



Research article

A wave of green start-ups in India—The study of green finance as a support system for sustainable entrepreneurship

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Abstract: Development of the economy cannot be done at the cost of deterioration of ecology. Green finance is the most practical way of economic development and ecological development. To tackle the urgent challenges of climate change, several summits and conferences have adopted a sustainable development framework for their action plans. The 2030 Sustainable Development Goals (SDGs) are a unique collection of seventeen time-bound goals that strive to balance the three sustainability objectives of economic, social, and environmental sustainability. This research has been carried out to assess the present status of green finance in India and see its impact on startups. A green startup's success probability and importance are explained with specific case studies. By extracting the data from various published reports, it has been found that government initiatives are turning green by providing green finance, and Indian startups are exploiting this opportunity by the implementation of sustainable entrepreneurship. India has been on a path toward green project finance for some years now, and significant adjustments have been made to the country's financial sector to embrace ecologically friendly methods. Businesses are the economy's engine, and adopting sustainable business practices is critical for reaching carbon neutrality.

Keywords: green finance; green economy; climate change; sustainability; startups; entrepreneurship

JEL Codes: G21, Q56, R11

1. Introduction

Sustainable development is a significant idea in environmental law that aims to balance economic growth and environmental conservation (Harris and Harris, 1997). To tackle the urgent challenges of climate change, several summits and conferences have adopted a sustainable development framework for their action plans (Tang et al., 2010). The 2030 Sustainable Development Goals (SDGs) are a unique collection of seventeen time-bound goals that strive to balance the three sustainability objectives of economic, social, and environmental sustainability (Bengtsson et al., 2018). Sustainability has become a catalyst for growth across all sectors of the economy. The financial industry, in particular, has been scrutinized for its contribution to environmental sustainability (Grabosky, 1994). In this context, “green finance” has become a popular subject of discussion among corporations worldwide. Green financing refers to all governmental and private organizations that offer financial help to projects promoting sustainable development. Climate change, renewable energy, environmental pollution, deforestation and carbon neutrality are just a few of these endeavors. However, each nation’s economy determines the environment in which green finance is relevant. While developed countries have the economic means necessary to support sustainability-oriented activities, developing countries confront several obstacles in financing their national objectives. The demand for green financing in the Association of Southeast Asian Nations is expected to reach three trillion US dollars by 2030. In 2009, during the United Nations Climate Summit in Copenhagen, wealthy nations promised to provide hundreds of billions of dollars in assistance by 2020 for climate change adaptation and mitigation activities. However, the objective has not been met. At CoP 26, the importance of wealthy countries financially assisting developing countries was reaffirmed. This essay will explore how a developing country like India is moving closer to green financing. Hence, it necessitates the introduction of green business model innovations to promote start-ups (Guo et al., 2022) in India.

Banks and non-bank financial businesses have historically provided the most funding for renewable energy (Bédard-Pagé, 2019). On the other hand, banks are hesitant to play a significant role in providing long-term finance for renewable energy projects since the possibility of an asset-liability mismatch burdens them (Taghizadeh-Hesary and Yoshino, 2020). Due to legislative constraints, the long-term funds available to insurance and pension funds in India are insufficiently channeled to satisfy the debt requirements of the renewable energy industry (Della Croce and Yermo, 2013).

As a result, existing traditional financing sources are insufficient to support capacity addition (Borghi et al., 2006). Given the enormous financial requirements of the renewable energy sector, there is an urgent need to identify alternative financing sources to supplement and expand renewable energy sector financing channels (Byrnes et al., 2013).

Green bonds are debt securities used to finance renewable energy initiatives. Companies that issue these bonds must spend the proceeds only in environmentally beneficial endeavors, such as renewable energy, waste management, clean transportation and sustainable land use (Rosembuj and Bottio, 2016). The introduction of green bonds will address the financial problems that have hampered the development of these “green” projects in the rapidly developing renewable energy industry (Banga, 2019).

India has ambitious aspirations for renewable energy installations, but financing and associated costs have been a significant impediment (Shrimali et al., 2013). India has set an ambitious goal of doubling its renewable energy capacity to 175 gigawatts by 2022, from slightly over 30 gigawatts presently. This will need a significant investment of US \$200 billion (Shrimali et al., 2013). This is not

an easy task. Compared to the United States and Europe, India's higher interest rates and unappealing conditions for borrowing increase the cost of renewable energy by 24–32 percent (Lewis, 2015).

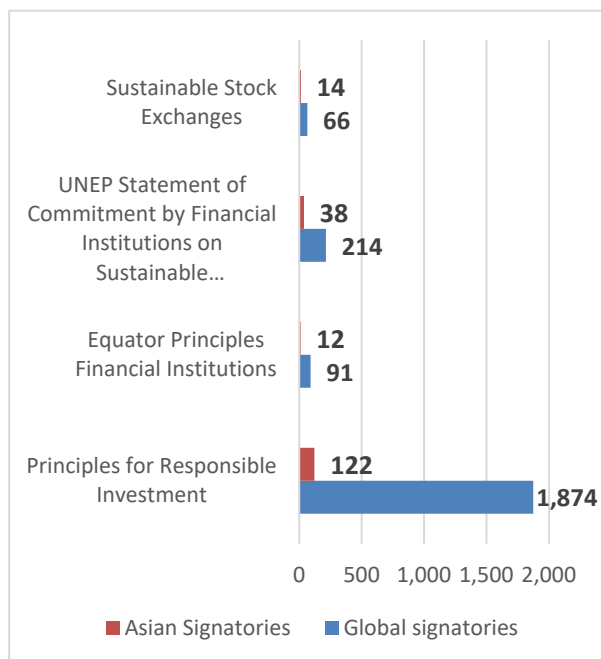


Figure 1. Participation of Asian Financial Institutions in Global Initiatives (Volz, 2018).

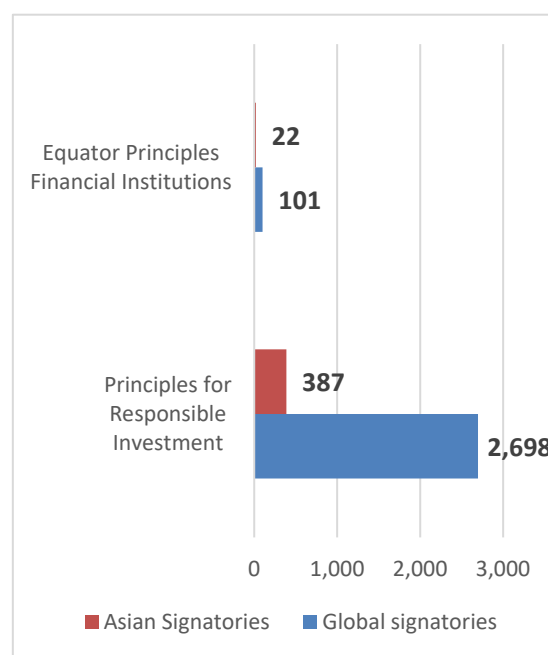


Figure 2. Participation of Asian Financial Institutions in Global Initiatives (As at end of 2019).

Notes: Asia includes Australia and New Zealand; Includes 3 from India: SBI Funds Management Private Limited, Equicap Asia Management Private Limited and Indus Environmental Services Pvt. Ltd. SOURCE-Volz, U. (2018, March). The latest information is collected from the programs' websites.

Climate change has been a priority for the G20 since its inception in 2008; however, the emphasis has shifted more recently to the circular carbon economy (CCE) to mitigate damaging emissions (Alsarhan et al., 2021). There are various flagship programs to expand global awareness and finance for green activities. These programs incentivize financial and non-financial enterprises to include environmental factors in their financing decisions (Durrani et al., 2020). Major flagship programs such as the Principles for Responsible Investment (PRI), the Equator Principles (EP) for financial institutions, the United Nations Environment Program (UNEP) and the Financial Institutions Statement of Commitment to Sustainable Development all suggest ways for signatories to implement green finance. Numerous Indian entities are signatories to these programs (Figure 1). However, ensuring a steady flow of finance into sustainable projects is possible only if there is a reliable source of information on the entities' overall management of environmental and social risks, as well as a track record of the entities identifying opportunities that provide a reasonable rate of return and environmental benefits (UNEP) (Rynes, 1989). In this regard, the Sustainable Stock Exchange initiative encourages stock exchanges in signatory countries to develop stock price indices that track the stock performance of a select group of companies operating in these countries that are pioneers in incorporating Environmental, Social and Governance (ESG) principles into their financial operations

(Klagge and Zademach, 2018). These indexes are intended to assist investors interested in investing in environmentally friendly enterprises (Waddock, 2008). Two of India's largest stock exchanges, the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE), are involved in this endeavor and produce their ESG indexes.

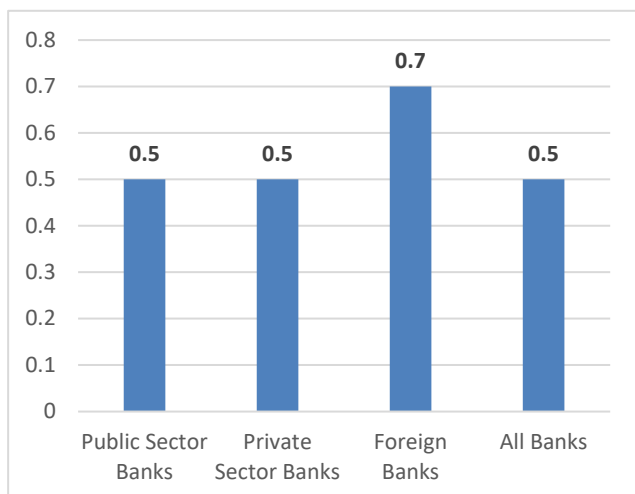


Figure 3. As percent of total bank credit (excluding personal loans). **Source:** BSR, RBI, Authors' calculations.

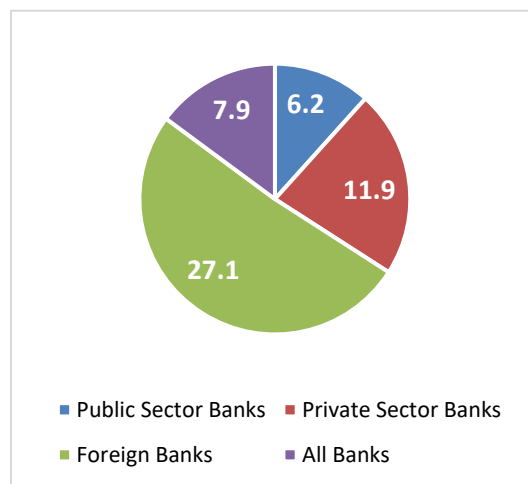


Figure 4. As percent of power sector credit. **Source:** BSR, RBI, Authors' calculations.

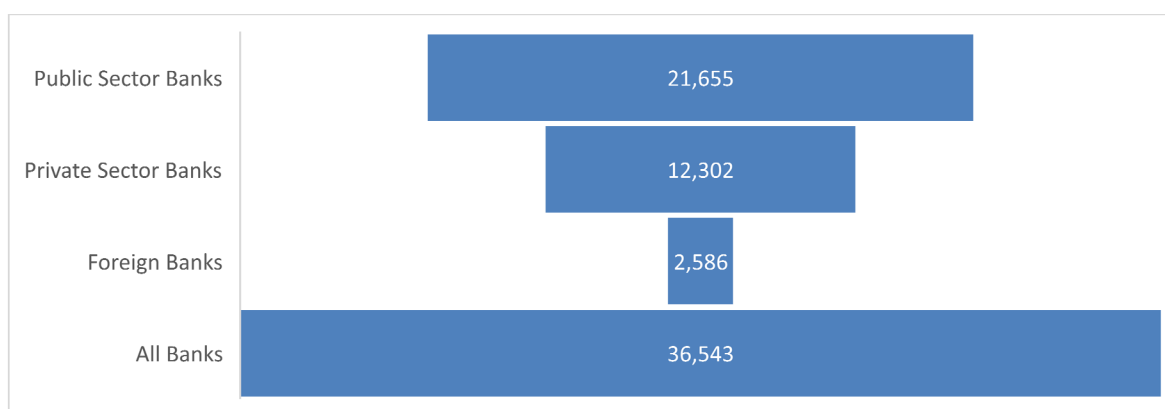


Figure 5. As percent of total bank credit (excluding personal loans). **Source:** BSR, RBI, Authors' calculations.

Figures 3–5 show Bank Credit Outstanding to Nonconventional Energy as in March 2020. The Reserve Bank of India included the small renewable energy industry in its Priority Sector Lending (PSL) plan in 2015 as part of its green financing push. As of the end of March 2020, the total outstanding bank credit to the non-conventional energy industry was around 36,543 crores, accounting for 7.9 percent of total outstanding bank credit to the power production sector (Figure 4), up from 5.4 percent in March 2015 (Figures 3–5). Commercial banks' exposure to non-conventional energy differed significantly among bank groups (Figures 3–5) and throughout India's primary states.

The emerging concept of a green startup has gained momentum because of the rising awareness campaigns for sustainable development. Also, after looking at the impact of lockdowns because of Covid-19 (Chopra et al., 2022), this topic has gained the attention of many researchers. Looking at the need and urgency to introduce sustainable development for a nation's progress, all major nations have laid out policies in terms of green finance to elevate sustainable entrepreneurship. Since it is an emerging topic, nothing much has been researched. Hence, there is a research gap, particularly for the Indian economy, which has become one of the most politically strong nations among the world's major forces. This paper is an attempt to fill the same. Hence, this topic is researched to reckon the present status of green startups in India. This nation has recently shown significant growth in the number of unicorns, a jump in export value and other economic aspects related to business growth. Moreover, it endeavors to assess and compare India's performance in sustainable entrepreneurship with the country which has performed better in terms of green startups.

After reading this paper, the reader will assess how the change in the industrial revolution of India is interjecting the idea of green manufacturing to enable India to move on the path of sustainable development. It will also highlight how the goal of making the economy green can be achieved by accentuating green finance. The triumph of green manufacturing as a segment of the new industrial revolution (Industry 4.0) can be achieved by fostering a conducive economic environment for startups, as they can be game changers. With India being a developing country, the range of growth businesses, especially startups, is relatively high. Hence, by covering all such aspects, this paper will analyze India's present status in promoting sustainable entrepreneurship and suggest some modifications for improving the green startup ecosystem.

2. Important definitions

A. Green Finance—The term “green finance” refers to any kind of organized financial activity that is designed to improve the environment. A variety of loans, financing instruments and investments are included in this program in order to promote the development of environmentally friendly projects or to reduce the climatic effect of more conventional ones.

B. Green Startup—As the name implies, a green (startup) firm provides goods and services that aid in creating a more sustainable environment. In a sustainable world, current demands are addressed without jeopardizing the capacities of future generations to satisfy theirs. Because of this, a green company is often known as a long-term company. It can also be described as a corporation that does not harm the environment, economy or local community in any way whatsoever.

C. Sustainable Entrepreneurship—Sustainable entrepreneurs are people or firms that use their primary operations to contribute to sustainable development. A sustainable entrepreneur develops and implements sustainable ideas for the mass market, which benefits the greater community as a whole. When it comes to creating new goods, services, industrial methods, techniques and organizational models that positively influence the environment and society, sustainable entrepreneurship is opportunity oriented.

D. Green Bond—It's a fixed-income instrument designed to generate funds for environmental and climate change initiatives. If the issuing company's balance sheet backs these bonds, they are likely to have the same rating as its other financial obligations. Green bonds have been referred to as climate bonds since the first decade of the 21st century; however, the two concepts are not necessarily synonymous.

3. Industry 4.0 and green finance

Industry 4.0, also known as the fourth industrial revolution, is widely regarded as a major step toward integrating and upgrading industries via the use of new technology (Sanders et al., 2016). Industry 4.0 methods have recently been developed to promote the circular economy and greener manufacturing aims while maximizing production efficiency (Awan et al., 2021). Industry 4.0 is a concept that intends to optimize production and eliminate waste creation, hence supporting the circular economy vision and sustainability elements. The circular economy's objective further converges with the notion of a green economy on economic and environmental levels. The shift to a green economy includes the efficient and effective use of natural resources, energy and new technology, resulting in economic development and employment creation. Adopting a green economic model may be successful if there is a global commitment and a strategically established framework for global investment that includes developing and developed nations (Awan et al., 2021). Industry 4.0, via digitalization of processes and innovation, has the potential to play a critical role in ensuring long-term development. It is also crucial for the successful expansion of green finance. Its components may help guarantee effective processing in businesses, which can help mitigate financial risks associated with environmentally friendly enterprises (Garcia-Muiña et al., 2018). It may also contribute to the advancement of financial system technology, resulting in increased system openness. The research provides an overview of both ideas and the common features that connect them to address the barriers to their acceptance (Chen et al., 2008).

4. Green economy and green finance

Pearce et al. (2013) introduced the notion of the green economy in their study "Blueprint for a Green Economy." The paper assessed the research and policy recommendations on several methods for environmental service value. Not only has environmental preservation gained prominence since then, but the emphasis has shifted to more effective resource exploitation and sophisticated resource consumption. The green economy is fueled by specialized policies aimed at eliminating or lowering ecologically detrimental subsidies, developing a market for ecosystem products and services and enabling institutions via the provision of market-based incentives, opportunities and enabling institutions. According to Babonea and Joia, the term "green economy" refers to a multifaceted notion that focuses on the economy and the environment (Vargas-Hernández, 2020). It is predicated on four fundamental principles: equality, ecological scarcity, environmental danger and human well-being. Green finance is motivated by the desire to move toward a green economy. As defined by the G20 research group, green finance is "the financing of initiatives that generate environmental advantages within the framework of ecologically sustainable development" (Ali et al., 2021). These environmental benefits include reductions in air, water and land pollution, reductions in greenhouse gas (GHG) emissions, increased energy efficiency while maximizing the use of available natural resources and mitigation of and adaptation to climate change, as well as their associated benefits. It is a stepping stone toward resolving many environmental concerns and bringing economies together on a sustainable path (Haines et al., 2007). If India wants to focus on making its economy green, it must focus on promoting green finance for developmental activities. Glancing at rising environmental issues, that country must take steps to scale up sustainable development initiatives.

5. India's startups can be game changers

According to research by Orios Ventures Partners, Indian entrepreneurs are expected to raise \$42 billion in 2021, up from \$11.5 billion the previous year. Additionally, the Indian government has designated 14,000 new enterprises for recognition in 2021 (Kovács et al., 2007). India now has 83 unicorns with a combined worth of \$277 billion as of January 2022. According to the latest Economic Survey 2021–2022, Delhi-NCR has surpassed Bangalore as India's new startup hub. Delhi-NCR added almost 5,000 recognized startups in the previous two years, while Bangalore added 4,514. However, Maharashtra has the most recognized startups, with 11,308 in total. In 2021, demand for office space in the Delhi-NCR area increased by 50% year on year, mainly owing to high absorption by startups and technology enterprises. In 2021, the office space sector will absorb 6.3 million square feet, while startups will absorb 1 million square feet (Ministry of Finance, 2020). By 2022, it is predicted that absorption of Grade-A office space would approach 700 million square feet, with Delhi-NCR accounting for the lion's share of this demand. Delhi-NCR increased by 35% yearly, from 3.88 million to 5.23 million square feet. The Dwarka Expressway will exacerbate this need. India has developed into the world's third biggest startup ecosystem, behind the United States and China (Haidar, 2022).

India's 61,400 startups and 83 unicorns are all ready to inject a boost into the country's commercial real estate industry over the next few years. In 2021, startups rented around 2.2 million square feet of office space in India's top three metros—Delhi-NCR, Mumbai, and Bengaluru—a 56 percent increase over 2020, coinciding with a flurry of \$1 billion-plus valuations. In a single year, India added 33 unicorns. Numerous sources currently indicate that India may soon add another 50 unicorns. Prime Minister Narendra Modi's announcement of the 16th of January as National Startup Day has infused fresh energy into companies. Rajeev Chandrasekhar, Union Minister of State for Electronics and Information Technology, Skill Development and Entrepreneurship, recently stated that the Indian economy's growth and expansion in job creation and investment would be primarily driven by the country's startup and entrepreneurial ecosystem over the next 25 years. The NCR-Gurgaon and NPR corridors will be big draws for investors, and with the completion of the Dwarka Expressway, demand for residential and commercial space is projected to skyrocket.

Social entrepreneurship fosters the development of a green sector that contributes to the resolution of environmental issues by creating new solutions (Edwards-Schachter et al., 2012). Certain businesses become green to mitigate environmental damage or get customer support. From energy sharing and ride sharing to commodities trading, green entrepreneurs can challenge any industry. This article examines the top three green startups identified by Cision PR Newswire in March 2020. These green firms have established their businesses on the foundation of a larger, more sustainable world. Green companies use technology to develop environmentally sustainable goods and promote social good. Green companies confront distinct obstacles in acquiring the proper investors and competing with entrepreneurs that are only focused on development (UNCTAD, 2017).

Nonetheless, some have achieved enormous success. The credit for this growth goes to the innovations that have been shown by the businesses to drive them on the developmental path (Ortigueira-Sánchez et al., 2022). Three green companies are profiled briefly here. Green businesses confront extra obstacles due to their intrinsic triple bottom line philosophy, which includes social responsibility, economic value and environmental impact. However, these companies often have founders with enthusiasm and drive to overcome obstacles, and they may scale rapidly while contributing to humanity's and the planet's health. Green firms attract venture capitalists and secure

additional money from socially responsible investors, green investors and popular crowdfunding platforms. Socially responsible investing (SRI) is an investment strategy that focuses on firms that explore socially aware economic possibilities, such as those in the green sector (Cohen et al., 2012).

The major tribulation encountered by entrepreneurs is regarding the scaling up of eco-startups. They hesitate to step forward in green projects because of various impediments like availability of technology, high cost of building products, innovations, etc. However, once the product is successfully designed, innovations can help make the environment sustainable. Then, with aggressive marketing of the product's benefit, it can be made acceptable in the market. Hence, innovations to make the environment clean and sustainable are required to make the product reach its utility value. One of the examples of innovation in eco-products is given below:

Case Study—Conversion of auto-rickshaw into green: Reflecting spirit of green startups in India

A Former Tesla Employee is Attempting to Make Indian Autorickshaws 100% Green.

Zero 21 Renewable Energy Solutions, a Hyderabad-based firm formed by former Tesla employee Rani Srinivas, manufactures inexpensive electric conversion kits for outdated petrol/CNG autorickshaws in less than three hours. The Delhi government appointed six makers of electric conversion kits in December 2021 to convert older petrol and diesel cars that cannot be driven on city streets into electric vehicles (EVs). The International Centre for Automotive Technology (ICAT), a testing, certification and research and development organization, has authorized these kits. Zero 21 Renewable Energy Solutions of Hyderabad is among the six manufacturers, a startup that created the ReNEW Conversion Kit. This e-kit enables both diesel and compressed natural gas-powered three-wheelers to make the switch to electric. The firm was founded in late 2017 by Rani Srinivas, a former Tesla Motors employee. Its objective is to harness “new technology and experienced skills to provide a diverse variety of battery-powered three-wheelers.” This commercial transport vehicle has a ten-year life expectancy. The Smart Mule can carry weights of up to 350–400 kg. Powered by a 130 (160) Ah lithium ferrous phosphate (LFP) battery, it ranges 120–130 kilometers on a single charge in all road conditions with 200 traffic stops, a peak power output of 2000 W and a maximum speed of 30 kilometers per hour. Among our clients are businesses that provide last-mile delivery of cooking gas, water cans and things from mom and pop stores, as well as e-commerce businesses.

Additionally, they built Smart Mule passenger cars, which commuters in Hyderabad use to link from metro stations to their homes. They provide a steady ride regardless of the road conditions. The Smart Mule X is next generation of the Smart Mule. It is nearing completion, and it will gain certification within a few months. It is capable of transporting a 1-tonne payload. Given India's increasing EV revolution, it is critical to consider what will happen to the many IC-engine cars already on the road. This is where the critical subject of electric car retrofitting comes into play. Aren't they increasing traffic congestion by adding extra vehicles? One cannot reduce pollution until the number of automobiles on the road is limited. Existing IC-engine or CNG-powered cars can be converted but the Delhi government must stop the conversion of older automobiles to electric vehicles, since more vehicles on the road would exacerbate our difficulties. Instead, primary focus should be conversion of public transport like autorickshaws. There are millions of auto-rickshaws in India. Unless you begin converting them, we will be unable to meet our 2030 objective of EV sales, accounting for 30% of private automobiles, 70% of commercial vehicles and 80% of two- and three-wheelers. Converting a three-wheeler from CNG/diesel to electric utilizing the company's ReNEW Conversion Kit takes around 3–4 hours. The procedure removes the engine, gearbox and diesel or compressed natural gas tank and replaces them with a controller, motor and battery backup.

The above case study is a classic example of how collective efforts of government and innovators can create synergies in the outcome. This is the learning for every Indian state and other countries, that if the government can act as a trigger to initiate innovation, there will be a chain reaction of achievements in new technology fields. Also, autorickshaw drivers must be motivated to switch from diesel-run autos to electricity-run vehicles. It is not easy for a driver to dump their old vehicle and purchase a new one because it is an enormous capital investment. So, the solution is to convert the old vehicles into e-vehicles. This case study shows the practical implications of the answer for tackling reluctant behavior for adaptability to new technology by the masses.

6. Fostering an eco-friendly startup environment

The proliferation of climate-tech efforts prioritizes the environment above profit; there is a need to mainstream them (Ajibola et al., 2020).

Given India's promises at COP26, it was believed that the Union Budget 2022–2023 would give the renewable energy industry a much-needed boost. Among the incentives agreed last week in Parliament was a tax exemption renewal for climate startups and their equivalents in other industries for another year. Notably, the advent industrial landscape now includes green startups (Ajibola et al., 2020).

Solar energy, photovoltaic (PV) manufacturing, electric cars, battery swapping, electronic trash and reverse logistics will almost certainly help startups not only find their feet but also dig in their heels to contribute more to climate mitigation efforts. However, they need an enabling environment and funding to advance their company concepts. As Abhishek Jain, Fellow and Director, Council on Energy, Environment and Water Livelihoods, put it, “Many fledgling firms struggle to compete with low-cost Chinese imports of electronics, controllers, and motors that are critical for diverse cleantech applications.” By incentivizing tiny, fledgling startups with a reduced GST rate, some of them may become more competitive until they acquire economies of scale (Dash, 2021).

6.1. Current trends that will redefine the future of the startup ecosystem in India

While many startups in the industry are still in their infancy, many were developed out of new ideas, cutting-edge technology advancements, out-of-the-box thinking, a love for problem-solving and a desire to be self-employed. These for-profit enterprises need funding and the appropriate governmental backing to succeed. Their dedication to climate mitigation often takes precedence over their desire to profit. The recent publication “Early-stage Climate-tech Start-ups in India: Investment Landscape Report 2021” by Impact Investors Council, Climate Collective and consultants Arete Advisors looks into these concerns and guides how to create a more favorable climate (OECD, 2018).

The analysis examined climate-tech startups over five years beginning in 2016 and found that 120 of them raised more than \$200 million in capital from 272 investors. Between 2016 and 2020, the startups raised a total of \$1.3 billion in equity funding. Between 2016 (18 agreements; \$102 million) and 2019 (58 deals; \$506 million), the industry's number and value of stock deals increased steadily before declining in 2020, owing to the pandemic (UNCTAD, 2021).

Additionally, the researchers discovered that a significant portion of funding went to startups focused on mobility and energy. “The most investment activity has been in sustainable transportation (including electric vehicle manufacturing, clean logistics and new components) (84 agreements; \$705 million). This is followed by energy (which includes clean energy production from novel feedstocks,

energy access, energy storage and energy optimization products), which witnessed 44 agreements worth \$301 million,” the study said, citing a “favourable regulatory climate and easy-to-measure impact indicators” (Herweijer et al., 2020).

However, industries like waste management, the circular economy, intelligent agriculture, biodiversity, forestry, green hydrogen and carbon capture have evolved at a slower rate and are just now coming of age. Though several creative startups have emerged, they need mainstreaming, often with novel technology or solutions based on artificial intelligence or the Internet of Things (IoT) (Rissman et al., 2020).

6.2. *The need for “patient capital”*

Along with the increase in startups, the research stated, there has been a fast development of an enabling ecosystem composed of incubators and accelerators, policy advocacy organizations and think tanks (Mwantimwa et al., 2021).

However, there were obstacles as well. For example, the sector accounted for just 9% of overall impact investing flows (which include financial inclusion, healthcare, agriculture, education and others). The transactions were “early-stage” and modest in size. Around 68% obtained seed money, while 83% of agreements were less than \$5 million (Martin, 2013).

According to a poll of investors and entrepreneurs, both parties identified “a lack of patient capital” as a weak link. They believed that “various structural interventions might assist in transitioning this sector from a specialized, specialist asset class to a more mainstream component of the country’s venture capital and impact investing ecosystems” (Ministry of Environment Land and Sea Italy and United Nations Environment Programme, 2016).

The paper advocated for tailored assistance for deep scientific and technology startups through dedicated centers of excellence, specialized entrepreneur support organizations and more academia-industry collaboration. Additionally, they need assistance in establishing market connections, with the government serving as the primary buyer and corporations as secondary purchasers. Extended fund tenures, grants and blended capital were required on the financial front. Topping it all off, legislation and regulation were required to subsidize and incentivize green activity, green development and green goods (Lehrer and Asakawa, 2004).

The case study discussed above shows that, if an entrepreneur can identify the business segment supporting sustainable development and if the founders have expertise in the field, funds can be raised from different sources. The business mentioned in the case will not be able to achieve its vision in the absence of capital, which it managed to arrange from other sources. However, like with Nishchay Chadha and Vipin Tyagi, not every green business has an angel investor. They can raise the funds because of their experience in the given field. So, this created an urge for government support to green startups to push them initially to help them take off from the runway. The case study shows that funds are required in massive amounts to scale up the business. Hence, where there is a deficiency of induced investment, necessary arrangements by the government in terms of green finance must be made. If adequate availability of green finance is not made, then achieving a carbon-neutral economy will remain a pursuit only.

Case Study—Development of funding ecosystem for green startups: A case study of Ace Green Recycling

Ace Green Recycling, a technology firm focused on battery recycling, has secured more than \$7 million in a fundraising round headed by Circulate Capital. Nishchay Chadha and Vipin Tyagi formed it with over 25 years of expertise in the metals and recycling industries. Along with angel investors, Climate Angels participated in the round. So far, the business has received around \$10 million, including this round.

The business claims to have developed the world's most efficient and clean lead-acid battery recycling technology and is now focused on developing fossil-fuel-free lithium-ion battery recycling technology. Unlike traditional recycling processes that require smelting, ACE functions at room temperature, produces no air pollutants or effluents and significantly decreases heavy metal emissions, the company stated. Lead and lithium-ion batteries are utilized in various applications, including automobiles, telecommunications, power production and data centers. With the rapid growth of the electric car sector in India and worldwide, ecologically friendly battery recycling will become even more critical, since conventional battery recycling may be a severe environmental polluter. The firm operates a recycling facility in the National Capital Region of New Delhi and wants to expand into overseas markets, including Thailand.

Additionally, it is considering Vietnam and Dubai. The firm has a worldwide clientele and just inked an agreement with India's Massive Mobility. Additionally, the cash will be used to advance the company's lithium-ion recycling technology. "At ACE Green, our mission is to guarantee that the battery recycling sector makes a constructive contribution to achieving sustainable global electrification. The company claims to be optimistic that with the backing of impact investors such as Circulate Capital and Climate Angels Fund, we will become an industry leader over the next five years," stated Chadha, co-founder and CEO of ACE Green Recycling. It intends to expand its staff of 30 individuals—spread throughout India, the United States and Singapore—to 50 over the next three months. The firm generates income by licensing its plug-and-play technology and operating its plants.

7. Lessons for India, from Germany's green startup ecosystem

Sustainable entrepreneurship is fundamentally the commercialization of sustainable technologies targeted at the mass market and benefiting society. Sustainable entrepreneurs are individuals or enterprises that contribute to sustainable development via their primary operations. Sustainable entrepreneurship is opportunity-driven and focuses on developing new goods, services, manufacturing processes, methods and organizational forms that significantly minimize social and environmental consequences while also improving quality of life (Schaltegger and Wagner, 2011).

According to the current Green Startup Monitor (GSM), issued March 3, the green startup ecosystem is increasingly greener, is more inventive and has a higher proportion of female founders than the conventional startup ecosystem. Green entrepreneurs are accelerating the development of the German economy toward a climate-neutral society, owing to their exceptional inventive potential (Fichter and Olteanu, 2021).

According to the Green Startup Monitor, green startups have become a critical component of the German startup ecosystem, with almost one in every three German firms being green. So-called transformational green startups—businesses that combine a sustainable emphasis with a growth mindset in order to disrupt value chains and markets—are particularly becoming an increasingly

essential element of the green startup ecosystem (Manolova et al., 2017). They do so by responding to the problem of transforming the German economy sustainably via fundamentally new entrepreneurial approaches to solutions that are more imaginative and technology-oriented than typical startups. German universities serve as a critical launching pad for ecological ideas. Almost a third of all green startups are in the research and development sector (Teitel, 2000).

Sustainability has become a primary objective for a large number of firms in Germany's startup ecosystem. As a result, it's unsurprising that the encouragement of solutions to address climate change is the most often requested policy objective of German entrepreneurs (Kuckertz et al., 2020). Additionally, it is obvious that green entrepreneurs are especially active in industries that are climate-sensitive: Over two thirds of all startups in the energy and food industries are environmentally friendly. Although green startups are present in practically every area of the German economy, other climate-sensitive sectors such as construction and real estate, which account for 25% of green startups, and tourism, which accounts for 18% of green startups overall, urgently need to catch up (OECD, 2021).

Additionally, green companies are pioneers in terms of diversity. At 21%, the percentage of female founders is much greater than in the overall startup environment. Likewise, financial service providers are subject to the same regulations. Startups in the banking, finance and insurance sectors are not generating enough momentum for the implementation of the EU's and German government's Sustainable Finance Strategy (UNGC, 2019).

Germany's dense network of world-class universities is the source of countless innovative green businesses. Almost a third of all green startups are in the research sector. Green founders often meet at universities (40%) (McKinley Global Institute, 2016). The percentage of founders with an engineering degree is much greater (29%) in green firms than in non-green startups (20%). While three out of four founders have benefited from advisory services and financial help such as EXIST financing, there is still a significant need to increase this support and to develop curricula that include sustainability as a cross-cutting theme in the learning process (Ministry, 2021).

As previously said, green startups make for a significant portion of all startups in Germany. However, substantial geographical disparities exist in terms of the total percentage of green startups in an area and the numerical distribution of startups in Germany, which also provide insight into the ideal place for international businesses wishing to launch a green company in Germany. While Mecklenburg-Vorpommern has a disproportionately high proportion (34% of all green businesses in the state), it only accounts for 2% of all green startups in Germany. North Rhine-Westphalia has the most green startups (19%), followed by Berlin (17%) and Baden-Württemberg (17%). There is a need to catch up in Brandenburg, Thuringia and Saxony-Anhalt, which each have less than 1% of all startups (Amelang, 2019).

The most significant problems for green companies are sales and client acquisition (63%), followed by product development (44%), access to financing (37%) and cash flow/liquidity issues (37%), respectively. Raising finances has historically been much more difficult for green entrepreneurs than for their non-green peers. In 2021, this will no longer be the case. Staff recruiting grows increasingly critical for both categories year over year—but green companies have less obstacles in this area. As in prior years, green businesses get 48% more government investment than non-green startups (42%) (OECD, 2015).

Along with fostering innovation to tackle climate change (62%), the three most pressing requests green startups make of policymakers are to simplify and target the granting of public contracts to startups (38%) and to streamline administrative services (35%) (Giroud and Ivarsson, 2020).

With accelerating climate change and other significant sustainability concerns, there is now widespread political agreement that a fundamental move toward a carbon-neutral economy and consumption is inevitable. According to the GSM, it is critical for almost three quarters of German businesses to have a good social or environmental effect. As a result, German startups serve as advocates for economic development on a sustainable basis (GOK, 2020).

8. Green bonds for sustainable development—India's efforts

Debt financing through green bonds is a significant determinant for launch and growth of a green startup (Giaretta and Giusy, 2021). India has begun its road toward carbon neutrality and has proposed a “Green Deal” to be implemented by 2070 (World Economic Forum, 2021). Green financing has been identified as a critical facilitator of decarbonization acceleration in the Green Deal (UK Green Finance Taskforce, 2018). It emphasizes increasing financial flows from both the national government and the private sector to create green infrastructure. It has identified four critical areas of attention to aid in accelerating green financing in India. To begin, a well-defined taxonomy paves the way for creating green initiatives and reducing transaction costs. Second, it is important to develop a framework for carbon pricing in India (OECD, 2015). Carbon pricing will guarantee that the costs of climate change mitigation and adaptation options are included in mainstream investment decisions. Third, it is important to use domestic investments by adding Green Infrastructure Investment Trusts (InvITs), including bond markets and green financing instruments. The final area is gaining access to global markets by reducing prevarication costs, establishing standards for external borrowing and removing any other legislative impediments to green finance in India (Forsbacka, 2021).

The Indian financial industry, particularly the banking sector, has been at the forefront of green finance growth. The Reserve Bank of India (RBI) issued a notice in 2007 emphasizing banks' significance and the need to pursue sustainable development. The Equator Principles were mentioned in this context, giving a framework for identifying, managing and evaluating risks to the environment and society while monetizing projects. In 2016, the RBI had the chance to produce a study on sustainable financial systems in partnership with UNEP and India (Goldar and Jain, 2021). The research delves into several aspects of India's financial systems and their role in promoting green financing. Moreover, an entrepreneurial mindset has a significant impact in the creation of new ventures in any country (Metallo et al., 2021). The Firms Act, 2013, requires major capital companies to contribute 2% of their annual revenues to Corporate Social Responsibility (CSR) initiatives such as environmental sustainability, ecological preservation, healthcare, rural development and education. The Indian government has proposed many plans and grants to encourage businesses to adopt more environmentally friendly practices. Carbon trading has been included in the country's policy framework through the “Perform, Achieve and Trade” plan (DMEO, 2021).

Additionally, the government has placed a premium on sectoral growth, particularly in the renewable energy industry, as part of its objective to transition to green energy. Additionally, the RBI has facilitated loans for renewable energy projects by businesses up to Rs. 15 crores and private persons up to Rs. 10 lakhs. In 2021, RBI became a member of the Network for Greening the Financial System (“NGFS”), a group of nationalized banks committed to advancing the transition to a green economy via measures that minimize environmental and climate-related risks.

SEBI has repeatedly issued numerous sustainable reporting criteria to encourage businesses to adopt sustainable practices. The first framework for reporting was the “Annual Business Responsibility

Reporting,” which was based on voluntary national criteria. One of the principles’ fundamental components was constructing a system for environmental management by enterprises that might discourage firms from causing environmental damage while conducting official activities. The “Business Responsibility Report” is another reporting format that tries to sustain businesses. The framework establishes a disclosure model that firms may use to assess their performances in the reporting categories. The “environment” concept has eight principles that the business must follow (SEBI, 2021). These include the proportion of recyclable materials used, total energy consumption, energy-saving methods and the amount of energy saved, water consumption and the amounts of water saved and recycled, greenhouse gas emissions and reductions, water treatment prior to discharge and biodiversity restoration. SEBI made a giant step forward in 2021 when it introduced the “Business Responsibility and Sustainability Report” (BRSR) to improve disclosure under the Environment, Social and Governance (ESG) criteria. BRSR is essential for the top 1,000 enterprises in 2022–2023. The BRSR framework is based on internationally recognized ESG standards, such as the Global Reporting Initiative (GRI), and includes qualitative and quantitative data. It is anticipated that ESG data in NIFTY 50 represents 40% of private enterprises, with a primarily positive track record (Amaral et al., 2020).

By 2023, the World Economic Forum estimates that the market for green bonds will be valued at more than two trillion dollars. Governments and corporations often issue green bonds the same way as traditional bonds, but the revenues are used to fund eco-friendly and net-zero initiatives. In 2015, India began investing in green bonds to address the financing demand for green development. The Securities and Exchange Board of India (SEBI) is the principal regulator of India’s green bond issuance and listing requirements. Between 2018 and 2020, green bonds accounted for only 0.7% of the Indian financial market, but this is far more than the proportion in industrialized nations such as the United States, the United Kingdom and Australia. Green bonds have grown exponentially in India, with over six billion dollars issued in the first half of 2021. India is investigating offshore green bond financing to bridge the gap as necessary to attain net-zero emissions. According to a reputable research organization in India, the government would need to spend 10.103 trillion dollars by 2070 to attain carbon neutrality. Two ways are being pursued to accomplish this goal: transitioning from coal to renewable energy and investing in technologies powered by green hydrogen. Leading renewable energy firms in India, such as Adani and Power Finance Company, have issued green bonds with a ten-year maturity, and the World Bank has invested in Indian green bonds on many occasions (Kaminker, 2015).

The government stated its plan to promote green bonds in the Union Budget to encourage investment in climate-friendly initiatives. This is a crucial step, as India urgently needs to increase the available funding volume to achieve its climate commitments and support low-carbon growth (Government, 2021).

According to the Ministry of Finance’s most recent estimates (2018), the cumulative cost of India’s present Nationally Determined Contributions (NDCs) is around \$3.5 trillion. According to current data, less than 10% of this is anticipated via multilateral and international routes. The remainder must be raised through the domestic banking system. However, green financing remains limited and small in size in India, although India is developing as the third-largest market for green bonds, after the US and China (Department of Economic Affairs, Ministry of Finance, Government of India, 2020).

Three distinguishing aspects characterize India’s green finance landscape:

1. Green finance is more expensive due to its unusual character, inherent risks and lack of a supportive legislative environment (Cochu et al., 2016).
2. The market is deficient in excellent and provable green financial products. Existing ones are

biased in favor of debt instruments that only cover a portion of the risk and size associated with long-term financing (United Nations, 2021).

3. Many initiatives aim to increase renewable energy capacity, with just a modest amount allocated to energy efficiency (Majid, 2020).

With few projects, infrastructure, industry, resource efficiency and transportation are all difficult industries.

While international accords demand that climate money be concessional or grant-based, private finance is not guaranteed to be such. Green financing often has a higher cost than conventional finance, which is a deterrent. The government lacks an appropriate governance structure to promote and institutionalize green financing. Practical policy guidelines will assist financial organizations in recognizing their obligations to green the finance industry. By requiring a portion of loans for green projects, risks may be mitigated, and the rate of return may be increased (Department of Economic Affairs, Ministry of Finance, Government of India, 2020).

At the institutional level, one may begin by establishing a globally agreed definition of green finance and mandatory disclosure standards for enterprises seeking funding. To avoid the proliferation of definitions, disclosures and reporting processes, the green finance taxonomy may be connected to the NDCs' aims. If the financial sector regulator accepts them as the standard for green lending, they may benefit overall costs and access to financing. A uniform green taxonomy might be established in the future to bring it into line with worldwide trends (Jena et al., 2020).

Why are funds to a critical adaptation fund declining despite the government's climate commitment? Companies must disclose the environmental effects of their operations to foster investor trust. SEBI requires the 1,000 biggest businesses listed on the stock exchange to submit corporate social responsibility reports. By establishing disclosure rules for these reports and enforcing them as part of a national information system, we can assist investors in overcoming knowledge asymmetry and reducing foreign capital costs (Ministry of Corporate Affairs, 2020).

Green finance cannot expand without the availability of high-quality and verified green products for investing, banking and insurance. Green bonds now dominate the market. There is, however, a basis for developing equity-based instruments in conjunction with policy instruments, such as blended finance or results-based funding (Asian Development Bank (ADB) et al., 2017).

Risk mitigation mechanisms are required. The notion of high risk and the increased expenses associated with producing these goods are significant barriers for the private sector. Along with traditional grants and concessional loans, public funds supported by international finance can be used to provide risk mitigation support in the forms of first-loss guarantees on debt and equity investments, hedge funds for external borrowings and subsidized insurance premiums for climate-resilient assets (Sarkar and Singh, 2010).

Renewable energy accounts for the lion's share of green financing today. Other industries that are traditionally seen as financially unviable, such as infrastructure, manufacturing, transportation and the circular economy, need financing on a comparable scale. Sectoral objectives with monitoring provisions and an incentive/disincentive system may promote capital flows and innovation. Other potential methods of boosting the profitability of such investments include establishing special funds to cover the associated risks and the central bank enforcing green lending standards (Lacy et al., 2015).

Mobilizing money for green objectives involves a combination of governmental encouragement, regulation and risk mitigation mechanisms. Its success will be contingent upon our ability to effectively employ public monies and policies to close the viability gap and scale investments (Reddy, 2013).

9. Findings

The Indian economy has shown a substantial concern for environmental problems. Policymakers in India are framing guidelines for making India's developmental activities greener with every new policy. Industry 4.0, i.e. the 4th industrial revolution, has emphasized the circular economy, which further converges with the notion of a green economy on economic and environmental levels. If the speed of implementation of Industry 4.0 can be enhanced by taking the help of specific catalysts, then the ecological concerns can be addressed significantly. If India is serious about making its economy more environmentally friendly, it must promote green financing for development projects. That nation has to increase its efforts to promote sustainable growth in light of mounting environmental concerns. India should exploit its startup potential to address environmental issues more quickly and efficiently. If the foundation of the business is eco-friendly, then it is easier to carry on its operational activities in a sustainable way. However, the interjection of green techniques by restructuring an old business causes friction in the working style of an entity. Therefore, providing green finance to startups can be a game changer for raising environmental issues.

10. Conclusions

To achieve net-zero emissions and other climate and environment-related objectives, considerable investments in decarbonization and innovation across all sectors of the economy will be necessary. Greening the banking system is critical to facilitating these investments. Numerous nations are still in the early stages of greening their financial sectors—transitioning to a financial system that directs money toward green goals and handles climate- and environment-related financial risks. Green finance—all financing and investment that contributes to these objectives—has been unable to grow up to the appropriate level. Nonetheless, the policy environment changes swiftly, with new initiatives and laws developing everywhere. By and large, the standards for Sustainable Finance are not dictated only by political forces and politicians. Indeed, there is considerable consumer pressure as well. Requests for “green” financial goods are increasing in number, as are client refusals to invest in firms that do not meet the new sustainability standards. As a result, financial service providers are under increasing pressure from investors and rating agencies to develop suitable measures for sustainable management and behavior and face new rivals that make sustainability a central pillar of their business cases. Environmental resilience results from the coexistence of biotic, abiotic and sociocultural factors capable of adapting to all types of dynamic change. The viability of a corporate entity is contingent upon the stability and supportiveness of the environment in which it operates. As a result, it demands that new enterprises participate in environmental protection and management to assure environmental sustainability in the future.

India has been on a path toward green project finance for some years now, and significant adjustments have been made to the country's financial sector to embrace ecologically friendly methods. Businesses are the economy's engine, and adopting sustainable business practices is critical for reaching carbon neutrality. With that being stated, rich nations have the primary responsibility for assisting emerging countries such as India. Strenuous efforts are being undertaken, such as designing a new climate plan by Canada and Germany, which aims to contribute hundreds of billions of euros a year by infusing an average of the cash created between 2020 and 2025. Regarding the Indian banking sector, numerous government laws have been implemented to encourage lending to carbon-neutral companies and environmentally friendly loans. As of 2021, ESG and green bonds have raised roughly \$7 billion in the United States, up from more than

\$1 billion in 2020. There is a need to focus on knowledge of business risk in the case of non-compliance with environmental due diligence. At this point, attorneys and law firms come in to provide legal advice on sustainable finance and financial services regulation.

This research lays the foundation for the emerging and pertinent subject of green finance and green startups. Considering this research, further studies comparing India's performance in sustainable entrepreneurship with other developing countries can be done. This comparison can be made by taking various economic integrations as bases, such as BRICS, SAARC, etc. Moreover, future research can focus on green finance's direct and indirect impacts on environmental issues.

11. Future research and limitations

This research is focused on how green finance promotes green startups in India. It discloses the intentions of India's businesspeople and policymakers to promote and elevate sustainable development. Hence, this research is only carried out specifically to exhibit the wave of green startups in the Indian economic system. Other developing countries' statuses in sustainable entrepreneurship are not assessed in the paper; this is the limitation of the research. Hence, future research can follow the same pattern of research in other developing nations to highlight the steps taken and successes achieved in the context of green entrepreneurship.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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