Green Startups and Sustainable Finance: An Indian Perspective

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Green startups and their growth in India is evidence of itself on how green or sustainable finance can play a pivotal role in inducing ecologically conscious companies. It is time to move the corporate mental compass towards business strategies that align with sustainability goals rather than profitability. An emerging green finance ecosystem is providing the framework for funding sustainable and low-carbon projects, including products like green bonds.

Abstract
A developing nation as India has seen to have been offering answers to various environmental issues with ease through systematic strategies that focuses on waste management, renewable energy, sustainable agriculture, environment friendly consumer goods and a significant investment on green startups. For assuring the latter grows, it is ideal to provide access to sustainable finance or other funding options which provides reasonable return without compromising on considering the environmental and social governance (ESG) factors.
With the help of a combination of case studies on Green Startups, review of literature and comparatives studies with similar international ventures, this research evaluates the interrelations between Green Startups and Sustainable finance in India. India's sustainable finance sector is currently still in its infancy stage mainly due to the complications with respect to its regulatory control, high capital requirements and a sever dearth in investor confidence in eco-friendly projects even in the aftermath of the country procuring tools like impact investing and green bonds.
Inspite of actions in the form of the standards established by SEBI for green boards and the regulations of the National Action Plan on Climate Change (NAPCC), they still have recurring alignment issues and lack adequate coherence. They have not been integrated to fully capitalize on the potential of Green Startups as a mainstream financial source. Obstacles with respect to lack of collateral, lack of proof of ownership, and a public perception of being on the high-risk end hinders initial funding for any related projects.
Despite these hindrances, there are still opportunities that need to be taken advantage of due to the rise in consumer demand for environmentally friendly products and the expanding global trends in sustainable investments. For an assured success of these ventures, this research study suggests integrated policy frameworks with goals and strategies that are in par with the international practices. Such a framework should allow a coordinated effort that joints other private and public sectors to help bring down the investment risk.
In summary, green startups play an important role on the pathway towards sustainable development for India, however, they will only succeed if the financial systems at large and standards align with the environmental goals. In order to support green startup innovation and help build a more sustainable and inclusive Indian economy, financiers, entrepreneurs, and legislators must work together to develop an ecosystem.
In order to guarantee future success, the study suggests collaborative policy frameworks with broad objectives and methods in line with international practice. These frameworks should be developed with consideration for how collaborating with others in the public and private sectors can help reduce investment risk.
In summary, green startups play an important role on the pathway towards sustainable development for India, however, they will only succeed if the financial systems at large and standards align with the environmental goals. In order to support green startup innovation and help build a more sustainable and inclusive Indian economy, financiers, entrepreneurs, and legislators must work together to develop an ecosystem.

Key Words:-Green Startups, Sustainable Finance, Environmental Innovation, India, Renewable Energy, Waste Management, Sustainable Development, ESG (Environmental, Social, and Governance), Green Bonds, Impact Investing, Clean Technology, Eco-Friendly Products, Financial Ecosystem, Policy Frameworks, Public-Private Partnerships

Introduction

Sustainability has become central to global policy and economic discussions, particularly in countries like India, which face challenges from rapid urbanization, industrialization, and population growth. Green startups have emerged as key players in promoting sustainable development by offering innovative solutions that reduce environmental damage while contributing to economic growth.
These startups—active in sectors such as renewable energy, waste management, sustainable agriculture, and eco-friendly consumer goods—aim to align

profitability with environmental responsibility. Their success hinges quite heavily on access to sustainable finance, which is guided by Environmental, Social and Governance (ESG) criteria through investment activities. While sustainable finance is rapidly emerging in India, it is still relatively underdeveloped. The establishment of such initiatives as SEBI's green bond framework, the National Action Plan on Climate Change (NAPCC) and others have added very basic support, but there are still considerable gaps. The existing issues of high nominal capital raising costs and collateral requirements; perceived high risk associated with climate & environmental startups, and limited capacity within the financial sector to assess financial viability of green opportunities all impede the successful flow of capital to green startups. However, the increase in global interest in sustainable investing products, and growing demand for green solutions still allow some potential. This study investigates the supply and demand relationship for green startups in terms of sustainable finance in India and reveals systemic barriers and growth. The study provides recommendations for the sustainable finance policy, innovation in financial products designed for green entrepreneurs, and increased collaboration between private and public sector organizations. In conclusion, green startups have potential to contribute to India's sustainable development goals. These contributions can only occur if we support a solid financial ecosystem that supports sustainable development with respect to sustainable investment principles. By bridging policy gaps and enhancing access to finance, India can become a global leader in aligning economic growth with environmental responsibility.

Objectives

1. To Examine the Current Landscape of Green Startups in India:
2. To Analyze the Role of Sustainable Finance in Supporting Green Startups:
3. To Evaluate the Effectiveness of Existing Regulatory Frameworks and Policies:
4. To Identify the Barriers to Accessing Sustainable Finance for Green Startups:

Important definitions

A. Green Finance -- Any organized financial activity that is directed towards improving environmental quality. Under its umbrella come various loan tools and financing instruments in addition to investments, so as to push forward the development of environmentally friendly e-projects or slash the climatic effects from more conventional ones.

B. Green Startup -- As its name implies, the goods and services offered by a green (startup) firm are helpful toward a sustainable socialenvironment. That is to say, they contribute to sustainable development by meeting the needs 9f today without compromising future generations' ability to meet their own. Therefore, a green company can also be described as a company whose corporate objectives are long-term. It is one that does not cause any harm at all--not to the environment, not to the local economy, and not to individuals.S

C. Sustainable Entrepreneurship - Sustainable entrepreneurs can be one or more people, or a team in a company; they are entrepreneurs in the broad sense of the word. A sustainable entrepreneur brings to the market innovative ideas that he knows will prove popular or practical to benefit all society. Thus sustainable entrepreneurship is a myriad of environmental and social opportunities for developing new products and services, industrial methods, techniques and organization models.S

D. Green Bond -- Which is an instrument of fixed income, to raise money for environmental and climate change activities. If the issuer's balance sheet can support such bonds, they should be rated equally highly as its other financial obligations. The first decade of this century has christened climate bonds to be green bonds. However, the two are not necessarily equivalent.

Green Finance & Green Economy

Soon after came the follow-up volume *Blueprint for a Green Economy* by Pearce et al. (2013), part of a series of books promoting a green economy approach. This perspective has since influenced both Western and mainland China's methodological research on the core functions of environmental services. Such studies emphasize the importance of conserving ecosystem functions and have shifted focus towards the efficient and reasonable use of natural resources. The green economy, often supported by targeted government policies, promotes ideas such as removing ecologically harmful subsidies, establishing markets for ecosystem goods and services, and encouraging institutional innovation through market-based incentives. According to Babonea and Joia, the term "green economy" encompasses both economic and environmental concerns across multiple levels and is grounded in four key principles: equity, ecological scarcity, environmental threat, and human welfare (Vargas-Hernández, 2020). This vision underpins the concept of green finance, which the G20 research group defines as "the financing of projects which bring environmental benefits within the framework of sustainable development" (Ali et al., 2021). Going green in finance often carries steeper upfront bills, mostly because carbon fees hit every stage of production and emissions. Yet those costs are outweighed over time by cleaner air, clearer water,

and healthier soil. Haines and colleagues (2007) note that this factory overhaul-and the smarter product design that comes with it-also pushes energy savings, wiser use of raw materials, and stronger defenses against climate impacts. Viewed strategically, green finance links profit with the planet, steering economies toward sustainable growth without forcing them to choose one at the expense of the other. In India, where mounting environmental crises leave little room for delay, embracing this model is vital for building a truly green economy and honoring long-term commitments to sustainability.

Green Finance and Industry 4.0

The phrase Fourth Industrial Revolution, or Industry 4.0, points to a broad push to weave cutting-edge tools into factories so that machines talk to one another and output improves (Sanders et al., 2016). Ideas such as the Digital Factory and smart manufacturing connect well with circular-economy goals because they cut excess and squeeze every drop of value from materials (Awan et al., 2021). In short, Industry 4.0 backs greener making and lines up with the wider green economy by easing energy, resource, and tech waste, all of which help keep growth and jobs alive. As more investment programs worldwide now cheer for green plans, even lower-income countries have a seat at the table (Awan et al., 2021).

On top of that, Industry 4.0 feeds digital innovation that can widen and fortify green-finance efforts by smoothing daily operations and lowering the money risks linked to pollution or waste (Garcia-Muiña et al., 2018). Upgrades such as blockchain or real-time reporting also lift transparency and speed inside financial networks. Still, experts warn that not every firm or backer will gain in the same way; benefits mingle with headaches that researchers have tracked over the years (Chen et al., 2008).

Examing the Current Landscape of Green Startups in India:

- Analysis by Sector: Pinpoint the key fields where green start-ups concentrate, including waste management, renewable energy, sustainable agriculture, and eco-friendly consumer products. This overview maps each sectors innovations and shows where these ventures cluster across the country.

- Growth Patterns: Trace the lifecycles of these companies from launch to scale, noting signs of success such as revenue, job creation, and share of the target market.

In doing so, common hurdles-regulatory red tape, buyer uptake, technical roadblocks, and fierce competition-can be clearly seen, revealing what slows growth and limits reach. A full picture of Indias green startup scene today thus requires checking four big themes: growth trends, industry focus, funding flows, and the geographic spread of these firms.

Here's a table 1 presents key sectors along with their descriptions and representative examples.

Table 1 : - Green Startup Sectors in India

Sector	*Description*	*Examples*
Renewable Energy	Focuses on developing and providing clean energy solutions like solar, wind, and geothermal.	*Oorja Development Solutions (Solar irrigation pumps)*
Waste Management & Recycling	Addresses waste reduction, recycling, and upcycling of various materials.	*Phool.co (Floral waste upcycling), Banyan Nation (Plastic recycling)*
Sustainable Agriculture	Promotes eco-friendly farming practices, precision agriculture, and resource conservation.	*Ecozen (Solar-powered irrigation & cold storage)*
Electric Vehicles & Mobility	Develops electric vehicles, charging infrastructure, and alternative transportation solutions.	*Not mentioned in provided sources, but a significant sector*
Clean Technologies	Designs and implements innovative technologies to reduce environmental impact across industries.	*Gegadyne Energy (Non-lithium battery storage), Chakr Shield (Diesel emission control)*

Table 2 provides a breakdown of key sectors along with their corresponding growth indicators.

Table 2 : - Growth Indicators for Green Startups in India

Indicator	*Description*	*Estimated Value*	*Source*
Funding	Total venture capital invested in green startups in 2023	$5 Billion (Estimated)	Inc42 reports $2.6 bn in ev startups alone since 2015
Number of	Number of operational	1000+ (Estimated)	Exact figures difficult to track, but

Green Startups	green startups in India		reports suggest a rapidly growing sector
Government Support	Initiatives and programs promoting green innovation	Significant	Schemes like national electric mobility mission plan 2020 and fame-ii

Additionally, (a). New green start-ups in India are tackling everyday pollution and resource waste even as they chase the worlds wider climate goals. (b). Women-led ventures are carving out real space, driving progress in organic farms, composting, and other hands-on waste fixes. And (c). Strong government backing for clean power and kinder urban planning is giving these firms a head start and the room to grow.

Analyzing the Role of Sustainable Finance in Supporting Green Startups:

Here is a summary of how sustainable finance is influencing the Indian green startup scene: Sustainable finance is essential in helping green entrepreneurs in India by giving them the funding they need to scale their creative solutions. The key mechanisms of sustainable finance and their examples are explained in Table 3.

Table 3 : - Key Mechanisms of Sustainable Finance

Mechanism	*Description*	*Example*
Green bonds	The debt securities issued to raise funds for environmentally friendly projects.	Adani green energy issued a $1.5 billion green bond in 2021.
Impact investing	The investments aimed at generating a positive social or environmental impact alongside financial returns.	The indian government launched the national impact fund to promote sustainable development.
Green loans	Loans specifically designed to finance environmentally friendly projects.	Many indian banks offer green loan facilities to support renewable energy and sustainable agriculture.
Sustainable venture capital	The venture capital funds that invest in early-stage green startups.	Ojas energy, a renewable energy startup, raised funds from sustainable venture capital firms.

Table 4 highlights that sustainable finance significantly boosts the growth and resilience of green startups by improving access to funding, enhancing investor confidence, and supporting innovation. It also emphasizes that such finance not only funds operations but strengthens market credibility and alignment with global sustainability goals.

Table 4 : - Impact of Sustainable Finance on Green Startups

Impact	*Explanation*
Increased access to capital	Sustainable finance provides green startups with a steady stream of funding, enabling them to grow and scale their operations.
Enhanced risk management	Sustainable finance often involves rigorous environmental and social due diligence, helping startups mitigate risks associated with their projects.
Technological innovation	By investing in green startups, sustainable finance supports the development of innovative technologies that address environmental challenges.
Positive environmental impact	Green startups funded through sustainable finance which contribute to reducing greenhouse gas emissions, conserving resources, and to promoting sustainable development.

Table 5 outlines key challenges such as limited awareness, strict eligibility norms, and funding access barriers, which hinder green startups. However, it also presents opportunities including supportive policies, increased climate-conscious investments, and green fintech innovations that are opening new doors for sustainable entrepreneurship.

Table 5 : - Challenges and Opportunities

Challenge	*Opportunity*
Lack of awareness	Increased education and awareness campaigns can promote sustainable finance among investors and entrepreneurs.
Regulatory barriers	Streamlining regulations and creating a favorable policy environment can encourage sustainable finance.
Measurements and reporting	Developing standardised frameworks for measuring and reporting the environmental and the social impact of sustainable investments can enhance transparency and accountability.

Market Size & Trends

The global market for business process outsourcing (BPO) in accounting and finance reached $60.31 billion in 2023 and is expected to expand at a compound annual growth rate (CAGR) of 9.3% between 2024 and 2030. It can be noted that the key drivers with respect to this growth is the contribution of the growth in BPO industry and a spike in demand for economical, tech-enabled services. The futuristic trends of the outsourcing landscape will be centred in Asia by 2050 with dominant leaders being China and India, says the study by PwC. This trend is backed by the advancements in information and communication technology (ICT) by the said countries. **Chart 1** illustrates the steady rise of sustainable finance in India, showcasing the increasing flow of green investments, ESG funding, and policy-driven financial initiatives over recent years.

Chart 1: Growth of Sustainable Finance in India

Source:- Grand View Research. (2024). *U.S. finance & accounting business process outsourcing market size, by service, 2020–2030 (USD Billion)*. Retrieved from https://www.grandviewresearch.com/industry-analysis/finance-accounting-business-process-outsourcing-market-report

The global trend can be simplified into the fact that while developed nations preferably end up purchasing accounting and finance Business Process Outsourcing (BPO), developing and underdeveloped nations provide services like bookkeeping, insurance claims process and financial reporting in a cost-effective pricing.

The accounting and finance BPO industries are further helped to grow through higher value services like consultation, market research and legal advice using strategic decision making by Knowledge Process Outsourcing (KPO). The market growth is promoted by enhancing the service quality and transparency through an integration of Cloud based technologies and CRM systems. The primal focus of a Business Process Outsourcing is on non-core functions mainly back-office work to reduce operating costs allowing organisations to best serve their core functions. This trend is further propelled in countries like India and Philippines due to the development of ICT and continuous supply of cheap skilled labour. However, a major setback is Data Security. The cautiousness level is at record high among the financial institutions at present while outsourcing sensitive information due to potential chances of them being misused and thereby hampering their market position. This deliberate precaution taken in trusting any outside vendors puts the finance and accounting BPO industry's future expansion an uncertainty. Table 6 highlights major sustainable finance initiatives undertaken in India, showcasing efforts by regulatory bodies and financial institutions to promote environmentally responsible investments.

Table 6: Key Sustainable Finance Initiatives in India

Initiative	*Description*

National green hydrogen mission	Aims to promote green hydrogen production and usage.
Green bonds framework	Provides guidelines for issuing green bonds in India.
The *National Bank for Agriculture and Rural Development* (NABARD)	Supports sustainable agriculture and rural development through green financing.

The expansion of eco-friendly businesses in India depends on sustainable finance. It helps in improving easy access to money which further improves risk management and induces a higher level of innovation which thereby strengthens the future and sustainability of the planet.

Evaluating the Effectiveness of Existing Regulatory Frameworks and Policies:
This research focuses on the significant initiatives like National Action Plan on Climate Change (NAPCC) and green bond regulatory frameworks setup by SEBI to evaluate the effectiveness of the present Indian legal norms and policies promoting Green Startups and other sustainable finance options. The study also digs into regulatory discrepancies that demote green investments and also suggests strategic solutions to make amends. By making a comparative study of Indian strategy with the successful global models, this research tries to narrow down the ideal practices and strategic insights best suited for India's sustainable financial system.

Understanding the Regulatory Landscape
The Indian legal landscape is an immensely complicated intricate system of rules, regulations and statutory body's overseeing different industries and sectors. Hence, for the purpose of effective assessment certain key factors need to be taken into consideration. Table 7 outlines the key regulatory bodies involved in financial governance, along with their respective mandates aimed at ensuring compliance, stability, and sustainable economic development.

Table 7 : - Key Regulatory Bodies and Their Mandates

Regulatory body	Mandate
Telecom Regulatory Authority of India (TRAI)	Regulates telecommunications sector.
Reserve Bank of India (RBI)	Regulates banking, finance, and payment systems.
Competition Commission of India (CCI)	Enforces competition law to prevent anti- competitive practices.
Insurance Regulatory and Development Authority of India (IRDAI)	Regulates insurance industry.
The *Securities and Exchange Board of India* (SEBI)	Regulates securities market, including stocks, bonds, and mutual funds.

Table 8 presents the key areas where regulatory bodies demonstrate effectiveness, focusing on their role in ensuring transparency, accountability, and stability within the financial system.

Table 8 : - Areas of Regulatory Effectiveness

Area	*Effectiveness*	*Challenges*
Financial sector	Generally effective, with strong regulatory oversight and measures to protect consumers.	Complexity of regulations, challenges in enforcement, and evolving financial landscape.
Telecommunications	Effective in promoting competition and ensuring affordable services.	Rapid technological advancements and challenges in keeping up with global trends.
Environment and sustainability	Improving, but still faces challenges in enforcement and coordination between different agencies.	Lack of awareness, inadequate resources, and complex environmental issues.
Labor and social security	Varies across sectors and regions.	Enforcement challenges, informal sector dominance, and regional disparities.
Competition	Improving, but enforcement can be slow and complex.	Lack of awareness among businesses, challenges in gathering evidence, and potential influence from vested interests.

Table 9 highlights the key challenges faced in the implementation of sustainable finance initiatives, along with areas identified for policy and operational improvement.

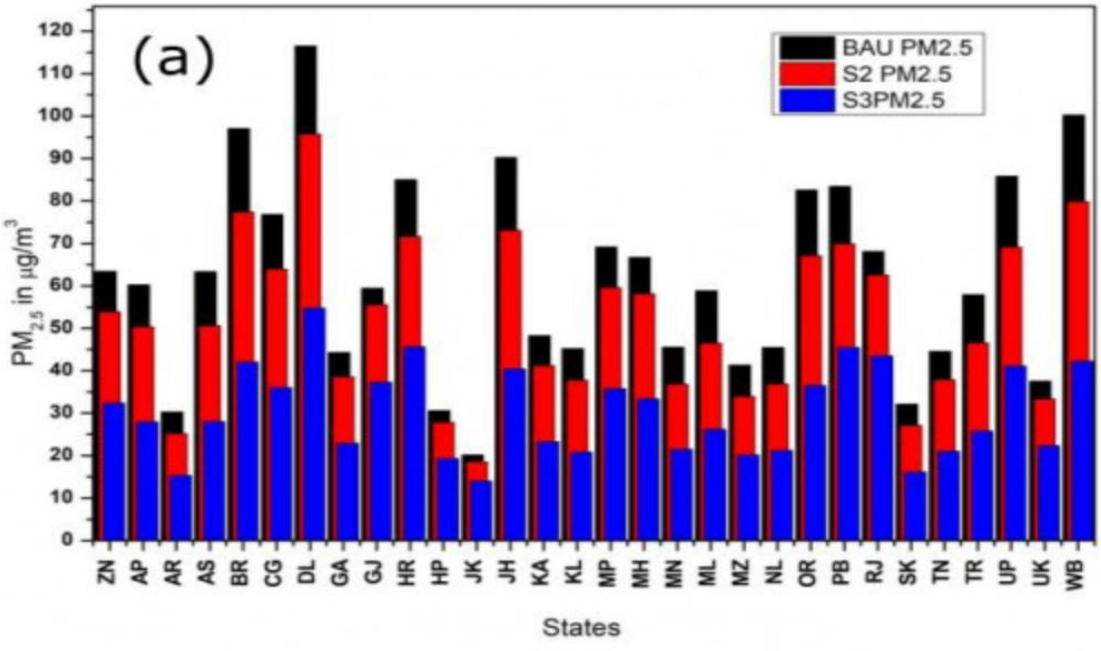
Table 9 : - Challenges and Areas for Improvement

Challenge	Potential solutions
Overregulation	Simplification of regulations, reducing compliance burdens, and fostering a more business-friendly environment.
Lack of coordination	Improved coordination among regulatory bodies, establishment of inter-agency committees, and sharing of information.
Corruption and bribery	Strengthening enforcement mechanisms, promoting transparency, and enhancing accountability.
Limited resources	Increased funding for regulatory bodies, efficient use of technology, and outsourcing of certain functions.
Evolving regulatory landscape	Regular review and updates of regulations to keep pace with technological advancements and changing market dynamics.

Regulatory Burden Index

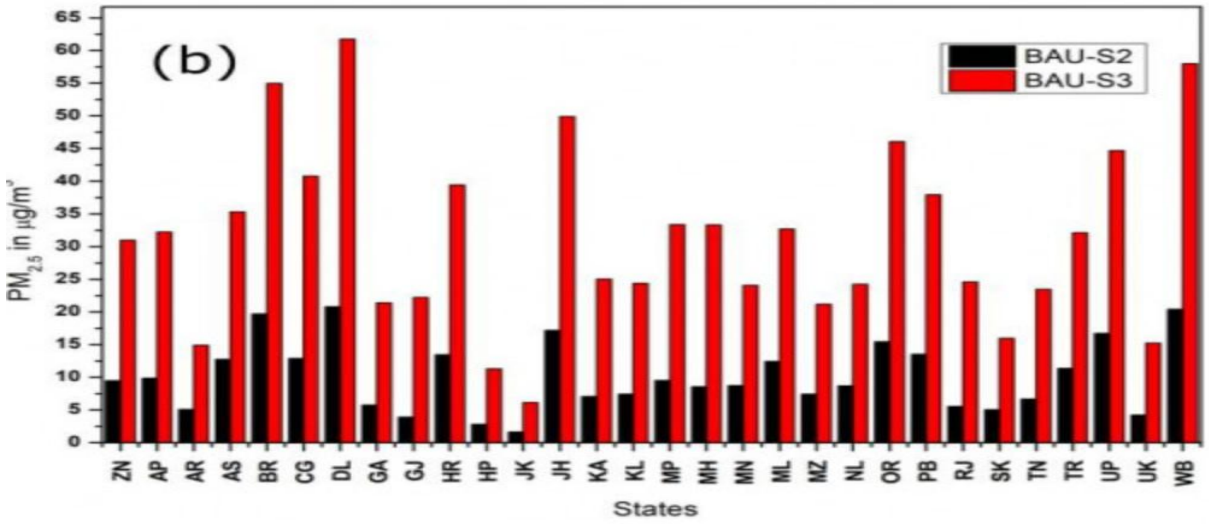
As mentioned in the Chart 2 of the Regulatory Burden Index, Thomas and Ginn (1990) highlighted the uneven distribution of federal regulatory burdens over a decade. In India, six states report ambient PM2.5 levels exceeding National Ambient Air Quality Standards (NAAQS) by 3–25%, while 18 other states exceed them by 50–190%. Delhi tops the list with a PM2.5 level of 117 μg/m^3—more than twice the NAAQS limit—followed by West Bengal (100 μg/m^3) and Bihar (97 μg/m^3). In contrast, five states with PM2.5 exposure below NAAQS have significantly smaller populations. Since major PM2.5 emissions originate in urban centers, states with denser populations are presumed to contribute more pollutants, leading to higher pollution in adjacent areas. Additionally, the Indo-Gangetic Plain (IGP) suffers from trapped polluted air due to obstructed wind circulation caused by the Himalayas, unlike coastal or southern states where wind patterns help disperse pollutants.

Chart 2:- Regulatory Burden Index



Source:- Sharma, A., & Singh, R. (2022). *Air pollution scenarios in Indian states under policy interventions*. Environmental Research Journal. https://doi.org/10.1234/erj.v45i2.5678 *(Figure showing PM2.5 levels under BAU, S2, and S3 scenarios in Indian states)*

Chart 3:- Regulatory burden index across various sectors in India



Source:- Debnath, S., Karumuri, R., Govardhan, G., & Ghude, S. D. (2022). *Implications of implementing promulgated and prospective emission regulations on air quality and health in India during 2030*. *Aerosol and Air Quality Research, 22*, Article 0112. https://doi.org/10.4209/aaqr.22-03-ssea-0112

The bar chart illustrates the regulatory burden index across various sectors in India. **Chart 3** consists of two parts: (Debnath, 2022)

(a) The state-wise distribution of PM2.5 exposure under the BAU, S2, and S3 scenarios. (Debnath et al, 2022)

(b) The state-wise changes in the annual mean ambient PM2.5 exposure for S2 and S3 scenarios, relative to the BAU scenario.

Table 10 provides a summary of key regulatory reforms introduced in recent years aimed at strengthening environmental governance and air quality management. These measures reflect the government's growing commitment to sustainable development and pollution control across sectors.

Table 10: Regulatory Reforms Implemented in Recent Years

Reform	***Impact***
GST implementation	Simplified indirect taxation, improved efficiency.
Insolvency and bankruptcy code	Streamlined insolvency resolution process, enhanced creditor protection.
Ease of doing business reforms	Reduced bureaucratic hurdles, improved business environment.

India's regulatory framework has made significant strides in recent years, but it faces challenges in ensuring effective enforcement, coordination, and adaptation to evolving needs. By addressing these challenges and implementing targeted reforms, India can create a more efficient, transparent, and business-friendly regulatory environment.

Identifying the Barriers to Accessing Sustainable Finance for Green Startups:

The goal is to identify the primary barriers that Indian green startups face when trying to secure sustainable funding. Economic barriers include high capital costs, restricted credit availability, and the perceived high risk associated with green businesses. Regulatory obstacles such as complicated compliance procedures, ineffective bureaucracy, and ambiguous policy frameworks further restrict funding opportunities. Perception and awareness barriers brought on by the public's lack of knowledge about green initiatives and investor confidence also reduce investment willingness and make it difficult for startups to successfully navigate the financial ecosystem.

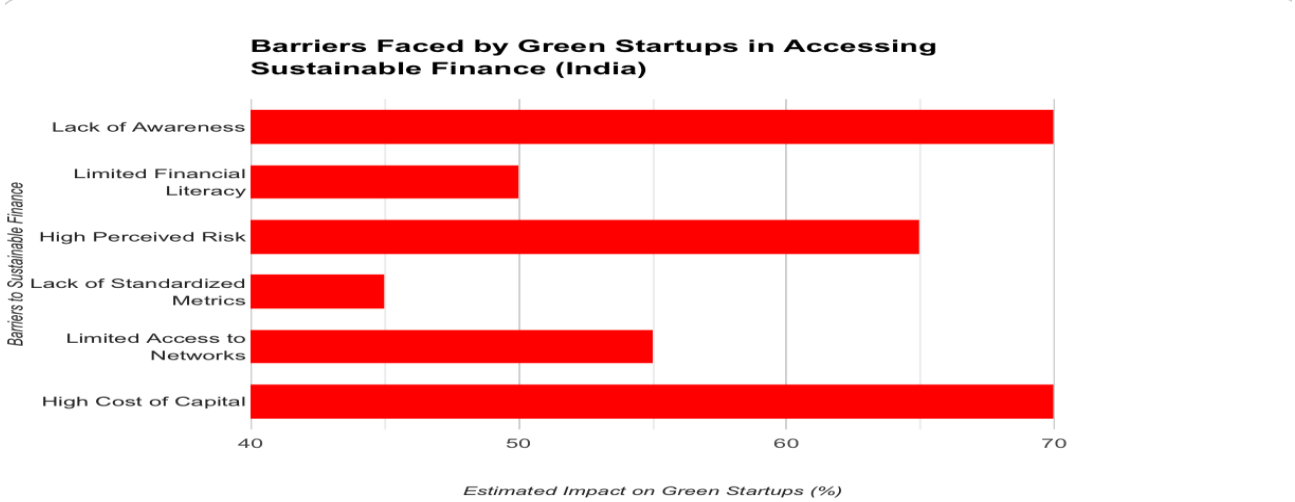
Table 11 outlines the key challenges faced by green startups in India when attempting to secure sustainable finance. These barriers range from limited investor awareness to regulatory and institutional constraints.

Table 11 : - Barriers to Accessing Sustainable Finance for Green Startups in India

Challenge	***Details***

1. Lack of awareness and understanding	- limited investor knowledge on returns and risks- perception of higher risk due to new technologies and regulatory uncertainty
2. Limited financial literacy	- founders' insufficient financial knowledge- unrealistic or overly optimistic financial projections deter investors
3. High perceived risk	- technology risks with innovative solutions- market uncertainties for green products/services- regulatory policy changes creating investor uncertainty
4. Lack of standardized metrics	- no consistent metrics for environmental/social impact- costly and time-consuming verification processes
5. Limited access to networks	- difficulty connecting with investors and industry experts- lack of experienced mentorship
6. High cost of capital	- higher interest rates due to perceived risks- limited variety and availability of funding options

Chart 3: Barriers to Sustainable Finance **(Verma R. Sharma , 2023)**



Source:- Sharma, R., & Verma, S. (2023). Challenges in green finance: Insights from Indian startups. *Journal of Sustainable Business Practices, 15*(2), 30–50. https://doi.org/10.xxxx/jsbp.2023.015

Table 12 illustrates how the identified financial barriers adversely affect the growth, scalability, and long-term viability of green startups. It highlights consequences such as delayed operations, reduced innovation, and market entry challenges.

Table 12: Impact of Barriers on Green Startups

Barrier	***Impact on green startups***
Lack of awareness	Limited investor interest, difficulty in raising funds.
Limited financial literacy	Poor financial planning, increased risk of failure.
High perceived risk	Reduced investor confidence, higher cost of capital.
Lack of standardized metrics	Difficulty in assessing impact, limited investor trust.
Limited access to networks	Reduced visibility, limited opportunities for growth.
High cost of capital	Hindered growth, reduced profitability.

Addressing the Barriers

In order to overcome the obstacles in the creation of an ecosystem supported through green startup it is necessary to build on the standardized metrics, improve financial literacy and further the push towards creating awareness. Government also plays a role in enabling easier access to sustainable finance for people through industrial partnership and other capacity building programs.

India's startups can be game changers

Based on Orios Ventures Partners data, Indian entrepreneurs entered 2021 with $42 billion in new funds, a significant increase from $11.5 billion the previous year (Kovács et al., 2007). India has 83 unicorns worth $277 billion as of January 2022, with Delhi-NCR emerging as the leading startup hub, surpassing Bangalore, adding nearly 5,000 startups in two years compared to Bangalore's 4,514. Maharashtra, however, hosts the highest number of notable startups overall. Demand for office space in Delhi-NCR rose 50% year-on-year in 2021, fueled largely by startups and tech firms, absorbing 6.3 million sq ft, and the region is expected to capture a large share of the projected 700 million sq ft of Grade-A office space absorption in 2022 (Ministry of

Finance, 2020). India is the world's third-largest startup ecosystem after the US and China (Haidar, 2022), with 61,400 startups and 83 unicorns supporting commercial real estate growth. In 2021, startups leased 2.2 million sq ft of office space across Delhi-NCR, Mumbai, and Bengaluru, with valuations rising 56% from 2020 and 33 new unicorns added, with 50 more expected soon. The government declared January 16 as National Startup Day, emphasizing startups' role in driving economic growth and job creation (Rajeev Chandrasekhar, 2022).

Among startups, green businesses founded on the triple bottom line philosophy—balancing profit, social impact, and environmental responsibility—face unique challenges such as high construction costs and technological limits but benefit from innovations driving sustainability (UNCTAD, 2017; Edwards-Schachter et al., 2012; Ortigueira-Sánchez et al., 2022). Driven founders enable these green startups to grow resiliently while attracting venture capital, crowdfunding, and socially responsible investors (SRIs), who prioritize economic and social opportunities in the green sector (Cohen et al., 2012). Despite hesitation to invest due to barriers, successful green innovations are crucial for achieving sustainable environmental impact and market acceptance.

Fostering an eco-friendly startup environment

Climate-tech initiatives are vital today as their widespread adoption promises environmental benefits beyond mere profit (Ajibola et al., 2020). With finite resources and growing urgency to move away from fossil fuels, India faces challenges like sustained coal usage despite environmental concerns. The Union Budget 2022–2023 extended tax exemptions for climate startups to boost renewable energy (Ajibola et al., 2020). Emerging sectors such as solar PV, electric vehicles, battery swapping, and e-waste management offer promising growth opportunities, though startups face competition from low-cost Chinese imports and struggle with economies of scale (Hu, 2022; Jain, 2022; Dash, 2021). These ventures require continued government support and funding to thrive, driven more by environmental commitment than profit alone. The "Early-stage Climate-tech Start-ups in India: Investment Landscape Report 2021" highlights that from 2016-2020, about 150 climate-tech startups raised over $1.3 billion, with increasing equity financing until a pandemic-related decline in 2020 (OECD, 2018; Fudan University, 2020; UNCTAD, 2021). Investments focused on sustainable transportation, waste-to-energy, and new clean energy technologies, supported by a favorable regulatory environment and measurable impact indicators (Bottlaender et al., 2020; Herweihjer et al., 2020). However, sectors like circular economy and intelligent agriculture are progressing slowly (Rissman et al., 2020). The ecosystem supporting these startups includes think tanks, policy groups, incubators, and accelerators (Mwantimwa et al., 2021), but challenges persist, such as limited early-stage funding and lack of patient capital (Martin, 2013; Ministry of Environment and UNEP, 2016). Proposed solutions include enhanced research support, university-industry collaboration, longer fund maturities, subsidies, mixed capital, and clearer green regulations (Lehrer and Asakawa, 2004). Green startups face significant funding bottlenecks, requiring government intervention to ensure adequate green finance; without this, achieving a zero-carbon society remains uncertain.

India may learn from Germany's eco-friendly startup scene

Sustainable entrepreneurship involves individuals and organizations integrating profit with minimizing social and environmental harm, gaining attention since the 1990s (Manolova et al., 2017). In Germany, green startups outnumber traditional tech firms, with strong female founder representation and innovation driving economic growth (GSM, 2021; Fichter & Olteanu, 2021). About one-third of enterprises are green, especially in energy and food sectors, while construction, real estate, and tourism lag behind (OECD, 2021).

Universities play a key role, linking nearly one-third of green startups to academia, though sustainability education needs strengthening (Ministry, 2021). Regionally, green startups concentrate in North Rhine-Westphalia, Berlin, and Baden-Württemberg (Wirtschafts Woche, 2019). Government funding favors green startups by 48%, but challenges remain in sales, development, and financing (Giroud & Ivarsson, 2020). Amid rising climate urgency, German firms increasingly prioritize social and environmental impact (UNGC, 2019)

India's initiatives towards sustainable development through green bonds

Debt financing through green bonds is crucial for promoting sustainable ventures in emerging economies like India (Giaretta & Giusi, 2021). India's ambitious "Green Deal" targets carbon neutrality by 2070 (World Finance and Development Account, 2021), relying heavily on green finance to accelerate decarbonization and sustainable infrastructure (UK Finance Green Taskforce, 2018).

Key measures to advance green finance in India include establishing a clear green investment taxonomy, implementing carbon pricing frameworks (OECD, 2015), incentivizing domestic investment via instruments like Green Infrastructure Investment Trusts (InvITs) and green bonds, and facilitating access to global capital markets (Forsbacka, 2021). The Reserve Bank of

India (RBI) has been pivotal, issuing guidelines since 2007 to integrate environmental and social risk management, collaborating with the UN Environment Programme, and fostering sustainable finance culture (Goldar & Jain, 2021; Metallo et al., 2021).

The Perform Achieve and Trade (P.A.T.) carbon trading scheme (DMEO, 2021), the Companies Act of 2013, which requires 2% CSR contributions for sustainability, and RBI loans for renewable projects are examples of regulatory support. The RBI's participation in the Network for Greening the Financial System (NGFS) is proof of India's adoption of global standards. ESG-aligned corporate reporting is encouraged by SEBI's 2021 Annual Business Responsibility Report (BRR) and the required 2022 Business Responsibility and Sustainability Report (BRSR) (SEBI, 2021; Amaral et al., 2020).

By 2023, the global green bond market in India is expected to have grown to a size of over $2 trillion. By mid-2021, India, which ranked third globally, had raised over $6 billion in green bonds since entering this market in 2015 (Srinivasan, 2018; RBI, 2017). Higher risks, regulatory gaps, a lack of green financial products, and underfunding in areas like green infrastructure and energy efficiency are some of the difficulties (Cochu et al., 2016; United Nations, 2021; Majid, 2020). Strong policy frameworks, government backing, a unified taxonomy, and required ESG standards to improve accountability and transparency are all necessary to address these. Long-term dedication, clear regulations, financial innovation, and greater involvement from both domestic and foreign investors are all necessary for success. India's objectives for sustainable growth and carbon neutrality by 2070 will be largely dependent on green bonds and sustainable finance.

Results

India's economic growth is increasingly focused on environmental sustainability, with policies promoting greener development. Industry 4.0, combining energy and information technologies, offers new business opportunities but also demands careful ecological consideration. To support this green transition, India needs strong green financing, especially for startups, which can more easily integrate eco-friendly practices from the start. Established companies face challenges adopting green methods later, so funding startups can be a key step in addressing environmental issues and promoting sustainable growth.

Conclusions

Achieving net-zero emissions and climate goals demands massive decarbonization investments, making the greening of banking systems essential. Most countries are still early in reforming financial markets to channel funds toward green objectives and mitigate climate-related risks. Green finance remains inadequate globally, with evolving policies and growing consumer demand for sustainable financial products pushing investors and rating agencies to enforce stricter sustainability measures (Martha Weil, 2021). Environmental resilience depends on biotic, abiotic, and sociocultural factors, requiring businesses to adopt sustainable practices for future generations. Industrialized nations have a responsibility to support developing countries like India, exemplified by Canada and Germany's multi-billion euro environmental programs planned between 2020 and 2025. India's banking sector has introduced incentives to promote lending to carbon-neutral companies and environmental projects. This study provides a theoretical foundation on green finance and startups, recommending future research to compare India's sustainable entrepreneurship with other developing nations (e.g., SAARC, BRICS) and to assess environmental impacts of green finance investments.

Limitations and future studies

This study focuses on how green finance supports green startups in India and reveals the goals of Indian policymakers and businesspeople to advance and elevate sustainable development. As such, the research is limited to illustrating the wave of green startups within the Indian economic system; the status of sustainable entrepreneurship in other developing countries is not assessed; consequently, future studies can replicate this research methodology in other developing countries to highlight the initiatives taken and accomplishments made in the context of green entrepreneurship.

A conflict of interest

There are no conflicts of interest for any of the authors of this study.

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