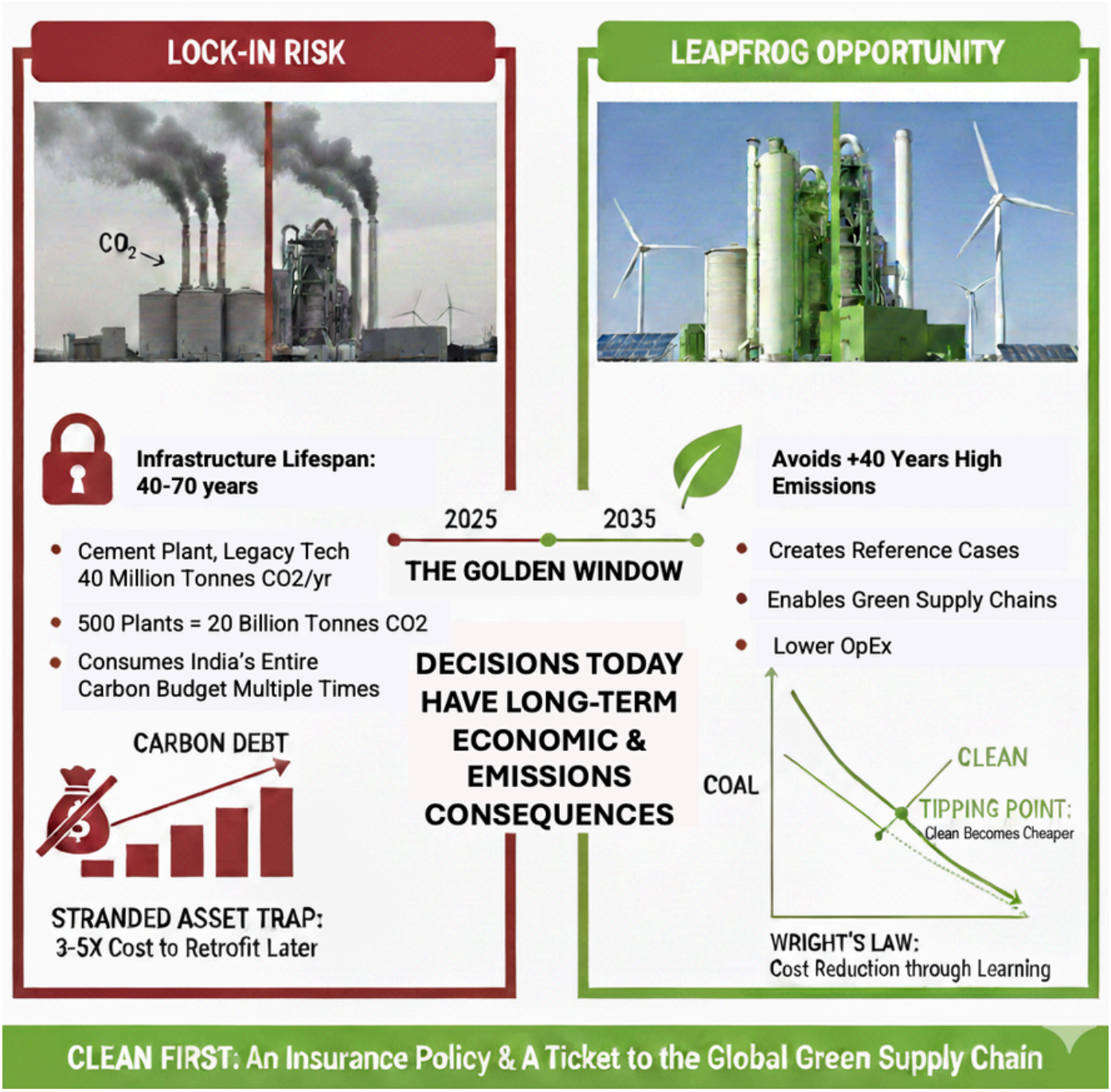
Business as Usual Trajectory



> The Math Is Unforgiving: India adds industrial capacity equivalent to Germany + Japan + South Korea over next 25 years. Whether this capacity is high-emission or low-emission determines not just India's emissions, but whether the world stays within 2°C.

Understanding the Lock-In Risk: a Concrete Example

Every industrial investment made today shapes India's emissions trajectory for decades to come. The concept of "lock-in" deserves emphasis because of its long-term implications:



The Window Is Closing: India is projected to add industrial capacity equivalent to current developed economy totals over the next 20 years. Decisions made in the 2025-2035 window will determine emissions trajectory through 2070 and beyond.

> The choice isn't whether India industrializes—that's inevitable and necessary for development.
>
> The choice is whether India industrializes with 1950s technology or **future-ready innovations.**

The Solutions (Innovations in Practice)

The Partnership Imperative

While India possesses world-class innovation capabilities, translating breakthrough technologies into industrial adoption requires bridging two distinct ecosystems—innovators and industry—each operating with different timelines, risk tolerances, and capabilities.

The Innovation-Industry Gap

Industry is not structured to innovate for itself. Businesses with R&D arms face long development timelines due to internal processes and established protocols. Startups, conversely, possess the agility to quickly develop solutions that would take industry significantly longer to produce.

The value proposition for partnership is compelling. Indian industrial decision-making is already influenced by climate risks and opportunities, and businesses will transition when presented with strong economic value propositions. However, translating this willingness into action requires overcoming structural barriers.

Overcoming Integration Barriers

Market gaps and nascency slow the integration of clean technologies. A critical disconnect often exists between what industrial customers expect as commercial readiness and what early-stage startups can achieve without industry partnerships. Industry operates with long-term assets, established quality standards, and equipment integrated into larger systems—creating high barriers to entry for new solutions.

Absent strategic partnerships, several factors limit adoption at scale. Industrial customers require demonstrated reliability, compatibility with existing infrastructure, and proven performance before committing to new technologies.

How Partnership Facilitation Works

Partnership facilitation bridges these gaps by ensuring business alignment, establishing foundations for robust operations, reducing integration friction, and navigating complex commercialization cycles. This includes creating agreement on timelines, certifications, quality standards, and contracting terms that work for both emerging innovators and established industrial players.

Widespread adoption becomes possible when solutions are cost-competitive, improve profitability, integrate easily with existing infrastructure, increase supply chain stability, maintain or enhance output quality, expand market access, and improve resource efficiency. Strategic partnerships accelerate the path to meeting these adoption criteria.

What Integration Looks Like in Practice

These examples illustrate why innovation needs active facilitation—the gaps aren't insurmountable, but require coordinated support that neither startups nor customers can provide alone.

Example 1: Equipment Certification Challenge - An innovative heat pump startup developed a system capable of delivering 150°C process heat at 40% lower cost than conventional boilers. However:

- Industrial customers required ASME certification for pressure vessels
- Testing and certification process: 18-24 months, ₹80 lakhs cost
- Startup lacked capital and couldn't wait 2 years for first sale

Solution: Partnership facilitator connected startup with anchor customer willing to co-invest in certification in exchange for deployment commitment

Example 2: Quality Consistency Concerns - A bio-materials company created a sustainable alternative to petroleum-based adhesive. Automotive manufacturer interested but:

- Required proof of batch-to-batch consistency across 100,000+ units
- Startup's pilot plant could only demonstrate consistency over 1,000 units
- Customer wouldn't commit without larger-scale proof; startup couldn't build larger plant without customer commitment

Solution: Blended finance enabled intermediate-scale demonstration plant, producing 50,000 units for customer validation before full commercial deployment

Example 3: Integration Timeline Mismatch - Textile manufacturer wanted to adopt new dyeing technology to reduce water use and emissions:

- Manufacturer operates 24/7 with thin margins; couldn't afford downtime for installation
- New equipment required 6-week installation and commissioning
- Existing contracts didn't permit production delays

Solution: Phased implementation plan developed with technical partner, installing during scheduled maintenance windows over 6-month period; temporary backup arrangements for critical deadlines

Example 4: Technical Support Requirements - Food processing company adopted novel energy-efficient refrigeration:

- Technology worked perfectly in testing but required optimization for specific product characteristics
- Startup had limited technical staff; couldn't provide on-site support across multiple shifts
- Customer needed 24/7 technical availability during commissioning

Solution: Partnership program funded temporary technical staff augmentation; knowledge transfer protocols ensured customer team could operate independently after 90-day transition

Why Business Model Innovation Is Critical

Beyond industry partnerships, business model innovation is often necessary for product viability. Despite compelling value propositions, customers will default to high-emissions incumbents if cleaner alternatives are not affordable or easily financeable.

Many emerging market businesses have limited access to debt, and industrial customer cash flows are insufficient to fund both capital purchases and operational stability. A review of small and midcap companies during Covid lockdowns revealed an average of only two months of cash on hand—highlighting the acute financial constraints facing potential adopters.

Business model innovations—such as ESCO, Pay-as-you-Save, product-as-a-service, and lease-to-own models—are necessary to enable transition. Many business owners prefer opex models to manage risks associated with equipment integration, potential impacts on product quality, and long-term equipment serviceability.

These models reduce perceived adoption risk and accelerate uptake among business owners who might otherwise defer upgrading to cleaner technologies, effectively removing purchase friction as a barrier to decarbonisation.

Efficiency without Capex

The Innovation: Smart Joules offers financed energy efficiency and cooling as a service (EaaS and CaaS) solutions such as JoulePAYS, JouleCOOL and DeJoule building management system. The company combines AI-driven analytics, and energy-efficient equipment to optimize energy consumption across C&I facilities.

The Business Model: Pay As You Save (PAYS) eliminates upfront capital requirements. Smart Joules finances and installs efficiency upgrades, then charges customers a percentage of the energy savings generated—typically 60-70% of savings. Cooling as a Service (CaaS) is a B-O-O-T model for centralized cooling along with long-term quality and energy performance assurances. Smart Joules designs, executes, finances and operates centralized cooling systems, then charges customers a fixed monthly capacity charge and variable monthly charges basis cooling consumed, much like electricity bills.

The Impact:

- Deployed across 52 commercial and manufacturing facilities
- Average energy reduction of 24%
- Total annual energy savings of 32.6 Crore kWh
- CO_2 emissions avoided: 240,000 tonnes
- Customer savings: ₹270 crores

Why It Works: By removing upfront CapEx costs and ensuring savings from day one, Smart Joules has removed friction to adoption for energy efficiency upgrades. The PAYS model also aligns incentives—Smart Joules succeeds only when customers save money.

Scalability: The model is replicable across India's commercial and industrial sectors, with planned expansion into manufacturing and district cooling. Current deployment represents less than 1% of addressable market.

INDRA Infrastructure without Investment

The Innovation: Indra Water's modular water treatment systems use advanced micro-electrolysis, filtration and AI-optimized processes to deliver industrial-grade water treatment at significantly lower capital and operating costs.

The Business Model: Water Treatment-as-a-Service (WTaaS) shifts the entire burden from customer to solution provider. Indra Water and its financial partners own, operate, and maintain the treatment infrastructure subject to financial due diligence. Customers pay only for treated water delivered, with pricing 20-30% below conventional approaches when total cost of ownership is considered.

The Impact:

- Facilities served across textile, pharmaceutical, and food processing industries
- 4 million liters of water treated daily
- Water quality consistently exceeding regulatory requirements
- 30-40% cost reduction vs. traditional treatment
- Zero capital investment required from customers

Why It Works: For many Indian manufacturers, water treatment is a necessary but non-core function. They lack expertise to operate treatment plants optimally and face unpredictable maintenance costs. Indra Water's service model transfers all these risks while delivering superior outcomes.

Scalability: India's industrial water treatment market is estimated at over USD 3 Billion . Current penetration is very low, representing massive growth potential as water scarcity intensifies.

Financial Innovation to Bridge the Capital Challenge

Even when technical innovations prove viable and business models demonstrate market fit, a critical barrier remains: access to appropriate capital. The unique characteristics of industrial climate innovations—asset-intensive, long development cycles, and novel risk profiles—require financial innovation to match the technical and business model innovation already underway.

The Capacity Paradox

Startups producing low-carbon materials for industry need guaranteed minimum manufacturing capacity to sign commercial contracts—yet the capital available for climate technologies is not prepared to provide first-of-a-kind (FoaK) funding. This creates a paradox: businesses must demonstrate capacity to secure contracts, but need contracts to justify capacity investment.

The Industrial Innovation Funding Gap

While investment into Indian climate tech has increased, it remains predominantly available at the very early stage (up to $2mn) and from $12mn onwards. Funds flow almost exclusively to asset-light business models like carbon tracking platforms or to heavily subsidized sectors like solar and EVs, leaving early-growth industrial innovations in a capital desert.

This funding gap persists because traditional finance models are fundamentally misaligned with industrial climate innovation. Venture capital, while future-looking, avoids asset-heavy models perceived to limit growth and upside potential. Private equity prefers later-stage companies with minimal growth funding requirements. Debt financing, designed as a low-risk instrument, applies even more stringent risk definitions in emerging markets—effectively ruling out novel technologies and unproven business models.

Adapting Financial Instruments

Financial innovation is necessary to price risk appropriately and underwrite first factories and emerging business models. Climate finance operates with a limited pool of instruments compared to the wider economy. Adapting and contextualizing common financial instruments—including equity financing for new industry, asset securitization, structured products, and tri-partite credit agreements—can ensure competitiveness with high-emission incumbents.

Hybrid and Structured Models

Risk capital that provides fit-for-purpose funding to eliminate excess perceived risk and optimize risk-reward outcomes is necessary to bridge the gap. Hybrid and structured models that combine early-stage VC growth mindset with a PE business modeling can address the specific capital needs of early-growth industrial innovations.

Asset-driven businesses have different growth and risk profiles from software-based startups. These businesses experience stepped growth—cycles of rapid increases followed by normalization, then further expansion as capacity scales. With each expansion cycle, risk of failure decreases significantly, creating a fundamentally different risk profile than binary software outcomes.

Multiple Instruments Options

- Blended-equity financing
- Performance risk guarantees, insurance
- Debt, including:
  - Tri-partite and other risk-sharing mechanisms
  - Guarantees
  - Interest rate subsidy
  - Structuring
  - Securitization
  - New underwriting models
- OTC Marketplaces (RBCF)
- Returnable Grants

The most meaningful de-risking will not be created by reiterating existing approaches. Risk and perceived risk vary at different parts of the spectrum, requiring varied capital quantum and deployment strategies. The most effective implementers will identify unique approaches responsive to specific challenges, demonstrating out-of-the-box thinking and technical capabilities to align capital with results across different scenarios.

The Path Forward

Achieving low-carbon economic development requires 5 strategic interventions that address the full spectrum of innovation barriers—from policy prioritization to capital deployment to market integration.

1. Prioritize Clean Industrial Innovations

Clean industrial innovations must become the cornerstone of India's decarbonization strategy. This requires recognizing that industry—not just energy or transport—drives India's emissions profile and calls for integrating industrial emissions reduction directly into economic development planning, creating industrial innovation targets alongside renewable energy goals, and elevating manufacturing and industrial innovation to national priority status.

2. Fund Accelerated Commercialization

The critical funding gap lies not in developing more prototypes, but in bridging proven innovations to market adoptio, requiring dedicated funding mechanisms specifically for the $2-12M range where startups have validated technologies but lack capital to scale. Priority must shift toward supporting first-of-a-kind plant deployments and business model validation rather than pilots.

Funders will need to adopt a modified risk-reward profile that accepts asset-heavy models and stepped growth patterns, provides patient capital with 7-10 year horizons, and leans into business fundamentals to reduce failure rates as compared to mainstream venture capital.

3. Innovate How Capital is Deployed

Financial innovation must adapt existing instruments to industrial innovation. This includes developing blended finance structures for industrial climate tech, structuring hybrid equity-debt models suited to asset-heavy innovations, creating guarantees and risk-sharing mechanisms for first-of-a-kind deployments, and deploying philanthropic capital strategically to de-risk commercial investment.

Implementation requires developing legal and regulatory frameworks, creating risk assessment methodologies tailored to industrial climate tech, standardizing documentation to reduce transaction costs, and building capacity among financial institutions to evaluate and fund these innovations.

4. Provide Specialized Support

Startups require intensive, specialized support to navigate the complex journey from innovation to market success. This encompasses three critical areas:

- business model and market entry faciliation including customer discovery, commercialization program development, contracting negotiation, and supply chain development),
- commercialization support addressing integration timelines, manufacturing scale-up, operations optimization, and working capital management),
- quality standards and certifications covering documentation development, quality management systems, and testing validation).

The implementation model involves intensive 12-36 month engagements combining direct support with expert network access, with continued funding contingent on achieving key milestones.

5. Foster Strategic Partnerships with Industry

Industry partnerships are essential to enable businesses to access innovations they cannot develop internally within required timelines while providing startups the customer engagement critical for commercial success. Three partnership models offer particular promise:

- **Anchor Customer Programs** featuring co-development and integration with clear milestones and shared risk-benefit structures
- **Industry Consortia Partnerships** enabling shared testing, validation, and collective procurement
- **Industrial Cluster Models** providing shared infrastructure to reduce individual company risk

Accelerating adoption requires incentivizing industry participation through recognition and awards for innovation leadership, as well as exploring preferential regulatory treatment and tax incentives for early adopters in collaboration with policy stakeholders.

Philanthropy as a Strategic Catalyst

Philanthropic climate capital as it exists in India is primarily focused on project-based funding and only early-stage R&D within climate technology and innovation. Industry, equally, is not positioned to fund the development and early deployment of innovation. This creates a significant innovation scaling capital gap.

Philanthropic capital can play an important role by:

- Funding innovation de-risking specific to market adoption including early commercialization navigation, business model design, operations optimization and quality verification (this is distinct from incubation or acceleration work or support of pilots)
- Seeding the design and implementation of blended finance instruments specifically for industrial climate tech
- Providing risk capital tranches in innovative instruments to catalyse investment in early commercialization and FoaK models, and crowd in commercial and public capital
- Supporting policy initiatives that:
    - Shift policy focus and resources toward industrial decarbonization
    - Introduce tax incentives for innovation demonstration and climate + industry innovation partnerships
    - Enable preferential regulatory treatment for early industrial adopters
    - Create industrial innovation targets alongside renewable energy targets

As pointed out by Climate Policy Initiative, "Suitable financial instruments are critical tools to enable finance flows to emission intensive industries...This includes blended finance instruments such as concessional loans, junior equity, and guarantees and novel instruments and mechanisms such as contracts for difference."

The Global Stakes and India's Beacon Role

India's Impact on Global Carbon Budget

> With India's current decarbonization plan, it will unilaterally consume 87% of the remaining 1.7°C carbon budget. In perspective, the world cannot meet the 2°C goal without India's accelerated transition, regardless of how aggressively developed nations decarbonize.

India possesses the capability to become the global beacon of clean economic development. To achieve its twin goals of economic transformation and climate leadership, it must forge its own path—one where innovation converts industrial growth from a climate challenge into a climate solution.

The combination of market dynamics, government policy, and climate innovation in India mean there is an ability to further decouple India's growth and emissions cost-effectively. India has identified climate technologies as a key driver of its growth, and Indian innovators and entrepreneurs are developing technologies that have the ability to outcompete high-emissions legacy technologies based on performance and economic factors.

Decarbonizing economic growth is a time-bound challenge that needs to be addressed in the emerging markets that are increasingly supplying goods to the global economy. As India embarks on rapid industrial expansion, early transition provides immediate and compounding long-term emissions reductions.

A failure to fully decarbonize by 2070 is projected to result in an additional $35 trillion loss to the Indian economy. Alternatively, decarbonization would function as an economic driver and growth engine projected to deliver $11T in additional economic growth—a net benefit of $46T to the Indian economy.

Building and strengthening industrial resilience through decarbonised growth will also function as an important adaptation tool for the economy and jobs of the future.

The tools exist. The opportunity is now. What remains is the commitment to prioritize, fund, and accelerate the innovations that will define India's—and the world's—economic and environmental future.

An accelerated, India-specific transition plan addressing industrial emissions and innovation is crucial for the world to meet the 2°C goal.

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