



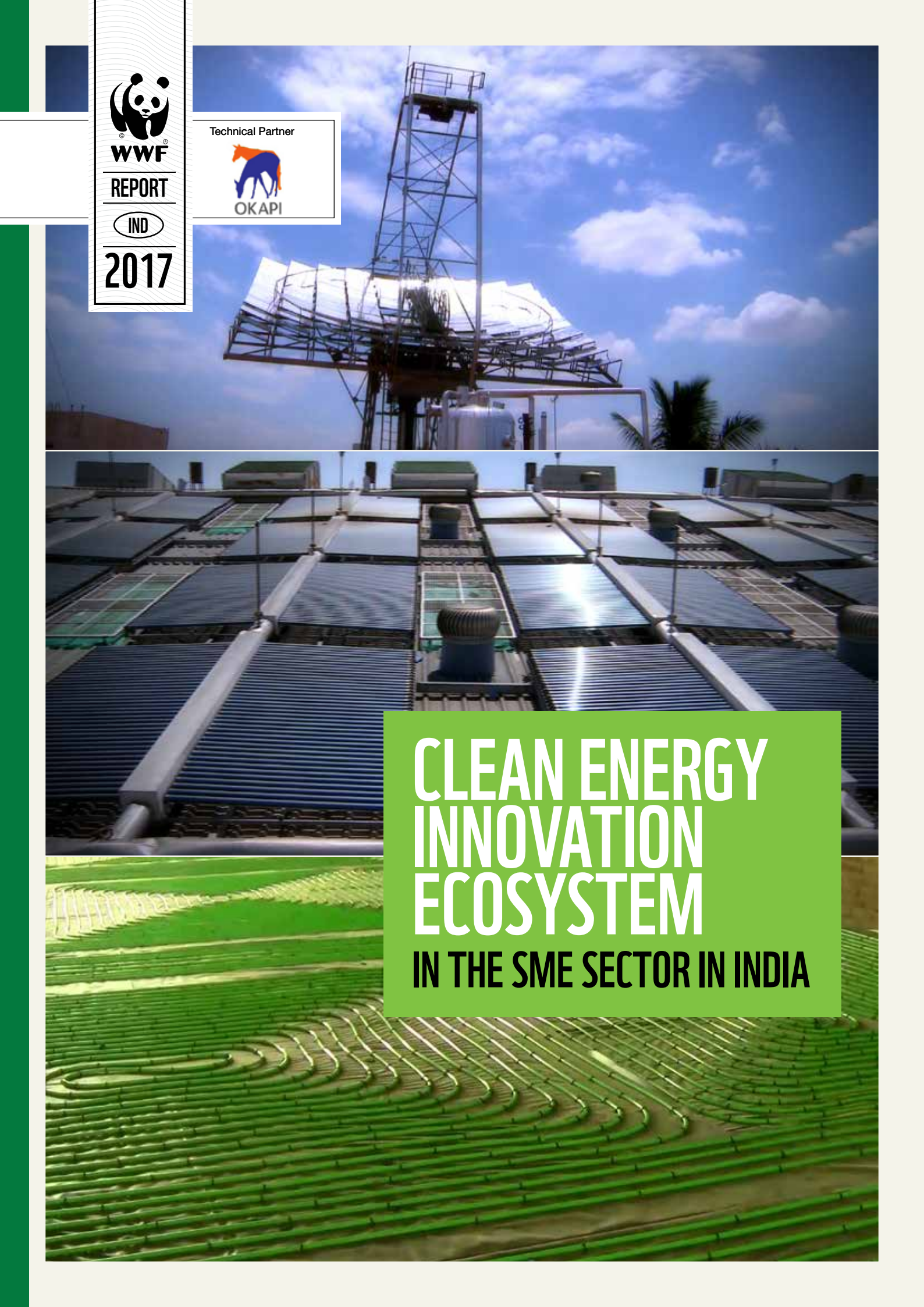
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The background is a collage of three images: a solar tower with heliostats at the top, a roof covered in solar panels in the middle, and a large-scale view of solar collectors in a field at the bottom.

CLEAN ENERGY INNOVATION ECOSYSTEM IN THE SME SECTOR IN INDIA

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Project Team

Okapi

Project Lead: Dr. Jessica Seddon

Lead Authors: Geetanjali Shahi and Krishna Kumar

Research Assistance: Aditi Agrawal, Anjali Neelakantan and Seema Kumar

WWF-India

Pugazhenthir Dhananjayan, Divya Joy, Philip Tapsall, T. S. Panwar

WWF-Sweden

Reviewer: Stefan Henningsson

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**CLEAN ENERGY
INNOVATION ECOSYSTEM
IN THE SME SECTOR IN INDIA**

EXECUTIVE SUMMARY

India has ambitious plans for its renewable energy sector. By 2022, the government seeks to expand renewable energy capacity to 175GW, with 100GW of solar and 60GW of wind, among other sources. In 2015, the Ministry of Environment, Forest and Climate Change announced, as part of India's Intended Nationally Determined Contribution, that the nation will reduce the emission intensity of its GDP by 33-35 per cent by 2030 from the 2005 levels.¹ Internationally, experts and leaders are calling India an exemplar for transitioning to renewable energy. Even as this transition is underway, the pressure to extend energy access to a wider portion of the population remains. Now, more than ever, it is imperative that the ecosystem for clean energy innovation in India is strengthened.

The main objective of this report is to assess the clean energy innovation ecosystem in India, with particular focus on the context for small and medium enterprises (SMEs), a group that contributes considerably to India's overall economy. It further develops a baseline mapping of this ecosystem and analyses the challenges and opportunities that exist in the clean energy SME sector in India. Building a strong ecosystem of financial and regulatory organizations and programmes to further the work of these SMEs will allow greater access to energy, particularly in energy-starved areas as well as scale up the reach and availability of clean energy while bringing down costs.

To begin with, the report draws on existing literature to provide an overview of the cleantech ecosystem and its leverage points. This part discusses the importance of SMEs in the ecosystem; the major technical, policy and financial barriers that SMEs face and the scope of SMEs in emerging cleantech sectors like solar, wind, biomass, solid waste management and green buildings. The instruments made available to cleantech SMEs by major government and financial stakeholders are also highlighted. Government initiatives like tax free bonds through IREDA, the credit guarantee trust for SMEs and the financing schemes provided by SIDBI are outlined along with the role of the government in schemes and initiatives to promote research in clean technology.

Major financing and mentorship avenues that are available to SMEs are also discussed in this section. These include accelerators, incubators (academic, government supported, independent and corporate), angel and venture investments, national and international grants and public-private partnerships. This section closes with the outlining of other significant stakeholders in the clean energy innovation ecosystem: academic institutions and industrial associations. This detailed overview may act as a useful resource for SMEs as well as startups that are looking to bolster the progress and scale of their innovations in clean energy.

¹ India to reduce the Emissions Intensity of its GDP by 33 to 35 per cent by 2030 from 2005 Level. (2 October 2015). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=128403>

The following section carries analysis from interviews and surveys conducted with SMEs, government and financial stakeholders in the clean energy innovation ecosystem. This study includes learnings from the interactive Climate Solver Workshops as well as online surveys. The purpose of the study was to gain a broad understanding of the community investing in clean energy innovation, get their perspectives on what the major challenges and opportunities are, and understand the major support initiatives that are currently available. The study was conducted in three major innovation hubs across India – Delhi in the north, Pune in the west and Bangalore in the south. The Climate Solver Workshops conducted in all the three innovation hubs acted as interactive networks, wherein financiers, government agencies and SMEs could interact. These workshops also helped moderate discussions on the big barriers faced by SMEs in this space. The ecosystem actor surveys conducted with 30 SMEs, 13 financiers and 8 government organizations focused on the ways in which SMEs interacted with other players, major challenges in these engagements from different stakeholder perspectives and types of support and schemes offered to SMEs.

Key findings from the surveys:

1. Access to affordable financing for innovations in clean technology is one of the biggest challenges faced by SMEs that are at self-financed early stages of product/service development. Marketing and sales costs were also cited as being a large burden. Tough conditions placed on loans and other financing has also led to a lot of scepticism and distrust of financiers amongst SMEs.
2. Creating new technology is indeed challenging for cleantech SMEs because of the lack of investment in R&D, cumbersome intellectual property rights and the overall high risk of investing in these new technologies.
3. Finding a significant customer base and demand for products and services in clean energy as well as a general lack of appreciation and understanding of these offerings amongst consumers, financiers and government stakeholders alike was a major barrier for SMEs.
4. Cleantech SMEs find it especially hard to find and retain trained, dedicated staff over long periods of time and at times, cannot afford to pay competitive salaries to attract qualified candidates.
5. There is a very recognizable lack of awareness about government schemes and provisions for SMEs. Inefficient implementation of existing policies and a slow creation of new policies that benefit SMEs from entering energy starved markets have also stalled rapid expansion of clean energy.
6. The high-risk nature of this sector has led most financiers to shy away from funding early stage ventures in clean energy and focus more on the post-pilot stages of growth, making R&D of new technology particularly difficult for startups.
7. Government agencies often struggle with understanding the market potential and value added by SMEs which has led to a fragile relationship between SMEs and government agencies in the clean energy space.

Recommendations:

Based on background research and interactions with stakeholders, the recommendations are as follows:

1. Greater collaboration among stakeholders, particularly between public and private financiers can help diversify risk and bridge the access gap between SMEs and the public sector, while adding to private financiers' portfolio.
2. Government organizations to focus on building greater awareness via outreach programmes for public sector schemes and initiatives. Additionally, focusing on effectively enforcing and implementing existing initiatives is essential if a real value addition is to be seen in the ecosystem.
3. It is crucial to maintain a carefully curated balance between a market-driven approach and government subsidies for the innovation and creation of relevant products for the various consumer segments as well as for making renewable energy a viable market for all the stakeholders involved.
4. There needs to be greater emphasis on infrastructure support mechanisms like business and technical incubators so as to build the ecosystem for new technology in renewable energy.
5. There is a great need to shift from collateral-based financing to project-based financing and convertible debt as alternative financing instruments will improve access to capital and funding for SMEs.
6. The formation of separate industry associations of the various segments within clean energy such as solar, biomass etc. can be greatly beneficial for sharing knowledge, best practices and building stronger ties with financial and government institutions.

In conclusion, the future of the transition to renewable energy in India and its potential in propelling economic growth needs a strong ecosystem for innovation in clean energy that focuses strongly on SMEs, not just as creators but also as end users of these products and services. But this is possible only on the back of greater involvement and collaboration among other key institutional and financial stakeholders. There is a strong need to simultaneously build a more effective policy framework for these enterprises to rely on. It is hoped that this report acts as a valuable resource for innovators and stakeholders in the ecosystem as well as a roadmap for the many developments that are yet to come for the clean energy ecosystem in India.



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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AEEE	Alliance for an Energy Efficient Economy
AIM	Atal Innovation Mission
BEE	Bureau of Energy Efficiency
BITS	Birla Institute of Technology and Science
BOOT	Build, Own, Operate, Transfer
CAGR	Compound Annual Growth Rate
CDPQ	Caisse de Dépôt et Placement du Québec
CEA	Central Electricity Authority
CEO	Chief Executive Officer
CFA	Central Financial Assistance
CGTMSE	Credit Guarantee Trust Fund for Micro & Small Enterprises
CII	Confederation of Indian Industry
CIE	Centre for Innovation, Incubation and Entrepreneurship
CLEAN	Clean Energy Access Network
CoE	Centre of Excellence
CPPIB	Canada Pension Plan Investment Board
CSP	Concentrated Solar Power
CSR	Corporate Social Responsibility
DFID	Department of International Development
DISCOMs	Distribution Companies
DST	Department of Science and Technology
ECBC	Energy Conservation Building Codes
EESL	Energy Efficiency Services Limited
ESCO	Energy Service Company
ESPC	Energy Services Performance Contract
FAO	Food and Agricultural Organisation
FI	Financial Institution
FICCI	Federation of Indian Chambers of Commerce and Industry
FY	Financial Year
GCC	Grand Challenges and Competitions
GCIP	Global Cleantech Innovation Programme
GDP	Gross Domestic Product
GEF	Global Environment Facility
GITA	Global Innovation and Technology Alliance
GST	Goods and Services Tax
GW	Giga Watt
IBPA	Indian Biomass Power Association
IEDC	International Economic Development Council

IESA	India Energy Storage Alliance
IFC	International Finance Corporation
IIC	Innovation & Incubation Centre
IIGP	India Innovation Growth Program
IIT	International Institute of Information Technology
IIM	Indian Institute of Management
IISc	Indian Institute of Science
IISER	Indian Institute of Science Education and Research
IIT	Indian Institute of Technology
IITGTIC	IIT Guwahati-Technology Incubation Centre
INR	Indian Rupee
INVENT	Innovative Ventures for Technology Development
IoT	Internet of Things
IPO	Initial Public Offer
IPR	Intellectual Property Rights
IREDA	Indian Renewable Energy Development Agency
ISB	Indian School of Business
JICA	Japan International Cooperation Agency
JNNSM	Jawaharlal Nehru National Solar Mission
KfW	Kreditanstalt für Wiederaufbau
M&A	Mergers and Acquisitions
M&V	Measurement & Verification
MA	Millennium Alliance
MANIT	Maulana Azad National Institute of Technology
MIT	Massachusetts Institute of Technology
MLI	Member Lending Institutions
MNC	Multinational Corporation
MNIT	Malaviya National Institute of Technology
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
MSDE	Ministry of Skill Development and Entrepreneurship
MSME	Micro Small and Medium Enterprises
MW	Mega Watt
NIDHI	National Initiative for Developing and Harnessing Innovations
NIIF	National Investment and Infrastructure Fund
NIT	National Institute of Technology
NITI Aayog	National Institute for Transforming India
NREL	National Renewable Energy Laboratory
NSIC	National Small Industries Corporation
NSRCEL	Nadathur S Raghavan Centre for Entrepreneurial Learning
NSSO	National Sample Survey Organisation
NSTEDB	National Science & Technology Entrepreneurship Development Board

O&M	Operation and Maintenance
OTPP	Ontario Teacher's Pension Plan
PDN	Public Distribution Network
PDPU	Pandit Deendayal Petroleum University
PE	Private Equity
PFC	Power Finance Corporation
PPA	Power Purchase Agreement
PPP	Public-Private-Partnership
PRAYAS	Promoting and Accelerating Young and Aspiring Innovators & Startups
PV	Photovoltaics
R&D	Research and Development
REC	Rural Electrification Corporation Limited
RECAI	Renewable Energy Country Attractiveness Index
RTBI	Rural Technology Business Incubator
S&T	Science and Technology
SBM	Swachh Bharat Mission
SECI	Solar Energy Corporation of India
SERIIUS	Solar Energy Research Institute for India and the United States
SIDBI	Small Industries Development Bank of India
SINE	Society for Innovation & Entrepreneurship
SJCE-STEP	Sri Jayachamarajendra College of Engineering – Science & Technology Entrepreneurs Park
SME	Small and Medium Enterprise
SMVDU TBI	Shri Mata Vaishno Devi University Technology Business Incubation Centre Society
TBI	Technology Business Incubators
TDB	Technology Development Board
TIDES	Technology Innovation and Development of Entrepreneurship Support Centre
TIETS	Technology Incubation and Entrepreneurship Training Society
TIFAC	Technology Information Forecasting and Assessment Council
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
US\$	US Dollars
USAID	United States Agency for International Development
VC	Venture Capital

1 INTRODUCTION

1.1 Need for Clean Energy Innovation

India requires significant energy to support its economic growth plans and to meet increasing demands for access to electricity, water and food, among other development objectives.² At present, India is also grappling with an existing situation of energy crunch wherein approximately 300 million people still do not have access to electricity and an estimated 700 million people have erratic and poor quality supply of power.³⁴ In spite of the rise in clean energy innovation over the last few years which has led to the nurturing of new business opportunities, better quality of life and the resultant economic growth, yet, a major portion of India's energy needs is met through fossil fuels such as coal, gas and oil (Planning Commission, 2012), all of which are being imported in varying quantities.⁵ While a fall in crude oil prices since 2014 has been reported to decrease India's fiscal deficit, any shortage in supply in the future is likely to strain the country's economy.⁶

A 2015 study by CSTEP that builds on the India Energy Security Scenarios (IESS) 2047 tool developed by NITI Aayog also makes the point that 'business as usual' scenario will only push us towards a high carbon resource-inefficient economy which will further burden a faster depletion of the exhausting natural resources. The study also states that if a sustainable development pathway is followed, by improving energy efficiency and switching to cleaner fuels, the demand for imported coal, oil and gas can come down substantially by 40, 24 and 58 per cent respectively. India, being one of the fastest growing economies of the world, is compelled to restructure its energy expansion strategies towards cleaner and low-carbon technologies. Global warming and climate change have further intensified the need to adopt cleaner technologies to power India's economic growth. It is now unanimously agreed that economic growth and development have to be guided by the key concerns of sustainability. There is a need to move toward cleaner, efficient and innovative solutions and renewable sources. To this end, clean energy innovation can play an important role in maintaining ecological balance, allowing India to secure some much-needed energy access, increasing economic growth and development, while simultaneously avoiding increasing air and climate-affecting emissions. India's efforts to reduce carbon will have a considerable impact in ascertaining the world's ability to adapt or mitigate climate change.⁷ Mitigating global warming requires an international response and

2 India Energy Outlook, WEO-2015 Special Report, http://www.worldenergyoutlook.org/media/weowebsite/2015/IndiaEnergyOutlook_WEO2015.pdf. (Accessed on 7 March 2017)

3 Chandra Bhushan and ArunaKumarakandath. (2016). "Mini-grids: Electricity for all", Centre for Science and Environment, New Delhi.

4 Bhushan, Chandra, "A Renewable Energy Future For India", Down to Earth 2016. <http://www.downtoearth.org.in/blog/a-renewable-energy-future-for-india-55363>. (Accessed on 11 March 2017)

5 Berry, S., Ghosh, A., Mathur, R., Basu, S., Ganesan, K. and Jones, R. (2016). Energizing India: Towards a Resilient and Equitable Energy System. Shell, CEEW, TERI.

6 Kundu, T. (27 January 2017). "Why oil can spoil India's budget math". Livemint. Retrieved from: <http://www.livemint.com/Industry/ro8NqXjBC4gk1i2OAdGYN/Why-oil-can-spoil-Indias-budget-math.html>

7 As per the 2016 edition of BP Statistical Review of World Energy, the largest increase in global carbon emissions in 2015 came from India (5.3 per cent).

substantial cleantech innovations. India can leverage this situation as an opportunity to be a leader in an evolving global market.

To reduce the country's carbon footprint, the Indian government has defined a number of objectives to meet the renewable energy target. These initiatives are - to install 100 GW of Solar, 60 GW of utility scale Wind, 5 GW of Small Hydro and 10 GW of Bio energy by 2022.⁸ The central government has also set up a Clean Energy Equity Fund (CEEF) of US \$2 billion, for renewable energy companies to meet the clean energy targets in collaboration with the National Investment and Infrastructure Fund (NIIF), NTPC (formerly known as National Thermal Power Corporation Limited), Rural Electrification Corporation Limited (REC) and Indian Renewable Energy Development Agency (IREDA).

Meeting these renewable energy targets and ensuring energy access to all necessitates clean energy innovation that will chart new and creative pathways toward low carbon development scenarios and also realize sustainable economic growth.

However, renewable energy generation is only one component of clean energy innovation. These innovations include a range of products, services and processes that harness renewable materials and sources of energy, significantly reduce the use of natural resources and cut down emissions and wastes. From batteries for electric-powered vehicles to solar power panels to energy consumption from biofuels and wastes are all part of these innovations. Industrialized nations such as the United States of America, Japan and Germany hold most of the clean technology patents, mostly in the field of clean transportation, energy efficiency and storage. Amongst the emerging nations, China is leading due to its rising involvement in cleantech innovations.⁹ Germany, Japan and South Korea hold the maximum number of cleantech innovation patents per unit of their GDP. As per the Global Cleantech Innovation Index (GCII) 2017, Nordic region has a very strong cleantech startup creation ecosystem and provides the most supportive environment for such startups. Denmark, Finland and Sweden top the list. As per this study, which spans 40 countries including the G20 countries, three factors play an important role in developing cleantech ecosystem in a country; ability to adapt to the growing demand for renewable energy, connectivity of startups with multinational corporate houses, public procurement, etc. to increase their success rates; and an increased international engagement to spur widespread adoption of clean technologies.¹⁰

Since clean energy innovation is an economic necessity, it is imperative to understand these innovation processes and the clean energy market. These innovations should complement the established national climate change goals and international carbon thresholds.

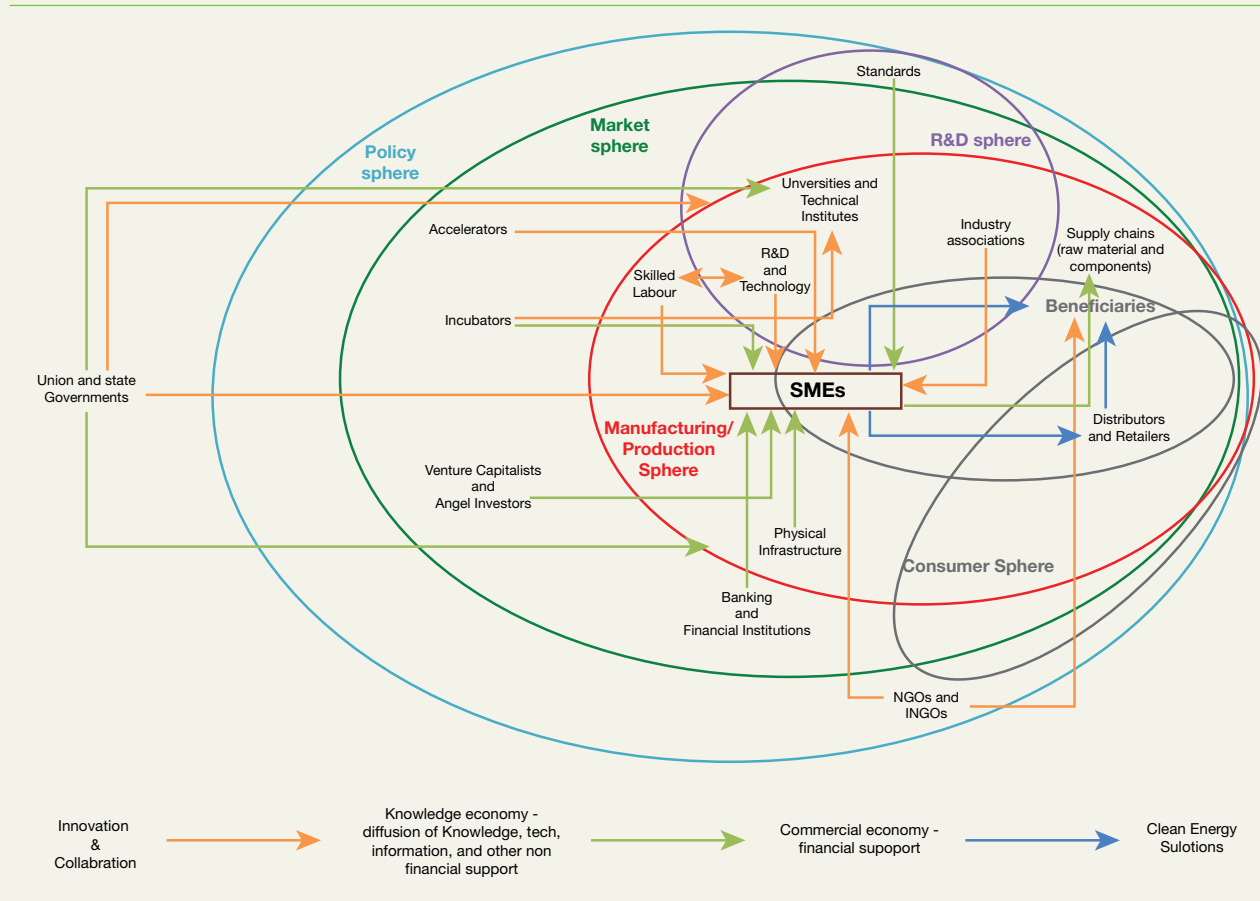
The following figure illustrates the key actors in the clean energy innovation ecosystem for Small and Medium Enterprises (SMEs).

8 Report of the Expert Group on 175 GW RE by 2022, Niti Aayog 2015, http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf. (Accessed on 7 March 2017)

9 The Dialogue: Leadership for the Americas (2016). Clean Energy Innovation in Latin America. [online] The Dialogue: Leadership for the Americas. Available at: <http://www.thedialogue.org/wp-content/uploads/2016/02/Clean-Energy-Innovation-in-Latin-America.pdf> [Accessed 16 Jun. 2017]

10 The Global Cleantech Innovation Index. (2017). Retrieved from <https://www.fi/mediabank/9906.pdf>

Figure 1: Clean Energy Innovation Ecosystem through SME Lens



The clean energy innovation ecosystem (refer Fig.1) consists of multiple actors – central and state government entities, accelerators/incubators, venture capitalists/angel investors, bank/financing institutions, departments/NGOs/think tanks, universities and R&D institutes, industry associations, end users. The various spheres, i.e. policy, research and development (R&D), market, manufacturing and consumer, represent distinct types of ecosystem actors. The arrows illustrate how they interact with each other, mainly through the diffusion of technology/knowledge and financial support. The arrows also convey the potential innovation that exists in each interaction between ecosystem actors, be it innovations in SME lending/investments, state or central government policies that incentivize demand for clean energy products/services, ways in which clean products/services reach end users, among other creative collaborations. SMEs are at the focal point of all these interactions, developing and providing clean energy solutions to end users.

The present study is an attempt to understand the key elements of this ecosystem centred around SMEs providing clean energy solutions and the dynamics of the interactions between the different actors. This study also identifies and prioritizes major challenges that the SMEs face, and the catalysts in this ecosystem. This will lead to identifying areas in the SME ecosystem that require additional supportive interventions.

1.2 Importance of SMEs in Clean Energy Innovation Ecosystem

SMEs¹¹, including startups¹², are the focal point of the clean energy innovation ecosystem. They are the engines of job creation and economic growth in the emerging market of clean technology.¹³ SMEs are dynamic, quick to adapt, ready to innovate to increase their productivity and address market demands.¹⁴ SMEs in India currently employ over 80 million people while contributing 8 per cent to the country's Gross Domestic Product (GDP) and 40 per cent to the country's total exports.¹⁵

Despite their robust contribution to the Indian economy, SMEs are plagued with barriers such as, high operating costs, scarcity of skilled human resource, limited access to working and expansion capital, limited access to technology/business incubation and end-user financing.¹⁶ To overcome these barriers, role of the other ecosystem actors such as government and financiers is crucial. Therefore, a favourable policy environment is required, that favours clean energy innovation and supports SME establishment and their expansion. It is important for unleashing their potential and encouraging innovation in the clean energy sector. It has become an economic necessity to promote SMEs that are actively engaged in design, deployment and scaling of clean technologies across the country to cut down on greenhouse gases emissions. The scenario is such despite the fact that there are clean energy technologies in the country but they are expensive to use and maintain. So the need of the hour is reduced cost and improved performance in innovation.

Clean energy innovation can fulfill two important objectives: 1) Providing energy access in energy-starved areas, and 2) Continuing efforts toward mitigating climate change impacts. SMEs can be the driving agents that make low carbon technologies affordable, increase the scale of clean energy consumption which has remained a luxury for far too long.

11 SMEs, for purposes of this Study, refer to the broader MSME Sector in terms of interactions with and analysis of the clean energy innovation ecosystem. (As per the MSMED Act 2006 (<http://msme.gov.in/sites/default/files/MSMED2006.pdf>), MSMEs are classified based on investment in plant and machinery and equipment. For micro enterprises in the manufacturing sector – investment does not exceed 25 lakhs, micro enterprises in the service sector – investment does not exceed 10 lakhs. For small enterprises in the manufacturing sector - the investment ranges between 25 lakhs to 5 crore; small enterprises in the service sector - the investment ranges from 10 lakhs to 2 crore. For medium enterprises in the manufacturing sector - investment ranges between 5 crore to 10 crore; medium enterprises in the service sector - investment ranges from 2 crore to 5 crore.)

12 The Indian Government only distinguishes Startup enterprises for its Startup India Initiative - (http://dipp.nic.in/English/Investor/startupindia/Definition_Startup_GazetteNotification.pdf). Startups could actually be one type of SMEs, as they are defined in the Initiative as entities whose turnover has not exceeded 25 Crore in any given financial year and are only upto 5 years old from the date of incorporation/registration (among other factors).

13 Vyas, Vani, "SMEs sector is the growth engine of Indian economy." People Matters, 13 February 2017. https://www.peoplesmatters.in/article/talent-management/sme-sector-is-the-growth-engine-of-indian-economy-14955?utm_source=peoplesmatters&utm_medium=interstitial&utm_campaign=learnings-of-the-day. Accessed on 12 March 2017.

14 "About MSMEs In India." 2017. http://www.smechamberofindia.com/about_msme.aspx. Accessed on 8 March 2017.

15 Id

16 Issue Paper 3: SMEs And Green Growth: Promoting Sustainable Manufacturing And Eco-Innovation In Small Firms". 'Bologna+10' High-level Meeting On Lessons From The Global Crisis And The Way Forward To Job Creation And Growth. Paris: OECD Working Party On SMEs And Entrepreneurship (WPSMEE), 2017. <https://www.oecd.org/cfe/smes/46404383.pdf>. Accessed on 8 March 2017

1.3 Clean Energy Innovation Ecosystem: An Overview of Major Barriers

The clean energy innovation ecosystem faces a number of challenges that all stakeholders in the ecosystem need to overcome to remain dynamic and functional. For example, this ecosystem requires sustained funding and favourable policies from central and state governments to thrive. While funds are available their alignment is a problem and it is challenging to find right deals. During stakeholder discussions, it was informed that early stage funding in India in this sector is weak, though some later stage funding similar to seed funding and Venture Capital (VC) is available. For technology innovation, grant funding plays a major role. So, it seems that it is not the funding as much as its implementation and usage that needs to be looked into. Government can play a key role in providing early stage support since private investors eventually will cherry pick projects that ensure higher return on investments. Nonetheless, policy makers, financiers and big businesses are beginning to realize the importance of investing in clean technology startups as a supplementary source of employment and revenue growth. This is the only way to achieve the Sustainable Development Goals and mitigate the financial and other risks involved with continued dependence on conventional sources of energy.

However, to bring clean energy innovation to scale there are certain barriers that SMEs face. These can be broadly categorised into the following categories:

1.3.1 Policy and Regulatory

Clean energy policies need to have a long-term vision, and clear guidelines, leaving no room for ambiguity. Such a policy environment ensures sustained investments, and thus the viability of the clean energy ecosystem. Stakeholder interactions and analysis of the existing literature suggest that in the absence of such a policy, many entrepreneurs and investors are wary of entering the space. For example, before the Draft National Policy on RE based Mini/Micro Grids came into force, investors were cautious of investing in this space due to lack of clarity on the future of mini grids for times when the central grids extended to areas with mini grids. Although this has paved the way for mini grids and grid interconnection, still there are certain issues that need to be addressed, such as Feed in Tariffs (FiT). There is no unified rate for FiT and since different states use different values, it is mostly based on mutual agreement between the state and the private developer.

FiT, accelerated depreciation, tax breaks are some of the incentives that the government offers on development of clean energy, however, stakeholder interactions suggest that these incentives are often inadequate for the diverse range of clean energy technologies (hydro, wind) and are also poorly implemented. Policies such as subsidies for coal can lead to market distortions and stall adoption of clean energy technologies. It also needs to be considered that there are multiple governing agencies that oversee the implementation of the policies and regulations. There is no single legal framework that governs the development of clean energy in India. In the absence of a unified framework, there are delays and as a result, diminished investor and entrepreneur confidence.

There is a need for a strong and clear policy and regulatory environment to attract investors and developers. A detailed analysis of various government programmes and initiatives in this space has been provided in the later sections of the report.

1.3.2 Technical

Clean energy technologies are considered expensive for mass deployment. Intermittent supply, low conversion efficiency and storage issues are some of the barriers that affect the economic feasibility of renewable energy projects. There is also a general lack of awareness regarding renewable energy technology development and related projects amongst financiers, investors, policy makers, developers and consumers.

More often than not, innovative ideas lack a reliable and long-term business plan, which financiers need to know before they invest as they look for long term viability of the businesses and assured returns on their investments. Moreover, need for technology and business incubation cannot be over-emphasised. More R&D labs are needed to translate ideas into proof of concept. India is low on cleantech R&D support (relative to national GDP) when compared with majority of the 40 participating countries. India's position amongst the participating countries, in terms of cleantech R&D Budget, fell from 15th to 32nd in the current assessment.¹⁷

1.3.3 Financial

Stakeholder interactions suggest small and medium developers in clean energy space struggle to get financial support at affordable interest rates to commercialize their technology. For example, during one of the stakeholder workshop a point was raised that equity financing is available mostly to startups as compared to established SMEs. Workshop participants felt that established SMEs were less likely to give up the control rights that would ordinarily go to an equity investor.

From the financier's perspective, there is a lack of information- and knowledge-sharing platforms, such as successful case studies and investment-grade data; these are often unavailable to them. Our interactions with various stakeholders revealed that good innovative ideas are often not backed by an economically sound business plan, and this deters financiers from investing in these projects.

These barriers have been discussed in greater detail later in the report.

17 The Global Cleantech Innovation Index. (2017). Retrieved from <https://www.fi/mediabank/9906.pdf>

2 CLEAN ENERGY INNOVATION ECOSYSTEM: AN OVERVIEW

2.1 Scope

On 22 April 2016, 195 countries from around the world came together to sign the ambitious “Paris Climate Accord”, an agreement within the United Nations Framework Convention on Climate Change (UNFCCC) that envisioned to battle the impending effects of climate change and “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.”¹⁸

Climate change is real. Its effects are increasingly felt around the world in the form of unseasonal rainfalls, droughts, cyclones, wildfires etc. The imminent nature of the threat is evidenced by the fact that nations around the world, shed their internal and external conflicts, overlooked other factors of regional strife and united for a common cause of climate change in Paris.

India formally ratified the Paris agreement on October 2016.¹⁹ The ratification exercise can be viewed as an extension of momentous strides undertaken in the cleantech sector by India in the last decade while furthering its commitment in the global fight for climate justice and environmental protection.²⁰

According to a recent Ernst and Young report, India has been ranked second on the Renewable Energy Country Attractiveness Index (RECAI).²¹ The report noted that there has been an exponential growth in installed capacity of wind energy (5.4 GW) in 2016-17 against a target of 4 GW, in addition to more than 10 GW of solar capacity in the last three years.²²

While these figures pale when compared to renewable energy installed capacity in countries like the U.S. and China, it is important to be mindful of the fact that India’s

18 Paris Agreement – Status of Ratification. (n.d.). Retrieved from http://unfccc.int/paris_agreement/items/9444.php

19 India ratifies historic Paris climate deal at U.N. (2016, October 2), The Hindu. Retrieved from <http://www.thehindu.com/news/national/India-ratifies-historic-Paris-climate-deal-at-U.N./article15422334.ece>

20 Cabinet Approves Ratification of Paris Agreement. (2016, September 28). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=151204>

21 Ernst and Young. (May 2017). Batteries: Leading the charge. Retrieved from: [http://www.ey.com/Publication/vwLUAssets/EY-RECAI-49-May-2017/\\$FILE/EY-RECAI-49-May-2017.pdf](http://www.ey.com/Publication/vwLUAssets/EY-RECAI-49-May-2017/$FILE/EY-RECAI-49-May-2017.pdf)

22 Ernst and Young. (May 2017). Batteries: Leading the charge. Retrieved from: [http://www.ey.com/Publication/vwLUAssets/EY-RECAI-49-May-2017/\\$FILE/EY-RECAI-49-May-2017.pdf](http://www.ey.com/Publication/vwLUAssets/EY-RECAI-49-May-2017/$FILE/EY-RECAI-49-May-2017.pdf)

renewable energy trajectory started from only 12.3 GW in 2008 to reach 57.4 GW in 2017, a five-fold increase in less than a decade.²³

The cleantech sector in India consists of a plethora of products, services and technology offerings. While the efforts to decarbonise electricity production have a significant environmental advantage, the climate-industrial complex also offers a major economic opportunity in the form of research and development of green technology, green jobs and substantial investments in cleantech sector. According to a recent report, 60,500 people were employed in the renewable energy sector as of 2016 in India, compared to 48,000 from 2015.²⁴ As of 2015, the value of renewable energy market was placed at US\$17 billion with an annual growth rate of 15 per cent.²⁵ The cleantech sector in India consists of established technologies such as solar, wind, biomass as well as emerging technologies such as energy efficiency, green buildings, smart grids, waste to energy.

Despite the recent developments and concerted efforts undertaken to achieve its ambitious renewable energy agenda, Indian cleantech sector has much ground to cover in order to improve its global standing. In the recent Global Cleantech Innovation Index (GCII) report, India witnessed a drop in its overall ranking (29), an eight-spot drop compared to its 2014 ranking. The change can be attributed to the decrease of venture capital funds targeting cleantech, significant drop in the cleantech R&D budget, low count of M&A transactions, depleted cleantech clusters, low cleantech exports and renewable energy job creation relative to GDP, while there was a marginal improvement in number of IPOs conducted relative to GDP.²⁶

A brief description, scope and role of SMEs in established and emerging cleantech sectors have been discussed below. These sectors are:

2.1.1 Solar

Solar energy forms a major chunk of the Indian government's ambitious plans to attain 175 GW of renewable energy by 2022. Out of the 175 GW, 100 GW is expected to come through solar energy, including 40 GW from solar rooftops.²⁷ In addition, the potential for solar energy in the country is estimated at 750 GW.²⁸

23 Tentative state-wise break-up of Renewable Power target to be achieved by the year 2022. (30 March 2013). Ministry of New and Renewable Energy, Government of India. Retrieved from: <http://mnre.gov.in/mission-and-vision-2/achievements/>

24 IRENA (2017), Renewable Energy and Jobs - Annual Review 2017, International Renewable Energy Agency, Abu Dhabi.

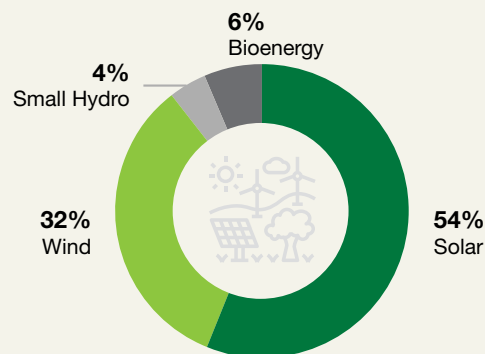
25 Swissnex India and Exubator Bangalore. (May 2015). Towards a cleaner India. Retrieved from: <http://www.swissnexindia.org/wp-content/uploads/sites/5/2016/05/Cleantech-Report.pdf>

26 The Global Cleantech Innovation Index. (2017). Retrieved from <https://www.fii/mediabank/9906.pdf>

27 NITI Aayog, Government of India. (December 2015). Report of the expert group on 175 GW RE by 2022. Retrieved from: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf

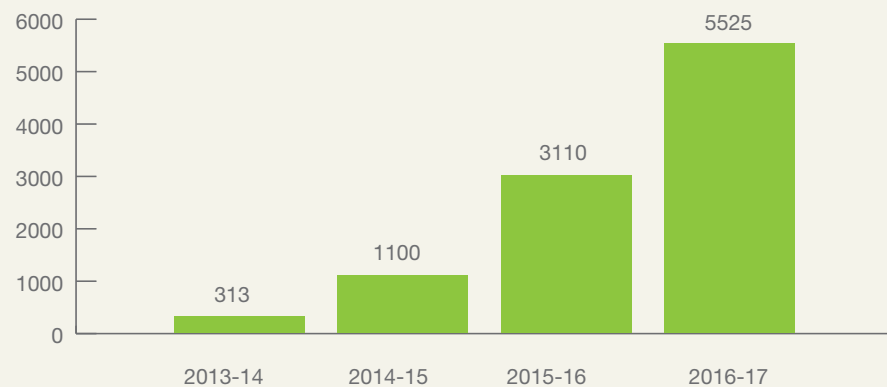
28 NITI Aayog, Government of India. (December 2015). Report of the expert group on 175 GW RE by 2022. Retrieved from: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf

Figure 2:
Renewable
Energy -
Vision 2022



As of April 2017, the installed capacity of solar stood at 12.5 GW, up from 2650 MW in May 2014.²⁹ The solar industry has seen an exponential growth over the last three years including an addition of 3 GW capacity in 2015-16 and 5.25 GW in 2016-17.³⁰

Figure 3:
Installed
capacity of
solar power
(in MW)



The solar energy sector saw significant growth due to a major policy shift by the government when it increased the 2022 solar target from 20 GW to 100 GW.³¹ In addition, a slew of supporting policy initiatives such as a reduction in solar tariffs from INR12 per unit in 2010 to INR2.44 per unit created a conducive environment for solar energy.³² It is worth noting that the recent solar tariffs are cheaper than average coal-based power tariffs (INR3.20 per unit).³³

29 Tentative state-wise break-up of Renewable Power target to be achieved by the year 2022. (30 March 2013). Ministry of New and Renewable Energy, Government of India. Retrieved from: <http://mnre.gov.in/mission-and-vision-2/achievements/>

30 Bhambhani, A. (6 April 2017). Cumulative Solar Power Capacity of India Crossed 12 GW As Of March 31 2017. Taiyang News. Retrieved from: <http://taiyangnews.info/markets/india-installed-over-5-gw-in-fy-2016-17/>

31 Ram, V. (5 January 2015). India likely to exceed target of 100 GW of solar power by 2022. Solairedirect chief. The Hindu Business Line. Retrieved from: <http://www.thehindubusinessline.com/opinion/columns/vidya-ram/india-likely-to-exceed-target-of-100-gw-of-solar-power-by-2022-solairedirect-chief/article6757490.ece>

32 Historic low Tariff of Rs. 2.44 per unit discovered in Bhadla Phase-III Solar Park in auction by SECI. (2017 May 12). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=161755>

33 PTI. (10 May 2017). Solar power tariffs drop to all time low of INR 2.62 per unit. The Hindu Businessline. Retrieved from: <http://www.thehindubusinessline.com/economy/solar-power-tariffs-drop-to-alltime-low-of-rs-262-per-unit/article9689784.ece>

The SMEs in solar space offer a wide range of services including manufacturing solar panels, inverters, batteries, micro-controllers, chargers, cable connectors, solar water heaters etc. With power electronics constituting 30 percent of the total cost of a plant, the expected expansion of solar capacity is a huge opportunity for solar energy SMEs.³⁴ An emerging application of solar energy is in the off-grid space, especially in rural electrification. In recent years, several technology and business models based on solar, like smart grids, mini/micro grids, solar home systems and solar lanterns, have emerged to address the abysmal energy poverty rampant in rural areas. However, despite the emergence of these technologies and business models, the installed capacity of off grid solar was only 471 MW, as of March 2017.³⁵ Farmers in electricity-starved regions are switching to solar water pumps from diesel pumps. As of October 2016, a total of 92,305 solar pumps have been installed across the country with 31,472 pumps installed in 2015-16 itself.³⁶ Recently, a group of farmers in Dhundi village in Gujarat established the world's first solar irrigation co-operative and have been selling the excess electricity through net metering from their 56.4 KW capacity plant back to the state grid at INR4.63/kWh.³⁷ Solar water pump sector is strongly supported by the central government with capital subsidy of up to 90 per cent. Additionally, various state governments have parallel capital subsidy schemes as well, like in Maharashtra where the farmer has to pay only 5 per cent of the total cost of the solar water pump. The scope for solar water pump market is massive. As of 2015, there were more than 9 million diesel pumps still in use in India.³⁸

2.1.2 Wind

Wind energy leads in the Indian renewable energy sector with a current installed capacity of 32.28 GW.³⁹ The Indian Government, in its push for 175 GW renewable energy, has carved 60 GW for utility scale wind.⁴⁰ However, onshore wind power potential is estimated at 302 GW only.⁴¹ The wind power tariffs have followed a trajectory similar to solar power, with a unit price of INR3.46 during recent bid for a

34 Kanth, K.R. (13 March 2012). Solar power is a big opportunity for small and medium units: Debashish Choudhury. Business Standard. Retrieved from: http://www.business-standard.com/article/sme/solar-power-is-a-big-opportunity-for-small-and-medium-units-debasish-choudhury-112031300095_1.html

35 Tentative state-wise break-up of Renewable Power target to be achieved by the year 2022. (30 April 2017). Ministry of New and Renewable Energy, Government of India. Retrieved from: <http://mnre.gov.in/mission-and-vision-2/achievements/>

36 Patil. M. (2017 June 5). Solar irrigation: India's farmers can sell electricity and save groundwater. Business Standard. Retrieved from http://www.business-standard.com/article/economy-policy/solar-irrigation-india-s-farmers-can-sell-electricity-and-save-groundwater-117060500095_1.html

37 Patil. M. (2017 June 5). Solar irrigation: India's farmers can sell electricity and save groundwater. Business Standard. Retrieved from http://www.business-standard.com/article/economy-policy/solar-irrigation-india-s-farmers-can-sell-electricity-and-save-groundwater-117060500095_1.html

38 Patil. M. (2017 June 5). Solar irrigation: India's farmers can sell electricity and save groundwater. Business Standard. Retrieved from http://www.business-standard.com/article/economy-policy/solar-irrigation-india-s-farmers-can-sell-electricity-and-save-groundwater-117060500095_1.html

39 Tentative state-wise break-up of Renewable Power target to be achieved by the year 2022. (30 March 2013). Ministry of New and Renewable Energy, Government of India. Retrieved from: <http://mnre.gov.in/mission-and-vision-2/achievements/>

40 NITI Aayog, Government of India. (December 2015). Report of the expert group on 175 GW RE by 2022. Retrieved from: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf

41 NITI Aayog, Government of India. (December 2015). Report of the expert group on 175 GW RE by 2022. Retrieved from: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf

250 MW wind farm.⁴² While this is marginally higher than coal-based power tariffs, and significantly higher than solar power tariffs, wind power tariffs have shown a general decline over the years.

This has been the result of various government policy interventions: introduction of bidding in wind energy sector, working with the states to resolve land acquisition, power purchase agreement (PPA) issues, drafting wind-solar hybrid policy and the National Offshore Wind Energy policy.

As wind energy is inherently capital intensive, multinational corporations (MNCs) and large-scale companies dominated a majority of the sector. However, SMEs have a strong presence in the supply chain including manufacturing of a wide range of electrical and mechanical components like generators, hydraulics, forgings, gearboxes etc. In fact, small-scale wind turbines are a strong emerging market with an estimated potential of 83 GW.⁴³

2.1.3 Biomass

Biomass, a carbon neutral fuel source has been a crucial energy source for more than 32 per cent of total primary energy use in the country.⁴⁴ More than 70 per cent of the population depends primarily on biomass for their energy needs.⁴⁵ Currently the installed capacity of bio power-based sources is 8.18 GW ⁴⁶ and bio-energy makes up for 10 GW of the 175 GW renewable energy target.⁴⁷

Current estimates place the availability of biomass in India at 500 million metric tonnes per year, while several studies have estimated surplus biomass availability at 120–150 million metric tonnes per annum.⁴⁸ While biomass is a much more reliable source of energy, when compared with wind and solar energy, the industry is often crippled by an unreliable supply chain. In order to increase the uptake of biomass, the Ministry of New and Renewable Energy (MNRE) has various schemes under Central Financial Assistance (CFA) including capital subsidy, financial incentives and tax holidays up to 10 years for biomass-based projects.⁴⁹

42 Ramesh, M. (24 February 2017). Wind power tariffs crash to INR 3.46/kWhr, set a new benchmark for auction. The Hindu Businessline. Retrieved from: <http://www.thehindubusinessline.com/economy/wind-power-tariff-drops-to-record-low-of-rs-346-per-unit-in-auction-by-solar-energy-corp/article9558585.ece>

43 Global Wind Energy Council. (November 2012). India Wind Energy Outlook 2012. Retrieved from: <http://www.gwec.net/wp-content/uploads/2012/11/India-Wind-Energy-Outlook-2012.pdf>

44 Biomass power and cogeneration programme. (n.d.). Ministry of New and Renewable Energy, Government of India. [Website]. Retrieved from: <http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/>

45 Biomass power and cogeneration programme. (n.d.). Ministry of New and Renewable Energy, Government of India. [Website]. Retrieved from: <http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/>

46 Tentative state-wise break-up of Renewable Power target to be achieved by the year 2022. (30 March 2013). Ministry of New and Renewable Energy, Government of India. Retrieved from: <http://mnre.gov.in/mission-and-vision-2/achievements/>

47 NITI Aayog, Government of India. (December 2015). Report of the expert group on 175 GW RE by 2022. Retrieved from: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf

48 Biomass power and cogeneration programme. (n.d.). Ministry of New and Renewable Energy, Government of India [Website]. <http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/>

49 Biomass power and cogeneration programme. (n.d.). Ministry of New and Renewable Energy, Government of India. [Website]. Retrieved from: <http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/>

With affordable technology and readily available raw material, biomass offers significant opportunity for SMEs in India. SMEs working on biomass are active across various sectors including biomass cultivation and processing, bio-energy production, transportation, equipment manufacturing, etc.

A crucial emerging market is the biomass improved cook stove. Biomass is mainly used as a cooking or heating fuel.⁵⁰ The resultant indoor air pollution has resulted in 1.3 million deaths every year in India.⁵¹ As a response, many SMEs have been improving the efficiency of traditional cook stoves, in addition to government interventions like the ongoing National Biomass Cook stove initiative.

2.1.4 Solid Waste Management

Against the backdrop of rapid urbanisation and rampant population growth, solid waste management has become a challenge for municipal and local government authorities. According to estimates, India generates 960 million tonnes of solid waste every year and is projected to generate 19 billion tonnes by 2025.⁵² A recent report on the solid waste market in India found the industry to be worth US\$ 13.62 billion by 2025.⁵³ Further, the report predicted the solid waste management market to grow at a compound annual growth rate (CAGR) of 7.14 per cent by 2015, while the e-waste management market and bio-medical waste management market were predicted to grow at 10.03 per cent and 8.41 per cent respectively, during the same time period.⁵⁴ With the recent revision to the Solid Waste Management Rules (SWM, 2016) there are significant business opportunities for SMEs in the waste to energy value chain including collection, segregation, recycling, transportation and energy recovery.

2.1.5 Green Buildings

In recent years, the green building market has gained significant traction. Recent estimates place the value of green building sector between US\$30 billion and US\$40 billion.⁵⁵ Multiple studies have reported that 75 per cent of the buildings that will be constructed in India by 2030 are yet to be built, and an estimated 1 lakh green buildings will be built by 2025, reflecting the sector's immense potential.⁵⁶

50 Mondal NK (2015) Biomass Smoke and Rural Health: Indian Women are at Risk. *J Biosafety Health Educ* 2:e116. doi: 10.4172/2332-0893.1000e116

51 Kanti, A. (9 September 2017). 1.3 Million Deaths Every Year in India Due To Indoor Air Pollution. *Business World*. Retrieved from <http://businessworld.in/article/1-3-Million-Deaths-Every-Year-In-India-Due-To-Indoor-Air-Pollution/09-09-2017-125739/>

52 Pappu, A., Saxena, M., and Asolekar, S.R. (June 2007). Solid wastes generation in India and their recycling potential in building materials. *Building and Environment*. Vol.42.Issue.6. pp 2311-2320. Retrieved from: <http://www.sciencedirect.com/science/article/pii/S0360132306001168>

53 Lewes, De. (29 September 2014). Waste Management Market in India – A \$13.62 billion opportunity by 2025, reveals new market research report by Novonous. Retrieved from: <http://www.prweb.com/releases/2014/waste-management-market/prweb12206976.htm>

54 Lewes, De. (29 September 2014). Waste Management Market in India – A \$13.62 billion opportunity by 2025, reveals new market research report by Novonous. Retrieved from: <http://www.prweb.com/releases/2014/waste-management-market/prweb12206976.htm>

55 Anon. (9 May 2017). India \$30-40 Billion Green Building Market Opportunity Outlook 2020 - Research and Markets. *PR Newswire*. Retrieved from: <http://www.prnewswire.com/news-releases/india-30-40-billion-green-building-market-opportunity-outlook-2020---research-and-markets-300454261.html>

56 Attractive Product and Business Opportunities in Green Buildings. EAI website. Retrieved from: <http://www.consult.eai.in/green-building-opportunities/>

The diversity of technologies and solutions in a green building presents SMEs with abundant opportunities including energy efficiency (lighting, heating and cooling), water conservation, sustainable building materials and practices, waste management, etc.

The cleantech sector in the country is undergoing a major shift with several new emerging markets and technology offerings. The current government has introduced several initiatives like 'Make in India', 'Digital India', 'Startup India' that are proving to be conducive for the growth of the cleantech industry.

2.1.6 Energy Efficiency

In line with the renewable energy industry, the energy efficiency sector has also achieved significant progress. In 2016-17, through programmes promoting energy efficiency, India was able to save 10 GW of capacity during peak hours. For perspective, the construction of a new 10 GW thermal power plant will cost INR70,000 crore.⁵⁷ In effect, this saving led to monetary gains. The savings have been possible due to two major schemes launched under the National Mission for Enhanced Energy Efficiency (as a part of the National Action Plan on Climate Change). (i) The Performance, Achieve, Trade (PAT) scheme, implemented by the Bureau of Energy Efficiency under the Ministry of Power is a market-based mechanism for improving energy efficiency in energy-intensive industries.⁵⁸ Under the scheme, 478 Designated Consumers (DCs) belonging to eight energy-intensive sectors - Aluminium, Cement, Chlor-alkali, Fertilizer, Iron and Steel, Pulp and Paper, Textiles and Thermal power plant - covering one third of the country's total energy consumption were given energy-efficiency targets. DCs exceeding the target were awarded Energy Savings Certificates (ESCerts) which can be traded with other DCs who have failed to achieve their target. (1 ESCert = 1 tonne equivalent of oil).⁵⁹ At the end of the first cycle of PAT (2012-2015), 3.8 million ESCerts were issued. In addition, the scheme was successful in emission reduction of 31 million tonnes of CO₂, energy savings of 8.67 million tonnes of oil equivalent, and avoided capacity addition of 5.6 GW resulting in monetary savings of INR37,685 crore. Further, the scheme resulted in channelling investment of INR24,517 crore into energy-efficient technologies.⁶⁰

(ii) The second scheme, Unnat Jeevan by Affordable LEDs and Appliances for All (UJALA), implemented by the Energy Efficiency Services Limited (EESL) an ESCO under the Ministry of Power has been replacing incandescent bulbs with LED since January 2015. As of July 4th 2017, the scheme has replaced 24.75 crore incandescent bulbs thus saving 32 billion units of electricity and monetary savings of INR12860 crore.⁶¹ Further, it has saved 6.4 GW of peak power demand and emission reduction of

57 Ramesh,M. (2017 April 11). Energy Efficiency 2.0. Business Line. Retrieved from <http://www.thehindubusinessline.com/specials/energy-efficiency-20/article9631198.ece>

58 Ministry of Power issued more than 38 lakhs Energy Savings Certificates to Industries (2017 March 22). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=159670>

59 Ministry of Power issued more than 38 lakhs Energy Savings Certificates to Industries (2017 March 22). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=159670>

60 Ministry of Power issued more than 38 lakhs Energy Savings Certificates to Industries (2017 March 22). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=159670>

61 UJALA. (n.d.). Retrieved from <http://www.ujala.gov.in/>

26 million tonnes of CO₂. The scheme further intends to add ceiling fans, water pumps and heavier load appliances like air conditioners under its outreach.⁶²

With a recent World Bank report valuing India's Energy Efficiency market at INR 1,00,000 crore,⁶³ a significant increase from INR44,000 crore in 2010 and an envisaged market potential to save 178 billion units of electricity (approximately 20 per cent of annual energy consumption) and 150 million tonnes of annual CO₂ emissions, there is a substantial potential for the Energy efficiency industry. SMEs perform a dual role in the energy efficiency market as consumers and providers. About 48 per cent of the total energy consumption in the industrial sector comes from SMEs, while more than 150 SMEs have been registered under BEE as suppliers of energy efficiency equipments and services.⁶⁴

With the explosion of data and added incentives to improve energy efficiency, there are many startups active in this space of energy efficiency. Their portfolios include improving energy efficiency by monitoring and analysing real time consumption data, trading Renewable Energy Certificates, energy efficient equipment's (lighting, heating, cooling etc.) and forecasting power generation data in wind and solar farms, etc.

2.1.7 Transport

Emissions from transport make up for 27 per cent of energy-related greenhouse gas (GHG) emissions worldwide.⁶⁵ In India, at 142.04 million tons of CO₂ eq, the transportation sector is the second largest contributor of energy related GHG emissions.⁶⁶ Between 1994 and 2007, the share of the sector in national GHG emissions has increased from 6.4 per cent to 7.5 per cent. With the increased economic activity and rapid development in urban areas, the transport sector is projected to become the fastest growing source for GHG emissions.

In order to curtail the effects of climate change, it is imperative to acknowledge the role of transportation sector and focus on sustainable and cleantech means of transportation. Further, efficiency in transportation sector will improve India's energy security. The transport sector relies on a single fossil fuel, petroleum and India imports 80 per cent of its petroleum requirements most of which is earmarked for the transportation sector.⁶⁷

The importance of the transport sector is well corroborated in the recent Global Cleantech Innovation Index with the sector bringing in an investment of US\$10.39 billion globally during the period from 2014 to 2016, making it a core cleantech investment sector.⁶⁸ While India's overall GCII ranking is 29, it is placed fourth

62 UJALA. (n.d.). Retrieved from <http://www.ujala.gov.in/>

63 Ashok, S. et al (2016). Utility Scale DSM Opportunities and Business Models in India. Retrieved from <https://openknowledge.worldbank.org/bitstream/handle/10986/26316/113214-WP-P147807-Utility-Scale-Opportunities-PUBLIC.pdf?sequence=1&isAllowed=y>

64 Sanyal, S., Eisinger, F. (2016). Enabling SME access to finance for sustainable consumption and production in Asia. Retrieved from <https://www.adelphi.de/en/publication/enabling-sme-access-finance-sustainable-consumption-and-production-asia-2>

65 The Global Cleantech Innovation Index. (2017). Retrieved from <https://www.fi/mediabank/9906.pdf>

66 India: Greenhouse Gas Emissions. (2010). Ministry of Environment and Forests Retrieved from http://www.moef.nic.in/downloads/public-information/Report_INCCA.pdf

67 Cleantech Global Trends and Indian Scenario. (2013). FICCI. Retrieved from <http://ficci.in/spdocument/20318/Cleantech-paper.pdf>

68 The Global Cleantech Innovation Index. (2017). Retrieved from <https://www.fi/mediabank/9906.pdf>

in total venture capital investment in transportation, underlining the importance and increasing opportunities present in the cleantech transport ecosystem. Indian government has taken several initiatives to reduce the carbon footprint of the transport sector. Standout initiatives include: (i) National Urban Transport Policy (NUTP) whose objective is to promote clean technologies in transportation in addition to mass rapid transportation and traffic management systems; (ii) introduction of fuel efficiency standards like Corporate Average Fuel Economy (CAFE) to ensure auto-manufacturing companies produce cars with increased mileage; (iii) the National policy on bio-fuel pushed the importance of using bio-fuel as an alternative clean energy fuel. The policy further proposed the mandatory blending of petrol and diesel with 20 per cent bio-fuel by 2017; (iv) the national electric mobility mission plan launched in 2013 envisages a sale of 6 to 7 million full range electric vehicles with a resultant liquid fuel savings of 2.2-2.5 million tonnes and reduction of 1.3 to 1.5 per cent in CO₂ emissions by 2020.⁶⁹

In addition, the Ministry of Petroleum and Natural Gas in its auto fuel vision and policy 2025 has recommended phased introductions of Bharat Stage IV norms in the entire country from April 2017.⁷⁰ Further, the recent Supreme court ruling banned the sales and registration of Bharat Stage III vehicles effective from 1 April 2017. The ban ensures that vehicles that are not compliant with Bharat Stage IV emission standards cannot be sold after 31 March 2017. The transition to Bharat Stage IV is projected to reduce particulate matter emissions by 80 per cent in new trucks and by 50 per cent in cars.⁷¹ With the government's recent announcement to start selling only electric cars by 2030, the cleantech transport ecosystem has a significant number of opportunities and large-scale investments in the future.⁷²

2.2 Government Instruments for Cleantech

Recent government-led initiatives, like Make in India, Digital India, Startup India, that promote entrepreneurship have been crucial for SME growth, expansion and financing. These programmes, in addition to the existing schemes for SMEs, seek to provide the much-needed financial support to the sector.

MNRE, the Ministry of Science and Technology, the Ministry of Small and Medium Enterprises (MSME), the Ministry of Commerce and Industry and the Ministry of Skill Development and Entrepreneurship (MSDE) are amongst the apex government institutions actively promoting innovations, and devising key financing instruments and policies for the cleantech SME sector.

IREDA, under MNRE, is the apex public financial institution for renewable energy projects in the country. During financial year (FY) 2016-17, IREDA supported 112 clean energy projects in solar, wind, hydro and biogas with a loan amount of INR102

69 Cleantech Global Trends and Indian Scenario. (2013). FICCI. Retrieved from <http://ficci.in/spdocument/20318/Cleantech-paper.pdf>

70 Auto Fuel Policy. (2015 April 27). Press Information Bureau Retrieved from <http://pib.nic.in/newsite/printrelease.aspx?relid=119754>

71 Supreme Court bans registration, sale of BS-III cars from April 1. (2017 March 30). Hindustan Times. Retrieved from <http://www.hindustantimes.com/india-news/supreme-court-bans-registration-sale-of-bs-iii-cars-from-april-about-a-million-vehicles-to-be-hit/story-KNkkWWCuHg8zKs38BSyrl.html>

72 Brodie, C. (2017 May 23). "India will sell only electric cars within the next 13 years". World Economic Forum Retrieved from <https://www.weforum.org/agenda/2017/05/india-electric-car-sales-only-2030/>

billion disbursed to a range of companies including but not limited to SMEs, with solar projects receiving INR47.85 billion of the support.⁷³ The principal clean energy financing arm of the government is planning to sanction INR130 billion for 2017-18.⁷⁴ In addition to tax-free bonds, IREDA mobilises funds through government loans and international lines of credit with development agencies and banks, like KfW, Japan International Cooperation Agency (JICA), Asian Development Bank (ADB) etc.⁷⁵ So far, IREDA has sanctioned INR370 billion of funding for clean energy projects resulting in a capacity addition of 7,000 MW.⁷⁶ Despite much of its funding going toward large-scale grid connected projects, a recent initiative on loan schemes for solar rooftop projects is believed to improve accessibility for SMEs.⁷⁷

Further, the Solar Energy Corporation of India (SECI), under MNRE, established to facilitate the effective implementation of Jawaharlal Nehru National Solar Mission (JNNSM), recently floated a 500 MW tender for solar rooftop in government buildings.⁷⁸ Additionally, a 2,300 MW tender for solar projects is currently in the works.⁷⁹

MSME has initiated several schemes over the years for supporting SMEs at different stages of expansion and across different parts of the value chain. These schemes include improving access to credit, upgrading technology for improving energy efficiency, improving marketing through international cooperation and assistance, skill and infrastructure development programmes.⁸⁰

An important scheme under MSME is the Credit Guarantee Trust Fund for Micro & Small Enterprises (CGTMSE). The Small Industries Development Bank of India (SIDBI) and the Indian government operationalised the CGTMSE, which is now crucial for first generation entrepreneurs. The scheme provides funds to its Member Lending Institutions (MLIs), which comprises banks and financial institutions, which in turn provide collateral free loans for startups and SMEs.⁸¹ The loan amount is up to INR10 million and can be structured as a term loan or working capital.⁸² As of May 2016, 119 active MLIs have extended an aggregated credit of INR1,135 billion against 24,31,490 proposals from micro and small enterprises.⁸³

73 Chandrasekaran. K. (10 April 2017). IREDA finances Rs 10,000 crore green projects during 2016-17. The Economic Times. Retrieved from http://economictimes.indiatimes.com/articleshow/58099563.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

74 Chandrasekaran. K. (10 April 2017). IREDA finances Rs 10,000 crore green projects during 2016-17. The Economic Times. Retrieved from http://economictimes.indiatimes.com/articleshow/58099563.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

75 Indian Renewable Energy Development Agency Ltd. (IREDA). (2016). Annual Report 2015-16 Retrieved from <http://www.ireda.gov.in/writereaddata/AnnualReport2015-16.pdf>

76 IREDA plans to raise up to \$300 mn via overseas borrowing. (2017, April 21). Retrieved from <http://www.moneycontrol.com/news/business/companies/ireda-plans-to-raise-up-to-300-mn-via-overseas-borrowing-2263407.html>

77 Sanyal. S., Eisinger. F. (2016). Enabling SME access to finance for sustainable consumption and production in Asia. Retrieved from <https://www.adelphi.de/en/publication/enabling-sme-access-finance-sustainable-consumption-and-production-asia-2>

78 Kenning.T. (18 April 2017). SECI halves Indian government building rooftop tender to 500MW. PV-Tech. Retrieved from <https://www.pv-tech.org/news/seci-halves-indian-government-building-rooftop-tender-to-500mw>

79 Singh. S. (9 January 2017). SECI to call 2,300-mw solar power bids soon: Ashvini Kumar. The Economic Times. Retrieved from <http://economictimes.indiatimes.com/industry/energy/power/seci-to-call-2300-mw-solar-power-bids-soon-ashvini-kumar/articleshow/56418501.cms>

80 Name of Schemes. (n.d.). Retrieved from http://dcmsme.gov.in/scheme_a.htm

81 Access to Credit – CGTMSE. (n.d.). Retrieved from <http://dcmsme.gov.in/schemes/scrcguarn.htm>

82 Access to Credit – CGTMSE. (n.d.). Retrieved from <http://dcmsme.gov.in/schemes/scrcguarn.htm>

83 Access to Credit – CGTMSE. (n.d.). Retrieved from <http://dcmsme.gov.in/schemes/scrcguarn.htm>

In addition, the National Small Industries Association (NSIC), under MSME, operates specific tailored schemes for positioning SMEs in a competitive role. It includes credit facilitation, single point registration and performance and credit rating.⁸⁴ Recently NSIC launched the online finance facilitation centre, an online financial platform for easing access to credit for SMEs.⁸⁵

The primary financial institution for fostering and financing SMEs is SIDBI. SIDBI provides direct financial assistance to SMEs, in addition to coordinating with financial institutions, and engaging in SME support. The schemes are targeted toward specific organizations in different stages of growth like SIDBI StartupMitra and SIDBI Growth Capital and Equity Assistance.⁸⁶

In order to promote cleantech innovations, energy efficiency and sustainable production methods, SIDBI has served as an important source of green financing. It has established credit lines with several financial institutions, and domestic and international government organisations. Some of the measures include:⁸⁷

- SIDBI-KfW Innovation Finance Programme
- UNIDO's Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters
- GEF-World Bank Financing Energy Efficiency with SIDBI and BEE
- SIDBI-JICA Energy Saving Line
- SIDBI-AfD Energy Efficiency Credit Line
- SIDBI-KfW Energy Efficiency Credit Line

In August 2015, the Indian Government through SIDBI, launched two crucial funds for funding startups and supporting SMEs.⁸⁸ The first fund, Indian Aspiration fund with an initial corpus of INR20 billion invests in venture capital funds for providing equity to Micro, Small and Medium enterprises.⁸⁹ The second fund, SIDBI Make in India Loan for Enterprises (SMILE) with a budget of INR10,000 crore will offer quasi-equity and soft short term loans with relaxed rules and regulations and improved access to finance for SMEs.⁹⁰

84 National Small Industries Corporation. (n.d.). Retrieved from <http://www.dcmsme.gov.in/partners/nsic.htm>

85 Bhakta. P. (24 August 2016). Rubique ties up with NSIC for easier flow of credit for MSMEs .The Economic Times. Retrieved from http://economictimes.indiatimes.com/articleshow/53843954.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

86 SIDBI. (n.d.) Retrieved from <https://www.sidbi.in/>

87 Sanyal. S., Eisinger. F. (2016). Enabling SME access to finance for sustainable consumption and production in Asia. Retrieved from <https://www.adelphi.de/en/publication/enabling-sme-access-finance-sustainable-consumption-and-production-asia-2>

88 Roy. A. (9 August 2015). Arun Jaitley launches funds for startups, small firms. Livemint. Retrieved from <http://www.livemint.com/Politics/9FaxOhSxGDqbJXLrVMrZcl/Arun-Jaitley-launches-funds-for-startups-small-firm.html>

89 Roy. A. (9 August 2015). Arun Jaitley launches funds for startups, small firms. Livemint. Retrieved from <http://www.livemint.com/Politics/9FaxOhSxGDqbJXLrVMrZcl/Arun-Jaitley-launches-funds-for-startups-small-firm.html>

90 Roy. A. (9 August 2015). Arun Jaitley launches funds for startups, small firms. Livemint. Retrieved from <http://www.livemint.com/Politics/9FaxOhSxGDqbJXLrVMrZcl/Arun-Jaitley-launches-funds-for-startups-small-firm.html>

2.2.1 Programmes Financing Energy Efficiency

Technology Upgradation Fund Scheme (TUFS)

In order to promote the uptake of state-of-the-art technology in textile and jute industry, the Ministry of Textiles introduced TUFS. With the recent amendments to TUFS, the textile industry is eligible to a capital subsidy, with a ceiling of INR30 crore.⁹¹ Through the new scheme, government is expecting investments worth INR1,00,000 crore and employment of 30 lakh people.⁹²

Integrated Development of Leather Sector (IDLS)

Implemented by the Ministry of Industries and Commerce, IDLS aims to upgrade the existing tanneries, footwear components and leather products in order to increase capacity, productivity and improve design and development.⁹³ The scheme is positioned as an investment grant, offering a 30 per cent subsidy to MSMEs on plant and machinery cost with a cap of INR50 lakh for the purpose of technology upgrade/modernization and/or setting up new units.⁹⁴

Credit Linked Capital Subsidy Scheme for Technology Upgradation (CLCSS)

CLCSS aims at promoting technology upgrading in Micro and Small Enterprises with an assistance of 15 per cent capital subsidy on institution finance with a cap INR15 lakh, for introducing quality technology in approved sub-sectors and products.⁹⁵

4E Financing Scheme

Under the fund scheme for financing end-to-end energy-efficiency investments in MSMEs (4E), a loan of up to 90 per cent of project cost, with an interest rate at 2.5 per cent less than the normal lending rate was provided to MSMEs for implementing energy-efficiency measures on an end-to-end basis with a cap of INR1.5 crore and a minimum loan amount of INR10 lakh.⁹⁶

Technology & Quality Upgradation Support for MSMEs (TEQUP)

TEQUP is positioned to promote energy efficiency, product quality certification and reduction of greenhouse gases in MSMEs. A grant of assistance of 25 per cent of project cost is provided for the induction of energy efficient technologies with a maximum cap of INR10 lakh. Further, the project or the machine is inspected by a certified energy auditor to ensure at least 15 per cent reduction in energy consumption.⁹⁷

91 TUFS. (n.d.). Retrieved from <http://texmin.nic.in/schemes/technology-upgradation-fund-scheme>

92 Cabinet approves Amended Technology Upgradation Fund Scheme for textiles industry. (2015 December 31). Business Standard. Retrieved from http://www.business-standard.com/article/economy-policy/cabinet-approves-amended-technology-upgradation-fund-scheme-for-textiles-industry-115123000748_1.html

93 FDDI. (n.d.). Retrieved from http://www.fddiindia.com/services-new/idls_index.html

94 FDDI. (n.d.). Retrieved from http://www.fddiindia.com/services-new/idls_index.html

95 DCMSME. (n.d.) Retrieved from http://www.dcmsme.gov.in/schemes/SCLCS_FOR_TU_SSI_UNITS.pdf

96 SIDBI. (n.d.) Retrieved from https://www.sidbi.in/files/4E_Financing_Scheme.pdf

97 SIDBI. (2017 February). OPTIMISM Vol 6. Retrieved from <https://www.sidbi.in/downloads/OptimismFebruary2017.pdf>

Scheme for Technology Upgradation/ Establishment/ Modernization for Food-processing Industries

The objective of this scheme, under the Ministry of Food Processing Industries, is to enable establishing, diversifying and modernizing food-processing industries including fruits and vegetables, milk products, meat, poultry, fishery and oil seeds. The assistance is positioned as a grant subject to 25 per cent of the plant and machinery and technical civil work with an INR50 lakh ceiling in 'general areas' and 33.33 per cent grant with a cap of INR75 lakh in 'difficult areas' (for example J&K, Himachal Pradesh, Uttarakhand, Sikkim, North Eastern States, Andaman & Nicobar Islands, Lakshadweep).⁹⁸

2.2.2 Role of Government in Research & Development

Investments in R&D are imperative for businesses in order to stay relevant and competitive in the domestic and global market place. Some of the government initiatives for providing financial assistance for research and development include:

SIDBI Revolving Fund for Technology Innovation (SRIJAN Scheme)

This fund provides assistance for development, demonstration and expansion of MSME with technology-based offerings.⁹⁹ The scheme developed in conjunction with Technology Information Forecasting and Assessment Council (TIFAC) provides assistance structured in the form of early stage debt funding, with a maximum amount of INR100 crore, on less stringent rules and regulations.¹⁰⁰

Promoting Innovations in Individual Startups and MSMEs (PRISM)

The Ministry of Science and Technology administers this programme by seeking to support innovators for developing prototypes and promoting disruptive innovations.¹⁰¹ Thrust areas for innovation include cleantech, green buildings, smart materials, waste to wealth and water and sewage treatments.¹⁰²

Atal Innovation Mission (AIM)

This is the Indian government's attempt to establish an innovation promotion platform involving academia and entrepreneurs to adopt a strong culture of innovation and R&D in India.¹⁰³

National Clean Energy Fund (NCEF)

The NCEF was created in 2010-11 utilizing the carbon tax (clean energy cess) for funding research and innovative projects in clean energy technology. The amount of clean energy cess on every tonne of coal imported or produced has been increasing

98 MOFPI. (n.d.). Retrieved from <http://www.mofpi.nic.in>

99 SIDBI. (n.d.). Retrieved from <https://www.sidbi.in>

100 SIDBI. (n.d.). Retrieved from <https://www.sidbi.in>

101 Department of Scientific and Industrial Research. (2012). Promoting Innovations in Individuals, Startups and MSMEs (PRISM). Retrieved from https://www.mygov.in/sites/default/files/master_image/Department%20of%20Scientific%20and%20Industrial%20Research.pdf

102 Department of Scientific and Industrial Research. (2012). Promoting Innovations in Individuals, Startups and MSMEs (PRISM). Retrieved from https://www.mygov.in/sites/default/files/master_image/Department%20of%20Scientific%20and%20Industrial%20Research.pdf

103 Atal Innovation Mission. (n.d.) Retrieved from <http://niti.gov.in/content/atal-innovation-mission-aim>

over the years, from INR50 to INR400 per tonne in the recent budget. Since its inception, INR54, 336 crore has been collected as a part of the coal cess, although NCEF has received only less than half of the collected amount.¹⁰⁴

In addition to the above programmes, there are targeted government-supported incubator and accelerator programmes for promoting innovative startups. These will be covered extensively in the next section.

Despite the presence of several layered financial assistance and incentive programmes, their efficacy remains weak due to lack of awareness. Many SMEs were largely unaware of the existence of CGTMSE fund, which is a crucial collateral-free financial instrument for SMEs.¹⁰⁵ Even some of the banks were unaware of the CGTMSE programme and its benefits.¹⁰⁶

2.3 Financial Instruments for Cleantech

The startup landscape in India is very vibrant, as is evident from the increase in the number of startups over the years across diverse sectors. According to a NASSCOM report on the Indian startup ecosystem, the number of technology startups in India is projected to reach 10,500 by 2020 from 4,750 in 2016. In addition, a conducive policy environment, targeted government programmes (Startup India, Make in India) and a growing digital customer base have increased the confidence of investors with the total startup funding in 2016 valued at USD 4 billion.¹⁰⁷ Further, the report identified e-commerce and aggregators as mature markets and fintech, edutech and healthtech as emerging markets. Globally, the Indian startup ecosystem ranks third, following the United States and the United Kingdom.

2.3.1 Funding Lifecycle

To evolve from the conception/idea stage, companies undergo several iterations of funding at different stages of their growth and for different purposes. During the initial stage, where an entrepreneur does not have a tangible product or service offering, an **incubator** who sees merit in the idea/concept, and shepherds the transition from the ideation to the prototype stage. Although the terms Incubators and Accelerators are often used interchangeably, the main difference lies in the engagement period. While Incubators typically work with a company in its initial phase (typical duration 6-36 months), **Accelerators** engage with the company for a shorter period of time (typical duration 3 -12 months) and essentially hone the startup for initial rounds of funding. Incubators and accelerators serve as important market linkages connecting nascent startups to venture capital (VC)/private equity (PE) market and relevant government programs.

¹⁰⁴ Chandrasekhar, A. (2017 July 4). How the Ganga and GST are hijacking India's clean energy fund. Scroll.in. Retrieved from <https://scroll.in/article/841910/how-the-ganga-and-gst-are-hijacking-indias-clean-energy-fund>

¹⁰⁵ Chakravarty, R. (2014, April 8). MSMEs lack awareness about easy and collateral-free loans available with banks. Electronicsb2b. Retrieved from <http://www.electronicb2b.com/industry-buzz/msmes-lack-awareness-about-easy-and-collateral-free-loans-available-with-banks-2>

¹⁰⁶ Sanyal, S., Eisinger, F. (2016). Enabling SME access to finance for sustainable consumption and production in Asia. Retrieved from <https://www.adelphi.de/en/publication/enabling-sme-access-finance-sustainable-consumption-and-production-asia-2>

¹⁰⁷ NASSCOM. (2016). Indian Startup Ecosystem Maturing. Retrieved from www.nasscom.in/download/summary_file/fid/135625

The startup ecosystem in India has several active incubators, both home grown and international. In 2016, the Incubator/Accelerator network in India registered an increase of 40 per cent.¹⁰⁸ More than 30 academic incubators were established in 2016 under the ambitious Startup India Stand-up India initiative.¹⁰⁹ India now has the third highest number of startup Incubators and Accelerators in the world, following US and China.¹¹⁰ Based on source of funding, incubators fall under different categories.

Academic Incubators constitute 51 per cent¹¹¹ of the total incubators in the country emphasizing the important role played by academic institutions in grooming the next generation of entrepreneurs. Some of the active academic incubators from premier institutions are tabulated below.

Table 1: List of Academic Institutions with Incubators

Indian Institute of Management (IIM) Ahmedabad, Centre for Innovation, Incubation and Entrepreneurship (CIIE)	Indian Institute of Management (IIM) Bangalore), NS Raghavan Centre for Entrepreneurial Learning (NSRCEL)
Indian Institute of Technology (IIT) Madras Incubation Cell	Indian Institute of Management (IIM) Rohtak
Indian Institute of Technology (IIT) Mandi	International Institute of Information Technology (IIIT) Hyderabad
Maulana Azad National Institute of Technology (MANIT) Bhopal	National Institute of Technology (NIT) Rourkela
National Institute of Technology (NIT) Jalandhar	Indian Institute of Management (IIM) Udaipur
National Institute of Technology (NIT) Calicut	Indian Institute of Technology (IIT) Ropar
Indian Institute of Technology (IIT) Bombay Sine	Indian Institute of Science Education and Research (IISER) Mohali
Indian Institute of Technology (IIT) Roorkee	Indian Institute of Management (IIM) Kozhikode
Indian Institute of Management (IIM) Raipur	National Institute of Technology (NIT) Warangal
Malaviya National Institute of Technology (MNI)T Jaipur	National Institute of Technology (NIT) Tiruchirappalli
Indian Institute of Technology (IIT) Patna	Indian Institute of Science Education and Research (IISER) Bhopal
Indian Institute of Science Education and Research (IISER) Thiruvananthapuram	Indian School of Business (ISB) Hyderabad
Birla Institute of Technology and Science (BITS) Pilani	

Sourced from NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Startup Ecosystem – 2017 report

¹⁰⁸ NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

¹⁰⁹ NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

¹¹⁰ NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

¹¹¹ NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

Academic Incubators are usually sector agnostic, but there are several academic and management institutes which have clean energy amongst their top three verticals. Academic incubators active in incubating clean energy companies are listed in table 2.

Table 2: List of Academic Incubators in the Cleantech Space

Atma Ram Sanatan Dharma College University of Delhi	IITM's Rural Technology Business Incubator (RTBI)
CIIE Initiatives, Centre for Innovation, Incubation and Entrepreneurship (CIIE)	Technology Business Incubator (University of Hyderabad)
Innovation & Incubation Centre (IIC) Pandit Deendayal Petroleum University(PDPU)	TIDES Incubation Centre, IIT Roorkee (Technology Innovation and Development of Entrepreneurship Support Centre, IIT Roorkee)
Shri Mata Vaishno Devi University Technology Business Incubation Center Society (SMVDU TBI)	Malaviya Centre for Innovation Incubation & Entrepreneurship - IIT Banaras Hindu University
NASSCOM-ERNET Center of Excellence (CoE) For Internet of Things (IoT)	IITG-Technology Incubation Centre (IITGTIC)
Sri Jayachamarajendra College of Engineering – Science & Technology Entrepreneurs Park (STEP-SJCE)	NSRCEL
Vel Tech – Technology Incubator	Society for Innovation & Entrepreneurship (SINE)
National Engineering College- Business Incubator	IIT Madras Incubation Cell
Indian School of Business- DLabs Incubator Association	IIIT Hyderabad T-HUB
J.S.S. Academy of Technical Education STEP (JSSATE- STEP)	Technology Incubation and Entrepreneurship Society (TIETS)

Sourced from Startup India – List of Incubators (2016)

The prominent cleantech startups incubated by academic incubators include: Aspiration Energy, Hydrocreatives (CIIE, Ahmedabad), Svadha Energies, Cygni Energy, Zazen Systems (RTBI, IIT Madras) and Persept Solar (NSRCEL, IIM Bangalore).

Government supported Incubators contribute 8 per cent¹¹² to the overall incubator ecosystem in the country. The major programmes, Science and Technology Entrepreneurs Park (STEPs) and Technology Business Incubators (TBI), are set up under the institutional framework of National Science and Technology Entrepreneurship Development Board (NSTEDB).¹¹³ NSTEDB, established under the umbrella of Department of Science and Technology (DST), is an institutional mechanism to help promote knowledge driven and technology intensive enterprises. The Board, having representations from socio-economic and scientific Ministries/ Departments, aims to convert “job-seekers” into “job-generators” through Science & Technology (S&T) interventions.¹¹⁴ STEP and TBIs are onboarded in and around academic, technical, management institutions, technology and research parks.

¹¹² NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

¹¹³ NSTEDB. (n.d.). Retrieved from <http://www.nstedb.com>

¹¹⁴ NSTEDB. (n.d.). Retrieved from <http://www.nstedb.com>

Venture Centres are inclusive and integrated centres for promoting entrepreneurs. They provide a dedicated support ecosystem for startups: promoting research, assisting with product prototyping, connecting with investors and filing patents. With a corpus funding of INR2 crore they are classified within the Seed Support System for Startups in Incubators of NSTEDB.¹¹⁵

Innovative Ventures for Technology Development (INVENT) is an incubation support programme in partnership with the Technology Development Board (TDB) and the Department for International Development (DFID) for creating an impact Investing pipeline for eight low-income states in India.¹¹⁶

Recently, the DST, through the NSTEDB launched an INR100 crore programme under its new National Initiative on Developing and Harnessing Innovations (NIDHI) - Promoting and Accelerating Young and Aspiring Innovators & Startups (PRAYAS) to address the funding void in developing prototypes.¹¹⁷ The Nidhi-Prayas is positioned to support disruptive innovations and 10 prayas centres will be established amongst the STEP's and TBIs, with support from the DST.¹¹⁸ This is inclusive of DST's commitment to infuse INR500 crore in the startup ecosystem through NIDHI. It includes funding of INR1 crore per startup (implemented through TBI), establishing TBIs across reputed academic institutions and research and development institutions. So far, DST has successfully launched more than 100 TBIs across India.¹¹⁹

Independent incubators make up 32 per cent of the ecosystem.¹²⁰ They offer a plethora of services including mentorship, capital, connection to angel investors, government schemes and coalition with corporate houses. Currently there are more than 200 incubators in India that fall in this category. Their thrust areas include health, e-commerce, education, fintech, energy, biotechnology and agribusiness. Independent incubators in the cleantech space engage in diverse areas including energy access, smart grids, waste to energy, small-scale wind mills, remote energy monitoring, biofuels and energy efficiency, to name a few. The active incubators in the cleantech space include Incube Ventures, International Centre For Entrepreneurship and Technology and Indian Angel Network Incubator.

A subgroup of incubators focused on social impact has been gaining significant traction. It includes organizations like Villgro (through its program Unconventional) and UnLtd India. Prominent startups incubated by these organizations include Ecozen solutions, Sustainearth, Sustaintech, Simpa Networks and First Energy.

Corporate incubators contribute 9 per cent¹²¹ to the incubator ecosystem. The advent of Corporate Social Responsibility (CSR) has resulted in several corporate houses establishing their in-house incubation cell and other corporate houses synergizing with

115 Venture Centre. (n.d.). Retrieved from http://www.venturecenter.co.in/dst_seed.php

116 Technology Development Board. (n.d.). Retrieved from <http://tdb.gov.in>

117 NSTEDB. (n.d.) Retrieved from <http://www.nstedb.com/new-programmes.htm>

118 NSTEDB. (n.d.) Retrieved from <http://www.nstedb.com/new-programmes.htm>

119 DST commits 500 crore for PM's Vision on Startup India. (2016 September). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=149571>

120 NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

121 NASSCOM. (2017). Incubators/Accelerators Driving Growth of Indian Start-up Ecosystem – 2017. Retrieved from <http://www.nasscom.in/incubatorsaccelerators-driving-growth-indian-startup-ecosystem-2017>

established incubators for their CSR. Standout examples include SAP, which allocates 40 per cent of its CSR budget for incubating startups and has integrated with IIT Bombay – SINE (Society for Innovation and Entrepreneurship) for incubation.¹²² Tata Motors works with Kwatt, a solar consultancy firm providing training to tribal youth on solar energy.¹²³ Mahindra group CSR grants seed investment to enterprises in the agri-tech sector with CIE¹²⁴ and Marico invested in Camtech (health sector) through Villgro.¹²⁵

Accelerators are the next step in the startup value chain. They are positioned as post-incubation initiatives for fast-tracking the early stage startups into the Venture Capital (VC)/Private Equity (PE) orbit. They are time-bound and rigorously structured programmes for achieving different objectives including idea validation and improving the scalability of the business model.

There are more than 60 active startup accelerators in the Indian startup ecosystem. The accelerators in the cleantech sector are listed in the table given below.

Table 3: List of Accelerators

Autodesk Entrepreneur Impact Programme	Brigade REAP
First light Accelerator	SAP-SINE Social S-Cube
SAP Startup Studio	Shell Make the future
The D.N.A – Bosch	Aarambh Ventures
Venture Nursery	AIM Smart City Accelerator

Sourced from Inc 42 – Top 60+ Active Startup Accelerators in India

Some of the standout government accelerator programmes include the Global Cleantech Innovation Program – a joint initiative by the United Nations Industrial Development Organisation (UNIDO) and MSME. It is funded by Global Environment Facility (GEF), for enhancing cleantech startups and connecting them to a strong network of potential Investors, mentors and partners¹²⁶ India Innovation Growth Programme (IIGP) - a public-private partnership between Department of Science and Technology and Lockheed Martin Corporation for building a strong innovation corridor.¹²⁷ Post the government's recent drive to promote startups, the programme rebranded itself as IIGP 2.0 promoting innovations with a strong social impact. Its current incarnation is a triparty partnership with Tata Trusts, DST and Lockheed Martin Corporation, and also includes Tata Centre for Technology and Design at

122 Startup India. (n.d.) Retrieved from <http://startupindia.gov.in/pdf/StartupIndia-Guidelines-for-Corporates-to-set-up-incubators.pdf>

123 Startup India. (n.d.) Retrieved from <http://startupindia.gov.in/pdf/StartupIndia-Guidelines-for-Corporates-to-set-up-incubators.pdf>

124 Startup India. (n.d.) Retrieved from <http://startupindia.gov.in/pdf/StartupIndia-Guidelines-for-Corporates-to-set-up-incubators.pdf>

125 Startup India. (n.d.) Retrieved from <http://startupindia.gov.in/pdf/StartupIndia-Guidelines-for-Corporates-to-set-up-incubators.pdf>

126 Global Cleantech Innovation Program. (n.d.) Retrieved from <http://www.unido.org/environment/o591190/climate-policies-and-networks/global-cleantech-innovation-programme.html>

127 India Innovates. (n.d.). Retrieved from <http://www.indiainnovates.in>

the Massachusetts Institute of Technology (MIT), CIIE at IIM Ahmedabad and IIT – Bombay.¹²⁸ The Global Innovation and Technology Alliance (GITA) is a non-profit joint venture between DST and the Confederation of Indian Industry (CII) for the promotion of government schemes/programmes to attract investment in Research and Development.¹²⁹ In addition, the NIDHI flagship scheme of DST includes – NIDHI Accelerator, NIDHI Seed Support System, NIDHI Entrepreneur in Residence, NIDHI Grand Challenges and Competitions (GCC) for Scouting Innovations and NIDHI Centre of Excellence for promoting the startup ecosystem.¹³⁰

Angel Investors typically invest in early stage businesses and disruptive innovations. The scope and size of funding varies with the stage of intervention. Angel investors themselves are well-established entrepreneurs with a strong background in creating and managing successful ventures. In India, the Indian Angels Network is a strong group of Angel investors providing mentorship and capital to early stage startups. The active angel investors in the cleantech space include: Anupam Mittal, Sanjay Mehta, Anirudh Dhamani, VikasTaneja and Steven Sule. Some of the prominent startups funded by angel investors include Fourth Partner energy and Ecosense sustainable solutions.

Venture Capital (VC) typically comes into the picture when the startup has developed a scalable business model and established a strong customer base and is looking to expand on a regional, national or international scale. VCs infuse large and varied amounts of expansion capital (depending on the funding series) in return for equity. There are more than 50 VCs active across various sectors in India. In the cleantech ecosystem, the prominent VCs are mentioned in table 4.

Table 4: List of Major Venture Capital firms

Infuse Ventures	Sangam Ventures
Caspian Ventures	SIDBI Venture Capital (Govt)
IFCI Ventures (Govt)	CTI – PFAN (Project Financing)
IREDA (Project Financing)	Venture East
TDB Venture Capital Fund	Google Impact Challenge

Sourced from Inc 42 – Top 47 Most Active Venture Capital Firms in India For Startups

The venture capital investment market in India, especially for the solar sector has been growing steadily over the years. In 2015, the sector raised more than US\$278 million from various sources.¹³¹ According to a Mercom report, the funding and mergers and acquisitions (M&A) in the Indian solar sector for January-March was US\$1.6 billion.¹³²

¹²⁸ India Innovates. (n.d.). Retrieved from <http://www.indiainnovates.in/>

¹²⁹ Global Innovation and Technology Alliance. (n.d.). Retrieved from <https://gita.org.in/>

¹³⁰ NSTEDB. (n.d.) Retrieved from <http://www.nstedb.com/new-programmes.htm>

¹³¹ Agarwal, A. (2017, June 10). Solar power: Foreign investors show keen interest in India Solar power: Foreign investors show keen interest in India. Financial Express. Retrieved from <http://www.financialexpress.com/opinion/solar-power-foreign-investors-show-keen-interest-in-india/710873/>

¹³² Global pension funds scout for deals in India's solar energy sector. (2017 May 1). vccircle. Retrieved from <https://www.vccircle.com/global-pension-funds-scout-for-deals-in-indias-solar-energy-sector/>

Some of the notable cleantech companies that have successfully raised large investments include Welspun Renewable Energy (US\$24 million from GE Financial Services) and CaptureSolar Energy (US \$125 million from PG Concept).¹³³

With the current standing of India in the Renewable Energy Country Attractiveness Index, KPMG forecasts for the share of solar power in India at 12.5 per cent (166 GW) by 2025 ¹³⁴. This, and a target to raise US\$100 billion investment in the solar sector alone over the next five years, has opened the market to global investors. Some of the world's largest pension funds including Canada Pension Plan Investment Board (CPPIB), Caisse de dépôt et placement du Québec (CDPQ), and Ontario Teacher's Pension Plan (OTPP) are hoping to capitalize on the solar market in India.¹³⁵ Further, Japan's Softbank along with its partners is planning to invest US\$20 billion in the solar power sector.¹³⁶ In addition, several international investors have successfully established their presence in India including APG, Brookfield Asset Management, JP Morgan and Morgan Stanley etc.¹³⁷, A US\$ 40 million investment from International Finance Corporation (IFC), World Bank's private sector arm in Tata Cleantech Pvt. Ltd. is currently in the works to build solar, wind and other related projects.¹³⁸

Various cleantech startups have been successful in raising substantial investments from the venture capital network. Some of the prominent companies include:

- Ecozen Solutions, a Pune-based solar powered micro-cold storage solution provider raised US \$ 1.1 million from agri-tech focused investment fund.¹³⁹
- Mera Gao Power (MGP), a low-cost Solar Microgrid model, has been pivotal in raising US \$ 2.5 million. Impact Investment Exchange helped MGP raise the funding from Insitor Impact Fund, the ENGIE Rassembleurs d'Energies Initiative, and the Electrification Financing Initiative.¹⁴⁰
- Husk Power Systems, agri-waste power producer raised US\$ 5 million in a funding round led by Acumen fund and Bamboo Finance.¹⁴¹

¹³³ swissnex India. (May 2015). Towards a Cleaner India. Retrieved from <http://www.swissnexindia.org/wp-content/uploads/sites/5/2016/05/Cleantech-Report.pdf>

¹³⁴ Agarwal, A. (10 June 2017). Solar power: Foreign investors show keen interest in India. Financial Express. Retrieved from <http://www.financialexpress.com/opinion/solar-power-foreign-investors-show-keen-interest-in-india/710873/>

¹³⁵ Global pension funds scout for deals in India's solar energy sector. (2017 May 1). vccircle. Retrieved from <https://www.vccircle.com/global-pension-funds-scout-for-deals-in-indias-solar-energy-sector/>

¹³⁶ Global pension funds scout for deals in India's solar energy sector. (2017 May 1). vccircle. Retrieved from <https://www.vccircle.com/global-pension-funds-scout-for-deals-in-indias-solar-energy-sector/>

¹³⁷ Global pension funds scout for deals in India's solar energy sector. (2017 May 1). vccircle. Retrieved from <https://www.vccircle.com/global-pension-funds-scout-for-deals-in-indias-solar-energy-sector/>

¹³⁸ IFC to invest \$40 mn in Tata Cleantech. (2017 May 17). vccircle. Retrieved from <https://www.vccircle.com/ifc-to-invest-40-mn-in-tata-cleantech/>

¹³⁹ Verma, A. (7 April 2015). Omnivore Partners invests \$1M in cold storage maker Ecozen Solutions; Villgro exits. vccircle. Retrieved from <https://www.vccircle.com/omnivore-partners-invests-1m-cold-storage-maker-ecozen-solutions-villgro/>

¹⁴⁰ Pothering, J. (6 June 2017). Mera Gao Power raises \$2.5 million to expand rural India reach. Impactalpha. Retrieved from <https://news.impactalpha.com/mera-gao-power-raises-2-5-million-to-expand-rural-india-reach-4d7efd82bf6b>

¹⁴¹ Gupta, B. (17 January 2013). Husk Power Systems raises \$5M in Series A funding led by Acumen Fund and Bamboo Finance. vccircle. Retrieved from <https://www.vccircle.com/renewable-energy-firm-husk-power-systems-raises-5m-funding/>

2.3.2 Other Funding Sources

In addition to the above channels, many startups in the cleantech space raise funding via national and international grant programmes, competitions and international development organisations. Some of the outstanding programmes in the cleantech space are listed in the following table.

Table 5: Major Funding and Grant Programs in Cleantech Space

Pacesetter Fund	Zayed Future Energy Prize
Parivartan Sustainability Leadership Awards	UN DESA – Powering the future
DBS Foundation	Smart Villages
Millennium Alliance	Development Innovation Ventures – USAID
Off-Grid Energy Challenge – The Climate Group	Sustainable Entrepreneurship Award
Global Innovation Fund (GIF)	Off-Grid Experts Awards

An important public-private funded initiative is the Indian Innovation Lab for Green Finance for accelerating investment in green infrastructure in India. Recently, the Indian Innovation Lab endorsed four green finance instruments to meet the investors' and SMEs' needs for sustainable growth in the cleantech sector. The instruments are: "Rooftop Solar Private Sector Financing Facility, Loans4SME (a lending platform for green investments), currency exchange platform FX Hedging Facility" and P50 Risk Solutions (a facility to reduce the cost and increase the amount of long-term debt for RE project)".¹⁴²

Although there is a strong presence of diverse financial instruments active across regional/national scale, the number of funds dedicated for cleantech is limited in scope and efficacy (refer appendix 1A for a comprehensive list of financial instruments and schemes available for the cleantech sector). It pales in comparison with the institutional support for sectors like health, fintech and e-commerce. The main challenges impeding strong support for this sector are their capital-intensive business models, longer time to reap return on investment, lack of innovation due to poor investment in R&D and increased reliance on government policy/support.

2.4 Other Major Actors

2.4.1 Universities/Research Institutes

Research institutes play a significant role in accelerating clean energy innovation initiatives. When linked to the industry, these institutes facilitate transfer of knowledge and technology, and provide support in transition from conceptualization of an idea to prototype development stage. To have a well-functioning and dynamic clean energy innovation ecosystem, there has to be a synergy between the research institutions and other stakeholders, including private players, policy makers and financiers. Financial support to such institutions is imperative for their long-term growth.

¹⁴² Green Finance Lab. (n.d.). Retrieved from <http://greenfinancelab.in>

At present, India has a strong pool of skilled manpower, coupled with low-cost structures, which offer cutting edge R&D and high-quality standards at competitive costs.¹⁴³ R&D when backed with able business leadership can simultaneously power the clean energy innovation ecosystem and cut the cost of clean technologies.

MNRE has a mandate to work toward promoting research, design, development, manufacture and deployment of new and renewable energy systems/devices. It also develops standards, specifications and performance parameters for these energy systems and devices to ensure they are at par with international levels. The R&D institutes under MNRE are: National Institute of Solar Energy (NISE), National Institute of Wind Energy (NIWE), Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE, formerly as Sardar Swaran Singh National Institute of Renewable Energy) and Solar Energy Corporation of India (SECI). Institutes such as Indian Institute of Technology (IIT), Indian Institute of Science (IISc), National Environmental Engineering Research Institute (NEERI), National Institute of Technology (NITs), Sardar Patel Renewable Energy Research Institute (SPRERI) are also doing research on these renewable energy systems and devices.

In addition to these institutes, India has also collaborated with international universities to spur clean energy innovation. For example, the Solar Energy Research Institute for India and the United States (SERIIUS) is a collaboration between the Indian Institute of Science (IISc), Bangalore, India, and the National Renewable Energy Laboratory (NREL), Colorado, USA. It has been set up with the objective of developing solar energy technologies that will help meet the country's targets for solar energy adoption and deployment under Jawaharlal Nehru National Solar Mission (JNNSM). These collaborations help in: assessing various technical, economic and policy issues in solar energy development and deployment in India; overcoming barriers to technology transfer through efficient coordination between research institutes and Industry; developing a platform for bilateral collaboration and functional international teams for research on solar energy science and technology.¹⁴⁴

The Clean Energy Research Initiative (CERI) established in 2009, is another such institution that has a mandate to build India's research competence, develop innovations around user needs, forge collaboration between industry and academics, and develop a pool of researchers who can meet the requirements of R&D professionals for clean energy.¹⁴⁵

2.4.2 Global Cleantech Innovation Programme (GCIP)

GCIP is an initiative by UNIDO and GEF to promote clean energy technologies that are affordable and can facilitate the transition to a low-carbon economy. The objective of this initiative is to identify and back cleantech innovators and entrepreneurs, build the capacity of national level institutions of its member countries for a sustainable

143 British High Commission, New Delhi (2008). R&D Ecosystem of India. [online] New Delhi: British High Commission. Available at: <http://www.rcuk.ac.uk/documents/india/studyrdindia-pdf/> [Accessed 10 May 2017].

144 Seriius.org. (2017). Solar Energy Research Institute for India and the United States. [online] Available at: <http://www.seriius.org/> [Accessed 16 Aug. 2017].

145 Dst.gov.in. (2017). Clean Energy Research Initiative | Department of Science & Technology. [online] Available at: <http://www.dst.gov.in/clean-energy-research-initiative> [Accessed 10 May 2017].

implementation of cleantech ecosystem and work with policy makers to develop a supportive policy framework for SMEs and entrepreneurs.¹⁴⁶

A key component of GCIP is its annual competition, which is a platform for short-listing the most promising innovators in the clean energy space across a member country. The shortlisted startups participate in an acceleration programme that not only mentors them, but also provides networking opportunities to meet potential investors and partners. This accelerator programme focuses on four clean technology areas: energy efficiency, renewable energy, waste beneficiation and water efficiency. The fourth cycle of India Cleantech Open Competition is currently underway.

2.4.3 Industrial Associations

The industrial associations and alliances largely focus on policy advocacy, financing, skills and training, technology, and networking.¹⁴⁷ Some of these are discussed here in detail.

Millennium Alliance (MA)

The Millennium Alliance (MA) is an initiative led by the Federation of Indian Chambers of Commerce and Industry (FICCI) with support from Department of Science and Technology (DST)'s Technology Development Board (TDB), the Indian Government and the United States Agency for International Development (USAID).¹⁴⁸ This initiative aims to support and commercialize low-cost, innovative solutions for those at the bottom of the pyramid and bring together key actors of the innovation ecosystem, including financiers such as social impact funds, venture capitalists, corporate foundations, angel investors and donors on one platform to support and scale these innovative solutions. This initiative supports clean energy enterprises through seed funding, technology and business incubation and networking opportunities.

Clean energy is among the focus sectors along with water and sanitation, education, affordable health care, agriculture and food security. Some of the notable innovations that have been awardees of this initiative are: smart cook stoves consisting of two generators that harness power from used biomass, a community clean water plant developed by Waterlife that provides clean drinking water at the rate of INR 5 per 20 litres and, a smart micro grid that has been able to cut distribution and transmission losses.¹⁴⁹

146 Unido.org. (2017). Global Cleantech Innovation Programme. [online] Available at: <http://www.unido.org/environment/o591190/climate-policies-and-networks/global-cleantech-innovation-programme.html> [Accessed 16 Aug. 2017].

147 USAID India (2013). Developing Effective Networks For Energy Access: An Analysis. [online] New Delhi: USAID. Available at: <http://thecleannetwork.org/downloads/27-CEEW-Scoping-Study.pdf> [Accessed 10 May 2017].

148 FICCI, S. (2012). Millennium Alliance - FICCI. [online] FICCI blog. Available at: <http://blog.ficci.com/millennium-alliance-ficci/838/> [Accessed 10 May 2017].

149 The Economic Times (2013). Nine Innovators get Indo-US Millennium Alliance Awards. [online] Available at: <http://economictimes.indiatimes.com/news/politics-and-nation/nine-innovations-get-indo-us-millennium-alliance-awards/articleshow/20748395.cms> [Accessed 10 May 2017].

Through the Millennium Alliance, USAID, FICCI, the Technology Development Board (TDB), and other partners, will help realize India's role as a global innovation laboratory.¹⁵⁰

Alliance for an Energy Efficient Economy (AEEE)

Formed in 2008, AEEE is a policy advocacy organization that develops policies to promote energy efficiency. AEEE works in close collaboration with both national and international level institutions such as the Bureau of Energy Efficiency (BEE), Energy Efficiency Services Limited (EESL), National Institute for Transforming India (NITI Aayog), SIDBI, FICCI, The World Bank, Shakti Sustainable Energy Foundation, American Council for an Energy Efficiency Economy, Lawrence Berkeley National Laboratory, etc. as well as the private sector, including SMEs, Energy Service/Savings Companies (ESCOs), and equipment manufacturers to provide them a single platform where the government and industry can coordinate with each other effectively and develop relevant policies.¹⁵¹

AEEE works toward promoting energy efficiency by developing awareness and capacity building of energy professionals; promoting relevant policies, networking and knowledge sharing. It has participated and contributed in initiatives such as Super EE Equipment Programme and Advance Metering. At present, AEEE has 40 members. Some of the initiatives that AEEE is involved in are:

- Energy Efficiency Conclave, an annual event where key actors of the clean energy ecosystem such as policy-makers, researchers, SMEs, financiers come together on one platform.
- Development of Energy Conservation Building Codes (ECBC) in states, in partnership with United Nations Development Programme (UNDP), GEF, BEE and the NITI Aayog.
- In partnership with SIDBI, AEEE has developed Energy Services Performance Contract (ESPC) and associated Measurement & Verification (M&V) template for adoption by SMEs, Financial Institutions (FIs) and other key stakeholders in clean energy sector. It is also working toward developing market assessment reports for stakeholders to identify and use the business opportunities in energy efficiency projects.¹⁵²

Ashden India Renewable Energy Collective (AIREC)

Established in 2001, this is a network of all former India-based winners of the international Ashden Awards for Sustainable Energy. It is a platform through which members come forward as a unified voice in influencing energy policy in India to accelerate access to renewable energy. The collective has partnered with the Shakti Sustainable Energy Foundation to document the implementation of rural energy projects. The members are also engaged in advocacy efforts for according 'priority'

150 Millenniumalliance.in. (2017). Millennium Alliance. [online] Available at: http://www.millenniumalliance.in/about_us.aspx [Accessed 10 May 2017].

151 Aeee.in. (2016). About AEEE – Alliance for an Energy Efficient Economy. [online] Available at: <http://www.aeee.in/about-aeee/> [Accessed 10 May 2017].

152 AEEE (2016). AEEE Highlights: 2016. [online] New Delhi: AEEE. Available at: <http://www.aeee.in/wp-content/uploads/2017/01/AEEE-Highlights-2016-1.pdf> [Accessed 10 May 2017].

status to banks providing loans for household renewable energy applications.¹⁵³ They are actively involved in policy dialogues on regulations for off-grid renewable energy, subsidies and incentives, and tariffs to develop a supporting policy environment.

Indian Biomass Power Association (IBPA)

IBPA has a mandate of increasing the use of biomass power and creating new jobs and opportunities in the biomass industry. They engage with policymakers at the state and central level and also keep the members updated about policies relevant for the biomass industry through regular briefings and research. Local owners and operators of biomass facilities, plant developers are members of IBPA. IBPA also participates in legislative processes and supports policies that increase the use of biomass power and other renewable energy sources in India's energy portfolio.¹⁵⁴

India Energy Storage Alliance (IESA)

Customized Energy Solutions Pvt Ltd established the IESA in 2012 to promote adoption and scaling up of energy storage technologies in the country and assess their market potential. IESA also assists REC in developing policies for annual procurement of solar installations and batteries.

IESA works toward creating awareness and knowledge sharing among its members. It facilitates interaction among the major stakeholders to develop understanding of the policy landscape and business opportunities in the clean energy ecosystem. IESA helps shape policies both at national and state level by participating and contributing in various working groups and taskforces such as National Taskforce for Renewable Integration set up by Central Electricity Authority (CEA), India Smart Grid Forum set up by the Ministry of Power (MoP), working group on energy storage for Maharashtra Electricity Regulatory Commission and standing committee on energy storage and hybrids by MNRE.¹⁵⁵

2.4.4 Clean Energy Access Network (CLEAN)

CLEAN, established in 2014, works toward supporting the growth of decentralised renewable energy by bringing together all the stakeholders in this space on one platform. The network facilitates interaction between practitioners, investors and the policy makers, and thus enables a better investment and policy landscape. CLEAN engages with its members (SMEs, startups in decentralised energy space) and incorporates their opinion to create effective and enabling policies for the decentralised clean energy space. They are also actively engaged in developing technology standards and product certifications along with various training and capacity-building initiatives.¹⁵⁶

¹⁵³ Ashden Awards, sustainable and renewable energy in the UK and developing world. (2016). Ashden India Renewable Energy Collective. [online] Available at: <https://www.ashden.org/india-renewable-energy-collective> [Accessed 10 May 2017].

¹⁵⁴ Indbiopower.com. (2016). IBPA. [online] Available at: <http://www.indbiopower.com/aboutus.asp> [Accessed 10 May 2017].

¹⁵⁵ Indiaesa.info. (2017). India Energy Storage Alliance - IESA Activities. [online] Available at: <http://www.indiaesa.info/index.php/about-iesa/india-energy-storage-alliance/iesa-activities.html> [Accessed 10 May 2017].

¹⁵⁶ Thecleannetwork.org. (2017). Overview : Clean Energy Access Network. [online] Available at: <http://thecleannetwork.org/about-us/overview.aspx> [Accessed 10 May 2017].

3 STUDY APPROACH AND METHODOLOGY

To understand the clean energy ecosystem, we reached out to the key actors, with a special focus on SMEs. The varied interactions of these ecosystem actors with each other, financial and non-financial barriers faced by them, the information flow in the ecosystem or the pattern of knowledge sharing and the enabling environment for ensuring information flow which is critical for an innovator/SME to understand the market demand of the innovation, technical training to be provided in the job seekers as well as facilitating better communication between the SMEs, were critically analysed. An attempt has been made to assess the clean energy innovation ecosystem's functionality.

3.1 Approach

This study was undertaken at a pan-India level in three major innovation hubs of India: Delhi in North India, Pune in Western India and Bangalore in South India.¹⁵⁷ The objective was to understand:

- The broader clean energy innovation community through narratives captured around the opportunities and challenges for the key ecosystem actors identified in the clean energy sector in different geographical regions
- Various initiatives undertaken by the state and other ecosystem actors in this space

For this study, we reached out to SMEs that catered to household energy requirements and/or more business/industrial applications. This included, among others, enterprises that deliver household cooking, heating, and lighting solutions as well as renewable electricity, and enterprises that provide clean-energy powered cooling, storage, pumping, and other commercial/industrial requirements. This approach is in line with prominent national and state policy goals of not only meeting household needs but also delivering energy for productive use. It allowed us to look comprehensively at enterprise growth paths that often cut across the two markets for clean energy.

A mixed methods approach was adopted in the study, using both quantitative and qualitative research methods. The study engaged with the ecosystem actors in two ways: through a survey questionnaire, facilitated interactions at regional workshops and semi-structured and follow-up of semi-structured interviews. This approach was based on our past work on sectoral innovation ecosystems in clean cooking, renewable energy, healthcare. We believe that this combination of bilateral

¹⁵⁷ Centres of the three regional hubs were selected by WWF-India

interaction (questionnaires and in-depth interviews) and facilitated dialogue is the best way to understand both the elements and dynamics of innovation ecosystem. The questionnaire ensured comprehensive, systematic, and open communication; while the dialogue allowed key tensions and opportunities for collaboration to surface from the interaction between participants in the innovation ecosystem.

3.2 Study Methodology

A comprehensive literature review was carried out to understand and analyse the innovation ecosystem around clean energy, enterprise growth successes, barriers and opportunities that the clean energy ecosystem presents to its actors. The literature review also helped in detailed assessment of the current interactions between ecosystem actors of different ecosystem 'spheres' and actors within 'spheres' – relationships between SMEs and educational institutions, for example, or between incubators and investors, respectively – that are important for analysing the functionality of the ecosystem as a whole.

3.2.1 Primary Research

Climate Solver Workshops

Okapi was the technical partner for the surveys conducted at the Climate Solver Workshops in the three cities corresponding to the three innovation hubs in India. The study team reached out to clean energy SMEs working on sustainable energy solutions, and garnered participation from government entities, venture capitalists, incubation centres, universities, foundations, financial institutions, industry associations and other relevant actors. The objective of the workshops was to enhance networking amongst SMEs and other actors in the innovation ecosystem at the regional/national level, and facilitate an understanding of opportunities for finance/business support avenues for SMEs. The study team provided them a background of the study, and moderated and led the discussions around challenges/barriers that the ecosystem actors face in the clean energy innovation ecosystem, particularly the SMEs.

The workshops consisted of panel discussions on the clean energy innovation ecosystem in a specific region, where major ecosystem actors and select winner(s) of the Climate Solver award¹⁵⁸ shared the challenges they faced, as well as the opportunities available to them.

These in-depth discussions provided valuable insight into the clean energy innovation ecosystem, particularly from the SME perspective, and how various ecosystem actors engage with one another. The panel discussion contributed to a collective understanding of the major challenges that afflict SMEs and financiers and government initiatives and schemes that are available to SMEs.

158 WWF-India's Climate Solver Initiative is aimed at strengthening the development, promotion and diffusion of low carbon technologies in Small and Medium Enterprises (SMEs) for the reduction of carbon-dioxide emissions and enhancement of energy access. For the past four years, the Climate Solver Initiative has sought to champion climate innovation by generating widespread awareness about the importance of transformative low carbon technologies and innovative business models, and underscoring the pivotal role innovation plays for clean energy access and growth

Short-listed/invited ecosystem actors who did not partake in these regional workshops were approached for brief interviews for a more detailed discussion on the clean energy innovation ecosystem.

Ecosystem Actor Surveys

For baseline mapping and understanding the dynamics of the clean energy innovation ecosystem, the study administered survey questionnaires (refer appendix IB, IC and ID) to SMEs, financiers, related government ministries/departments, and sector experts (appendix IE). These questionnaire surveys were shared with the regional Climate Solver Workshop participants through an online form via Survey Monkey. A few ecosystem actors who were not able to attend the workshops were also contacted for participation in the surveys. Follow-up discussions were conducted in few cases to obtain further clarity and elaboration on specific responses from the survey questions.

The surveys helped to understand the role of each of the actors in the clean energy innovation arena, their motivations, their perceptions of opportunities and constraints in the ecosystem. The focus was on understanding ecosystem actor roles, internal and external challenges, and the kind of support they require to overcome these challenges, the nature of interactions with other ecosystem actors, and their suggestions on strengthening the ecosystem. These perspectives formed the raw material for building a comprehensive and dynamic ecosystem map from the SME perspective.

SME Survey

A total of 30 clean energy SMEs participated in the online survey questionnaire. The questionnaire consisted of both multiple choice and open-ended questions (Refer Appendix IB). The purpose of the SME survey was to analyse and develop a better understanding of SMEs in the cleantech ecosystem in the country, their technology offering, aspirations and challenges. In addition, the survey facilitated identification of thrust areas in the cleantech space that require interventions and assess the ability of the cleantech innovations to overcome the policy and financial barriers they quite frequently have to face. It helped analyse the impact of the policies on their growth and the type and quality of the communication channel generally used by the SMEs and other actors to reach out to each other. An understanding of these questions is important for analysing various policies, financial and non-financial support that the clean technology innovators regularly require.

Based on the responses received from the SMEs, individual follow-up interviews were conducted, to bring out the larger narrative along with specific details about how the responses vary within the same space. For example, differences in the extent and force of barriers faced by a startup and a well-established SME.

Several thematic challenges, including human resource, R&D, policy/regulation, market demand, access to capital and infrastructure, have been analysed to provide a more informed understanding of the effects of these challenges on business expansion/scaling.

In order to capture the study as a microcosm of the cleantech space, companies that are in different stages of development, and have diverse technology offerings, with national and global presence, were selected. Two out of thirty said they had manufacturing hubs outside India, while nine were selling products/services outside India as well. The survey was structured to bring out the following thrust areas of operation:

1. Energy efficiency/Energy savings: Energy applications in: Industry/manufacturing, transport, building/construction.
2. Energy access: Renewable energy-based cooking solutions (e.g. clean cook stoves), renewable energy-based lighting solutions (eg. household appliances, off-grid/mini-grid, solar home systems), and renewable energy-based productive applications (e.g. solar powered water pumps, de-husking, dryers).
3. Smart-grid/energy storage/smart meters
4. Renewable energy: energy applications in Industry/manufacturing, transport, building/construction.
5. Waste management/waste to energy conversion

Financier Survey

A survey questionnaire using Survey Monkey platform was used to reach out to public and private financiers in the three regions. A total of nine financiers responded to the online survey and based on their responses, follow-up interviews and discussions were carried out.

Government/Public Sector Survey

The study team, through a questionnaire survey, reached out to key government departments and international agencies to understand their role in this space, the initiatives they have undertaken and the barriers they faced in the process, if any. International agencies (donor agencies, UN bodies) work in collaboration with the central government. These agencies have an overall focus toward developing technical knowledge and awareness and through various ways also provide mentoring support to the cleantech enterprises.

The government units approached for the study include NITI Aayog, Ministry of MSME and Skill Council for Green Jobs. The international agencies include UNIDO and GIZ.

These ecosystem actors were identified through a comprehensive literature review and informational interactions with the WWF-India and Okapi professional network in the cleantech space.

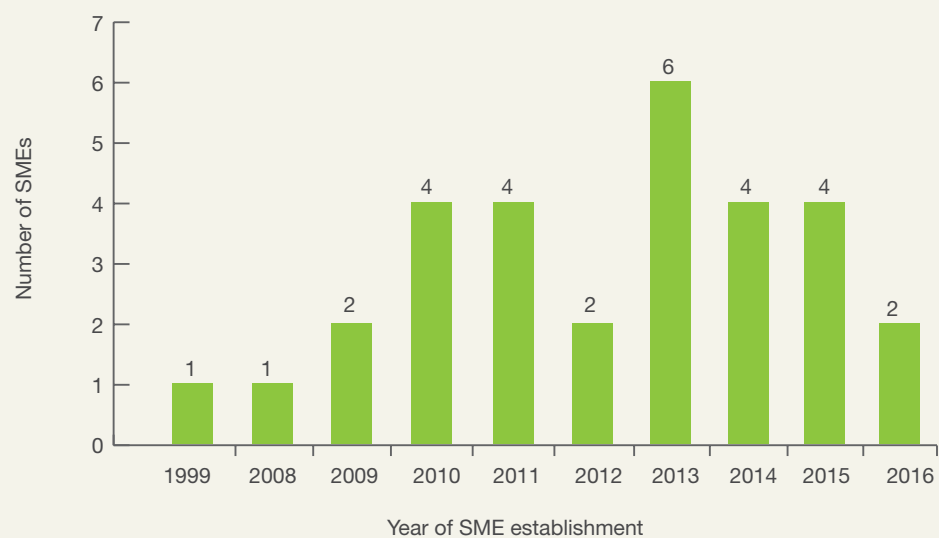
4 STUDY FINDINGS AND OBSERVATIONS

4.1 SME Survey

Majority of the respondents (70 per cent) were either active in multiple fields within a thrust area or active across several thrust areas. For example, an SME active in clean cook stoves also had operations in the waste to energy space. This offered an important insight into the cleantech space, which is its likely adaptability to new technologies as well as its fluid definition of core activities based on projects.

While it was not the intention of the survey, the results showed a bias toward solar-based SMEs, while areas like waste management, waste to energy and energy storage, small scale wind and micro hydro were largely unrepresented. Even in SMEs with multiple technology offerings, their operations were skewed toward solar technology. Many SMEs were active in several applications of solar including heaters, lighting, pumps, dryers etc. Some of the SMEs that were currently active in solar had in-house research underway to include other renewable energy sectors. The prevalence of solar based SMEs reflects a fairly conducive policy environment, market demand, ease of expansion and financial viability for solar products and services.

Figure 4
Year of
Establishment
of SMEs



Out of the 30 SMEs surveyed, more than 80 per cent were established during the last seven years, with only one SME being established in 1999. These numbers, while reflecting the nascent stage of the sector also establish a strong narrative for the general growth of cleantech organisations in India in recent years.¹⁵⁹ A majority of the SMEs were active in several districts/states across India.

In terms of the stage of product development, 70 per cent of the SMEs had a commercially viable offering and were looking to scale/expand their business, while 24 per cent were in the post-pilot and commercialization phase.

Figure 5:
SMEs
Interviewed by
Sector

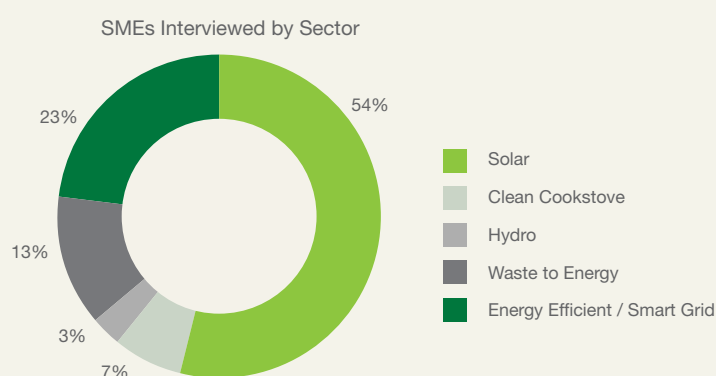
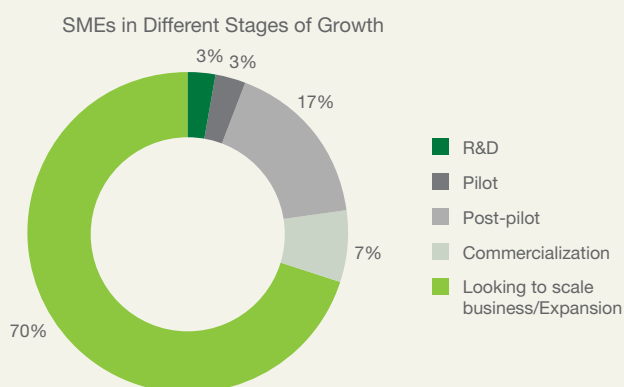


Figure 6:
SMEs in
Different Stages
of Growth



While 73 per cent of the respondents characterized the strength of their workforce to be under 25, the annual turnover of the respondents varied significantly from less than INR10 lakhs to INR25 crore.

While the median annual turnover for all SMEs stood at INR1.5 crore, the annual turnover of SMEs with a solar product/service tended to be larger, with a median annual turnover of INR2.25 crore per year against non-solar SMEs at INR 1.1 crore.

¹⁵⁹ Kashyap, S. (16 April, 2015). Rise of clean tech in India: Urjas Energy raises US\$100, 000 funding. YourStory. Retrieved from: <https://yourstory.com/2015/04/urjas-energy-funding>

Figure 7:
Distribution
of SMEs in
the Northern,
Western and
Southern
regions

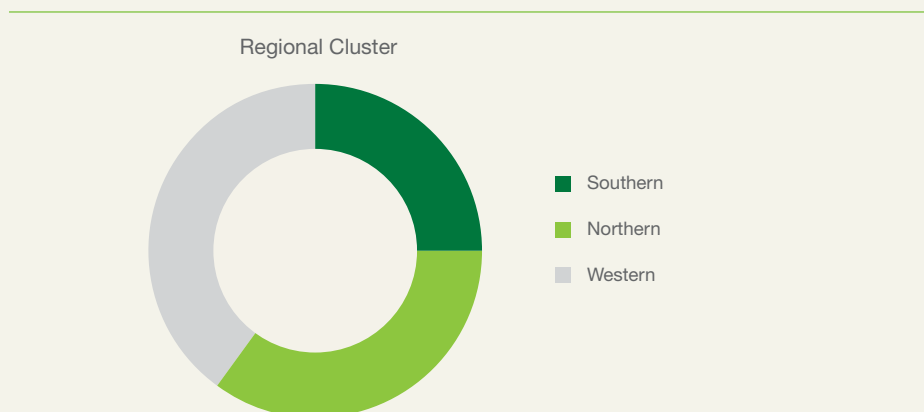
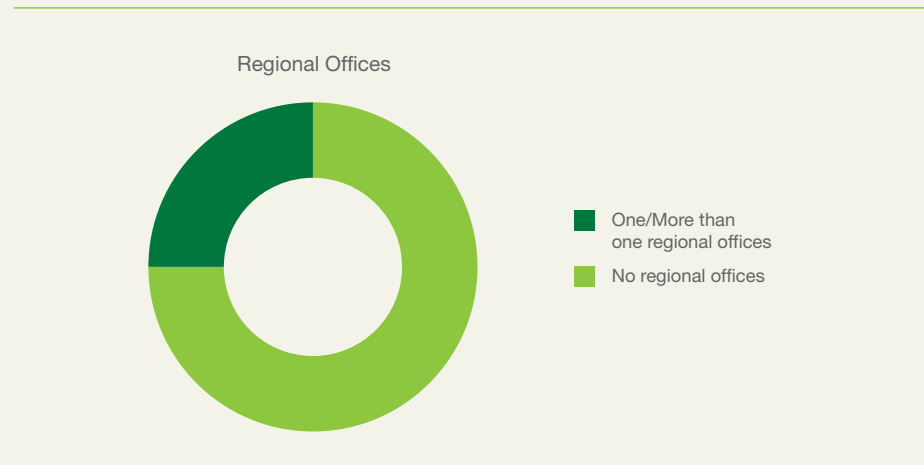


Figure 8:
SMEs with
Regional
Presence



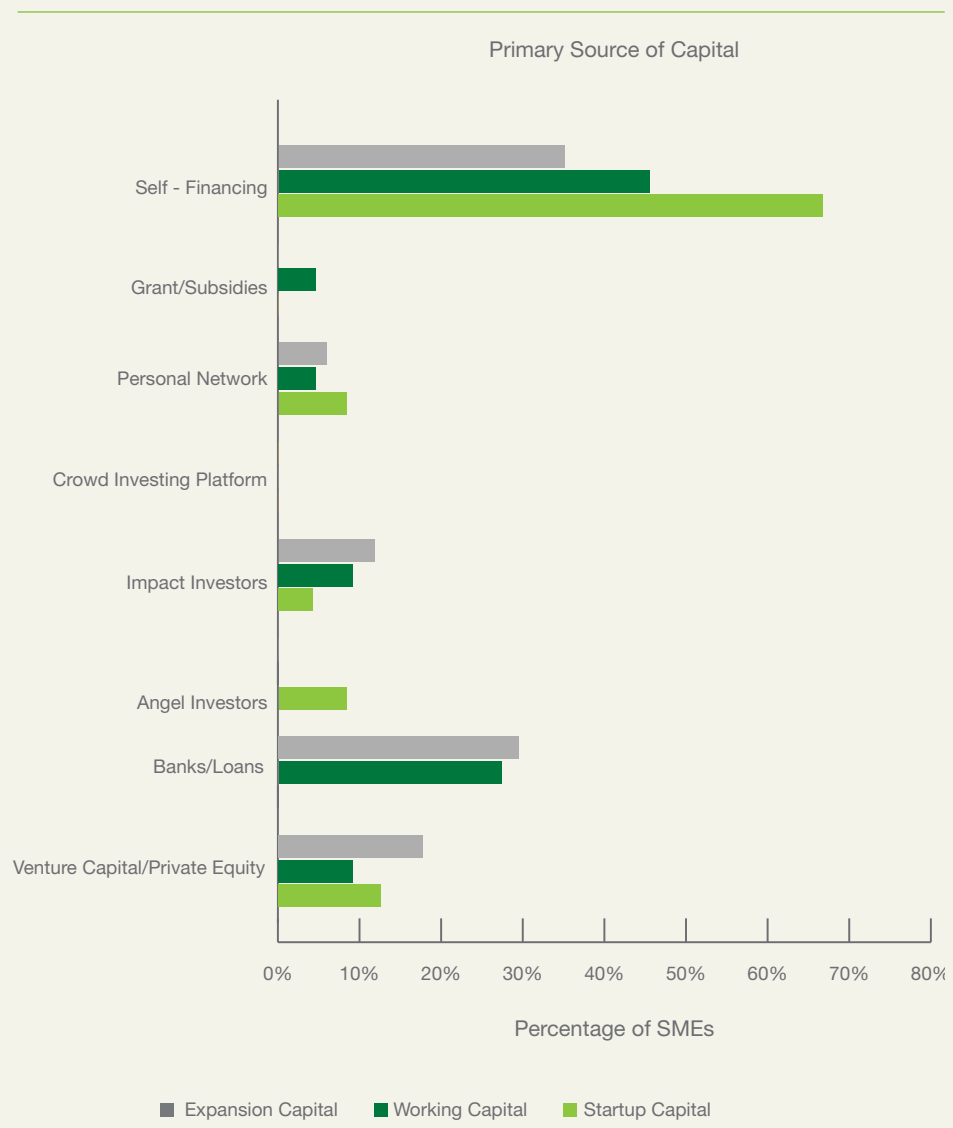
In terms of an international footprint, 30 per cent of the SMEs with global operations were from the non-solar space and included sectors like energy efficiency, green building, micro cold storage and waste management.

The source of capital for an SME evolves in conjunction with the size and stage of the SME. Majority of the SMEs (75 per cent) either self-financed or used their personal network for starting up their business. Self-financing seemed to be the consistent option even during the working (50 per cent) and expansion stage (35 per cent) following which, bank loans, private equity and impact investments were frequently cited as the source of expansion capital.

SMEs were largely unaware of sector-specific public financial loan instruments. In many cases, they were denied loans citing lack of collateral and poor credit history. There was a general apathy among respondents toward the efficacy of bank loans, given their personal experience or the experience of their colleagues in accessing loans.

Very few firms were successful in claiming government subsidies/grants, the remaining SMEs were largely unaware of the subsidies they are entitled to. Even to those who were aware of existing subsidies/grants, these channels remained elusive due to significant backlogs among the existing applicants.

Figure 9:
Primary
Source of
Capital for
SMEs

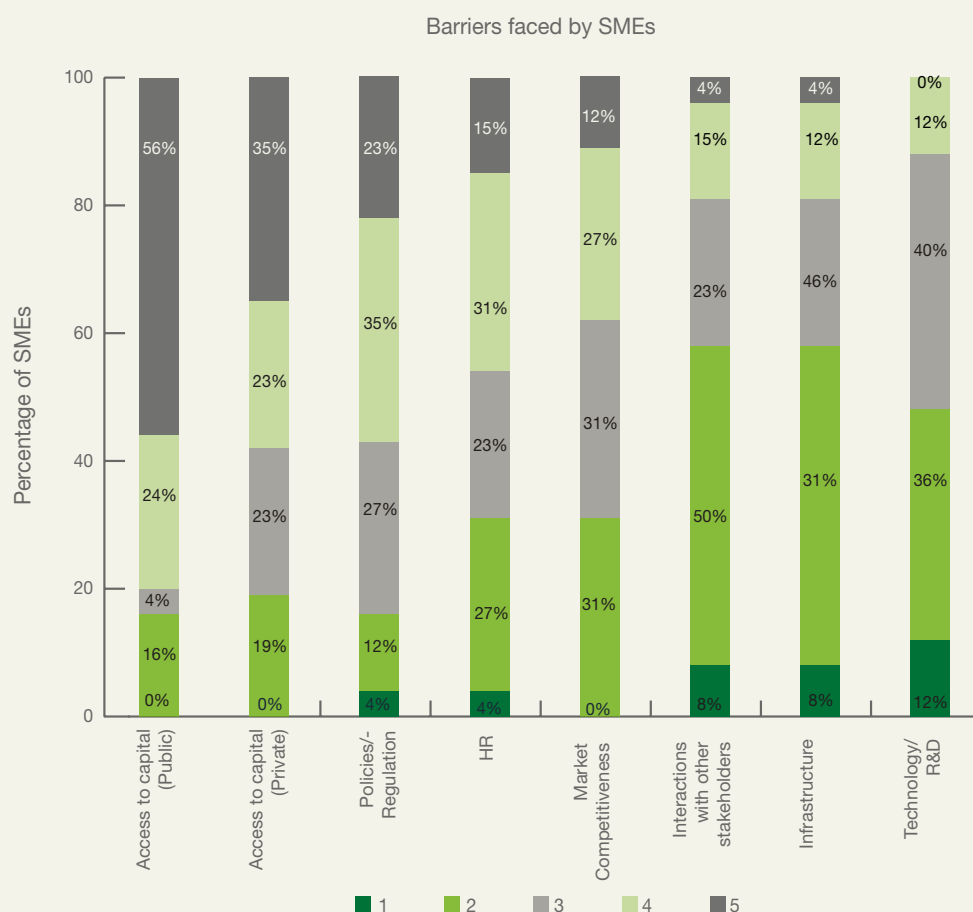


Private and government-supported incubator and accelerator programmes, including international development grants were cited as an important source of capital by 11 SMEs. This included programmes like Global Cleantech Innovation Program, WWF Climate Solver, USAID, NCL Venture Centre and CIIE Incubation cell.

4.2 Challenges faced by SMEs

The following graph represents the challenges faced in several thematic areas in the cleantech ecosystem. Each of these challenges is discussed in detail below.

Figure 10
Barriers faced by the SMEs on a scale of 1-5 (least challenging to most challenging)



4.2.1 Human Resource

Human resource was cited as a significant challenge by a majority of SMEs (70 per cent). Many SMEs were either unable to afford the level of talent needed or unable to find qualified staff for specific needs. One SME mentioned the time and effort required for skilling workers as a significant challenge. Interestingly, staff retention was not a significant challenge.

Figure 11:
Major Human
Resource Barriers
faced by SMEs (least
challenging to most
challenging)



This finding was largely in line with industry-wide reports of access to human capital being a significant barrier to growth of the cleantech entrepreneurs. A 2010 report stated “Lack of trained personnel for training, demonstration, maintenance and operations along with inadequate awareness and information programs for technology dissemination impedes renewable energy penetration.”¹⁶⁰

A recent article¹⁶¹ cited three major human capital challenges for businesses in cleantech. The first was the need for “feet on street”- outreach teams that build community trust and a consumer base in small towns and rural areas- the oft-cited target customer base for cleantech SMEs. There is heavy reliance on community buy-in for products and services offered by cleantech SMEs in these regions that requires a dedicated “frontline force” that speaks the local language, understands consumer preferences and has a deep technical knowhow of the products, and articulates their role in the improvement of consumers’ quality of life. The second challenge was in finding appropriate middle management that can manage this fleet of people on the ground, while also having experience in building partnerships and operations to keep up with rapidly expanding business that is typical of this sector. Finally, finding experienced leadership teams was a significant challenge for founders of cleantech startups. Leadership teams need a combination of entrepreneurial experience, deep domain and technical knowhow and an understanding of the complex ecosystem and various stakeholders. The relatively nascent cleantech space and the geographical

¹⁶⁰ Infrastructure Development Finance Company Ltd. (10 Feb 2010). Barriers to development of renewable energy in India & proposed recommendations. Retrieved from <https://www.idfc.com/pdf/publications/Discussion-paper-on-Renewable-Energy.pdf>

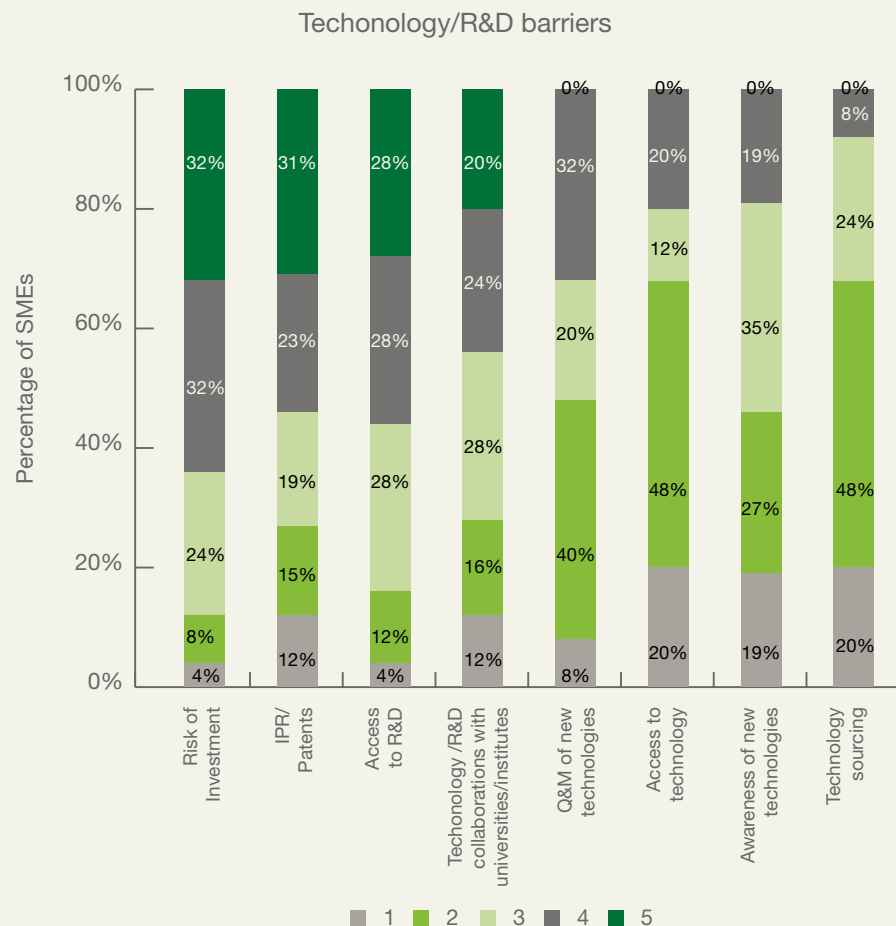
¹⁶¹ Menon, D. Nunes, P. (19 April 2017). Human capital: A primary barrier to scale for Indian cleantech startups. Yourstory. Retrieved from <https://yourstory.com/2017/04/cleantech-startups>

challenges in India have led to human capital being a persistent impediment to achieving growth and scale.

4.2.2 Technology

The survey captured the relative ease in access to technology with majority of SMEs (68 per cent) citing it as the least challenging metric. This was true for technology sourcing, awareness, expertise, operation and maintenance of new technologies. While accessing existing technologies was not a challenge, the ecosystem for creating new technologies was cited as being extremely challenging. Factors such as poor access to R&D infrastructure and a tedious and cumbersome Intellectual Property Rights (IPR)/patent process, in addition to a lack of investment in disruptive innovations and limited collaboration with academic institutions, exacerbated the underserved innovation ecosystem.

Figure 12:
Major Technology/
R&D Barriers faced
by SMEs (least
challenging to most
challenging)



These findings are also in line with industry-wide recognition of the lack of technological and R&D infrastructure in the renewable energy sector. Given the fact that the renewable energy and cleantech sector in India is fairly nascent, the need for R&D to develop new, cost-effective, and scalable technology is crucial.

However, lack of access to financing and infrastructure to support the technology and costs associated with R&D have led to replication of existing manufacturing technology. While the knowledge base has improved, the consumer base and demand still remains a challenge thereby making investing in the technology still a risk for financiers.

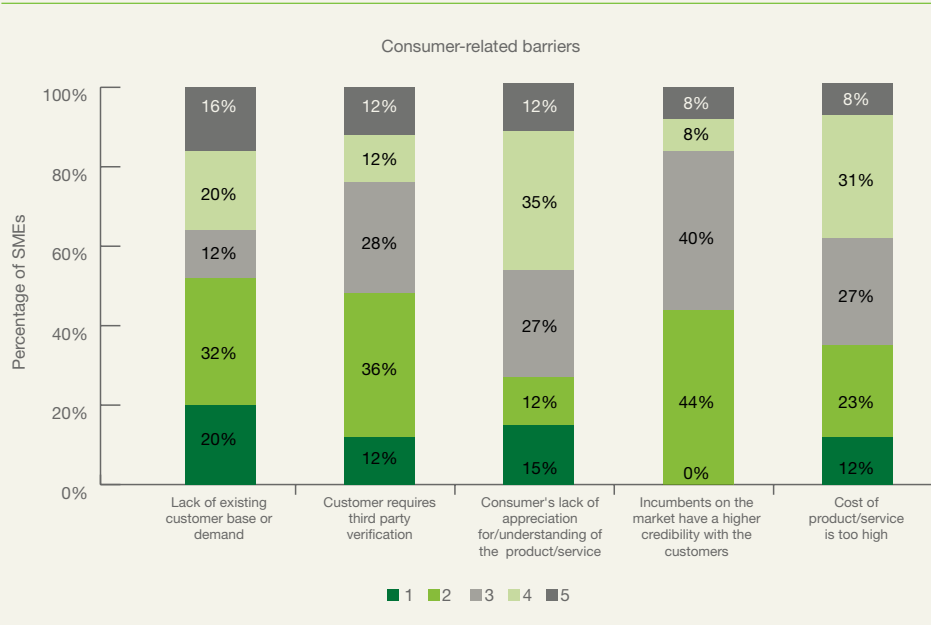
Developing R&D and manufacturing capacity is crucial in India, because as India moves to higher targets for renewables, a lack of local technology and research will manifest in growing imports. These imports are associated with greater costs, increasing the financial burden on SMEs in the cleantech and renewables space.¹⁶²

The need to prioritize, build up and maintain accountability for R&D infrastructure has been emphasized in various ways and across numerous platforms. Yet, the National Clean Energy Fund, administered by the Ministry of Finance and established to aid in the spread of renewable energy, was found to have operational inconsistencies. Money that was supposed to fund cutting edge R&D and manufacturing technology was instead found to have been used to cover the budgetary shortfalls of other ministries and departments.¹⁶³

4.2.3 Consumer/Customer related challenges

Consumer acceptance of new products and technologies is an important indicator of the product and the developer’s success. Clean technology SMEs have been struggling in this regard. 75 per cent of the respondents cited lack of understanding of their product/service as a major challenge impeding the expansion of their business.

Figure 13:
Major Consumer
Barriers faced
by SMEs (least
challenging to most
challenging)



¹⁶² International Partnership on Mitigation and MRV. Developing renewable energy targets and supporting strategies. Retrieved from https://www.transparency-partnership.net/sites/default/files/india_gpa_long_0.pdf

¹⁶³ Krithika, P.R. Mahajan, Siddha. (2014, March). Background paper Governance of renewable energy in India: Issues and challenges. The Energy and Resource Institute. Retrieved from <http://www.teriin.org/projects/nfa/pdf/working-paper-14-Governance-of-renewable-energy-in-India-Issues-challenges.pdf>

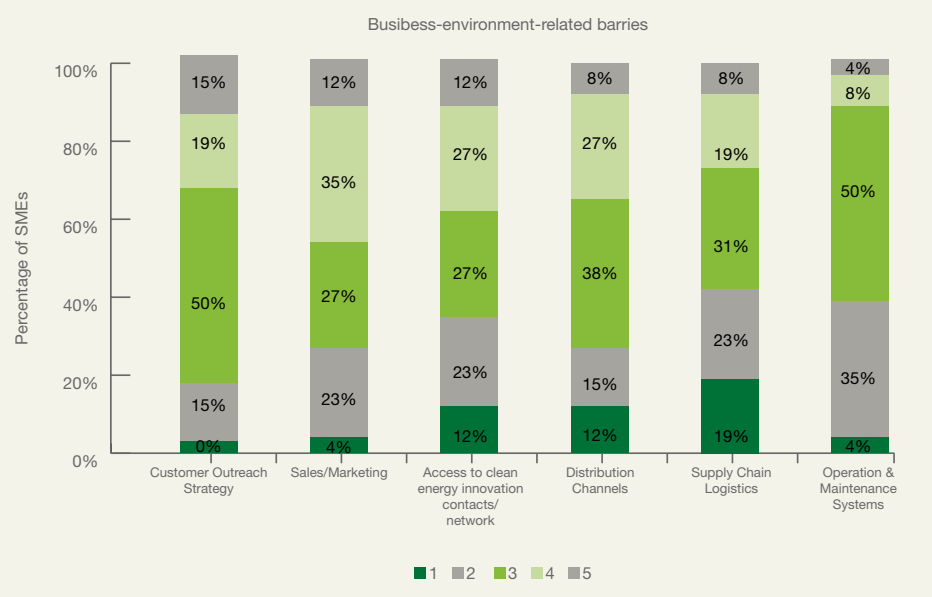
While there is an appreciable demand for these products, the high cost of product/ services was cited as an important obstacle affecting business. This was significantly higher for solar-related products/services, which typically require a high upfront investment cost.

Across the renewable energy and cleantech sector, convincing consumers of the efficiency and value added by renewable energy technology is a significant obstacle to overcome. Most cleantech companies target geographically hard to reach consumers -in rural areas and small towns - as their primary consumer base. Hence, they are faced with the challenge of having to understand the consumer mindset, and conveying the value added by their products to the quality of their lives. There is a heavy reliance on community buy-in for cleantech products – a consequence of insufficient readily available information, the lack of a flourishing competitive market and a high-risk perception about cleantech. The need for greater information dissemination, as well as a dedicated outreach team is essential to overcome this barrier. A major cleantech investor also cited the importance of involving potential customers early on in the product development process, to build trust and sell them based on the efficiency and value of these products.¹⁶⁴

4.2.4 Business Environment

Majority of the SMEs (75 per cent) found sales/marketing significantly challenging. Corroborating the previous customer related challenges, 85 per cent of SMEs cited customer outreach strategy as a major challenge. This is further compounded by poor access to clean energy innovation networks, as cited by 65 per cent of the respondents.

Figure 14:
Barriers related to
Business Environment
(least challenging to
most challenging)



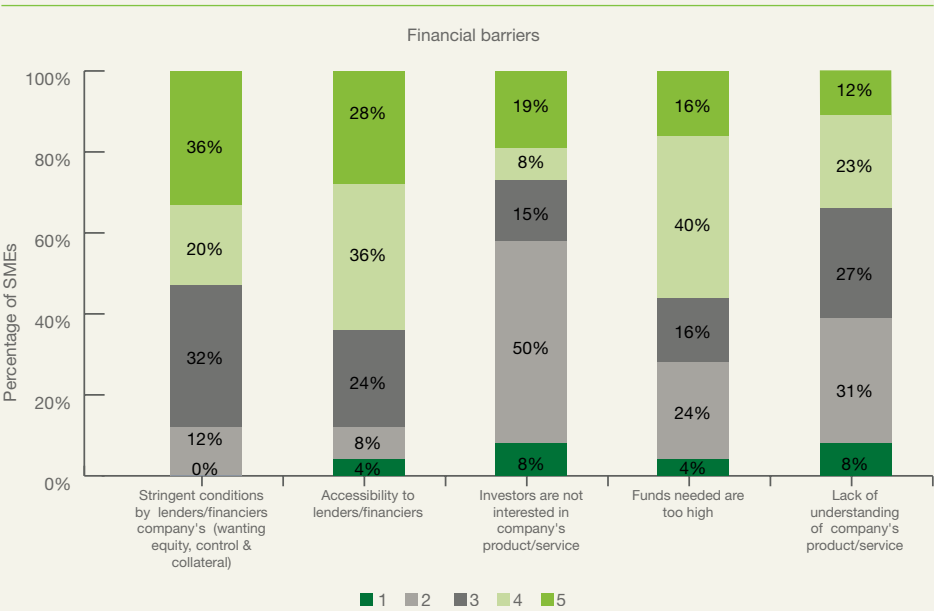
¹⁶⁴ From ideas to the market: Bridging the gap between cleantech entrepreneurs and investors. (2015, June 17). Asian Development Blog. Retrieved from <https://blogs.adb.org/blog/ideas-market-bridging-gap-between-cleantech-entrepreneurs-and-investors>

The biggest challenges that came up were issues with supply chain and distribution channels. The issue of underdeveloped supply chains being a significant hindrance to the growth of renewable energy is consistent with global sentiments. An International Economic Development Council (IEDC) survey conducted in 2012 with renewable energy firms in the United States showed that firms, particularly in solar power, viewed underdeveloped supply chains as an obstacle to growth.¹⁶⁵ Closer home, a 2015 KPMG report stated that underdeveloped supply chains are a significant challenge for solar companies in India. For instance, Indian manufacturers do not have sufficient access to upstream domestic raw material supplies of polysilicon and wafers.¹⁶⁶ Securing the supply chain is crucial in job creation and reducing the high risk associated with the renewable sector.¹⁶⁷

4.2.5 Finance

Access to reliable and affordable source of capital has been a recurring challenge for the SME sector. The cleantech SME sector faces many woes due to lack of understanding of their new products/services. The capital-intensive nature of clean technologies, combined with long lock-in periods of investment, has limited the uptake/expansion of the cleantech ecosystem. 88 per cent of the respondents cited poor accessibility to available financial channels, in addition to stringent conditions (excessive control/collateral) laid by available financiers as major challenges hindering their growth.

Figure 15:
Financial Barriers
faced by SMEs
(least challenging
to most
challenging)



165 Thorstensen, L. Chen, J. Brown, E. (2013). Understanding Renewable Energy Businesses: Aligning Renewable Energy Firms and Economic Developers: A Survey of Renewable Energy Companies Retrieved from http://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Renewable_Energy_Businesses.pdf

166 KPMG. (2015.) Solar Manufacturing in India; A KPMG Report. Retrieved from <http://www.energetica-india.net/>

167 FICCI. Securing the Supply Chain for Solar in India. Retrieved from <http://ficci.in/spdocument/20294/Supply-Chain-paper.pdf>

Access to financial capital is recognized as one of the most significant challenges in the cleantech sector by experts. A 2010 IDFC report on the renewable energy sector notes, “The development of renewable energy faces barriers in obtaining competitive forms of finance due to lack of familiarity and awareness of technologies, high risk perception, and uncertainties regarding resource assessment. Renewable energy projects tend to have little or no fuel costs and, low operation and maintenance (O&M) costs but their initial unit capital costs tend to be much higher than fossil generation systems. The higher ratios of capital cost to O&M cost are significant because they indicate that these projects carry a disproportionately heavy initial burden that must be financed over the life of the project. This makes exposure to risk a long-term challenge (which also has policy and regulatory-risk implications).”

The report also stated that the non-provision of subsidies due to the unavailability of adequate government resources significantly affects the life of renewable energy projects. The small size of projects in the sector also results in lower gross returns, even though the rate of return on investments in renewable energy is on par with industry standards of what are considered attractive investments.¹⁶⁸

In an interview conducted by the Asian Development Bank (ADB)¹⁶⁹ with Kunal Upadhyay, the Chief Executive Officer (CEO) of Infuse Ventures, a major Indian cleantech incubator and seed stage funder, he pointed out that venture capital and angel investors prefer to finance internet and mobile based businesses over cleantech businesses. Given the heavy costs of R&D in the sector, lack of adequate capital is a major reason why products and services are unable to move past the pilot stage to commercialization.

Additionally, in the energy space, the administrative burden associated with applying and availing government subsidies hinders entrepreneurs from availing this facility.¹⁷⁰ India’s solar power goal of producing 100 GW by 2022 is in peril of not being met because of weak financial infrastructure and access to cheap financing, according to an IndiaSpend analysis.¹⁷¹ In 2015, India invested US\$10.2 billion¹⁷² in renewable energy which was only a quarter of the annual investment needed. Further, in last quarter of 2016, the government auctioned fewer renewable energy projects than it needed to in order to meet the renewable energy goals. Lenders and investors are hesitant to invest in renewable energy because of the uncertainty around whether publicly owned power distribution companies will eventually buy the power generated. Due to a general decline in the financial health of state governments, they have often not honoured power purchase agreements (PPAs), causing a constant delay of payments to

168 Infrastructure Development Finance Company Ltd. (2010, Feb 10). Barriers to development of renewable energy in India & proposed recommendations. Retrieved from <https://www.idfc.com/pdf/publications/Discussion-paper-on-Renewable-Energy.pdf>

169 From ideas to the market: Bridging the gap between cleantech entrepreneurs and investors. (2015, June 17). Asian Development Blog. Retrieved from <https://blogs.adb.org/blog/ideas-market-bridging-gap-between-cleantech-entrepreneurs-and-investors>

170 EBTC. (2013). Market Access Intelligence for Doing Business in India in Cleantech Sectors. Retrieved from http://ebtc.eu/pdf/131029_REP_Market-Access-Intelligence-for-DBI-in-Cleantech-Sectors.pdf

171 “Why India might not achieve its 2020 renewable energy targets”. (2017 Jan 9). Panchabuta. Retrieved from <http://panchabuta.com/2017/01/09/why-india-might-not-achieve-its-2020-renewable-energy-targets/>

172 Frankfurt School-UNEP Centre. (2016). Global Trends in Renewable Energy Investment 2016. Retrieved from http://fs-unep-centre.org/sites/default/files/publications/globaltrendsrenewableenergyinvestment2016lowres_0.pdf

Independent Power Providers.¹⁷³ Hence, investors are sceptical of the financial viability of investing in this sector.¹⁷⁴

While a lot remains to be done to achieve greater access in financing SMEs in the cleantech space, there have been recent improvements. The capital expenditure per watt of solar energy produced has been on the decline, and the cost of a unit of solar power has also significantly gone down to a record low of INR 2.44 per unit of solar power.¹⁷⁵ Additionally, the power sector's main financier, the Power Finance Corporation (PFC) is looking to shift its focus from conventional energy to renewable energy, last mile distribution infrastructure and transmission. They have a lending target of INR 70,000 crore for the 2017-18 fiscal year.¹⁷⁶ They have reduced their lending rates to 9.5-11 per cent for renewable energy projects and to 10.75-12 per cent for transmission projects in an effort to attract more projects.

4.2.6 Government Programmes

The respondents were largely indifferent to the role of government in the cleantech space. For there are many policies and programmes that foster and support innovation, yet there have been very few outreach/awareness programmes to ensure effective implementation. SMEs have, hence, framed their business/technology model independent of government policies/programmes. In addition, an inconsistent and fragmented policy framework, combined with recent initiatives like demonetisation and Goods and Services Tax (GST), has often sent shock waves across the business pool. For instance, with GST going into effect from 1 July 2017, ambiguity prevails across the solar supply chain. While the GST for solar modules is at 5 per cent, but same components are taxed at a higher rate for other applications.¹⁷⁷ For example, the transformers intended for usage in solar project is expected to be taxed at 5 per cent, but for other applications, they are taxed at 18 per cent. Similar inconsistencies can be observed in the inverter, cables and wires domain. Moreover, even if all the components are taxed at 5 per cent, the EPC cost is projected to rise by 3 per cent. Further, if the modules are taxed at 5 per cent and other components are taxed 18 or 28 per cent, the EPC cost of the project is projected to increase by 6 per cent.¹⁷⁸

To corroborate further, another case in point is electrification in remote rural areas with either no power supply or poor quality of power supply where the Indian government has announced ambitious targets for household electrification. This provides huge opportunities for clean energy SMEs and investors. However, the sector continues to grapple with either a lack of effective and enabling policies or the

173 EBTC. (2013). Market Access Intelligence for Doing Business in India in Cleantech Sectors. Panchabuta. Retrieved from http://ebtc.eu/pdf/131029_REP_Market-Access-Intelligence-for-DBI-in-Cleantech-Sectors.pdf

174 EBTC. (2013). Market Access Intelligence for Doing Business in India in Cleantech Sectors. Panchabuta. Retrieved from http://ebtc.eu/pdf/131029_REP_Market-Access-Intelligence-for-DBI-in-Cleantech-Sectors.pdf

175 Historic low Tariff of Rs. 2.44 per unit discovered in Bhadla Phase-III Solar Park in auction by SECI. (2017 May 12). Press Information Bureau. Retrieved from <http://pib.nic.in/newsite/PrintRelease.aspx?relid=161755>

176 Power Finance Corporation to revamp its lending portfolio. (2017, June 7). Panchabuta. Retrieved from <http://panchabuta.com/2017/06/07/power-finance-corporation-to-revamp-its-lending-portfolio/>

177 GST launched but clarity still missing for the solar sector. (2017 July 3rd). Bridge to India. Retrieved from <http://www.bridgetoindia.com/gst-launched-clarity-still-missing-solar-sector/>

178 GST launched but clarity still missing for the solar sector. (2017 July 3rd). Bridge to India. Retrieved from <http://www.bridgetoindia.com/gst-launched-clarity-still-missing-solar-sector/>

efficient delivery of the existing policies. SMEs, for example, who have set up mini grid plants in villages with no or poor electricity access face an uncertain future for their business in case of grid arrival. Although, interconnection pilots are being conducted and states like Uttar Pradesh and Madhya Pradesh have drawn mini grid policies. Also, with a national mini grid policy in the draft stage, there are many factors such as tariff, ownership, Public Distribution Network (PDN) infrastructure, cost factor of system upgrade, etc. that need to be looked in to even when grid interconnection materializes. While there are a number of existing government schemes and initiatives for off-grid rural electrification (mostly solar PV), stakeholder interviews revealed that the guidelines regarding roles and responsibilities of the stakeholders are not clearly defined in many of these schemes/initiatives, and this often hinders implementation of these government schemes.

On a positive note, 30 per cent of the SMEs cited government actions and initiatives such as mandatory spending on CSR activities, Swachh Bharat Mission (SBM), net metering and Incubator/Accelerator programs like Startup India as helpful in establishing/expanding their company. An overview of these schemes/initiatives has been provided below.

CSR Mandate

The Indian government's ratification of the Paris Accord in 2016 has given hope to the clean technology industry; renewable energy and sustainability initiatives are likely to receive a boost from CSR funding. Given that ensuring environmental sustainability is one of the activities that qualify as a CSR initiative, companies are beginning to employ strategically designed efforts to CSR projects. As a part of these CSR initiatives, corporations are also likely to engage in public-private partnerships with the government on renewable energy projects.¹⁷⁹

Swachh Bharat Mission

The Swachh Bharat Mission has played a major role in bringing cleanliness and environmental issues into popular discourse. The Economic Times reported that 39 per cent of companies they surveyed had allocated funds to Swachh Bharat.¹⁸⁰

Despite criticism regarding the pace and success of the SBM, since the launch of the campaign, waste-to-energy projects have begun to garner greater investor interest with as many as 24 projects in different stages of construction and five projects of 79 MW have already been tendered, adding up to a total of 312 MW as of March 2016.¹⁸¹ According to the Ministry of Urban Development, in 2016, INR 65,000 crore¹⁸² of

179 Rana, N. Majmudar, U. (2 Jan 2017). Sustainability and CSR trends for India in 2017. The Economic Times. Retrieved from <http://blogs.economictimes.indiatimes.com/ResponsibleFuture/sustainability-and-csr-trends-for-india-in-2017/>

180 Rana, N. Majmudar, U. (2 Jan 2017). Sustainability and CSR trends for India in 2017. The Economic Times. Retrieved from <http://blogs.economictimes.indiatimes.com/ResponsibleFuture/sustainability-and-csr-trends-for-india-in-2017/>

181 Chandra Prasad, G. (23 March 2016). Waste-to-energy projects see revival in investor interest. LiveMint. Retrieved from: <http://www.livemint.com/Industry/B9q700vtN6YL5jxndS3rjL/Wastetoenergy-projects-see-revival-in-investor-interest.html>

182 Chandra Prasad, G. (23 March 2016). Waste-to-energy projects see revival in investor interest. LiveMint. Retrieved from: <http://www.livemint.com/Industry/B9q700vtN6YL5jxndS3rjL/Wastetoenergy-projects-see-revival-in-investor-interest.html>

public and private investment was budgeted for city waste management, cleanliness initiatives and waste to energy projects over three years.

Net Metering

Net metering is an agreement that allows the solar PV system owner to sell excess solar energy to the utility company or buy deficit energy from the utility company, using a meter to track this energy exchange.¹⁸³ As of May 2017, 30 states and union territories in India¹⁸⁴ have policies that support connecting to the grid for solar PV. Net metering is expected to help boost consumer shifts to solar energy. However, net metering has not quite taken off as expected with Distribution Companies of India (DISCOMs) and consumers still hesitant to buy into the idea. This is largely due to lack of awareness, inconsistent and poorly planned implementation methods and a poor tariff structure.¹⁸⁵ Thus, there is a greater need for institutional and regulatory support, in addition to awareness programmes, to achieve the true potential of net metering.

Startup India

The central government's Startup India movement is likely to have positive implications for fledgling businesses in renewable energy as well. Startup India promises single day registration for startups via a mobile app. Given the number of startups poised to break into the commercial market in India, this ease of registration is an encouraging sign. The campaign also promises relaxed norms for public procurement for startups. As a large number of energy-related projects, particularly solar, are executed via government tenders, the relaxed norms on turnover and experience means startups have greater access to business opportunities. The government is also setting aside a corpus of INR 500 crore per annum for a credit guarantee fund for startups. Given the capital-intensive nature of cleantech, this means greater access to funds. Finally, the tax exemption on startups for three years is also hugely encouraging for new entrepreneurs in the renewable energy field.¹⁸⁶

4.2.7 Infrastructure

SMEs in the energy access category that provide power through solar PV technology by setting up mini/micro grids or working on a waste to energy model, need good infrastructure support, primarily in the form of land availability – a scarce resource. For instance, installation of plants for converting waste to energy often requires large tracts of land. However, the per capita availability of land, is low and, there are often competing interests and demands on it. Similarly, SMEs in the clean cooking sector need access to high quality technology innovation labs for production of improved cook stoves that meet the emission standards as well as customer acceptance criteria. However, these technology labs are few in number. Infrastructure, thus, is

183 Net Metering policy for roof top PVs in various states in India. (2017 May 2). Bijli Bachao. Retrieved from <https://www.bijlibachao.com/using-renewables/net-metering-policy-for-roof-top-pvs-in-various-states-in-india.html>

184 Net Metering policy for roof top PVs in various states in India. (2017 May 2). Bijli Bachao. Retrieved from <https://www.bijlibachao.com/using-renewables/net-metering-policy-for-roof-top-pvs-in-various-states-in-india.html>

185 Rooftop Solar In India: Undeniable Growth, Yet Challenges Exist. (2017 Feb 17). Vikram Solar. Retrieved from <https://www.vikramsolar.com/rooftop-solar-in-india-undeniable-growth-yet-challenges-exist/>

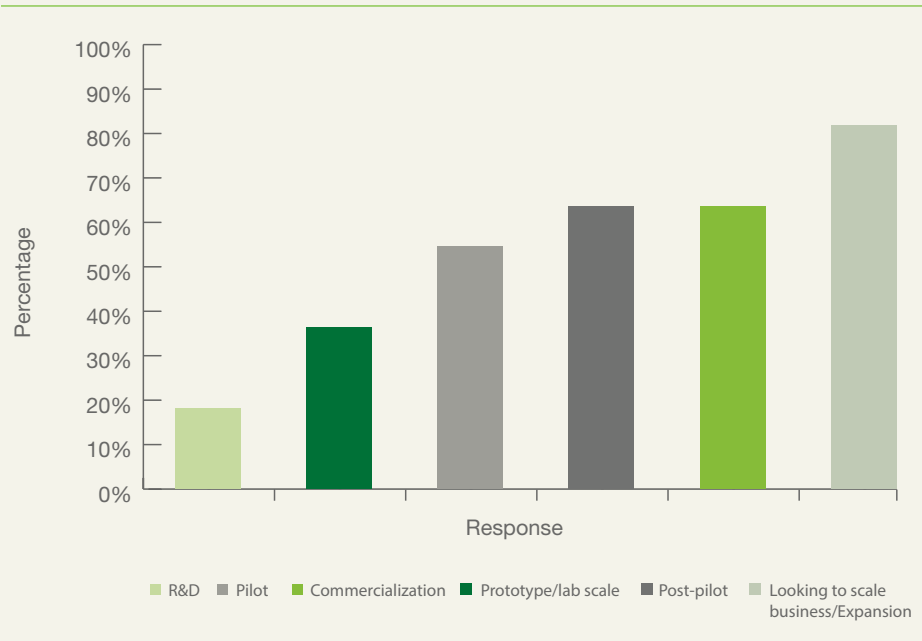
186 Khanna, K. (17 Jan 2016). #StartupIndia Action Plan- What it Means for Solar. Sunkalp Solar. Retrieved from <http://blog.sunkalp.com/startupindia-action-plan-what-it-means-for-solar/>

an important component of an enabling environment for a clean energy innovation ecosystem.

4.3 Financier Survey

Key Takeaways

Figure 16:
Financier - Stage of
Intervention



Of the 11 financiers surveyed, 5 were banks who provided some sort of debt funding. The remaining 4 provided funding via equity instruments. While most of these financiers provided funding at the post-pilot stages of growth, the initial ideation and prototyping stages of growth did not seem to be of high priority. In part, this is largely because financiers, particularly banks and debt providers, are concerned about the bankability and profitability of cleantech ventures in earlier stages. Only 2 respondents provided technical support across various stages of growth in addition to funding at certain stages as they felt SMEs typically lack mentorship and a strong support system as they navigate the growth cycle. This seems to be in line with the findings from SMEs who stated lack of support at the R&D stages of the growth process as a significant challenge.

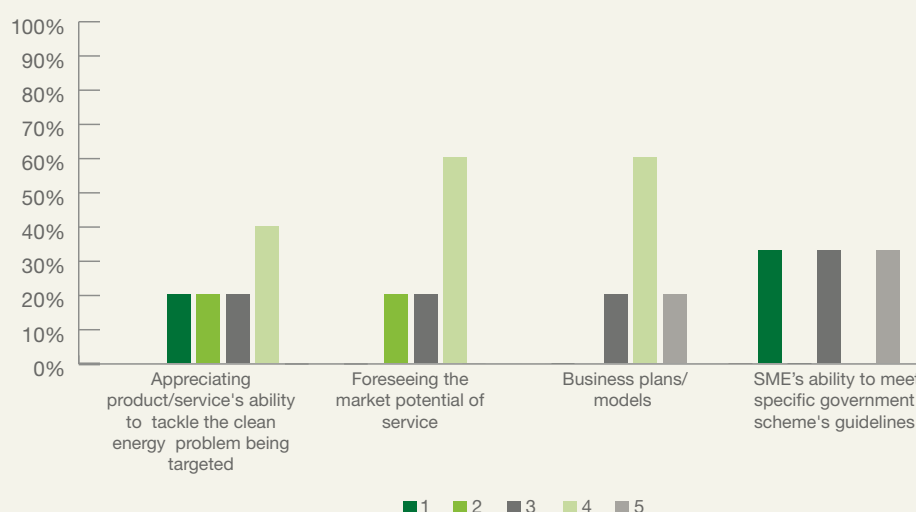
Most financiers also favored collaboratively funding and investing in cleantech ventures because the risk sharing advantages along with the ability to leverage various forms of capital and share the burden of due diligence. When asked what parameters they considered when evaluating a cleantech venture for funding, the market potential of the product along with the ability of the venture to adequately and efficiently address the problem it was trying to solve ranked particularly high.

4.4 Government/Public Sector Survey

Key Takeaways

Skill development, policy engagement and intervention, financial and technological support as well as mentoring and incubation were among some of the schemes that these organizations provided.

Figure 17:
Government sector
challenges (least
challenging to most
challenging)



Among the biggest challenges these organizations faced when interacting with cleantech SMEs, appreciating the ability of the product/ service to effectively address the issue at hand, business plans as well as foreseeing market potential ranked highly.

A number of these organizations had steady collaborations with private sector and multilateral agencies. They also used these stakeholder collaborations as well as other government organizations as outreach channels to engage with SMEs. Finally, while most organizations and their schemes were aligned with the SDGs, comparatively fewer in number were aligned with the recently ratified Paris accord.

5. RECOMMENDATIONS AND CONCLUSION

The overriding purpose of this study was to gain an understanding of the clean energy space, with a careful assessment of its key actors and an emphasis on SMEs and the role they play in this space. Interactions with these ecosystem actors through structured interviews, climate solver workshops, follow-up discussions along with a review of the secondary sources has helped not just in analysing the various barriers of the ecosystem but also the steps that can be taken to overcome them.

Government bodies and financiers can play a major role in efficient implementation of the recommendations provided in this section. These recommendations incorporate inputs and suggestions from not just the SME representatives but also some of the financiers that were approached for the study.

5.1 Recommendations

Collaboration between public and private financiers while investing in clean energy SMEs

As discussed earlier, access to finance has been cited as a major barrier faced by SMEs to get their innovation to the market and for further scaling up of operations. Partnerships between public and private financiers are likely to bridge this funding gap. This also removes a lot of teething troubles SMEs are likely to encounter, for instance, partnership with a private body will remove bureaucracy-related hindrances to some extent, and make the process quick. Also, government schemes/initiatives for the SMEs have been severely under-resourced in terms of manpower requirements for implementation and consequently it is difficult for SMEs to access them. A public-private collaboration can solve this manpower crunch, while the private financiers can use this partnership to broaden their portfolio of work and minimise the risk component of investing in clean technologies. It is important that such a collaboration strives for better environmental performance by investing in right technology.

In December 2016, the central government announced a 'Fund of Funds' scheme (FFS) worth INR 10,000 crore, under 'Startup India' initiative, to build a nurturing ecosystem for innovation driven startups. This scheme is to be managed and implemented by SIDBI. The procedure is that FFS will invest in Alternate Investment Funds (AIF)¹⁸⁷ which in turn will invest in innovation-based startups in various fields. Efficacy of this initiative, to a large extent, would depend on how this is deployed.

¹⁸⁷ Alternate Investment Funds (AIF) are registered under Security and Exchange Board of India (SEBI).

Private sector involvement here in any capacity would enhance the quality of due diligence and mentoring. A Public-Private-Partnership (PPP) would be an ideal scenario. PPPs are ideal for investments in an innovation ecosystem that require sustained support and capital. VCs are more focused on early and profitable exit that limits their financial support to early stage startups.¹⁸⁸

‘INFUSE’ is one such collaboration to support innovative startups in the clean energy sector. MNRE provided resources to the CIIE and the latter raised more than matching resources from private entities to set up the INFUSE Ventures which it now operates professionally, while an independent investment committee oversees the due diligence.¹⁸⁹ It focuses on businesses in cleantech and sustainability (renewable energy, energy efficiency, distributed energy, green buildings etc.) and provides business/mentoring support, access to seed and early stage fund along with networking opportunities with potential partners.

Better awareness and outreach programmes for the relevant existing policies and strict enforcement of environmental laws and regulations

It is clear that there is no dearth of state/central policies in the clean energy innovation space. However, there is a lack of understanding and clarity about these policies amongst the innovators, financiers and sometimes even within government departments. To deal with this the government can develop and support platforms for stakeholders of clean energy innovation ecosystem to participate in clean energy policies and regulatory decision making for its effective and efficient delivery.

The Swachh Bharat Mission was cited as one of the most effective initiative as it brought about increased awareness among the consumers of waste to energy products. A government representative stated that some of the recent government initiatives have helped bring confidence in the clean energy market and the ease of doing business has significantly improved. ‘Jan Dhan Yojana’, ‘Mobile Banking’, ‘Digitization campaign’, ‘Start Up India’, ‘Skill India’ are a few of the successful initiatives. However, these are quite recent and the impact on the clean energy ecosystem depends largely on their successful implementation and effective delivery in the long run.

On the other hand, there are schemes like Technology Development Board (TDB) funds that require more awareness. There should be proper guidance and framework in place for subsidy disbursement. Another suggestion that came up during the stakeholder interactions is for the government to come up with technology specifications in tenders and policies. There are a number of policies in place but no specification has been provided for any particular technology.

Apart from increasing awareness levels across all types of stakeholders, it is also important that the existing environmental regulations and policies are strictly enforced and adhered to. This in turn can lead to more investments in the sector, followed by greater demand for clean energy products and services. For example, to spur demand

188 iima.ac.in. (2016). How the state can foster innovation. [online] Available at: <https://www.iima.ac.in/web/fdp/whats-going-on-at-iima/article3> [Accessed 18 Jun. 2017]

189 iima.ac.in. (2016). How the state can foster innovation. [online] Available at: <https://www.iima.ac.in/web/fdp/whats-going-on-at-iima/article3> [Accessed 18 Jun. 2017]

side enforcement, banks have started adding solar lighting or rooftop subsidy to the housing loans, which has the potential to boost their usage in urban markets.

Need to maintain a balance between market-driven approach and subsidies

An energy entrepreneur approaches a market on the basis of tangible economic benefits that it can provide to the customers. For example, customers in rural areas are approached from the perspective of addressing gaps in energy access, while customer in urban areas are approached as potential targets for roof top solar. This market demarcation is crucial to doing business. However, government policies do not segregate these two elements, i.e. off-grid vs mini/micro-grid subsidies. For urban customers using solar roof tops, it would be a better deal to offer them income tax credit (based on capex on rooftop solar for instance) instead of subsidies. While subsidies cannot be written-off completely, they can definitely be planned and implemented more effectively. Subsidies on fossil fuels, for example, create barriers for a market for renewable energy and energy efficiency and hence a level playing field should be provided. These are important to bring down lending costs for investors, and offset higher costs of early stage startups in developing their markets. This will allow consumers to access energy at affordable rates.

Strengthening of infrastructure supporting clean technology SMEs (especially business/technology incubation)

Majority of the existing incubators/accelerators tend to focus on software industries, such as Information Technology (IT), data analytics, and fintech. They do not embrace cleantech/renewable energy etc. to a great extent. And although there are a number of incubators and accelerators that offer support to early stage startups, there are very few that have cleantech as one of the focus areas. CIIE, Ahmedabad, MVIF at NIF, TDB at DST, RTBI at IIT Madras are amongst few of them. However, it is necessary to further develop dedicated incubators or Climate Innovation Centres where SMEs developing clean technology can test their products, develop their plans and obtain seed funding in the process. Also, all the existing incubators should be encouraged to embrace Sustainable Development Goals (SDGs) and in the process, focus on cleantech startups as well.

Business & Technology Incubation

Stakeholder consultations revealed that while SMEs/startups possess innovative and bright ideas, they lack a supportive business plan to implement the ideas and scale them. Such SMEs end up losing out on funding. Often, SMEs lack proper documentation/paperwork, which is a necessity while approaching financiers. From a financier's perspective, it is important to conduct due diligence on the SMEs before funding, for instance on the sustainability of SME innovation coupled with the business model and their expansion/scaling plan. This is to ensure that SMEs do not shut down a few years down the line - this would be a waste of the financier's resources.

Similarly, there is a pressing need to increase the scale of funds for Research and Development (R&D), prototyping and technology incubation in the clean energy space. A review of existing literature suggests that there is a distinct lack of support for early stage prototyping in the country. Most of the support that is available tends to focus more on commercialization and the marketing side of the venture, rather than on technology development, idea formation, proof of concept, prototyping, and patenting.

Going forward, initiatives are being taken in this direction. National Initiative for Development and Harnessing Innovations (NIDHI), was launched in September 2016 with an objective to support ideas and innovations in the startup ecosystem. Under this initiative, government will be spending INR500 crore in next few years to drive startup initiatives. PRAYAS (Promoting and Accelerating Young and Aspiring Innovators & Startups) is one of the components of NIDHI which provides innovators an access to the Fabrication Laboratory and a grant money up to INR10 lakh. Additionally, INR1 crore is provided as seed money per startup (implementation through incubators). The key stakeholders of this initiative include various government units, R&D institutions, financial institutions, angel investors, venture capitalists.¹⁹⁰

Access to Research and Development (R&D) labs is the first step towards innovation. An impactful step that the government can take is to have representation by successful innovators/entrepreneurs in committees presiding over the R&D funds.¹⁹¹

Shift in Perspective - Financial institutions to move away from a collateral-based funding approach

Project Financing

Most of the investors prefer equity financing in an early stage startup. Established SMEs, on the other hand, get insufficient attention as debt financing from public sector banks is difficult to come by. In such a scenario, private players can come together to provide 'project financing' for established SMEs. It would significantly help SMEs in raising finances for Build, Own, Operate, Transfer (BOOT) projects

190 Ministry of Science and Technology (2016). DST commits 500 Crores for PM's Vision on Startup India. [online] Available at: <http://piib.nic.in/newsite/PrintRelease.aspx?relid=149571> [Accessed 16 Aug. 2017].

191 Global Cleantech Innovation Programme India 2013-2017: Stories and Lessons A GCIP Journal. (2017). [online] New Delhi. Available at: http://www.idemi.org/downloads/gcip_india/GCIP%20Journal.pdf [Accessed 16 Aug. 2017].

which are becoming the norm in the green business sector. It addresses risks through securitisation of cash flows and 'bankable' contracts between the various parties involved.¹⁹² Tata Cleantech Capital, for example, adopts a similar model of investment.

Convertible Debt

Instead of investing in early stage equity, which is risky for both investor and the entrepreneur as the latter hasn't even tested the product in market, it is better to opt for debt funding during the early stages. Convertible debt is one such option. In this kind of debt financing, there is an option to convert debt into equity at a later stage when the entrepreneur is ready to apply for a second or more round of investments.

As per a study conducted by National Knowledge Commission (NKC), 63 per cent of all early stage startups in the country are self-financed (support from family and friends) while the remaining 37 per cent access funds from formal sources such as banks, angel investors, venture capitalists etc.¹⁹³ This figure of 37 per cent is quite low, however, a lot of initiatives are currently underway to change the funding landscape. The growing Indian Angel Network (IAN) is a good example here. It has investors from various countries and has invested in over 17 portfolio sectors. The Indus Entrepreneurs (TiE), National Association of Software and Service Companies (NASSCOM), Indian Venture Capital Association (IVCA) and SINE (Incubator based at IIT Mumbai) are some of its partner members. The 'Startup India' initiative, over a period of time, will provide startups with the skills to apply for credit and support through a 'Credit Guarantee Fund for Startups' to cater to this credit access problem. Cleantech SMEs should make use of such initiatives so that equity is more easily raised apart from the financing options like project finance and convertible debt.

Fragmented Cleantech sectors (waste to energy - energy efficiency, storage) to form industry associations

Fragmented sectors lose out on securing representation in policy and regulatory decision making, and accessing finance. However, by forming industry associations their demands can be more coherent. They can empower themselves with adequate capacity to meaningfully engage in international or national discourses. An industry association could act as a platform allowing the SMEs to adeptly respond to dynamic issues affecting the sector.

India has a very low number of formal cleantech organizations when compared to some of the smaller economies such as Hungary, Holland, Denmark, etc.¹⁹⁴

192 Sanyal, S. and Eisinger, F. (2016). Enabling SME Access to Finance for Sustainable Consumption and Production in Asia: An overview of Finance Trends and Overview in India. [online] SWITCH-Asia. Available at: http://www.switch-asia.eu/fileadmin/user_upload/Publications/2016/Green_Finance_Study_-_2016_-_India.pdf [Accessed 4 Jul. 2017].

193 Nathan Associates-FICCI (CMSME) (2014). Nurturing Entrepreneurship in India. [online] New Delhi. Available at: <http://ficci.in/spdocument/20432/Nurturing-Entrepreneurship-in-India.pdf> [Accessed 11 Aug. 2017].

194 The Global Cleantech Innovation Index. (2017). Retrieved from <https://www.fi/mediabank/9906.pdf>

5.2 Conclusion

A thriving clean energy innovation ecosystem assumes national priority in an attempt to balance economic development with climate change. SMEs are one of the major contributors to this transition towards a low carbon economy, not just as a source of clean energy innovations but also as its end users. However, SMEs cannot do so without support from other stakeholders in the cleantech ecosystem, especially central and state governments, and public and private financiers.

Joint interventions are required to help them overcome some major barriers and provide an enabling environment to become pioneers of change. A combination of good public policy and right investment environment is needed for this clean energy innovation ecosystem to scale up.

The government's envisaged plan to install 175 GW of renewable energy capacity by 2022, along with dedicated efforts to promote energy efficiency, waste-to-energy, green buildings, and sustainable transport presents a huge opportunity for innovators/entrepreneurs in the cleantech space. In the current scheme of things, when the government is coming up with a number of initiatives to promote startups and innovation, it may be time for clean energy ecosystem to advocate for a central place in the emerging economic order.

APPENDICES

Appendix 1A

Summary of Funding Instruments/Support/Schemes for the Cleantech sector

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
Modified Special Incentive Package Scheme (M-SIPS)	Department of Electronics and Information Technology (DeitY)	Technology hardware, Internet of Things, aeronautics/aerospace & defence, automotive, non-renewable energy, renewable energy, green technology and nanotechnology.	Startups in electronic manufacturing	Capital subsidy of 20% for startups in SEZ and 25% for startups in non-SEZ for units engaged in electronics manufacturing. For non SEZ units: reimbursements of CVD/ excise for capital equipment	http://www.msips.in/MSIPS/
NewGen Innovation and Entrepreneurship Development Centre (New Gen IEDC)	Department of Science and Technology	Chemicals, technology hardware, healthcare & lifesciences, aeronautics/aerospace & defence, agriculture, AI, AR/VR (augmented + virtual reality), automotive, telecommunication & networking, computer vision, construction, design, non-renewable energy, renewable energy, green technology, fintech, Internet of Things, nanotechnology, social impact, food & Beverages, pets & animals, textiles & apparel.	Partnering parent institution should have at least 5000 square feet for establishing NewGen IEDC, library, qualified staff etc.	One-time non-recurring financial assistance of INR 25 lakhs, in addition, non-recurring grants will be made available for covering working capital cost.	http://www.nstedb.com/institutional/edc.htm
Atal Incubation Centres (AIC)	Atal Innovation Mission	Chemicals, technology hardware, healthcare & life sciences, aeronautics/aerospace & defence, agriculture, AI, AR/VR (augmented + virtual reality), automotive, telecommunication & networking, computer vision, construction, design, non-renewable energy, renewable energy, green technology, fintech, Internet of Things, nanotechnology, social impact, food & beverages, pets & animals, textiles & apparel.	Partnering institution would have to provide a built-up space of at least 10,000 sq. ft to qualify for the financial support.	Grant-in-aid of INR 10 Cr to each AIC for a maximum of five years to cover the capital and operational expenditure cost in running the centre.	http://niti.gov.in/content/atal-incubation-centres-aics

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
National Clean Energy Fund	Indian Renewable Energy Development Agency (IREDA)	Renewable energy, clean energy, green energy plants.	Refer link	Refer link	http://www.ireda.gov.in/writereaddata/Revised%20IREDA%20NCEF%20Refinance%20Scheme.pdf
Bridge Loan Against MNRE Capital Subsidy	Indian Renewable Energy Development Agency (IREDA)	Renewable energy, clean energy, green energy	MNRE Accredited Channel Partners, State Nodal Agencies (SNA) and other stakeholders, as approved by MNRE, who have already submitted valid claims of Capital Subsidy at IREDA, which are pending for release of payment on account of non-availability of funds, will be eligible under the scheme.	The selected startup or government business projects will get up to 80% of the existing pending eligible capital subsidy claim, as verified by the IREDA with a minimum loan assistance of INR 20 Lakhs.	https://www.startupindiahub.org.in/content/sih/en/resources/government-schemes/bridge-loan-against-MNRE-capital-subsidy.html
Bridge Loan Against Generation-Based Incentive (GBI) Claims	Indian Renewable Energy Development Agency (IREDA)	Renewable energy, clean energy, green energy	Renewable energy developers who have already submitted a valid GBI claim which is processed and pending on account of non-availability of funds, will be eligible under this scheme.	A minimum loan assistance of INR 20 Lakhs is provided under this scheme.	http://www.ireda.gov.in/writereaddata/Scheme%20Document-%20Bridge%20loan%20GBI.pdf
4E (End To End Energy Efficiency)	Small Industries Development Bank of India (SIDBI)	Sector Agnostic	MSME units in the manufacturing or services sector which are in operation for at least three years and have earned cash profit in the last two years of operation are eligible. The startup should not be in default to any bank/ FI. The unit should have undergone a process of Detailed Energy Audit (DEA) through a technical agency/consultants having BEE certified Energy Auditors.	A loan of up to 90% of project cost, with an interest rate at 2.5% less than the normal lending rate was provided to MSME's for implementing energy efficiency measures on an end to end basis with a cap of INR 1.5 crore and a minimum loan amount of INR 10 lakh	https://www.sidbi.in/files/4E_Financing_Scheme.pdf

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
Sustainable Finance Scheme	Small Industries Development Bank of India (SIDBI)	Green Energy, Non-renewable Energy, Technology Hardware, Renewable Energy	Renewable energy projects such as solar power plants, wind energy generators, mini hydel power projects, biomass gasifier power plants, etc. for captive/ non-captive use. Any kind of potential CP investments including waste management. Suitable assistance to OEMs which manufacture energy efficient / cleaner production / green machinery/ equipment. Either the OEM should be an MSME or it should be supplying its products to a substantial number of MSMEs.	Term loan/working capital to ESCOs implementing EE / CP / Renewable Energy project provided either the ESCO should be an MSME or the unit to which it is offering its services is an MSME. The rate of interest will be applicable on basis of credit rating of MSME's.	https://www.sidbi.in/files/SIDBI_Ebrochure_SFS.pdf
Technology Upgradation Fund Scheme	Ministry of Textiles	Energy Efficiency	Textiles and Jute industry	capital subsidy, with a ceiling of INR 30 crore.	http://texmin.nic.in/schemes/technology-upgradation-fund-scheme
Integrated Development of Leather Sector	Ministry of Industries and Commerce	Energy Efficiency	Tanneries, footwear components and leather products	An investment grant, offering a 30% subsidy to MSME's on plant and machinery cost with a cap of INR 50 lakhs for the purpose of Technology Upgradation/ Modernization and/or setting up new units.	http://www.fddiindia.com/services-new/ids/forms/Not_11thPlan.pdf
Credit Linked Capital Subsidy Scheme for Technology Upgradation	Ministry of MSME	Energy Efficiency	Sector Agnostic	Assistance of 15% capital subsidy on institution finance with a cap INR 15 lakh, for introducing quality technology in approved sub-sectors and products	http://www.dcmsme.gov.in/schemes/sccredit.htm

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
Technology and Quality Upgradation Support for MSMEs	Ministry of MSME	Energy Efficiency	Sector Agnostic	A grant assistance (25% of project cost) is provided for the induction of Energy Efficient technologies with a maximum cap of INR 10 lakh. Further, the project or the machine is inspected by a certified energy auditor to ensure at least 15% reduction in energy consumption	http://msme.gov.in/WriteReadData/DocumentFile/technology & quality10. pdf
Scheme for Technology Up-gradation/ Establishment/ Modernization for Food Processing Industries	Ministry of Food Processing Industries	Energy Efficiency	Food processing industries	The assistance is positioned as a grant subject to 25% of the plant & machinery and technical civil work with a INR 50 lakh ceiling in General Areas and 33.33% grant with a cap of INR 75 lakh in Difficult Areas.	http://www.mofpi.nic.in/
SIDBI Revolving Fund for Technology Innovation (SRIJAN Scheme)	Small Industries Development Bank of India (SIDBI)	Agnostic	MSME	The scheme developed in conjunction with Technology Information Forecasting and Assessment Council (TIFAC) provides assistance structured in the form of early stage debt funding, with a maximum amount of INR 100 crore, on less stringent rules and regulation	https://www.sidbi.in/TIFAC_SIDBI_Revolving_Fund_for_Technology_Innovation_SRIJAN_Scheme.php
Grant	Development Innovation Ventures - United States Agency for International Development (USAID)	Agnostic	Sector Agnostic	STAGE ONE is for projects in the proof of concept phase: DIV will grant these projects up to \$100,000 dollars over one year, STAGE TWO is for larger projects, typically to expand across a country. DIV will grant Stage Two projects up to \$1 million. STAGE THREE is for much larger projects. For grants of up to \$15 million over several years.	https://www.usaid.gov/div

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
Grant	Powering the future, We want - United Nations Department of Economics and Social Affairs (UNDESA)	Green Energy	Sector Agnostic	UNDESA offers a grant in the amount of one million US dollars to fund future capacity development activities in energy for sustainable development. The Grant is awarded to an individual, institution or partnership based on past and current achievements, with the objective of promoting leadership and innovative practices in meeting the global energy challenge	https://poweringthefuture.un.org/about
Grant	PACESetter Fund - Promoting Energy Access through Clean Energy (PEACE)	Off-grid clean energy	To be eligible, projects must be focused on improving the viability of off grid renewable energy businesses and organizations, under served individuals and communities in India without access to grid connected power or with limited or intermittent access less than 8 hours per day using small scale (under 1 megawatt) clean energy systems.	Fund of INR 50 crore (USD 7.9 million) is available for innovative, early-stage off-grid clean energy projects.	http://pacesetterfund.org/pacesetter.html
Grant	Zayed Future Energy Prize United Arab Emirates (UAE)	Renewable Energy, Sustainability	Profit seeking enterprise with less than US \$100 million in annual revenue	A prize amount of US \$ 1.5 million is awarded to the winner	http://www.zayedfutureenergyprize.com/en/
Grant	Off grid Energy Impact Smart Villages	Off-grid clean energy	Sector agnostic	A prize amount of INR10 lakh is awarded to the winner	http://e4sv.org/
Grant and Risk Capital	Global Innovation Fund	Agnostic	Social Enterprises	Grants and risk capital worth US\$ 200 million	http://www.globalinnovation.fund/about-us
Grant	DBS Foundation – Social Enterprise Grant Program	Agnostic	Social Enterprises	Prototype grants SGD 50,000 Organisational Grants – SGD 100,000 Scaling up grants	https://www.dbs.com/dbsfoundation/grant-programme/default.page

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
Grant	Millennium Alliance Awards USAID, TDB and FICCI	Education, water, health, sanitation, clean energy, agriculture food security	Sector Agnostic	Stage 1 – INR30 lakhs – Piloting or Testing an Innovation Stage 2 – INR1 crore – Scaling or testing an innovation which has been successfully piloted	http://www.millenniumalliance.in/ma_awards.aspx
Venture Capital	Blume Venture Advisors Pvt. Ltd.	Multi sector fund (green sectors invested in includes energy efficient lighting and carbon capture)	Sector Agnostic	Ticket size is INR10 million	http://www.blumeventures.com
Venture Capital	SIDBI Venture Capital Ltd. (SVCL)	Multi sector focus (green sectors invested in includes renewable energy, automotive efficiency and sustainable agribusiness)	Sector Agnostic	Ticket size is INR63 to 189 million	http://www.sidbiventure.co.in
Venture Capital	Infuse Ventures – CIIE and IIM Ahmedabad	Exclusive focus on green sectors (renewable energy, energy efficiency, eWaste, sustainable agribusiness and green IT)	Clean energy sector	Ticket size is INR63 million	www.infuseventures.com
Venture Capital	Green India venture Fund (GIVF) – IFCI Venture Capital Funds Ltd	Exclusive focus on green sectors (renewable energy, energy efficiency and solid waste management)	Clean energy sector	N/A	http://www.ifciventure.com
Venture Capital	Global Environment Fund	Exclusive focus on green sectors	Clean energy sector	Ticket size is INR63 to 315 million	http://www.globalenvironmentfund.com
Private Equity	Fidelity Growth Partners	Multi sector focus (green sectors invested in includes renewable energy)	Clean energy sector	Ticket size is INR315 million and higher	http://www.fidelitygrowthpartners.in/
Private Equity	Peepul Capital	Multi-sector focus including green and inclusive business (particularly clean and water access)	Clean energy and water	Ticket size is INR315 million and higher	http://www.peepulcapital.com/
Impact Fund	Aavishkar India Micro VC Fund	Multi-sector focus including green and inclusive business (particularly clean and water access)	Clean energy and water	Ticket size is INR62.3 million	http://www.aavishkaar.in/
Impact Fund	Acumen	Multi-sector focus including green and inclusive business (particularly clean and water access)	Clean energy and water	Ticket size is INR62.3 million	http://acumen.org/

Instrument	Organization	Thrust areas	Eligibility	Funding	Website
Impact fund	Villgro Innovations Foundation	Sector Agnostic	Social Enterprise	Upto INR65 lakhs	http://villgro.org/unconvention/
Impact Fund	Factor[e] Ventures	Sector Agnostic	Cleantech Ventures	IN 1.2 crore – 3.2 crore	http://www.factor.com/
Grants	New Ventures	Sector Agnostic	Clean Energy	Grants upto INR9.5 crore	http://www.regainparadise.org/
Debt	TATA Cleantech Capital	Sector Agnostic	Clean Energy	Between INR1.2 crore- INR 12 crore	http://www.tatacleantechcapital.in/

Appendix 1B

Climate Solver + Fostering Clean Energy Innovation in SME Sector in India

Clean Energy Innovation Ecosystem SME Survey

[The information provided in this survey will only be used for research, analysis, report preparation and WWF-India's compilation of the clean energy innovation entrepreneurs/SMEs database. Identity of the SME will remain anonymous; however, a list of all SMEs participating in the Survey will be published.]

Contact Information

Name of SME:

Person of Contact/Designation:

Telephone/Mobile:

Email:

Company Information

- 1 What year was your company founded?
- 2 Where are your company's HQ and/or regional offices?
- 3 Where are you selling your product/service? Where are your major hubs? Which States and Districts within India? Globally?
- 4 Where are your major manufacturing hubs? Which States and Districts within India? Globally?
- 5 Which sector in Clean Energy is your company focusing on?
 - a. Energy efficiency/Energy Savings
 - i. Energy applications in Industry/manufacturing
 - ii. Energy applications in Transport
 - iii. Energy applications in Building/Construction
 - b. Energy Access
 - i. Renewable Energy-based cooking solutions (e.g. clean cook stoves)
 - ii. Renewable Energy based lighting solutions (e.g. household appliances, off-grid/mini-grid, solar home systems)
 - iii. Renewable Energy Based productive applications (e.g. solar powered water pumps, de-husking, dryers)
 - c. Smart-grid/energy storage/smart meters
 - d. Renewable Energy
 - i. Energy applications in Industry/manufacturing
 - ii. Energy applications in Transport
 - iii. Energy applications in Building/Construction
 - e. Waste management/waste to energy
 - f. Others

- 6 Is your innovation mainly a:
 - a. New breakthrough in technology, or
 - b. Innovative business model (that makes an existing package of technologies more attractive on the market), or
 - c. A combination of a and b
 - d. Other

Human Resource Capacity

- 7 How many people does your company employ?
 - a. 1-10
 - b. 11-50
 - c. 51-100
 - d. >100
- 8 What is the breakdown of Permanent versus Contract employees?
 - a. Permanent - How many permanent employees?
 - b. Contract – How many employees are on a contract basis?
- 9 Number of Employees in different departments:
 - a. Technical
 - b. Human Resources/Administration
 - c. Finance
 - d. Sales/Marketing

Technical Capacity

- 10 At what stage of growth is your company in?
 - a. R&D (Your company is conducting investigative activities to develop new product/ processes)
 - b. Prototype/lab scale (An early sample/model is ready to be tested)
 - c. Pilot (Your company is conducting a small scale preliminary study to evaluate feasibility, time, cost, adverse effects and impacts (if any))
 - d. Post-pilot (Your company is incorporating lessons from the pilot stage to improve the product and ready for market entry)
 - e. Commercialization
 - f. Looking to scale business
- 11 How many units of your products are in the market in total?
- 12 What were your annual sales volumes in units last financial year?
- 13 What was your total production capacity in units last financial year?
- 14 What was your company's turnover (in INR) in the last financial year?

Financial Capacity

- 15 What was your source of startup capital, working and expansion capital (online form will have separate options for startup, working and expansion capital)?
 - a. Venture Capital/Private Equity
 - b. Banks/Loans
 - c. Angel Investors
 - d. Impact Investors
 - e. Crowd Investing Platform

- f. Personal Network
 - g. Grants/Subsidies
 - h. Self-financing
 - i. Other
- 16 Have you been selected in any large business development/ technology incubation, accelerator or investment programmes? If yes, please specify:

Challenges

- 17 Rate Main Challenges endured by your company.
(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)
- a. Human Resources
 - b. Technology/Research & Development
 - c. Policies/Regulation
 - d. Market Competitiveness
 - e. Access to capital (Public/Government Schemes)
 - i. Startup Capital
 - ii. Working Capital
 - iii. Expansion Capital
 - f. Access to capital (Private)
 - i. Startup Capital
 - ii. Working Capital
 - iii. Expansion Capital
 - g. Infrastructure
 - h. Interactions with other stakeholders in the clean energy community in order to meet existing enterprise needs and/or scale enterprise.
 - i. Other
- 18 Rate Main Employment/Human Resource Challenges
(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)
- a. Cannot afford level of talent needed
 - b. Cannot find qualified staff for specific needs (e.g. managerial, engineering/technical, sales/marketing) and/or cannot invest in skills training
 - c. Cannot retain staff
 - d. Other

Please elaborate on these barriers/challenges and support needed.

- 19 Rate Main Technology/ R&D Challenges
(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)
- a. Access to Technology
 - b. Technology Sourcing
 - c. Knowledge/Awareness/Expertise in available and/or new technologies
 - d. Operating/Servicing/Maintenance of new technologies
 - e. Access to infrastructure for R&D
 - f. IPR/Patents
 - g. Risk of Investment (Probability/likelihood of incurring losses on technology failure)
 - h. Technology/R&D Collaborations with Universities/Institutes, Incubators/ Accelerators and/other Entities
 - i. Other

Please elaborate on these barriers/challenges and support needed.

20 Rate Main Consumer/Customer related Challenges

(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)

- a. Consumer's lack of appreciation for/understanding of the product/service
- b. Lack of existing customer base or demand
- c. Cost of product/service is too high
- d. Customer requires third party verification
- e. Incumbents on the market have a higher credibility with the customers
- f. Other

Please elaborate on these barriers/challenges and support needed.

21 Rate Main Business related Challenges

(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)

- a. Supply Chain Logistics
- b. Distribution Channels
- c. Sales/Marketing
- d. Operations & Maintenance Systems
- e. Customer Outreach Strategy
- f. Access to clean energy innovation contacts/network
- g. Other

Please elaborate on these barriers/challenges and support needed.

22 Rate Main Challenges with Accessing Capital (online form will have separate options for startup, working and expansion capital)

(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)

- a. Lack of understanding of company's product/service
- b. Funds needed are too high (e.g. for setting up/scaling business operations – depending on what type of capital, adoption of new technology infrastructure upgrades, etc.)
- c. Accessibility to lenders/financiers
- d. Investors are not interested in company's product/service
- e. Stringent conditions by lenders/financiers (wanting equity, control & collateral)
- f. Other

Please elaborate on these barriers/challenges and support needed.

23 Rate Main Infrastructure Challenges

(Rate each on a scale of 1-5: 1 = not challenging, 5 = extremely challenging)

- a. Access to land/appropriate space (facility)
- b. Access to reliable and consistent power supply
- c. Access to water
- d. Access to proper waste management facilities
- e. Other

Please elaborate on these barriers/challenges and support needed.

- 24 What are the main policy/regulation challenges that you face? Please elaborate on these barriers/challenges and support needed.
- 25 Are you sharing/advertising your technology/innovation with the clean energy (innovation) community? If so, how?
 - a. Blogs
 - b. Newsletter circulation
 - c. Conferences/Workshops
 - d. Other
- 26 What kind of relationship do you have with your financiers/lenders (board member, director, mentor)?
- 27 How are you interacting with other SMEs, government departments, potential financiers for knowledge sharing, capacity building and staying current with policy/regulations and trends (financial and otherwise)?
 - a. Conferences/Workshops
 - b. Online groups
 - c. Community Meet-ups
 - d. Government/Private Industry Associations
 - e. Other

Additional Questions

1. Where are your products manufactured (if applicable)?
2. What is your assessment of the financial and non-financial support services available to you? What are the major gaps in these services?

Appendix IC

Climate Solver + Fostering Clean Energy Innovation in SME Sector in India

Clean Energy Innovation Ecosystem Government/Public Sector Survey

Contact Information

Name of Government Ministry/Department/Public Sector Unit:
Person of Contact/Designation:
Telephone/Mobile:
Email:

Questionnaire

- 1 What schemes (finance, technology, business incubation, skill development/training) are offered by your Department/Ministry to support SMEs?
- 2 What are the biggest challenges your Department/Ministry faces when engaging with SMEs?
(Rate each on a scale of 1-5: 1 being not challenging, 5 being extremely challenging)
 - a. Appreciating technology/innovation/product's ability to tackle the clean energy problem being targeted
 - b. Foreseeing the market potential of technology/innovation/product
 - c. Business plans/models
 - d. SME's ability to meet specific government scheme's guidelines
 - e. Other
- 3 Are there synergies between your Department/Ministry and private sector players and/or multilateral agencies in supporting SMEs or other stakeholders engaged in clean energy (innovation)?
- 4 How do you engage with SMEs for feedback on relevant policies/regulations pertaining to your Department/Ministry?
- 5 Is your Department/Ministry working to align your SME innovation portfolios with the agreed Sustainable Development Goals in 2015 ? (Y/N)
- 6 Has your Department/Ministry aligned its SME innovation portfolios with the agreed climate convention objective in Paris 2015 of staying well below two degrees global warming? (Y/N)

Additional Questions

1. What are you seeing as the bigger challenges for SMEs for access to financial and other non-financial support services?
2. What are the main investment risks you see across SMEs?
3. What is your assessment of the various government policies/initiatives and how effective they are/will be in addressing the challenges that SMEs face in scaling up/expanding their business?

Appendix ID

Climate Solver + Fostering Clean Energy Innovation in SME Sector in India

Clean Energy Innovation Ecosystem Private/Public Sector Financier¹⁹⁵ Survey

[The information provided in this survey will only be used for research, analysis, report preparation and WWF-India's compilation of the clean energy innovation entrepreneurs/SMEs database. Identity of the Private Financier will remain anonymous; however, a list of all Private (and Public) Financiers participating in the Survey will be published.]

Contact Information

Name of Company or Government Department/Ministry:
Contact Person/D designation:
Telephone/Mobile:
Email:

Questionnaire

- 1 What sort of financier is your company?
 - a. Venture Capital/Private Equity
 - b. Bank (Public or Private)
 - c. Angel Investor
 - d. Impact Investor
 - e. Crowd Investing Platform
 - f. Other
- 2 At what stages of growth does your company provide financial support to SMEs¹⁹⁶? And why?
 - a. R&D (The company is conducting investigative activities to develop new product/processes)
 - b. Prototype/lab scale (An early sample/model is ready to be tested)
 - c. Pilot (Your company is conducting a small scale preliminary study to evaluate feasibility, time, cost, adverse effects and impacts (if any))
 - d. Post-pilot (Your company is incorporating lessons from the pilot stage to improve the product and ready for market entry)

¹⁹⁵ For purposes of this survey, the term financier refers to an entity or individual providing financial support to SMEs through business loans (debt), equity investments, debentures or other instruments.

¹⁹⁶ Based on the MSME Act 2006, SMEs are enterprises where investment in plant and machinery/equipment is between INR25 lakhs to INR 10 crore in the manufacturing industry and between INR 10 lakhs to INR 5 crore in the service sector. Source: http://www.dcmsme.gov.in/ssiindia/defination_msme.htm.

Additionally, the Government of India has defined Startups for its "Startup India" Initiative as an enterprise which is up to 5 years old since the date of its incorporation/registration, its turnover for any financial year has not exceeded Rs. 25 crore and is working toward innovation, development, deployment or commercialization of new products. According to this definition, some Startups could also constitute as SMEs.
Source: http://dipp.nic.in/English/Investor/startupindia/Definition_Startup_GazetteNotification.pdf

- e. Commercialization
 - f. Looking to scale business/Expansion
- 3 What financial instruments (business loans, equity, debenture, other instruments) do you typically provide to SMEs at different stages of growth?
 - 4 Considering the trends in the last few years, what is the typical amount of financial support you provide in a particular SME at different stages of growth?
 - a. Minimum Investment
 - b. Maximum Investment
 - c. Average
 - 5 Do you partner with other financiers to provide financial support in the same SME? If yes, please elaborate on the following:
 - a. Why do you collaborate – what do you look for in collaborators?
 - b. How do you find collaborators?
 - 6 How strongly do the following criteria influence your decision in providing financial support in a SME?
 Rate each of the criteria on a scale of 1-5. (1 = not at all, 5 = very strongly)
 - a. Market potential of technology/innovation/product/service
 - b. Innovative aspect/Uniqueness of technology/innovation/product/service
 - c. Problem being addressed by the technology/innovation/product/service
 - d. Ability of the technology/innovation/product/service to make a positive environmental and/or societal impact (e.g. providing modern and enhanced/better quality access to energy, water, food access to low-income communities) and scale
 - e. Comprehension of the technology/innovation/product/service
 - f. First mover advantage
 - g. Professional competence of the SME team
 - h. Presence of the SME on digital platforms
 - i. Success of individual team members in other ventures (awards, prizes, other recognitions)
 - j. Business Plan/Presentation of technology/innovation/product/service
 - k. Other financier support
 - l. How much the SME is already valued
 - m. Option of equity, control and collateral in the SME
 - n. Growth/expansion plan of the SME
 - o. Other
 - 7 In addition to financial support, what support services do you provide to SMEs?
 - a. Technical/Value addition advisory of existing product
 - b. Strategic advisory support (new business ideas, modeling of competition strategy, market entry)
 - c. Operational advice and support (marketing/sales, human resources management, networking, procurement, efficiency)
 - d. Others
 - 8 What conditions do you place upon SMEs while providing financial support to them? (e.g. Collateral, RoI, Maximum Leverage Ratios, etc.? At what stages of SME growth do you place those conditions?
 - 9 Do you engage in any sort of market assessment study before providing financial support in a clean energy (innovation) SME?
 - 10 What are the challenges and barriers you face while providing financial support in clean energy (innovation) SMEs?

- a. Clarity of Investment Regulations
 - b. Business plans/models
 - c. SME's ability to meet specific Financier conditional guidelines
 - d. Other
- 11 How are your SME financial support services aligned with or influenced by major government policies/initiatives (e.g. Make in India, Startup India Initiative, Niti Aayog Atal Innovation Mission, India Inclusive Innovation Fund, Technology Promotion, Development and utilization Programme, Multiplier Grant Scheme, Priority Sector Lending, etc.)?

Appendix 1E

List of Experts Consulted

Name	Type
GIZ	International Development Agency
CLEAN	Alliance for Off-grid Energy sector
Ministry of Micro, Small and Medium Enterprises	Government
UNIDO	Intergovernmental Organization
NITI Aayog	Government
Skill Council for Green Jobs	Government
Small Industries Development Bank of India (SIDBI)	Financier – Government Bank
Infuse Ventures	Financier – Venture capital/Private equity
TATA Cleantech Capital	Financier - Infrastructure Finance Company - NBFC
New Ventures India	Research and Consulting
YES Bank	Financier - Private Bank
Asha Impact	Financier – Venture capital/Private equity
Factor[e] Ventures India	Financier – Impact Investor
Villgro Innovations Foundation	Financier – Impact Investor
Indian Angel Network	Financier – Angel Investor
National Innovation Foundation	Financier - Government

About WWF-India

WWF-India is one of the leading conservation organizations in the country. It is a science-based organization which addresses issues such as the conservation of species and its habitats, climate change, water and environmental education, among many others. Over the years, its perspective has broadened to reflect a more holistic understanding of the various conservation issues facing the country and seeks to proactively encourage environmental conservation by working with different stakeholders.

The Climate Change and Energy Programme of WWF-India is working towards climate resilient future for people, places and species that support pathways for sustainable and equitable economic growth. WWF-India is actively engaged in promoting renewable energy uptake, enabling clean energy access, demonstrating renewable energy projects in critical landscapes, and overall promoting sustainable clean energy solutions. Climate innovations, low carbon development and renewable energy at scale are the thrust areas of the programme.

To know more, log on to: www.wwfindia.org

About Okapi Research and Advisory

Okapi Research and Advisory is an India-based research and strategy group focussed on building ecosystems for collaboration and innovation in delivering sustainable development. It works with policymakers to shape the interface between public and private initiatives, financiers to design channels for financing impact, and system influencers to develop forward-looking, evidence-based strategies for achieving collective purpose. Okapi is incubated by IIT Madras and has offices in Chennai and Delhi.

More about Okapi: www.okapia.co



Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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(Formerly World Wildlife Fund)

WWF-India Secretariat

172-B Lodi Estate

New Delhi 110003

Tel: 011 4150 4814 Fax: 011 4150 4779