Impact of ClimateTech Startups on Sustainable Development Goals in India

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Abstract*—ClimateTech startups in India are emerging as pivotal players in advancing the United Nations Sustainable Development Goals (SDGs) through innovative solutions in clean energy, sustainable mobility, climate-smart agriculture, water, and waste management. This paper provides an academic analysis of the impact of Indian climate technology startups on SDGs, supported by literature and data. We outline the rapid growth of India's ClimateTech ecosystem in recent years, with over 2,600 startups identified (around 800 active) working to integrate economic growth with environmental sustainability [3]. These ventures contribute directly to SDG targets such as affordable clean energy, sustainable cities, responsible consumption, and climate action by deploying renewable energy systems, electric mobility, precision agriculture, water purification, and recycling innovations. We discuss sector-wise contributions, highlight real- world examples and data on emissions reduced, energy saved, and communities benefited. Despite significant progress, ClimateTech startups face numerous challenges in scaling their impact – from funding gaps and high capital intensity to policy and market barriers. Only a small fraction (˜2.5%) of Indian climate startups reach growth-stage financing [4], reflecting the need for patient capital and supportive regulations. We examine how government policies and ecosystem enablers are addressing these issues through initiatives like the International Solar Alliance, National Green Hydrogen Mission, and specialized climate fi- nance instruments. Investment trends indicate growing interest (e.g. US$5 billion invested in 2022, up 29% since 2019 [12]) but also recent volatility. The paper concludes that ClimateTech startups are instrumental for India's progress toward the SDGs and a low-carbon future, provided that strategic policy support, innovation-friendly funding, and multi-stakeholder partnerships continue to strengthen this nascent ecosystem. A future outlook is offered on scaling climate innovations to achieve India's 2030 SDG targets and 2070 net-zero commitment.

I. Introduction

Climate change poses a formidable threat to India's sustainable development, with the country ranked as the world's seventh most climate-vulnerable major economy [2]. At the same time, India has embraced the United Nations' Sustainable Development Goals (SDGs) for 2030 and pledged ambitious climate targets, including achieving net-zero emissions by 2070 and sourcing 50% of energy from renewables by 2030 [1]. Bridging the gap between development and decarbonization requires innovative, scalable solutions. In this context, **ClimateTech startups** – ventures developing technologies for climate change mitigation and adaptation – have a critical role. ClimateTech encompasses new solutions to minimize green- house gas emissions and provide eco-friendly alternatives to conventional technologies [1]. These startups directly address multiple SDGs by leveraging technology and entrepreneurship to drive sustainability.

India's startup ecosystem, now the world's third largest, has rapidly expanded into climate-focused innovation. ClimateTech is a relatively recent addition, but the sector has shown *remarkable growth*. In the past decade, over 2,600 climate-focused startups were registered in India (with ˜800 still active as of 2024) [3]. This growth reflects a strong commitment to integrating economic development with environmental sustainability. The number of climate tech ventures has surged from only a few dozen in the mid-2010s to hundreds today [10]. Alongside this, investment in Indian ClimateTech has accelerated. Venture capital funding in the sector reached a record high of approximately US$5 billion in 2022 – a 29% increase since 2019 [12] – signaling a robust vote of confidence in the potential of these startups. However, much of this capital remains concentrated at early stages, and a large gap persists in growth-stage financing for companies ready to scale [4]. Indian climate entrepreneurs must also innovate under unique market constraints: domestic consumers and industries are often unable or unwilling to pay a "green premium" for sustainable products, forcing startups to develop cost-effective solutions that can scale in price-sensitive markets [2].

This paper provides a comprehensive analysis of how India's Climate Tech startups are contributing to the SDGs, the sector-wise impact of their innovations, and the challenges they

face in scaling up. We first examine, through literature and data, the contributions of Climate Tech ventures to specific SDGs in key sectors – clean energy, sustainable mobility, agriculture, water, and waste management. We then discuss the major challenges hindering these startups from achieving greater impact, including financing hurdles, technology risks, and policy barriers. Next, we explore the enabling role of government policies, investment trends, and support ecosystems (incubators, funds, networks) in catalyzing ClimateTech growth. Finally, we summarize the findings and offer a future outlook on the trajectory of Climate Tech in advancing India's sustainable development objectives.

II. Literature Survey

India's climate-tech ecosystem is witnessing exponential growth, with numerous startups emerging to address climate challenges in alignment with Sustainable Development Goals (SDGs). Several recent studies have explored the interplay between climate-tech innovation, financial inclusion, and urban sustainability frameworks. In [1], IIMA Ventures and MUFG present a comprehensive overview of India's climate-tech startup landscape, categorizing over 300 startups across segments such as energy, mobility, agriculture, and carbon management. The report highlights the rapid scaling of sectors like electric mobility and clean energy, fueled by venture capital interest, policy support, and a growing demand for sustainable solutions. This study is crucial as it outlines the market potential, innovation hotspots, and investment dynamics shaping India's climate- tech future. Refaat et al. [2] examine the intersection of financial inclusion, FinTech, and climate action in the context of Industry 4.0. They argue that digital financial services not only enhance access to green financing but also improve the resilience of small and medium enterprises (SMEs) against climate risks. The paper emphasizes how FinTech innovations such as blockchain and AI can drive climate-related SDG tar- gets, particularly in emerging economies. In the Indian context, Bhalla and Pandey [3] critically analyze the challenges and progress India has made toward achieving SDG targets under the climate change theme. Their study explores areas such as policy implementation gaps, coordination issues between central and state agencies, and the need for technology- driven interventions. While acknowledging India's strides in renewable energy adoption and environmental reforms, the authors call for a greater push towards climate resilience through startup-led innovation. On the urban sustainability front, Berniak-Woz´ny et al. [4] propose a framework for incubator-city collaboration to foster smart and sustainable cities. The paper discusses how climate-tech startups, when embedded in municipal innovation ecosystems, can deliver scalable solutions for urban challenges such as waste management, air quality monitoring, and energy efficiency. This framework underlines the strategic role of local governance in nurturing climate entrepreneurship. Omeragic´ et al. [5], through an international lens, explore the synergistic role of FinTech, climate action, and clean energy access, with a focus on enabling technologies and regulatory environments. Their conference proceedings underscore the relevance of cross-sector collaboration and digital innovation in accelerating progress towards SDGs 7 (Affordable and Clean Energy) and 13 (Climate Action). Collectively, these works highlight a multidimensional perspective: from startup ecosystems and financial technologies to policy frameworks and urban collaboration. However, there remains a research gap in quantifying the **direct impact of Indian climate-tech startups on specific SDG targets**, especially considering regional disparities, scalability constraints, and regulatory uncertainties. This study aims to fill that gap by analyzing case studies and startup performance indicators in the Indian context.

III. Identified Gaps

Based on the reviewed literature, the following gaps are identified:

1) **Lack of Comprehensive Impact Assessment Framework**:
   Existing studies lack a unified methodology to evaluate the cross-sectoral SDG impact of ClimateTech startups in India. Most research focuses on specific SDGs (like SDG 7 or 13), ignoring the interlinkages with others such as SDG 3 (Health), SDG 6 (Clean Water), and SDG 11 (Sustainable Cities).
2) **Limited Longitudinal and Geographic Scope**:
   Many analyses are confined to metro cities or specific time frames. There is insufficient data on ClimateTech adoption and impact in Tier-2 and rural regions of India.
3) **Startup-Level Data Deficiency**:
   While funding trends are tracked extensively, startup-level operational data (carbon saved, resources optimized, communities impacted) remains fragmented or proprietary.
4) **Weak Integration of Stakeholder Perspectives**:
   Few studies incorporate voices from multiple stakeholders — including local governments, investors, consumers, and environmental NGOs — in understanding the broader systemic impact of ClimateTech solutions.
5) **Underdeveloped Metrics for SDG Contribution**:
   Most startups lack standardized frameworks or indicators aligned with the UN SDG targets, making it difficult to quantify and compare their contribution across the ecosystem.
6) **Insufficient Focus on Scalability and Policy Feedback Loop**:
   There is minimal research on the scalability barriers for ClimateTech startups and how their field-level insights can feedback into more adaptive and responsive policy design.

IV. Climate Tech Startups and SDG Contributions in India

ClimateTech startups in India directly address a range of SDGs by providing innovative solutions that promote environmental sustainability, economic development, and social well-being. By their very nature, these ventures align closely with **SDG 13 (Climate Action)**, developing technologies to reduce greenhouse gas emissions or help communities adapt to climate impacts. In doing so, they generate co-benefits for other goals: **SDG 7 (Affordable and Clean Energy)** through renewable energy and energy-efficiency solutions, **SDG 11 (Sustainable Cities and Communities)** through clean transportation and air quality improvements, **SDG 6 (Clean Water and Sanitation)** via water conservation and purification technologies, **SDG 12 (Responsible Consumption and Production)** by enabling recycling and circular economy models, and **SDG 2 (Zero Hunger)** by making agriculture more sustainable and climate-resilient.

Recent analyses highlight that India's ClimateTech sector is driving sustainability across diverse industries [12]. For instance, startups are supporting the transition to cleaner *energy* sources at scale, developing smart grids and energy storage to meet growing energy needs while cutting emissions. In *mobility*, climate innovators are electrifying transport and enabling smart mobility solutions, curbing urban pollution and moving the country toward greener transportation. In *agriculture and food systems*, ClimateTech ventures introduce sustainable farming practices, precision agriculture, and supply chain transparency tools that reduce emissions and enhance resource efficiency [12]. They also develop climate-resilient aggrotech interventions that improve productivity and farmers' incomes under changing climate conditions. Further, startups are *greening industry and infrastructure* by offering low- carbon materials, energy-efficient building designs, and IoT solutions for industrial resource management. Emerging ClimateTech solutions even tackle carbon capture, sequestration, and emissions monitoring – critical for long-term climate mitigation and risk management. Through these diverse path- ways, Indian ClimateTech startups act as force-multipliers for the SDGs, injecting innovation into traditionally hard-to- abate sectors and accelerating progress where conventional approaches have lagged.

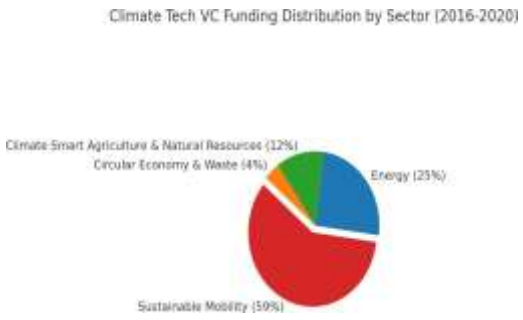

Fig. 1. Sectoral share of climate-tech startup funding in India (2016–2020). Mobility: 59%, Energy: 25%, Agriculture: 12%, Waste: 4% [12].

Quantitatively, the *impact* of ClimateTech startups on SDGs can be seen in energy savings, emissions averted, and communities served. For example, a single energy-efficiency startup in India (Smart Joules) reports saving over 235 million kWh of electricity and eliminating 164,000+ tons of CO emissions through efficiency upgrades in hospitals and commercial buildings [16]. Likewise, climate-focused enterprises have enabled affordable solar power for off-grid villages, provided clean drinking water to thousands of households via novel filtration devices, and diverted tons of waste from landfills through recycling technologies (all aligning with SDGs 6, 7, 11, 12). In the following sections, we delve into specific sectors to detail how Indian startups are advancing sustainability goals in each domain.

V. Sectoral Insights

A. Clean Energy

Clean energy is the centerpiece of ClimateTech in India, with startups playing a vital role in advancing SDG 7 and climate mitigation (SDG 13). India has set ambitious renewable energy targets (e.g., 450 GW of renewables by 2030) and startups are helping realize these goals by driving down costs and innovating in deployment models [17]. A majority of climate startups in India are focused on energy supply, management, or storage. In fact, energy and power-related ventures have attracted the lion's share of climate tech investment – collectively with transport accounting for about 94% of all climate-tech funding in India from 2019 through 2023 [18].Energy-focused startups contribute on multiple fronts. Many provide *renewable energy solutions* such as solar PV, wind and hydro innovations, and solar micro-grids for rural electrification. They are helping India expand clean energy access to underserved areas while displacing fossil fuels. Others focus on *energy efficiency and management*, developing IoT-based smart grid systems, AI for demand response, and efficient appliances to reduce wastage. For example, startups deploying smart sensors and analytics for electricity distribution have helped utilities and industries cut transmission losses and optimize power usage. The impact can be significant: efficiency solutions by ventures like Smart Joules have saved hundreds of millions of kWh and crores of rupees in energy costs for clients [16]. Such outcomes directly support SDG 7's targets on energy efficiency. Additionally, ClimateTech innovators are pioneering *energy storage* (advanced battery technologies, thermal storage, etc.) to overcome intermittency in renewables [16]. By enhancing grid stability and storage capacity, these startups facilitate a higher share of solar and wind in the energy mix, thus accelerating progress toward SDG 7 and India's climate commitments.

An important contribution of energy startups is in *energy access and equity*. Several social enterprises have deployed off-grid solar systems, clean cooking solutions, and pay-as-you-go renewable energy services in remote regions, aligning with SDG 7's mandate for universal energy access. By 2023, India's renewable capacity (including solar, wind, hydro)

reached 196 GW – about 44% of the installed power mix [12] – a milestone to which startup innovations in solar home systems, mini-grids, and financing models have materially contributed.

B. Sustainable Mobility

The transport sector is another major focus of Indian ClimateTech startups, contributing to SDG 11 and SDG 13 by decarbonizing mobility and improving urban air quality. India's transportation emissions are significant, and the push for electric mobility and cleaner transportation has opened a vast arena for innovation. Startups have risen to the challenge by developing EVs, shared mobility platforms, battery swapping infrastructure, and intelligent transit systems. Electric vehicle startups are at the forefront. Companies like Ather Energy, Ola Electric, and Mahindra Electric are pioneering domestic EV design and manufacturing, helping shift India's vehicle market toward electrification. Notably, Ather Energy grew from an IIT-incubated startup to a publicly listed company by 2025 [19], exemplifying how innovation in e- mobility can scale. ClimateTech startups have also introduced *EV ride-hailing and delivery services* (e.g. BluSmart's electric taxi fleet, Zypp Electric's e-scooter logistics), which cut urban pollution and align with SDG 11's sustainable transport goals. These services demonstrate viability of clean mobility without sacrificing convenience or cost – a key consideration in Indian cities. Beyond vehicles, startups are tackling *supporting infrastructure and technology* for sustainable mobility. Several ventures focus on *battery technology and charging infrastructure*, developing faster-charging batteries, battery recycling solutions, and networks of charging stations to support EV adoption. Others leverage IoT and data analytics to optimize traffic flow, encourage public transit use, or facilitate carpooling – all contributing to reduced congestion and emissions.

The rapid electrification of transportation is boosted by strong policy signals in India. The government's FAME scheme provides purchase incentives for EVs and subsidies for charging infrastructure, greatly lowering market entry barriers for EV startups [17]. ClimateTech entrepreneurs have leveraged this environment to introduce cost innovations like low-cost e-scooters and financing models that make EVs accessible. As a result, electric mobility startups have drawn considerable investor attention; mobility startups comprise a bulk of climate tech funding in recent years [18].

C. Climate-Smart Agriculture

Agriculture remains the livelihood backbone for a large share of India's population and is closely linked to SDG 2 and SDG 12. However, it is also highly vulnerable to climate change and a significant emitter of GHGs. ClimateTech startups in India are pioneering climate-smart agriculture solutions that enhance productivity and resilience while lowering the environmental footprint of farming.

One major area of innovation is *agri-tech for efficiency and sustainability*. Startups are providing precision farming tools – such as IoT sensors, satellite imaging, and data analytics – to optimize water usage, fertilizer application, and crop health. By tailoring inputs to needs, these solutions increase yields and farm incomes while reducing excess fertilizer runoff and nitrous oxide emissions.

Another impactful innovation is in *climate-resilient farming infrastructures*. Notable is the greenhouse-in-a-box by startup Kheyti, which provides smallholder farmers with a low-cost modular greenhouse to protect crops from extreme weather [9]. This innovation enables farmers to grow vegetables under controlled conditions using 90% less water and with higher yields, insulating them from heatwaves and erratic rains.

Startups are also addressing *agricultural waste and emissions*. Companies like Strawcture and Dharaksha Ecosolutions are converting crop residues into sustainable materials, preventing open burning and reducing carbon emissions.

D. Water and Sanitation

Ensuring clean water and sanitation (SDG 6) for India's vast population is a pressing challenge, exacerbated by climate change. Nearly 600 million Indians face high water stress, and by 2030 water demand is projected to double supply [8]. ClimateTech startups focus on water management, access, and sanitation – vital for SDG 6.

In the WASH sector, over 1,400 startups were recognized in water, sanitation, and waste management by April 2023 [11]. Ventures tackle issues from drinking water purification to wastewater treatment. Examples include community water ATMs powered by solar and IoT, modular sewage treatment plants, and robotic scavenging devices that eliminate manual sewer cleaning [11].

Government programs like Jal Jeevan Mission and Swachh Bharat Mission have created an enabling environment, and many startups partner in these initiatives to scale impact.

E. Waste Management and Circular Economy

Effective waste management is central to SDG 12, and ClimateTech startups are introducing circular economy innovations that reduce, recycle, and repurpose waste. India generates 62 MT of solid waste annually, yet only 20% is treated, leaving the majority dumped [7]. Startups like Recykal and Attero Recycling streamline recycling and resource recovery, improving waste separation and processing. Bioresource innovations include biomethanation, pyrolysis of plastics, and biofuel production. For instance, Buyofuel operates an online platform for trading biofuels and agro-waste, encouraging industrial consumers to switch from fossil fuels [15]. EPR regulations for plastics and electronics have spurred waste-tech growth by mandating producer accountability.

VI. Challenges in Scaling ClimateTech

Indian ClimateTech startups face key challenges:

1) **Funding Gaps and Investment Barriers:** Only ˜25% of startups secure any funding, mostly seed, and 2.5% attain Series A or beyond [4], [5]. Total investment

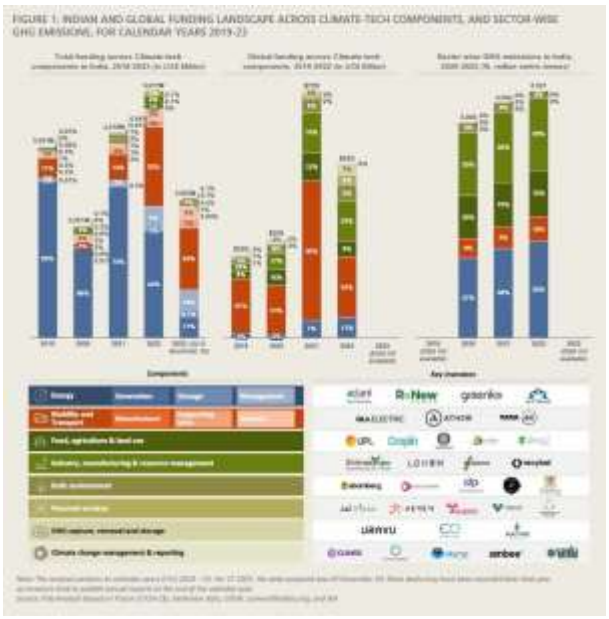

Fig. 2. Climate-tech investment vs. sectoral GHG emissions: mobility energy heavily funded vs. underfunded agriculture waste [18].

from 2014–2024 was US$3.6 billion, overshadowed by fintech's US$19 billion [5].

2) **High Technological and Market Risks:** Deep-tech innovations carry higher RD costs and longer timeframes, deterring traditional VCs and creating a "valley of death" for pilots to scale.
3) **Deep-Tech Orientation and Talent Challenges:** Around 58% of climate startups involve hardware or new materials, requiring specialized labs and experts, which are scarce [14].
4) **Policy and Regulatory Hurdles:** Complex approvals, inconsistent state regulations, and slow public procurement cycles impede market entry.
5) **Market Education and Adoption:** Behavioral barriers and price sensitivity require significant outreach and innovative business models to drive adoption.

VII. Government Policies, Investment Trends, and Ecosystem Enablers

India's policy framework and support ecosystem have evolved to enable ClimateTech:

- **Policy Commitments:** COP26 Panchamrit goals, National Solar Mission, FAME scheme, Biofuel Policy, and National Green Hydrogen Mission (INR 19,744 crore) provide clear market signals [12], [17], [20].
- **Startup Support:** Startup India, DST and AIM challenges, MNRE incubators, and WASH innovation sprints offer grants, mentorship, and piloting opportunities [**?**].
- **Climate Finance:** Climate-focused funds like Avaana Capital, Peak Sustainability Ventures, Ankur Capital, and global investors (Breakthrough Energy) are emerging, though funding remains volatile (2023 dip to 57% of 2022 levels) [18].

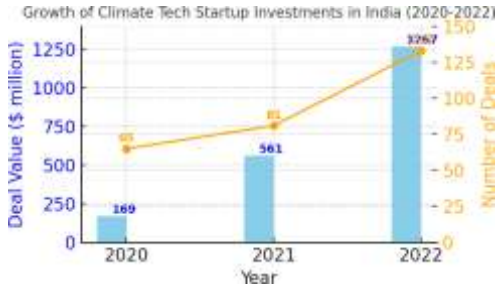

Fig. 3. Annual climate-tech funding in India (2020–2022): $169 M → $1.27 B; deals from 65 to 133.

- **Infrastructure and Partnerships:** Growth in renewable installations, EV charging rollout, international alliances (ISA), and corporate innovation challenges foster collaboration and market access.

Fig. 4. Evolution of India's climate commitments, 2015–2022: NDC (2016), COP26 Panchamrit (2021), updated NDC (2022) [20].

VIII. Conclusion and Future Outlook

ClimateTech startups in India are instrumental in driving SDGs through clean energy, sustainable mobility, climate-smart agriculture, water, and waste management solutions. Their innovations have yielded measurable benefits, such as millions of kWh saved, thousands of tons of emissions averted, and improved livelihoods. Yet, scaling remains challenging due to funding gaps, deep-tech risks, and regulatory complexities. Government targets and supportive ecosystem initiatives are helping to bridge these gaps, but continued efforts are needed – including patient capital, streamlined regulations, and robust partnerships. The future outlook is optimistic: with sustained policy commitment, strategic investment, and ecosystem maturation, ClimateTech startups are poised to transform India's sustainable development trajectory and serve as models for other emerging economies. They hold the key to integrating climate action with inclusive growth and achieving India's SDG goals and net-zero ambition.

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