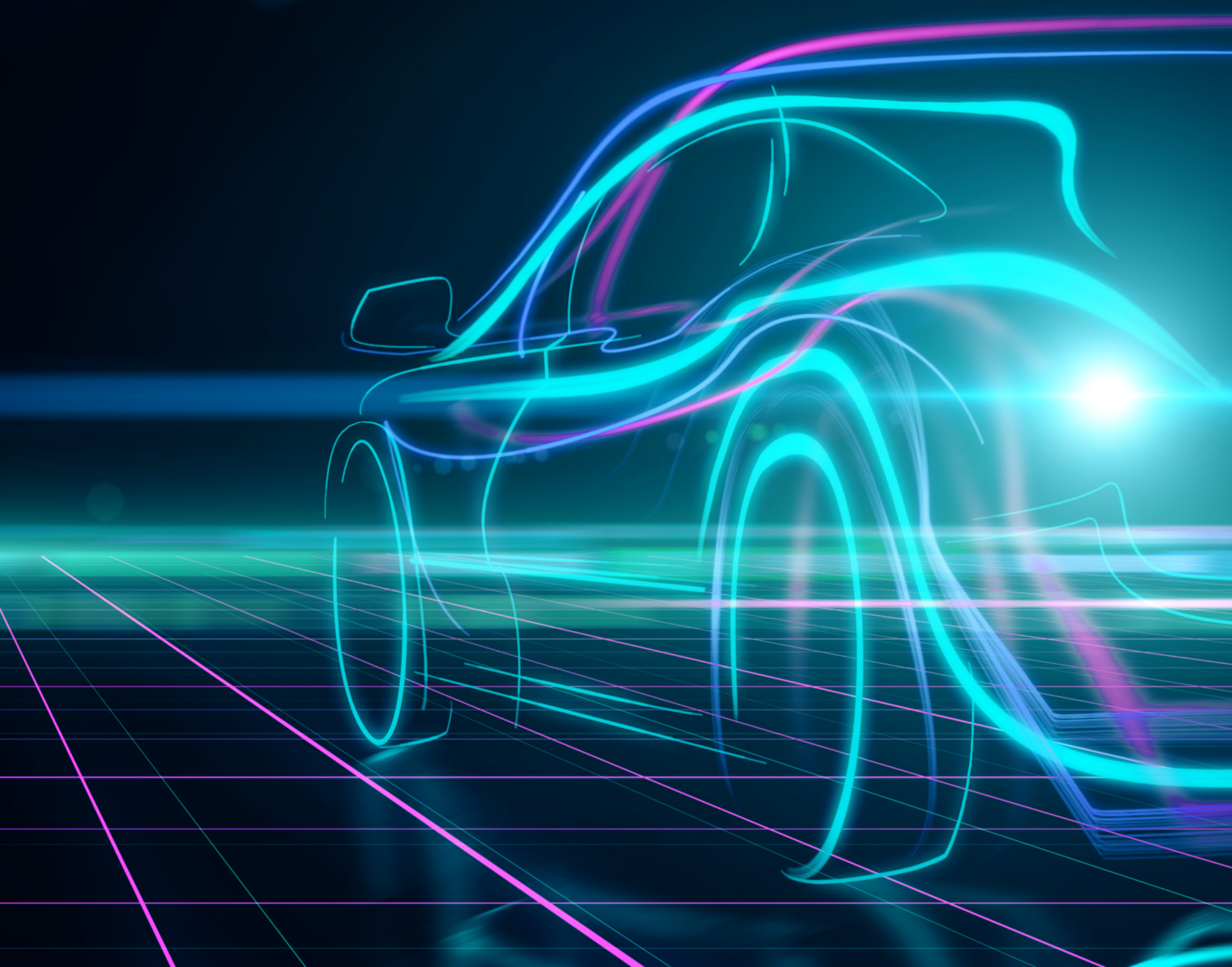
Indian Climate Leadership

Innovation, Technology & Net Zero



1. Balancing economic growth and emissions reductions

India has an ambitious net zero agenda, with a set of 'enhanced targets' to reach net zero by 2070[1]. Evidence suggests that India exhibits a good track record of low emissions per capita, compared to other major global economies[2]. India has implemented a range of policy measures to lower GHG emissions – ranging from the incentives for GHG reductions, domestic production of solar energy, to enhancing the production of green hydrogen. Further, as part of its net zero targets, India has an ambition of achieving 50 percent of its energy production through renewable sources by 2030 through the installation of 500 GW renewable energy (RE) capacity – as of February 2023, India has achieved a third of this target by developing total RE capacity of 168.96 GW[3].

However, with India being poised to be one of the fastest growing economies of the world, and with population levels forecasted to reach 1.66 billion by 2050[4] – energy needs are expected to rise, to ensure commensurate economic growth, poverty reduction, and energy security and access for all[5]. Notably, over three-fourths of the India of 2050 (and 80-plus percent of the India of 2070) is yet to be built. Developing this robust infrastructure in India will multiply energy demand across sectors: power (eightfold), steel (eightfold), cement (threefold), auto (threefold), and food (twofold)[6]. In this context, it is important to ask: *Can India balance its economic ambitions with its commitments to reducing GHG emissions? What forms of policy adjustments does India need to fulfil the dual goals of economic growth and climate action? How can India drive mass market green solutions rather than more resource-intensive and high-end innovations?*

2. Getting to Net Zero

As in most countries, cutting GHG emissions and getting to net zero in India requires adjustments across the policy, business, and research sectors, and changes in the ways people live, work and travel. At the outset, decarbonization requires Research and Development (R&D) in new technologies and infrastructure to reduce carbon emissions. However, India's R&D expenditure is low and there continue to be gaps in R&D budgets for researching improved, energy-efficient solutions[7]. Notably, India spends 0.7 percent of its GDP on R&D, and the private sector's contributions to such spends are low, when compared to global averages[8]. Further, strategic partnerships between industry and academia are still nascent. Here, India's Anusandhan National Research Foundation Bill 2023 is significant. This Bill proposes to establish the Anusandhan National Research Foundation (NRF) – an apex body for research and innovation in India, including in the field of environmental and earth sciences, health, agriculture, engineering, and technology[9]. While the NRF opens possibilities for corporates and the private sector to invest in R&D efforts, it is vital to ensure that the avenues of publicly funded science remain open - through funding and technical partnerships.

In this context, it is important to develop solutions and spaces to enhance R&D spending and encourage deeper innovation – this can be done by enabling experimentation and stronger collaborations based on mutual trust between multiple stakeholders such as governments, civil society, technology, academic, and finance actors. For instance, there is a need to create an enabling environment for research ideas to be rapidly developed, tested, and scaled up – through incubation labs (as seen in the Atal Innovation Mission[10] and in IIT Madras, under the leadership of Professor Ashok Jhunjhunwala[11]) that connect research houses and business enterprises. This will help foster greater partnerships between Indian corporates and Indian research houses (including academia, specialized research agencies, and think tanks), while fulfilling existing gaps in research funding and technical capacities. There is also a need to direct venture capital and private equity money – in addition to seed and angel investing – towards enterprises/innovations that reduce carbon emissions and which drive India's decarbonization agenda. Sustainability-Linked Bonds (SLBs) can vitally transform the landscape of India's climate finance landscape by incentivizing the achievement of various sustainability-related indicators, while ensuring that investors and corporates are able to flexibly use the proceeds from the issuance of such bonds[12]. Here, it is vital to discuss: *Why have R&D spends historically*

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[1] London School of Economics. 2022. *Link*.
[2] Intergovernmental Panel on Climate Change. United Nations. 2022. *Link*.
[3] Press Information Bureau. Government of India. 2023. *Link*.
[4] Department of Economic and Social Affairs, United Nations. 2022. *Link*.
[5] International Monetary Fund. 2023. *Link*.
[6] McKinsey and Company. 2022. *Link*.
[7] Ministry of Environment, Forest and Climate Change. Government of India. 2022. *Link*.
[8] World Bank. 2018. *Link*.
[9] PRS India. 2023. *Link*.
[10] Atal Innovation Mission. Government of India. 2023. *Link*.
[11] IIT Madras. 2023. *Link*.
[12] Norton Rose Fulright. 2020. *Link*.

been low in India? How can research-linked Incentives be introduced to encourage greater R&D investment in GHG emissions reductions by corporate India? Can research-linked incentives be adequately directed towards domestic R&D - to avoid it all going abroad? How can strategic private-public partnerships raise funds for R&D and ensure their effective use?

3. Sectors needing Ideation

In building strategies to help India reach net zero, it is important to consider certain key sectors in which innovation can be unleashed to reduce GHG emissions:

- **Transport** in India is the fastest growing source of carbon emissions, mainly from the combustion of oil. In fact, India's transport sector is responsible for 13.5 percent of its overall carbon emissions, with road transport accounting for about 90 percent of the overall energy consumption within this sector[13]. Electrifying forms of transport is key for decarbonising: road transport in India has begun to electrify at a remarkably fast pace, particularly buses and two-wheelers. Notably, over half of India's three-wheeler registrations in 2022 were electric, and India's share of electric cars more than tripled in the last year[14]. In addition to electrification, it is also worth exploring some demand-side measures, such as a modal shift away from personal vehicles towards public transport (for example, railways)[15]. Safe, reliable, and intermodal public transport systems hold the potential to significantly lower the carbon emissions associated with the transport of freight and passengers, while relieving the pressures on road networks. . Here, it is important to discuss: *how can India change its transport mix from the present reliance of 70 percent on road transport, to more dependence on rail and surface transport? How can supply side and demand side interventions help in reducing emissions from India's transport sector?*
- **Cement** production in India is a key emitter of GHGs, and a sector that is expected to grow in the years to come: India is presently the second-largest cement market in the world with its market size expected to double between 2020-2030[16]. Further, the bulk of carbon emissions associated with cement production come from clinker calcination. Reducing clinker content in cement has safety implications, given that the clinker content contributes to the cement's binding and compressive strength. India's decarbonisation of its cement industry has clear implications on its overall climate action commitments. The challenge is to identify and invest in transformational innovations (which promise significantly less emissions, and significantly higher energy levels). Various strategies have been proposed to drive such an agenda – including R&D for seamless transition to non-coal technologies (using cleaner fuels like hydrogen)[17], establishing the definition and standards for green and low-carbon cement[18], and using biomass (presently used for household fuel needs), and employing recycled concrete in cement production[19]. It is worth exploring: *can India's cement industry be decarbonised through sustainable and transformational innovations or is there a risk of a Tesla-style disruption (marked by radical mass production at low cost, which exacerbates internal competition among producers and resultant downward price spirals? What incentives can help enhance the production of green cement? To what extent can new technologies ensure the decarbonisation of India's cement industry, while not risking the quality or safety levels associated with the product?*
- **Steel** production in India is highly emissions-intensive and contributes to a third of India's direct CO_2 emissions from industrial sources. Steel production across both larger and smaller facilities in India is highly coal-intensive, making steel decarbonisation a vital pathway for achieving India's net zero targets[20]. It is crucial to explore whether cleaner fuels – for instance, green hydrogen can be used to support decarbonised 'green steelmaking'. Driving material circularity by reusing and recycling raw materials can also save 50-95 percent emissions in material production across steel[21]. Material and operational efficiencies are likely to play a key role in decarbonising this industry: notably, pulverised coal injections can help reduce import burdens, and waste heat recovery systems (WHRS) have the potential to increase energy efficiency in steel production. It is worth asking: *how can more clean energy forms (including green hydrogen) be integrated into steel production in India? How can decarbonisation be practised while aggressively pursuing energy-efficient steel manufacturing processes*? *How can India's*

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[13] Climate Action Tracker. 2020. *Link*.
[14] International Energy Agency. 2023. *Link*.
[15] Climate Action Tracker. 2020. *Link*.
[16] World Economic Forum. 2022. *Link*.
[17] Ministry of Environment, Forest, and Climate Change. Government of India. 2022. *Link*.
[18] Rocky Mountain Institute. 2023. *Link*.
[19] McKinsey and Company. 2022. *Link*.
[20] Atlantic Council. 2022. *Link*.
[21] McKinsey and Company. 2022. *Link*.

steel production sector be restructured to ensure the best use of clean fuels and raw materials, while fulfilling domestic demand?

- **Aluminium** production in India continues to be highly carbon intensive - in fact, evidence suggests that the average intensity of GHG emissions from India's aluminium production is 48 percent higher than the global average[22]. These high emissions are generally associated with the use of coal for generating and capturing power during aluminium production processes. Decarbonising India's aluminium industry can involve a number of strategies, including switching to renewable energy sources for power production to produce green aluminium (as has been the trend in most Western economies), carbon capture and storage, inert anode and fuel switching[23] It is also important to note that carbon emissions from aluminium produced from scrap aluminium (secondary production) is significantly lower than the primary route. In India, only 38 percent of overall aluminium production comes from secondary production, and the bulk of scrap aluminium is imported – this highlights the need to invest in scrap collection infrastructure as part of the wider decarbonisation agenda. *Does India have the necessary capacity and resources to sustainably join the global race to produce green aluminium? To what extent can India phase out primary production and prioritise secondary production of aluminium? What policy and infrastructural adjustments are needed to facilitate the decarbonisation of India's aluminium industry?*

- **Agriculture** is one of the largest emitters of GHGs in India. Indian farming practices are associated with the over-application of nitrogen-based fertilisers[24]. Evidence suggests that decarbonisation in the agriculture sector can help to reduce sectoral emissions by half in 2050, while optimising fertiliser costs for farmers and reducing the government's significantly large annual subsidy budget (which currently stands at INR 1,75,099 crore[25] for FY 2023-24)[26]. It would be important to consider the ways through which technology – including Artificial Intelligence (AI), Geographic Information Systems (GIS), and remote sensing techniques – can be used to empower farmers on-ground with relevant and scientifically robust information on sustainable farming, optimal use of fertilisers, and predicted extreme weather events. Customising such information by crop and ecological zone would further help to protect yields while reducing the costs to farmers. Further, reducing paddy farming emissions by practicing rice-straw upcycling, dry seeding, and rice intensification (SRI) India's rice cultivated area and reducing livestock emissions by adopting efficient feeding and manure management practices would be critical for decarbonising agriculture. Against this backdrop: *Can India have a digital revolution in agriculture (for instance, though the Digital Soil Health Cards) like in finance? In what ways can emissions from crop fields and livestock be reduced, while ensuring the growth of India's agricultural sector? What synergies can be achieved with other sectors to decarbonise India's agricultural sector?*

4. Factors to consider

While thinking about the strategic actions to be taken to decarbonise various critical sectors in India's economy, it is also important to consider certain factors associated with the efficiency, sustainability, and equity implications of such actions. For one, there are '*greening costs'* associated with decarbonising or 'greening' various sectors, including costs associated with the purchase of low-carbon assets and infrastructure, R&D before venturing into newer energy forms/fuels, infrastructural development to facilitate circularity and waste recycling, and other logistical and technological expenses – to name a few[27]. In such a context, it is useful to build hypothetical cost scenarios, to estimate the costs associated with every decarbonisation move. It is also worth forecasting the levels of market demand associated with various goods from carbon intensive industries, and to invest in 'greening' such industries accordingly. For instance, it may not be worth investing in greening a steel plant with a life cycle of 60 years, if it is forecasted that the demand for steel products will fall significantly or if a steel substitute will be demanded in the next 20 years. In this context, it is important to discuss: *To what extent do the benefits of greening India's industries outweigh the greening costs? Are there certain sectors wherein greening efforts may not be lucrative in the long run? How can policy and financial support help mitigate some of the costs associated with the decarbonisation agenda in India? How can Production Linked Incentives be directed to prefer greener industry, rather than any industry?*

It Is also important to factor in the impacts of India's decarbonising agenda on Micro, Small and Medium Enterprises (MSMEs). While being responsible for 30 percent of India's Gross Domestic Product (GDP) MSMEs continue to rely primarily on the grid's electricity for meeting their energy needs – however, such

[22] CRU Group. 2020. *Link*.
[23] Investment Information and Credit Rating Agency of India Limited. 2023. *Link*.
[24] McKinsey and Company. 2022. *Link*.
[25] Down to Earth. 2023. *Link*.
[26] McKinsey and Company. 2022. *Link*.
[27] World Economic Forum. 2022. *Link*.

electricity is highly carbon intensive with a carbon concentration of 74.7 percent[28]. Presently, MSMEs in India generate 110 million tonnes of carbon dioxide annually and are therefore critical drivers of India's decarbonisation agenda[29]. At the same time, it is important to note that MSMEs face a range of challenges that impede them from achieving net zero emissions, at least in the short term – these include small scale production capacity, lack of access to technology and infrastructural adjustments, low levels of capital and lack of access to credit, and threats from global competition. However, while MSMEs may presently lack the financial or technical resources to rapidly achieve net zero, there are a minimum set of solutions that they can drive, such as by tracking and reporting on their emissions, switching to cleaner forms of energy where possible, recycling materials, promoting sustainable packaging, and adopting energy-efficient transportation processes[30]. Going forward, it would be worth asking: *How can MSMEs be better empowered through policy support to decarbonise at scale – given their numbers and their spread across the country? What forms of financial and technological solutions would help MSMEs achieve net zero, while not compromising upon their profitability and overall growth prospects? Is there a role for 'local support groups' that can be activated to support the decarbonisation agenda of MSMEs (such as city-level chambers of commerce)?*

Further, in the context of cleaner fuels, it is important to consider the extent to which green hydrogen can be a viable energy source for India's growth prospects. Presently, green hydrogen is considered to be a vital pathway for facilitating India's net zero ambitions – with potential uses in industry, transportation, and power generation. India's National Green Hydrogen Mission seeks to make India a leading producer and supplier of green hydrogen in the world by developing green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country[31]. However, there are certain challenges associated with producing green hydrogen: for one, green hydrogen is more expensive to produce than regular hydrogen produced from fossil fuels – costing about $2 more per kilogram. Further, there re challenges with storing and transporting green hydrogen in an economical manner. In addition, there are risks that green hydrogen production and adoption may slow down the growth of other renewable energy sources (such as solar, wind energy). Against this backdrop, it is vital to discuss: *How does India ensure that green hydrogen does not slowdown renewable energy expansion? How does India ensure that hydrogen is deployed where hydrogen is needed, and renewable energy electricity is used wherever it can be used? How can India drive down the price per kilo of green hydrogen? What does India need to do to become a significant green hydrogen exporter to geographies that do not have the manufacturing infrastructure?*

Finally, it is important to document and leverage best practices in decarbonisation from the Indian context, particularly those which have reduced GHG emissions at scale. Notably, LED (Light Emitting Diode) bulbs have proven to be highly effective in reducing the emissions intensity associated with energy use, for domestic and street lighting in India[32]. The Government of India's UJALA Scheme has successfully provided energy-efficient LED bulbs to domestic consumers at affordable prices, by aggregating the demand for LED bulbs, providing incentives to manufacturers through regular bulk procurement by the public sector, enhancing consumer awareness, and distributing LED bulbs. This in turn has contributed to the reduction of 38.7 million tonnes of carbon dioxide emissions annually[33]. The LED case study also provides an example of India's experience of *leapfrogging conventional emission reduction pathways* – by reducing the costs of LED bulbs, India was able to empower millions of households to transition from zero electricity to energy-efficient LED lighting. Similarly, the case study of ITC – a leading private company driving a decarbonisation agenda – is interesting. ITC uses a range of strategies to mitigate climate change risks, and to reduce carbon emissions – including the use of wind, solar and biomass energy. Within ITC, each company business is mandated to increase its renewable energy consumption and has specific GHG reduction targets. Through such strategic actions, ITC has been able to meet 80 percent of its energy needs from renewable sources, while reducing overall emission levels[34]. Here, it would be useful to ask: *how can such best practices in energy efficiency and renewable energy use be scaled up more widely? How can policy and/or financial incentives support similar innovations at scale? What role does the private sector play in India's decarbonisation agenda? Is there a business case for 'responsible business'? Will 'green bonuses' incentivise the private sector to follow responsible business practices and to better integrate decarbonisation into corporate frameworks and targets? What is the role of private-public partnerships in promoting decarbonisation in India?*

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[28] Intellecap. Aavishkaar Group. 2023. *Link*.
[29] Centre for Science, Technology and Policy. 2018. *Link*.
[30] SME Climate Hub. 2023. *Link*.
[31] National Portal of India. 2023. *Link*.
[32] United Nations Environment Programme. 2023. *Link*.
[33] Press Information Bureau. Government of India. 2022. *Link*.
[34] ITC Limited. 2023. *Link*.

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