



EARLY-STAGE CLIMATE-TECH STARTUPS IN INDIA

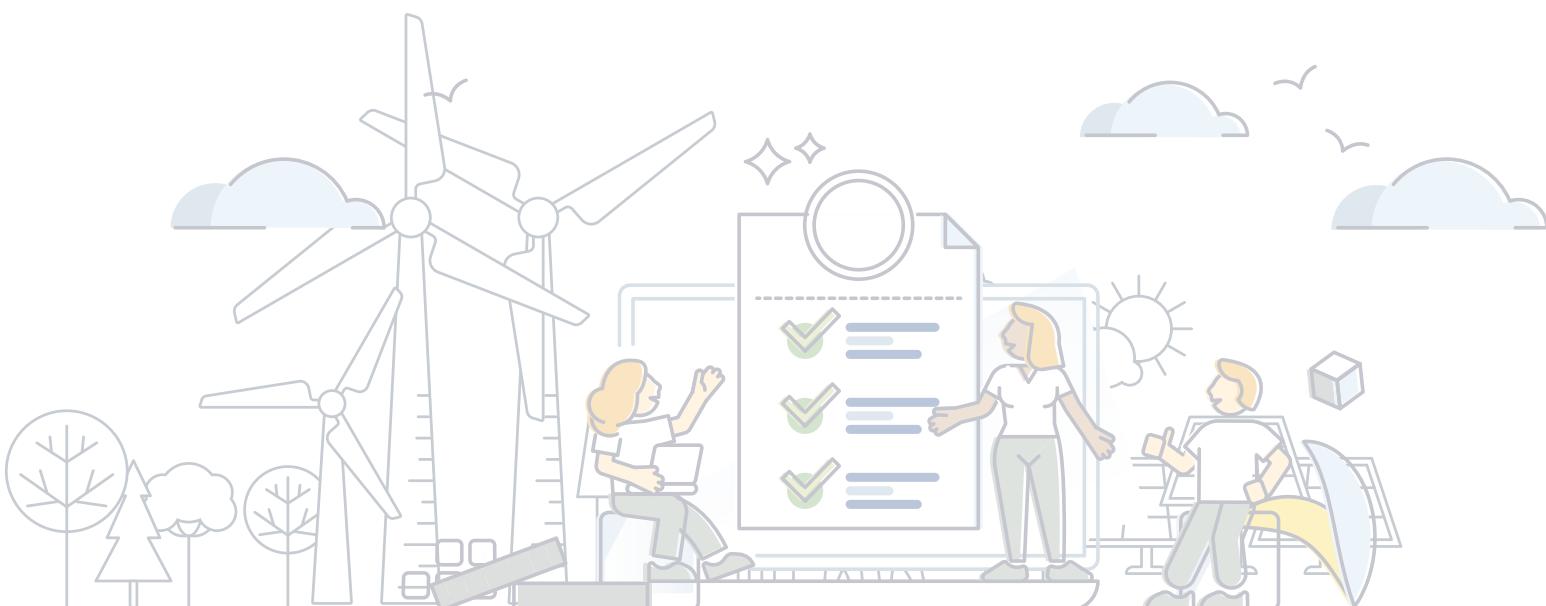


Investment Landscape Report 2021

Supported by

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Foreword

Early-stage Climate-tech Startups in India: Investment landscape 2021 is an endeavour by the Impact Investors Council, Climate Collective and Areté Advisors to spotlight the activity in the Indian climate tech ecosystem over the last five years. The report serves three key objectives – first, to deconstruct and adequately socialize the landscape of less understood solutions and innovative business models that characterize the current wave of climate-tech activity in the country. Second, to pave the way towards a unified taxonomy for the ecosystem that can help leap-frog the space in response to the growing climate crisis. Finally, to provide a coherent narrative and framework that can help climate-related start-up investments become mainstream.

Climate change is now a clear and present danger; a problem so severe and immediate that a Business-As-Usual approach is no longer an option. Climate action—a deep and sustained decarbonisation of every aspect of our lives—is clearly a global priority now. Governments, Nations, Cities, Capital Allocators, Policy Think tanks and major Global Companies have all made commitments to a transition to net-zero. For achieving this goal, though, innovative and transformative low-carbon technologies, supported by conducive policies and abundant capital are the key. The discourse on climate finance in India has hitherto, centred around utility-scale renewable project financing, with well-established business models and institutional mechanisms. On the other hand, innovation-focused early-stage start-ups with the potential for significant climate impact, albeit carrying associated technology risk haven't received similar attention. While there is perhaps a quiet revolution underway in climate-tech in India, the sector lacks a coherent narrative and a distinct identity, within the wider impact space.

This report—an effort towards addressing this anomaly—puts the spotlight on the innovations in the climate-tech space. We hope to help climate-related start-up investments transition from a niche narrow asset class to a more mainstream element of the VC and Impact Investing ecosystem in the country. The study helps chronicle the investment flow into climate-tech enterprises in India and also delves into the story behind the numbers.

Which climate-tech sub-sectors are seeing an upsurge in innovative solutions and attracting investments?

Who have been the capital providers to climate-tech so far?

Is there enough capital for the early-stage innovators?

What are the enablers and barriers to climate-tech investing?

These are some of the questions that this paper attempts to answer, through an in-depth ground-up study of early-stage equity deals in climate-tech between 2016 and 2020, and a combination of interviews and surveys with key stakeholders including investors, entrepreneurs and incubators/accelerators.

We are grateful for all the support from all survey participants and industry practitioners who helped build this report.

We hope you find this report useful. Your feedback and comments will be most appreciated.

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Areté Advisors LLP

Introduction

01



India is acutely vulnerable to the climate crisis and ranked

#7



on the Global Climate Risk Index 2021.¹

A rise in average global temperatures is leading to disruptive changes in temperature and pressure patterns. These in turn are leading to more frequent and extreme weather conditions like floods, droughts, etc. Year 2020 was among 3² of the warmest years on record with more than 200 natural disasters in the first 6 months alone.³ There are multiple factors that make India particularly vulnerable.



FIRST

India has a long coastline which makes her prone to coastal floods. Between 1990 and 2016, India lost about 235 sq. km. of land due to coastal erosion.⁴



SECOND

India has a high dependency on the monsoon. Nearly 55% of India's arable land is dependent on rain-fed agriculture and agriculture-linked production amounts to 18% of India's GDP—as a result, any adverse changes in the monsoon levels could have a significant impact on the economy.⁵

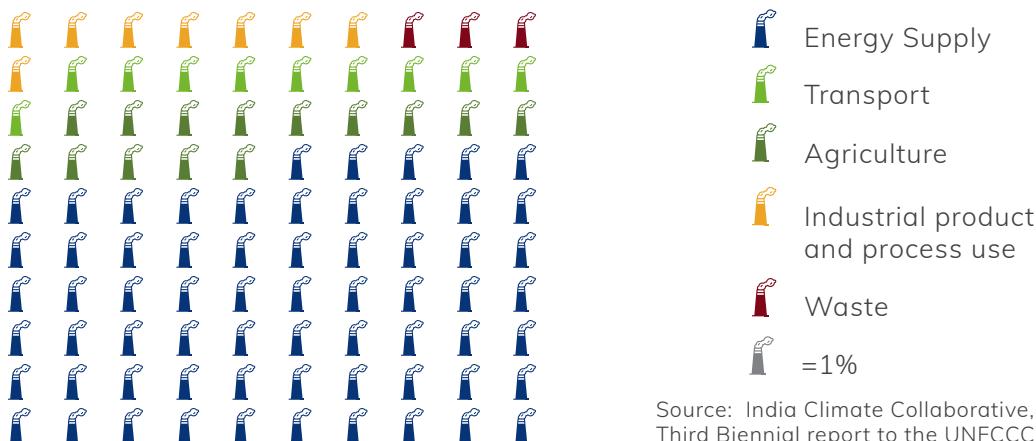


THIRD

India's low per capita income of about USD1,900—even below the lower middle income country average (USD2,200)—implies limited social safety nets, which limits the country's ability to mitigate the impacts of the climate crisis.^{6,7,8}

These harmful impacts of climate change have been evidenced in the last few years. India has witnessed an increase in severe climate change induced natural disasters—including cyclones like Tauktae, Amphan, Yaas and Nisarga. In 2019 alone, the floods and cyclones in India caused an economic loss of about USD 18 billion.⁹

Exhibit 1: Sector-wise emissions for India



Even as it is vulnerable to climate change, India is also the third largest emitter of GHG in the world contributing to over 7% of global emissions.¹⁰

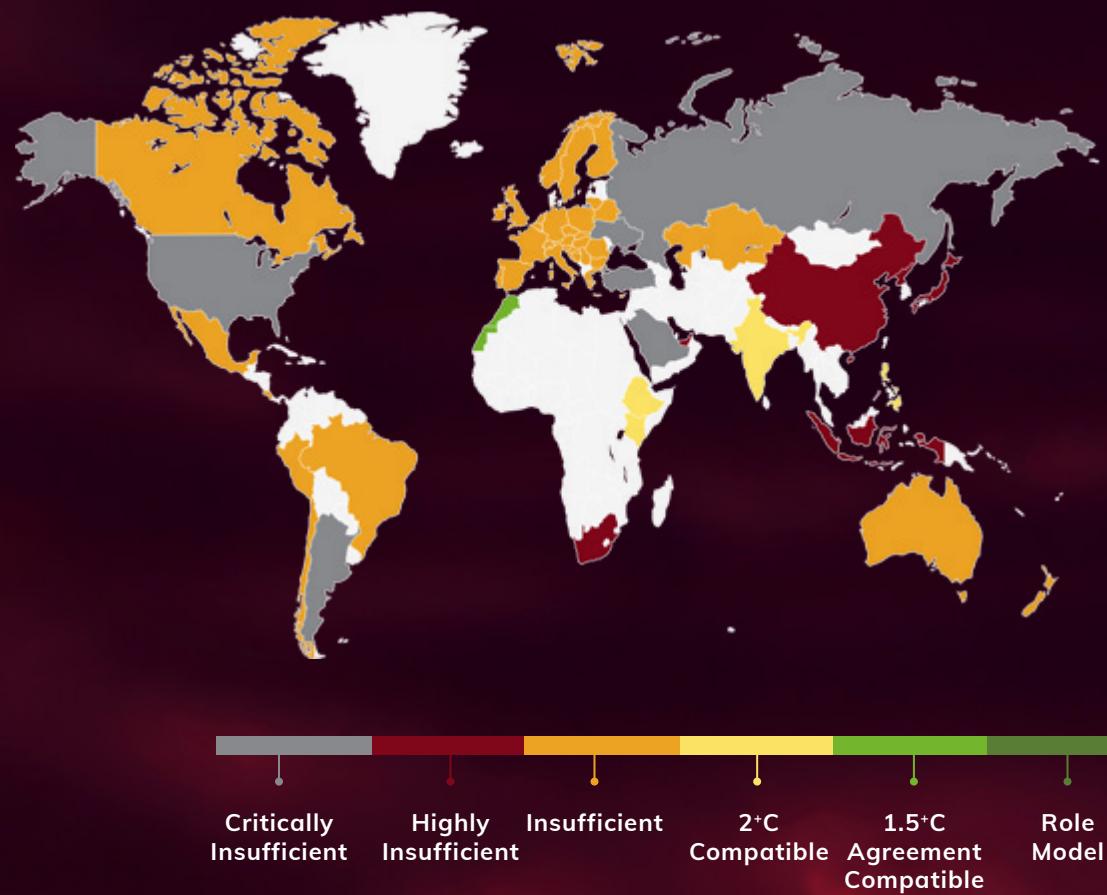
India's share of global emissions has increased from 3% in 2000 to 7% in 2020.¹¹ Going forward, as the country continues to urbanize and become more affluent, India's share in global emissions is likely to increase further. Four major sectors (energy, transport, agriculture, and waste) contribute to ~90% of India's emissions.

In response to the increasingly alarming situation, the Government of India (GoI) has made a series of ambitious climate action commitments.

Several initiatives have been activated from 2008 onwards under the National Action Plan for Climate Change (NAPCC), which aimed to help India fulfil its development objectives while reducing the emission intensity of its economy. This included the formation of eight missions under the NAPCC¹², setting up the International Solar Alliance, the establishment of the National Clean Energy and Environment Fund, etc. The Paris Agreement brought 196 nations to a common cause through the submission of their Nationally Determined Contributions (NDCs), essentially the countries' domestic action plans to curb climate change (which were to be updated by 2020).¹³

The common motive was to limit emissions so that global warming is limited to below 2 degrees celsius, and India was one of the largest countries to make commitments that were largely 2 degrees celsius compatible (See **Exhibit 2**). It sought to do this through long-term infrastructure and technology changes. A lot of Government work has been focused on emission reductions and a shift to renewables—and consequently the technology ecosystem in this space has thrived. This will be discussed in detail in **Chapter 5**. As pressure for climate action increases—we will see increasing Government action focused on other sectors like waste, nature and environment, water, habitats, which will provide an impetus to the ecosystems for these sectors.

Exhibit 2: India's objectives under the Paris Agreement and NAPCC



India's commitments in Paris:

1. To reduce the greenhouse gas emission by 33%-35% of its GDP by 2030 compared to 2005 levels
2. To increase the share of non-fossil fuel source linked electricity to 40% by 2030
3. To increase the forest cover to create carbon sinks equivalent of 2.5 to 3Bn tonnes of carbon dioxide

Source: <https://climateactiontracker.org/countries/>

Exhibit 3: The Indian government's commitments to climate change

| | National Mission | Objective | Achievements |
|---|--|--|---|
|  | National Solar Mission | Establish India as an international front runner in solar energy | 91 GW of energy commissioned of 100 GW planned by 2022 |
|  | National Mission for Sustainable Agriculture | Promote sustainability and resilience of agriculture, protecting food supply | 33,000 Ha bought for rice intensification 52,000 Ha of trees planted. |
|  | National Water Mission | Conservation, preservation, and equitable sharing of water resources | Financial support of state specific plans (SSPs) Nodal agencies monitor SSPs |
|  | National Mission for Green India | Establish and oversee sustainable ecosystems e.g. planting forests | Afforestation activity on 1.4 Lakh Ha of Land (5 Lakh Planned) |
|  | National Mission for Enhanced Energy | Regulating energy use in high-impact industries with certificate/credit system | PAT Cycle I ↓ 31 MtCO2 PAT Cycle II: ↓ 61.34 MtCO2 |
|  | National Mission for Enhanced Energy Efficiency | Promotion, and safeguarding of Himalayan ecosystem | Centres established in 11 Himalayan states Designed assessment tool |
|  | National Mission for Strategic Knowledge for Climate Change | Recognition of challenges and solutions around climate change, promoting targeted research | 14,000 trained under 116 programs 23 R&D programs across India |
|  | National Mission for Sustainable Habitat | Promote habitat sustainability and address climate change, focused on urban areas | 1,987 completed projects 4,375 projects underway |

Source: India, Third Biennial Report to the UNFCCC

Exhibit 4: India's performance on key SDGs is impacted by climate action

| Name of Initiative | Number of companies on board |
|--|------------------------------|
| RE 100 Transitioning to renewable energy | 04 |
|  SCIENCE BASED TARGETS <small>DRIVING AMBITIOUS CORPORATE CLIMATE ACTION</small> | 26 |
| Developed in line with the scale of reduction required to keep global warming below 2 degree | |
| EP 100 Energy-smart companies improving their energy productivity to lower their emissions and improve their competitiveness | 10+ |
| Internal Carbon Pricing | 14 |
| Factoring GHG emission into investment decisions and business operation | |

Source: Business Standard: A greener land? Carbon Pricing gaining favour in India(2019); the RE100.org (2021), EP100.org(2021), SBTi.org(2019)



Indian companies too have started to follow suit on climate action.

Large legacy multi-sector companies have ratified voluntary global commitments, specifically around emissions reduction. Most of these targets are only to be met over the next decade. As these companies start to mobilize on the ground we can expect the supply chains to be decarbonized. We are also seeing younger companies, e.g., new Unicorns and Soonicorns (Zomato) in logistics and e-Commerce make a bid to "go-green". The ripple effect from all this work will be visible in this next decade of action and boost India's climate ecosystem, including climate-tech startups.



India's stance on climate action has also positively impacted our performance on several key SDGs.

Exhibit 5: India's performance on key SDGs impacted by climate action

| | |
|---|--|
| 6  Clean Water and Sanitation | <ul style="list-style-type: none">Having treatment of waste water among other parameters <p>• India's overall score is 83/100 in 2020</p> <p>• Making India a front runner</p> |
| 7  Affordable And Clean Energy | <ul style="list-style-type: none">Having percentage of LPG/PNG connections against number of houses as a criteria <p>• India's overall score is 92/100 in 2020</p> <p>• Making India a front runner</p> |
| 11  Sustainable Cities and Communities | <ul style="list-style-type: none">Having criteria like percentage of houses having sewage and waste collection systems <p>• India's overall score is 79/100 in 2020</p> <p>• Making India a front runner</p> |
| 12  Responsible Consumption and Production | <ul style="list-style-type: none">Having criteria like plastic waste generated, per capita fuel consumption, etc. <p>• India's overall score is 74/100 in 2020</p> <p>• Making India a front runner</p> |
| 13  Climate Action | <ul style="list-style-type: none">Having matrices like CO2 saved from LED bulbs, disaster resilience score, etc. <p>• India's overall score is 54/100 in 2020</p> <p>• Making India a performer</p> |
| 14  Life Below Water | <ul style="list-style-type: none">Criteria include percentage increase in area under mangroves, mean shore zone coastal water quality – Biochemical Oxygen Demand and Total Nitrogen, etc. |
| 15  Life on Land | <ul style="list-style-type: none">Having forest and tree cover as a percentage of total geographical area among other parameters <p>• India's overall score is 66/100 in 2020</p> <p>• Making India a front runner</p> |

Source: Authors have referred to data from Niti Aayog's SDG Index¹⁴



Despite the momentum on climate action, there is still a gap between the existing and required infrastructure capacity if we are to meet the targets; this gap has been exacerbated by Covid-19.

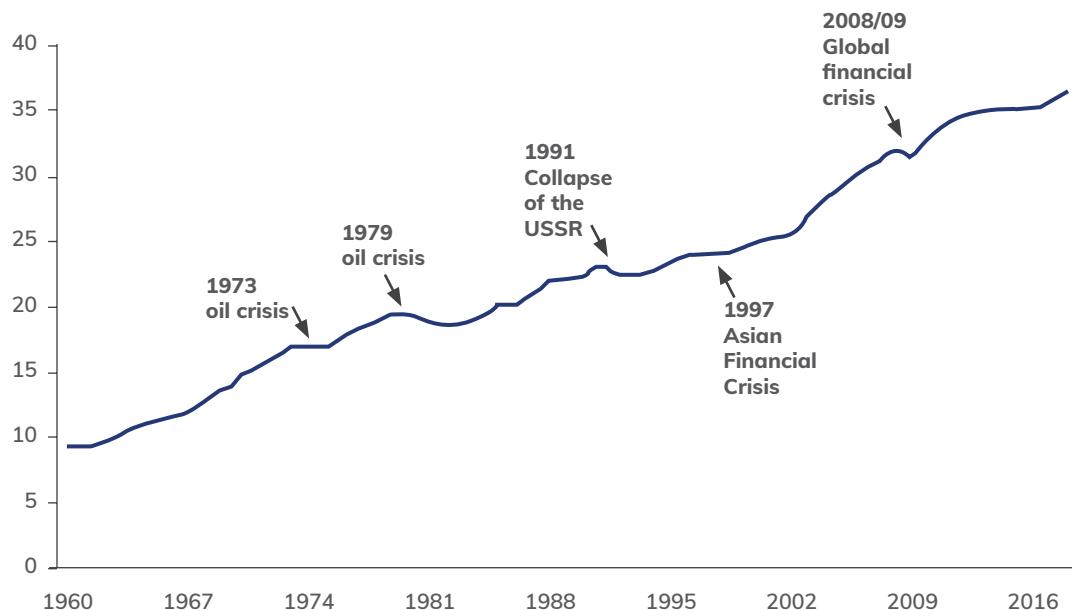
While India has performed well in the renewable energy segment, we are lagging on targets around carbon capture. As of 2021, India was able to achieve less than 3% of its plantation target under the Green India Mission.¹⁵ Estimates suggest that meeting our NDCs would require nearly USD2.5 trillion between 2015 and 2030.¹⁶ In the last two years, India has been stymied

due to the pandemic. Since March 2020, the Government expenditure on healthcare infrastructure has justifiably increased, which in turn has impacted our ability to spend on other equally essential needs such as climate action. There is a similar story for businesses, philanthropies, and non-profits who have re-directed their funding to pandemic relief and rehabilitation.

There is a very real fear that as companies and governments think of building back—it may be brown, not green.

While there has been a slight reduction in the emissions due to lower commercial and transportation activities over the past few quarters, this effect is transitory. In the past, the strong thrust on a rapid and robust recovery after large economic shocks have often led businesses and governments to choose emission-heavy recovery paths, rather than climate-proof ones (see **Exhibit 6**)—and this is something that we have to guard against.

Exhibit 6: Emissions after previous economic crises



Source: Data from OECD Policy Responses to Coronavirus (COVID-19) report on 'COVID-19 and the low-carbon transition: Impacts and possible policy responses'

Consequently, there is a need for new and innovative solutions that transform the way the stakeholders engage with the ecosystem and the natural world; startups provide one such clear pathway.

As India continues to build towards a USD 5 trillion economy in the next few years, there needs to be deep and sustained decarbonization of the economy beyond the energy sector—including the way we travel (transport), the way we grow food (food, agriculture, land use), the way we live

(sustainable retail and consumption), the way we work (built environment), and the way we manufacture (industrial processes and materials).¹⁷

In short, there needs to be behavioural changes in consumers, governments, businesses, and enterprises alike. In addition to incumbent stakeholders, startups will be the key in helping drive and scale these changes—not least because startups have proven to be great at piloting new pathways and further developing inventions to the point that they become

ubiquitous—by enhancing their availability, practicality, affordability, and reliability. For instance, Amazon first upended the way bookstores work, then brought out the Kindle that changed the way people read, and over the years has expanded its footprint in so many ways that now as a company it has become an important presence in many people's lives.

A similar story has played out in the electric vehicles space, by one of the more famous startups of our times—Tesla.

Startups provide just the tool-kit for this wide-scale impact. By enabling innovation around products, processes and business models they have the potential to disrupt the way we live our lives. An illustration of the impact of startups in the India context is showcased below (**Exhibit 7**).

Exhibit 7: A snapshot of the ecosystem impact of startups

| | Types of Innovation | Illustrative example of Indian Start-ups |
|---|---|---|
|  Product Innovation | Bringing new products or improving existing products to make them more user friendly, reliable and secure | Ola, Rapido, Yulu etc- providing convenient and reliable transport options to customers in a conventionally unstructured segment in India - Myntra providing one stop online fashion store; convenience and security through easy return and refund |
|  Process Innovation | Improving/enhancing the methods/process to reduce redundancy and time taken | Flipkart: Leveraging technology to create a new wave of how India shops online- convenience, reliability and security established in e-commerce space; Ninjacraft: Connecting farmers and customers directly; reducing inefficiency in the supply chain; cost saving from low food wastage |
|  Business Model Innovation | Finding a more efficient yet scalable way to run a business, via a revenue streams, optimizing cost structure or better managing risk | Swiggy and Zomato- Provided restaurants and home chefs with new channels for sales (i.e. access to people in their homes) while eliminating the cost of maintaining the delivery channels |

Source: Data from Ola Impact (2021) and Yourstory (2019)

Note: The categorizations in Exhibit 7 are not water-tight, simply one way to frame the innovation and impact of startups



Climate and clean tech startups will be vital in deploying low-carbon innovations with global impact, helping national economies achieve their climate goals—nowhere is this truer than in India

Governments, nations, cities, capital allocators and major global companies have all made commitments to a transition to net-zero—but these commitments are dependent, among other factors, on new and scalable technological and business model innovations.

Over the last few decades, we have witnessed startup ecosystems that have emerged the world over and have drastically reduced the cost of creating a business and enabled entrepreneurs to

rapidly experiment to develop a product that works and is deployable at scale—and this entirely revolutionary connected ecosystem is now finding root in the climatetech space as well. Climatetech startups, therefore, will be critical in discovering the low-carbon innovations that can scale rapidly, be contextually relevant and continuously evolve to meet changing consumer preferences.

Given this context, the report explores three distinct threads around the climate startup ecosystem in India:

01 We want to unpack, and adequately socialize this new landscape of less understood solutions and business models.

To preface our discussions, it is pertinent to note that the first phase of the clean technology revolution (Clean tech 1.0) was largely focused on large infrastructure, capital-intensive projects with a strong energy-sector focus.

Between 2006-2011 venture capital firms witnessed a new wave (a boom and a bust) where investors drove funding to clean energy technology. Nearly half the invested capital of USD25 billion was lost, given that the nature of venture capital funding didn't match the nature of these startups (capital-intensive R&D requirements, long time to market).

This will be covered in detail in **Chapters 7 and 8.**¹⁸

In the Indian context, in recent years a majority of the investment focus has been around asset-finance for large clean energy (primarily solar and wind) projects where business models and institutional & regulatory frameworks are relatively well established. Fortunately, this large asset base has led to a growing number of technology-led startups that are leveraging new innovations to service these assets. In addition, there are a large number of climatetech startups leveraging innovative business models to solve what are, at the root, difficult environmental and sustainability-related problems. Through this report, we want to ensure that the landscape of new startups is understood so it can be better supported and socialized across the broader ecosystem.

02 There is an urgent need for climate-related startup investments to transition from a niche asset class to a more mainstream component of the impact-investing ecosystem in the country.

India is already witnessing the transformative effect of the confluence of capital, technology, and entrepreneurship in socially relevant fields like Education, Financial Inclusion and Healthcare. For instance, impact investments in healthcare saw ~USD500 million in 2019 alone after

the entry of commercial investors.¹⁹ Given its size and complexity, the climate startup space needs a similar mainstreaming and this study is an effort in that direction. similar mainstreaming and this study is an effort in that direction.



Finally, at its current stage, the Indian climate startup ecosystem can benefit from a coherent narrative and a more 03 unified taxonomy.

The current ecosystem for climatetech startups in India lacks a coherent narrative and a distinct identity, notwithstanding the ability of these innovative solutions to create climate impact at scale. Building and refining this coherent narrative will help the space leap-frog forward.

The India Climate Investment Conclave is an endeavour by IIC, in collaboration with Climate Collective and Arete Advisors, to put a spotlight on the early-stage climate innovations in India and bring together different stakeholders in the ecosystem to create a more vibrant investment climate.

Through this report, we deconstruct the growing climatetech startup and investment landscape in India.

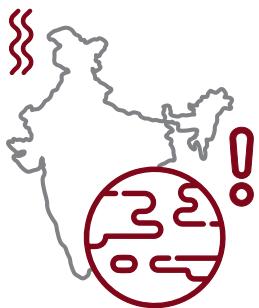
In **Chapter 3** we showcase our approach and methodology. In **Chapter 4** we provide a high-level overview of our findings from transactions in this space over the last five years. In **Chapter 5** we deepdive into sectors where climatetech startups are prominent. In **Chapter 6** we spotlight innovative startups. In **Chapters 7 and 8**, we share the challenges and aspirations of investors and entrepreneurs in this space.

Finally, we close **Chapter 9** with our recommendations on the way forward for the sustained growth of this space—one which will be vital over the next few decades.

Executive Summary

02





India is the **3rd largest** emitter of GHGs and also acutely vulnerable to the climate crisis.

India's share in global emissions has doubled over the last twenty years²⁰, and is only expected to rise, owing to increasing urbanization and growing affluence in the country. At the same time, India is acutely vulnerable to the climate crisis and ranked #7 on the Global Climate Risk Index 2021 due to its dependence on rainfed agriculture, a long coastline, and low social safety nets.

Studies indicate that India's per capita GDP is likely to shrink

6.4%
by 2100

if the rise in temperature continues at the current rate in the absence of large-scale adoption of mitigation and adaptation interventions.

Given the gravity of the climate crisis, there is a need for new and innovative solutions that transform the way that economic activity is undertaken and how consumers and businesses interact with the natural world—startups provide one such clear pathway.

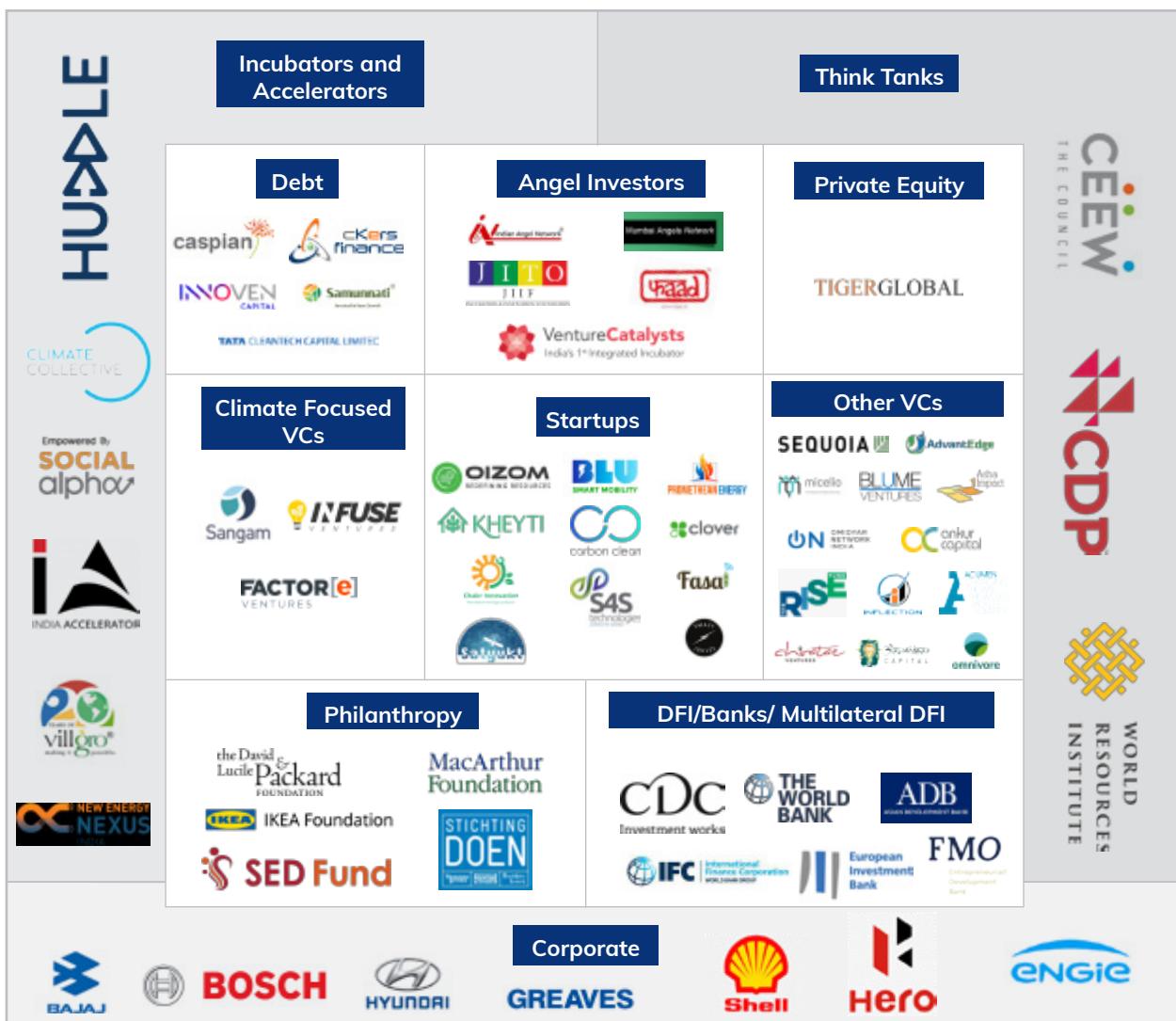
As the Indian economy continues to grow, there needs to be a deep and sustained decarbonization of the economy beyond the energy sector (a sector that has seen nascent but growing trends toward decarbonisation over the last decade)—including the way we travel (transport), the way we grow food (food, agriculture, land use), the way we live and consume (sustainable retail and consumption), the way we work (built environment), and the way we manufacture (industrial processes and materials). This requires behavioural changes in consumers, governments, businesses, and enterprises alike. In addition to actions by incumbents, startups will be key in driving and scaling these changes.

Climate-tech in India is on the cusp of disruptive growth, helped by a host of factors including a large asset base in clean energy developed over the last decade, and by a growing recognition of the need for climate action both globally and within India.

The climate-tech startup space in India, while nascent, is vibrant and has a variety of organizations, at different stages, working on solving for climate mitigation, adaptation and resilience. Climate-tech enterprises attract funding from multiple

sources including impact investors, angel investors, venture capital funds, private equity funds, and DFIs. The enabling ecosystem including incubators and accelerators, policy advocacy groups, and think tanks is also rapidly expanding.

Exhibit 8: The ecosystem of climate-tech in India



120
Climate-tech
start-ups
raised equity
capital of

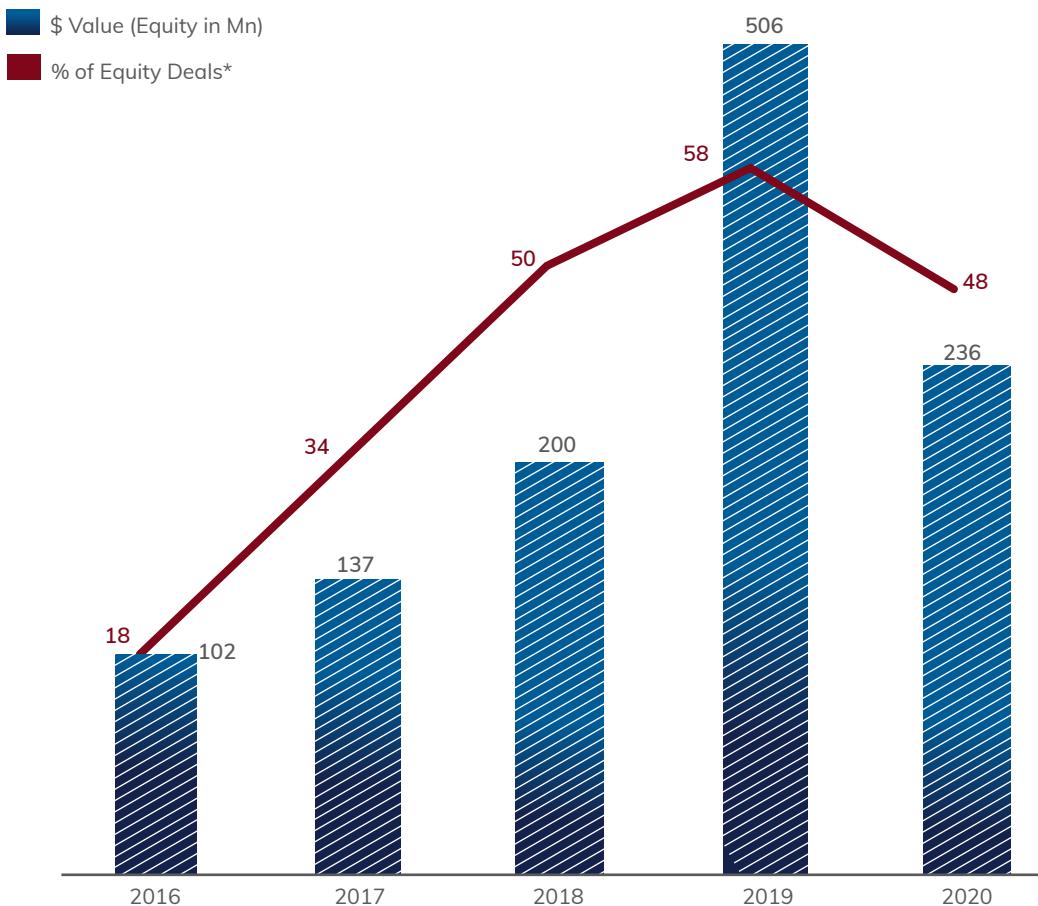
\$1.2 billion
from 2016 through 2020



Among the impact-oriented sectors, this infusion accounts for 16% by volume (number of deals) and 9% by value. While the climate-tech sector was on an upward trajectory till 2019, with both equity infusion and the volume of deals growing at a healthy CAGR of 70% and

48%, respectively, the climate-tech startup space—like many other sectors—faced a temporary slowdown in 2020.²¹ Two hundred and seventy-two unique investors have been a part of over 200 funding rounds in the last five years for early-stage climate-tech startups.

Exhibit 9: Investment in Climate-tech Ecosystem in India (2016-20)

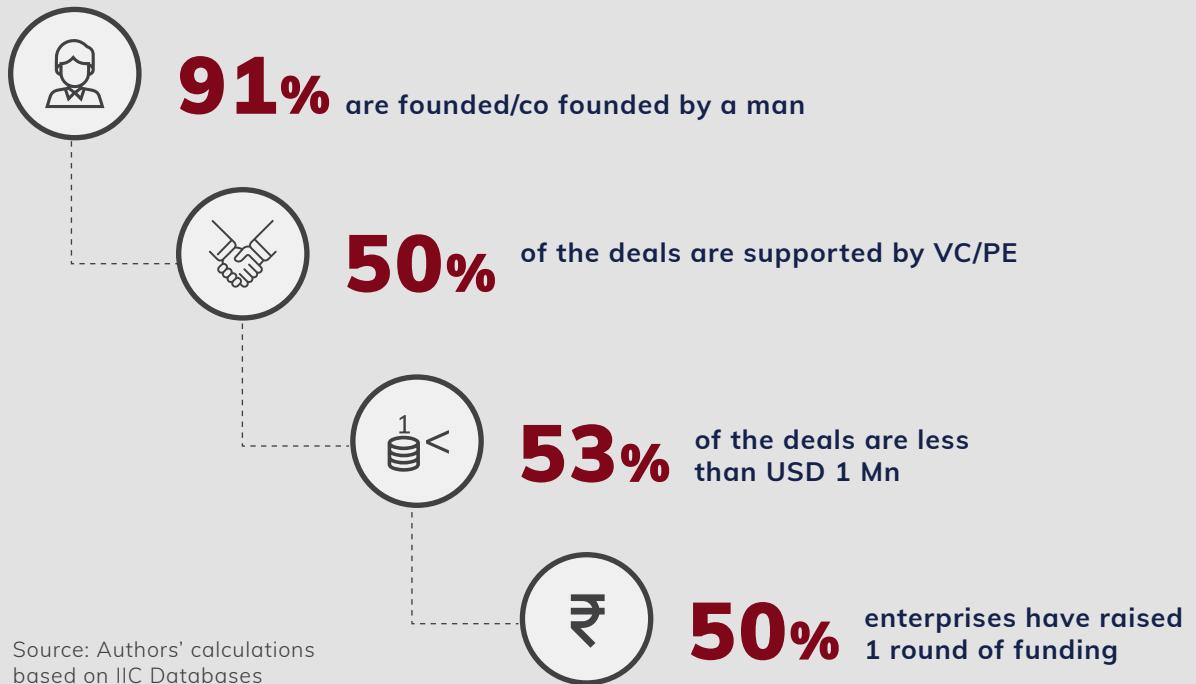


Source: Authors' calculations based on IIC Databases

Note: There is an outlier investment (Ola Electric) in 2019. Ola Electric raised about ~USD 300Mn

A typical enterprise in the climate-tech sector has received one round of funding and is founded by a man—a typical deal is for <USD1 million and is supported by VC/PE

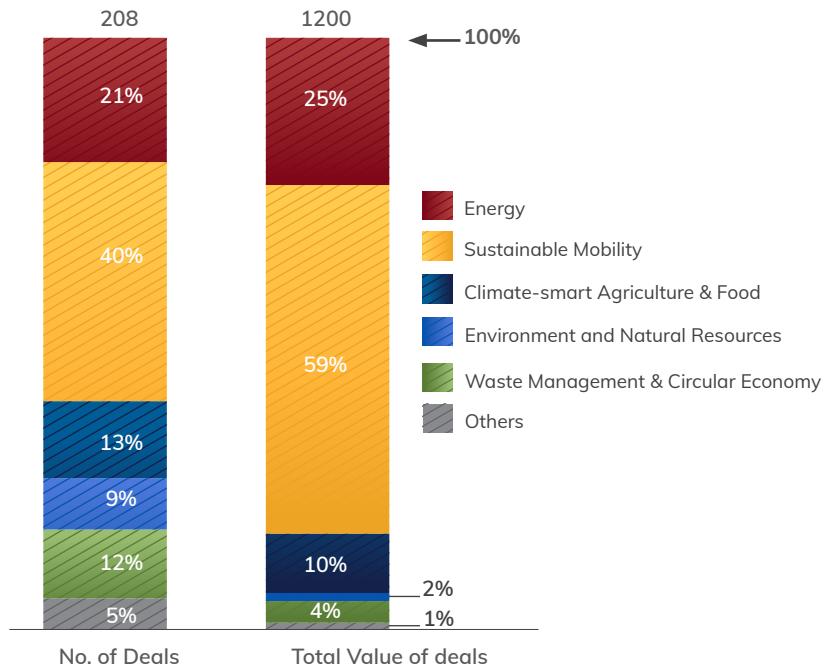
Exhibit 10: Median climate-tech enterprises and deals in India (2016-2020)



60% of the deal volume, and ~80% of the value of deals comprise of mitigation-oriented innovations in energy and transportation, in line with global trends

Exhibit 11: Investment Split by Value (USD'Mn) and Volume (# of Deals) across climate-tech sub-sectors

Source: Authors' calculations based on IIC Databases



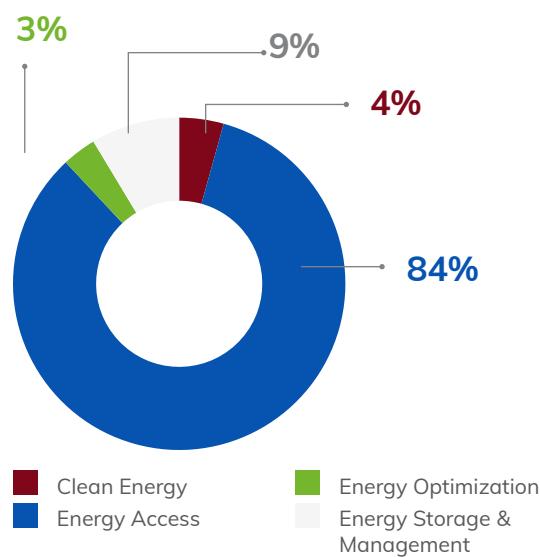
The prominence of energy and mobility startups globally is mirrored in the Indian climate-tech space as well. Over the last decade, these sectors have witnessed significant techno-commercial progress, a predominantly favourable policy environment, and seen the evolution of more standardized frameworks for impact measurement which have led to increased market adoption.²² Given their large share

of contributions to global GHGs (~70%+)²³, this has been a very positive development.

On the other hand, sectors like smart-agriculture, waste, environment and natural resources that need more localized/contextualised designing are still ramping up in the Indian context.

Across climate sectors we see investors driving attention to specific segments that are in line with the country's needs and aspirations

Energy



Illustrative enterprises across sub-sectors

zenatix
A Hero Electronix Venture

TESSOL
Innovate. Preserve. Grow

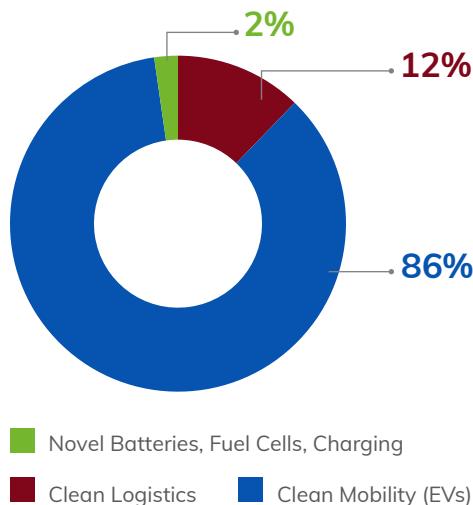
d.light

OORJA

Key investment theses:

Strong social impact lens is driving investor interest to energy access: Impact investors consider startups providing solar / biomass/ biogas powered solutions for energy access favourably. While not the focus for global commercial capital (more focused on clean energy, and energy optimization) - they attract investor attention in India given our development context. Note: For the purpose of this report, project and asset finance for the grid-connected renewable energy sector has been excluded, given its relative maturity

Sustainable Mobility



OLA ELECTRIC

BLU
SMART MOBILITY

LITHION

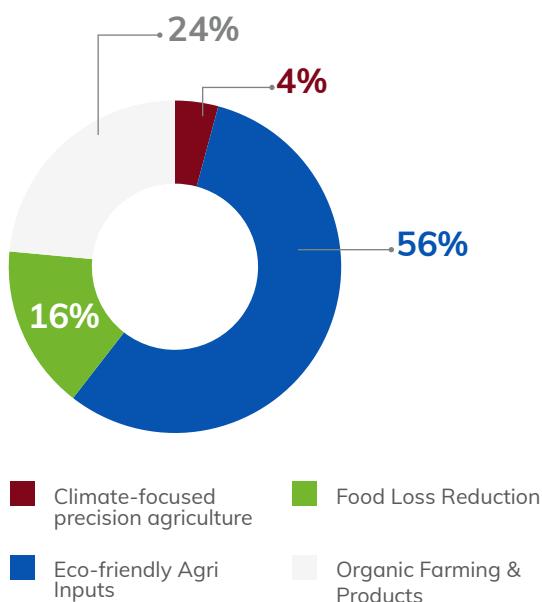
LOG 9 MATERIALS

ATHER

Key investment theses:

OEMs are keen to create a new E-Mobility brand – this has attracted investor interest: Despite the high infrastructure costs and barriers, “clean mobility” has attracted multiple enterprises eager to replicate the success of Tesla, and the homegrown Ola Electric. These investments cut across vehicle categories, e.g., e-bicycles, e-scooters, e-motorbikes, three-wheelers, passenger cars, cargo vehicle-platforms, etc. Various use cases have also been supported, such as passenger commute and commercial logistics/ goods delivery.

Climate-smart Agriculture & Food



Illustrative enterprises across sub-sectors

ecozén

Fasal

SEEDWORKS

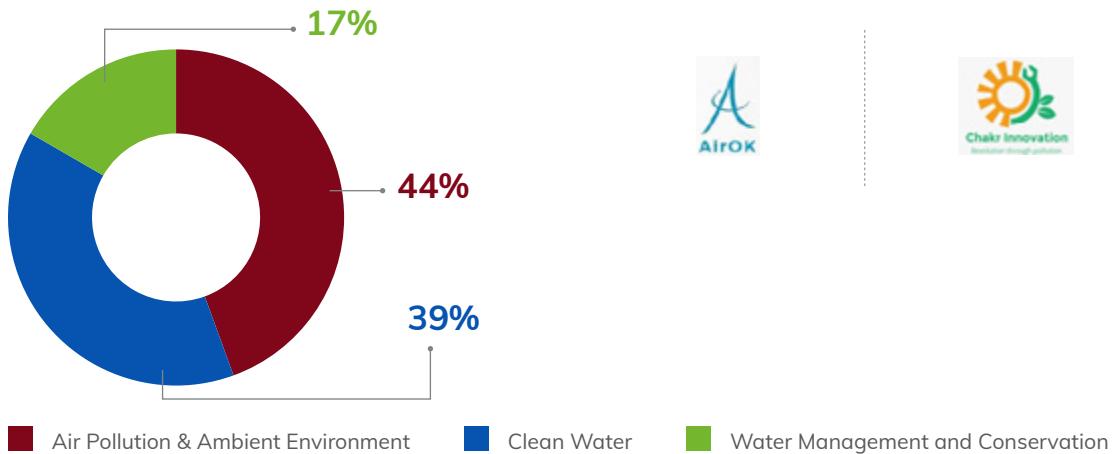
TELLURIS BIOTECH

wingreens farms

Key investment theses:

Eco-friendly agriculture inputs that directly impact farmer incomes have been a focus for investors in India: When investing in these innovations, the priority for investors has been to identify commercially viable production processes, and the potential for income-enhancement of farmers through improved yields and / or reduced food loss. Climate impact has been a secondary priority.

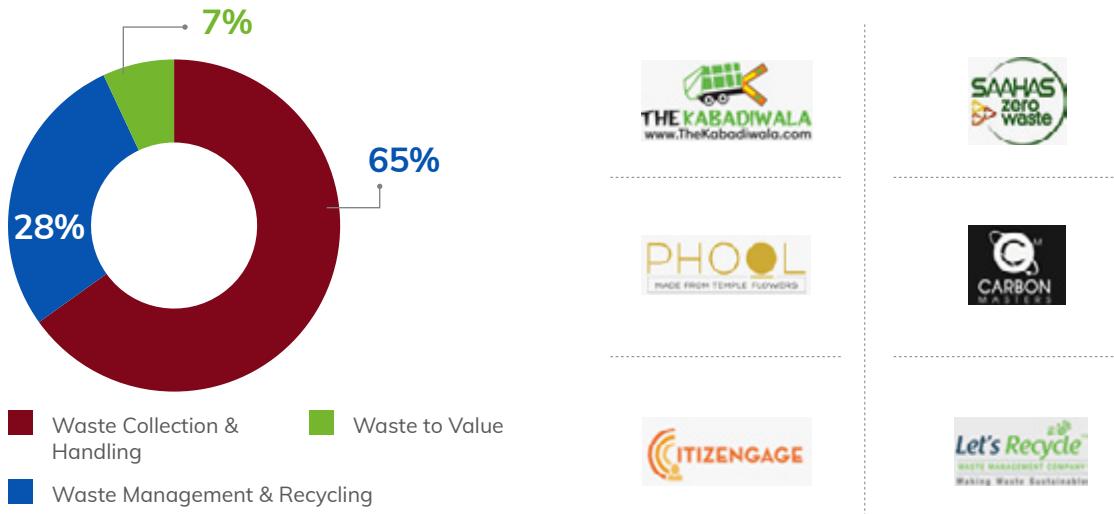
Environment & Natural Resources



Key investment theses:

Investors are prioritizing startups based on India's regulatory framework (air pollution) and development context (water): Examples of the types of innovations that investors have supported in air pollution include solutions to monitor and clean indoor air, air purification solutions, air pollution capture solutions and data harvesting and analytics solutions. Solving India's clean drinking water challenges, purification technologies for drinking water, and treatment of wastewater are the key themes that have found investor backing

Waste management and Circular Economy

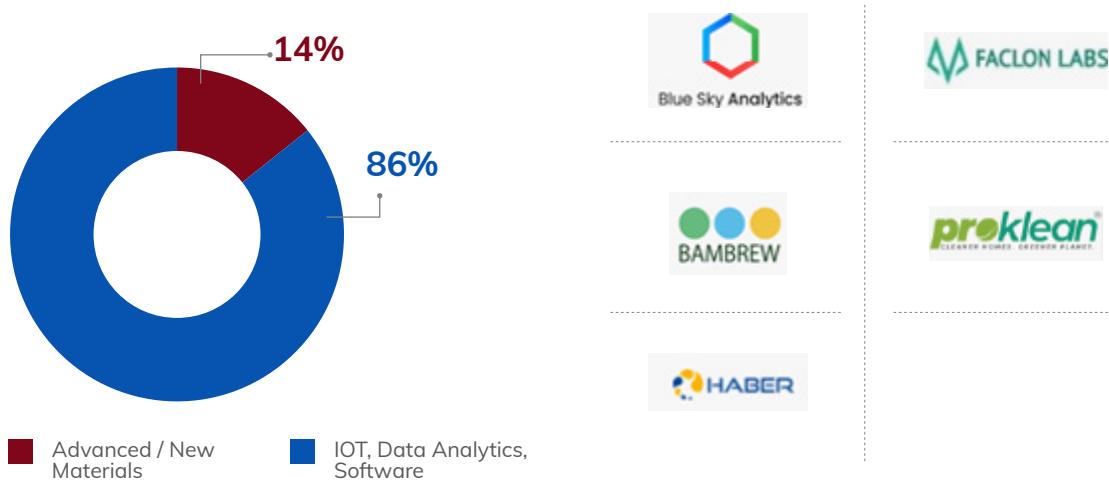


Key investment theses:

Given the extent of India's waste problem, the sector has attracted multiple startups. However, most are nascent and present in the collection and segregation segment, and there is limited focus on processing and recycling: Most startups in the space provide services for post-consumer waste collection and pick-up, built on soft-technology platforms that in some cases combine IoT, algorithms and analytics to measure, track and control waste from collection to recycling. Among these, there is a preference for innovations that focus on solving needs of large customers (B2B rather than B2C (issues in scaling), B2G (long sales cycles, cashflow risks etc)

Others

Illustrative enterprises across sub-sectors



Key investment theses:

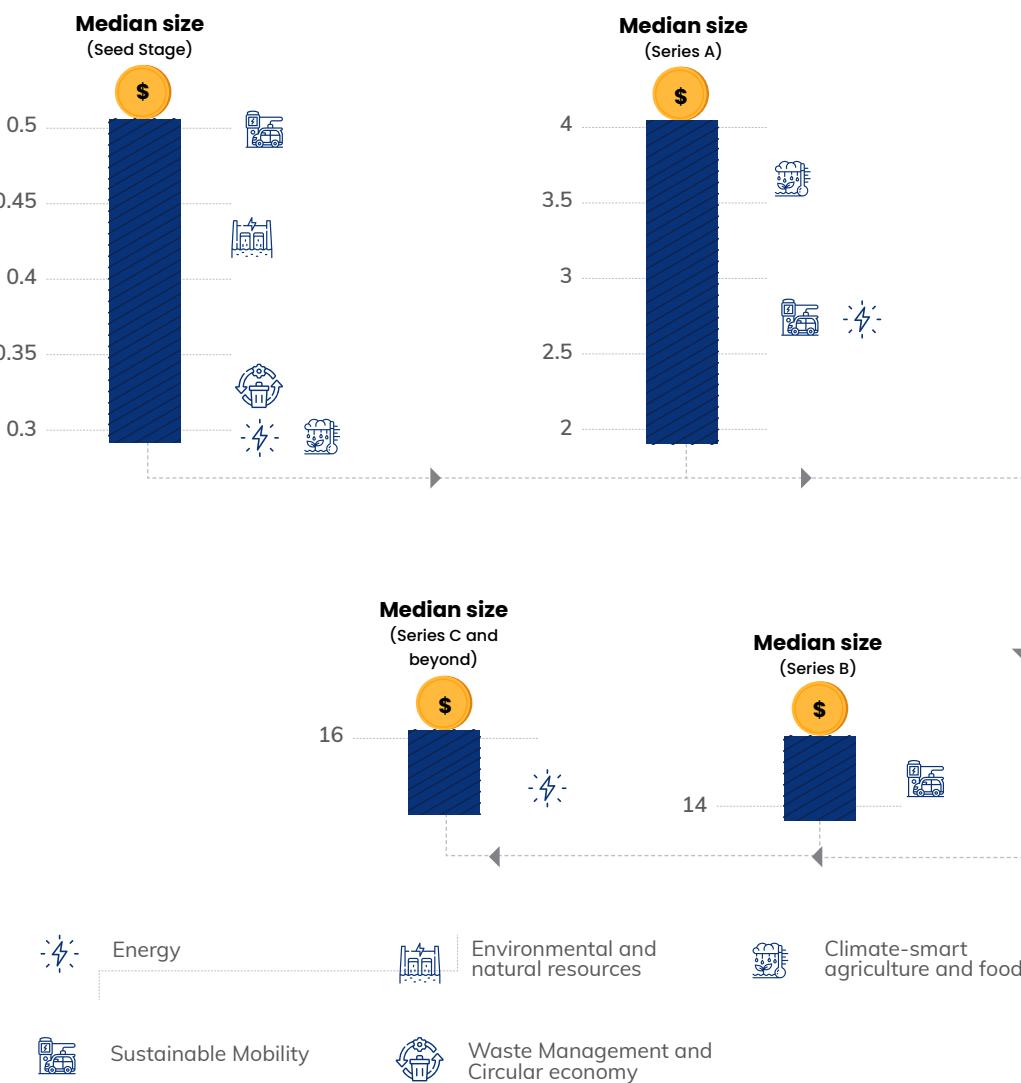
Investor interest is also being directed to cross-cutting sector solutions: Two broad themes emerge- the first rely on solutions integrating IoT, data analytics, software to achieve climate impact. The second focuses on the creation of advanced materials to improve the resource efficiency or performance of climate-tech solutions

The differences in median deal size across sectors shed light on the relative maturity of the sectors in India—here too energy and mobility are ahead of the curve:

Deals are similarly sized in the seed-stage, in the range of USD 300,000-500,000. At later stages several sectors thin out, while energy and sustainable mobility remain prominent. Sectors like waste management and circular economy, and environment and

natural resources are still in early growth stages and deals for these sectors are present largely in the seed stage.

Exhibit 12: Median deals across climate-tech sectors (2016-2020)



Source: Authors' calculations based on IIC Databases

The outlook across climate-tech sectors is strong and there are green shoots across several sub-sectors

Exhibit 13: Outlook for climate sub sectors



Energy

- Innovations that enable better monitoring and use of energy will find greater adoption
- More demand for energy load management technologies
- Adoption of energy efficiency solutions will continue
- Deep-tech innovative clean energy solutions (e.g. hydrogen) are bubbling but need strategic capital to be deployed



Mobility

- Strong investor momentum in energy storage and management for mobility applications
- Solutions for resolving infrastructure gaps hold potential
- Solutions that make EV adoption affordable and easy will continue to see traction



Climate smart agriculture and food

- Need to look at blended finance models as well as end-consumer financing solutions for sub-segments
- Green-shoots in deep-science material innovations, with startups developing alternative proteins like lab-grown, plant-based meats, proteins extracted from eco-friendly agri-crops



Environment and natural resources

- Customer demand for indoor clean air solutions will grow
- Indian cities face an acute water crisis, and therefore water-use management and conservation innovations will see growing demand
- Growth of startups working in carbon capture



Waste management and circular economy

- Investors are willing to back innovations that have a technology-enabled or deep-science play with proprietary in-house technologies
- Investors favour models that enable aggregation
- Asset light models to find space in this sub-sector



Others

- New sustainable and eco-friendly materials and products that replace ones that damage the environment or health will garner interest from investors
- Digital solutions cutting across various climate impact use-cases will have a clear growth story
- Increased interest among investors to look for Climate focused fintech solutions

Survey Findings

While the outlook for the sector is positive, certain challenges have emerged from the ecosystem that are blocking the mainstreaming of climate tech. Over the course of research we surveyed and interviewed with participation from about 33 investors and 32 entrepreneurs. Key messages from these are below:

1. Both entrepreneurs and investors brought out the need for more patient capital and a more accommodative risk return profile:

Nearly 90% of the entrepreneurs surveyed spoke about challenges pertaining to funding. Climate-tech entrepreneurs surveyed highlighted that a “lack of patient risk capital” was one of the key challenges that they were facing. Almost 45% of the entrepreneurs surveyed also shared that the challenges around funding were worsened by “stringent return expectations”. These challenges are reflected upstream as well. The general perception by GPs is that the risk-return profile of deep-tech climate startups is not well suited for venture capital, given that climate-tech solutions need deep R&D and long timelines for commercialisation - and this is compounded by the fact that there have been relatively few successful exits in this space.

2. The ecosystem expressed a clear need for a coherent impact narrative:

30% of the investors surveyed attribute the lack of a standard, harmonized taxonomy in the Indian context as a deterrent. While several disclosure frameworks exist, there aren't standardized norms or practices that can be adopted by small companies. This is also reflected on the investors side. Most investors felt that “Establishing a common taxonomy” (53%) and “capacity building workshops” (47%) were important to mainstreaming climate investments.

3. Entrepreneurs requested for support with technology stabilization and scaling:

61% of entrepreneurs surveyed have described a key challenge around “Technology stabilisation, operations, manufacturing at scale”. There are intrinsic challenges given the highly technical nature of innovation in the climate sector and given the absence of clear well-established pathways for scaling. Only 6% of accelerators/incubators are specifically geared towards climate action—and even these don't always provide support with deep tech solutioning. Similarly, company boards are more geared towards business and management advice than climate expertise.²⁴

4. The ecosystem drove home the need for policy nudges to mandate climate action:

Climate action is often a public good. Almost 56% of founders surveyed believe that a “regulatory nudge” for greater climate action will be a critical boost for the climate-tech ecosystem.

A better understanding of the current state of the climate-tech ecosystem and these challenges have driven specific recommendations on the way forward.

Exhibit 14: Outlook for climate sub sectors



Approach and methodology



This report is a ground-up study of equity investments, between 2016 and 2020, into Indian early-stage innovation-focused climate-tech startups.

The key terms that are crucial for understanding the methodology and approach used in this study are explained below, while other key definitions are captured subsequently in the appendix.



Key Terms

- 1. Climate-tech startups:** Refer to for-profit enterprises that use technology to create climate impact through mitigation and/or adaptation technologies, and related environmental challenges.
- 2. Early-stage:** Refers to startups that have raised early rounds of external equity, typically ranging from seed capital to Series B between 2016 and 2020.
- 3. Innovation:** These refer to technology-led solutions to climate-related problems that are at an early stage in their lifecycle. These innovations may include -
 - Product innovation:** Creating new products or disruptively better versions of existing products that can help significantly reduce adverse effects on climate in terms of emissions or assimilation of harmful substances and/or help better adapt and become resilient to adverse climate change effects
 - Process innovation:** Creating new, efficient and significantly better processes that improve productivity in manufacturing, product use or service delivery to help reduce resource use and wastage.
 - Business Model innovation:** Finding a more efficient yet scalable way to run a business, via new revenue streams, optimizing cost structures or better managing risk.



The Approach and Methodology

For the purpose of this study, we collected data from deal-flow analyses, interviews, quantitative surveys, and desktop research.

1. Quantitative Data Analysis

- The analysis on investment flows presented in this report is based on a database of 122 climate-tech enterprises that received equity funding between Jan 1, 2016 and December 31, 2020 in India (i.e enterprises either incorporated or headquartered in the country).
- This database was compiled at the 'enterprise' level (irrespective of the type of investor, impact or commercial fund).
- The quantitative data was used to draw insights on the overall investment trends in the climate-tech space and across its sub-segments.

A. Inclusion Criteria

The following was applied by the team at IIC and CC teams to select the enterprises -

- For-profit enterprises which leverage the power of technology to conserve and effectively manage waste, water, food or other elements causing environmental challenges.
- For-profit enterprises which focus on reducing GHG emissions through their process and/or product innovations.
- For-profit enterprises with a sustainability lens, i.e, positive environmental impact stated as one of their core objectives and/or measured by the firm or the investor.

All enterprises had to meet at least one of the above conditions to be included in the database.



B. Exclusion Criteria

The following exclusion criteria were applied for the data analysis presented in this report:

- This report excludes large-scale energy-infrastructure enterprises (such as utility-scale renewable energy, rooftop solar business) and other already well-funded organizations. While the climate impact of these organizations is beyond question, these business models are well-established and stable, and thus more suited for commercial pools of capital such as private equity or project debt, rather than early-stage venture capital.
- The report does not assess other climate-related organizations (civil society institutions, grass-roots organizations, policy groups) unless they are within the ambit of the for-profit startup ecosystem
- The report excludes startups that are not early stage and are not “innovative” (definition included below)
- The report at present does not focus on some of the areas under the broader lens of “green finance” - which includes large projects under afforestation, grasslands, croplands etc.
- The report excludes deals where the amount of funds raised was undisclosed.
- Finally, the study is limited to startups in India.

2. Qualitative Analysis

The report covers the motivation and challenges in the climate startup ecosystem from two broad lenses: the investors and the entrepreneurs.

- **Investors:** We reached out to a wide spectrum of investors (including impact investors, commercial VCs, Foundations, DFIs, and angel investors) to understand from them (i) their future outlook on the Indian climate space as a whole (ii) their perspectives on the opportunities and challenges around investing in early-stage climate-tech startups in India; (iii) specific sub-segments, and business models that they focus on supporting within the climate space (iv) attractiveness of the Indian climate-investing space in terms of returns, impact potential, scalability.
- **Entrepreneurs:** We reached out to the founders of startups that have received early-stage funding to understand from them (i) their intrinsic motivations for building a startup working to address climate change; (ii) their perspectives on the opportunities and challenges for entrepreneurs in the climate-tech sector; (iii) specific barriers around raising capital at the early and/or growth stage and (iv) challenges in growing a climate business in India for entrepreneurs.

Methodology:

- We conducted a series of semi-structured interviews and surveys, with participation from about 33 investors and 32 entrepreneurs.
- The interviews included 45 minutes to hour-long discussions led by IIC, Arete Advisors, and Climate Collective.
- The analyzed results from surveys were used to support the qualitative research findings from interviews. We have consciously not considered categorisation of the climate-tech ecosystem insights by fund size, intent (impact vs market return), investment type (equity vs debt), or investment stage and/or sector due to a relatively smaller population set.

Details on experts interviewed and surveyed can be found in the **Appendix 2**.

3. Desktop Research: Reports referred to for the study have been included in the references.





Classifying climate tech startups

The climate space is cross-cutting, varied and encompasses many different themes. It can be classified into different sub-sectors from multiple viewpoints.

- One approach is to classify climate-tech startups based on the sector they operate in, such as energy, agriculture and land use, built environment, mobility and transport, heavy industry, GHG capture and storage, or climate and earth data capture.
- Alternatively, climate-tech innovations are also often classified through the lens of mitigation, adaptation and resilience, depending on the type of outcome they primarily expect to have.



Consequently, for the purposes of this study and deriving from the practices as mentioned above, we have chosen to follow a classification for India-focused climate-tech startups that fit well with stakeholder needs, prevalent markets, as well as global climate goals and GHG emission reduction imperatives that are increasingly becoming a core focus among all stakeholders.

Six Climate Sub-Sectors

- 1 Energy
- 2 Sustainable mobility
- 3 Climate smart agriculture & food
- 4 Waste management & circular economy
- 5 Environment and natural resources
- 6 Others

**DEAL FLOWS,
INVESTMENTS, AND
STARTUPS HAVE BEEN
CATEGORIZED ACROSS
THESE MAJOR THEMES
TO DRIVE INSIGHTS ON
UNDERLYING TRENDS AND
NUANCES THAT DRIVE
OVERARCHING AGGREGATE
INSIGHTS. DETAILS AROUND
THE TAXONOMY AND
INCLUSIONS CONSIDERED
UNDER EACH ARE
SHOWCASED IN EXHIBIT 15
BELOW:**

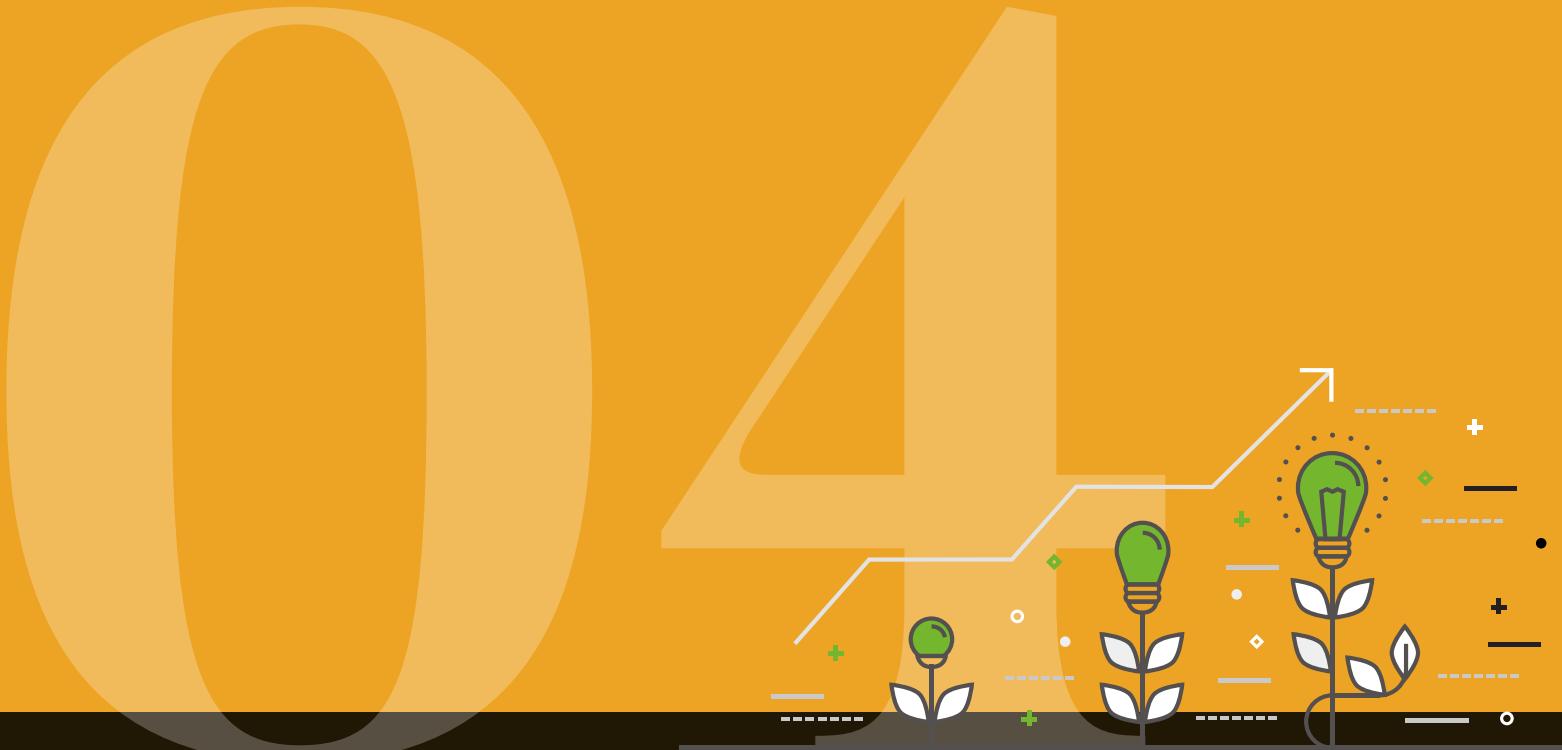


Exhibit 15: Details around taxonomy & inclusions for each key theme

| | Impact Imperatives | Key components/sub-sectors explored |
|--|---|---|
| Energy  | <ul style="list-style-type: none"> • Clean energy generation and use to lower emissions • Lowered emissions through improved energy storage, management, re-use, recycle for various end use applications. • Energy Efficiency and/ or optimized energy use across sectors for energy use/loss reduction. • Increased energy access for off grid, rural use towards improved productivity, incomes, livelihoods, health impact. | <ul style="list-style-type: none"> • Energy Access • Energy Optimization • Clean Energy • Energy Storage & Management |
| Sustainable mobility  | <ul style="list-style-type: none"> • Low carbon mobility solutions for people and goods • Improved supply chains, energy storage and management, components for sustainable mobility/ clean vehicles. • Lowering adoption barriers for sustainable transport | <ul style="list-style-type: none"> • Clean Mobility (EVs) • Clean Heavy Transport – Marine/ Aviation/ Trucking • Novel Batteries, Fuel Cells, Charging, Components • Clean Logistics, Fleets, Connected Vehicles. |

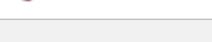
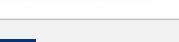
| | Impact Imperatives | Key components/sub-sectors explored |
|---|---|---|
| Climate-Smart agriculture and food | <ul style="list-style-type: none"> • Restore the ecosystem, soil or environment for sustainable agriculture & food – through practices, processes, inputs • Minimize food loss • Reduce resource or inputs use and increase yields • Develop and produce alternate / sustainable food products | <ul style="list-style-type: none"> • Organic Farming & Products • Eco-Friendly Agri Inputs • Food Loss Reduction • Alternative Proteins • Climate-Focused Precision Agriculture |
| Environment and natural resources | <ul style="list-style-type: none"> • Control or reduce pollution in air and ambient environment • Reduce water use and wastage • Improve access to clean water • Capture Green House Gases, store and/ or convert to value-added products • Monitor and reduce forest-cover loss and promote climate-friendly land-use | <ul style="list-style-type: none"> • Clean Water • Air Pollution & Ambient Environment • Forestry & Climate Friendly Land-Use • Carbon Capture, Utilization or Storage • Water Management and Conservation |
| Waste management and the circular economy | <ul style="list-style-type: none"> • Divert waste from landfills, oceans and environment towards value-added products • Develop new/ advanced materials that are biodegradable/ circular in nature | <ul style="list-style-type: none"> • Waste Collection & Handling • Waste to Value • Waste Management & Recycling |
| Others | <ul style="list-style-type: none"> • Other types of materials, products, services and solutions that help mitigate emissions and/or adapt to climate change effects cutting across sectors and/ or end-use applications | <ul style="list-style-type: none"> • Advanced/ New Materials • IOT, Data Analytics, Software • Climate Fintech |

Overview of early-stage venture-backed climate-tech investments in india



The climate-tech startup ecosystem in India, though nascent, is vibrant and has a variety of organizations, at different stages, working on solutions for climate resilience, mitigation, and adaptation. The eco-system attracts funding from multiple sources, including but not limited to impact investors, angel investors, venture capital funds, private equity funds, debt financing, etc. The sector is also rapidly expanding its enabling ecosystem, including corporates (R&D), incubators and accelerators, policy advocacy groups, and thinktanks.

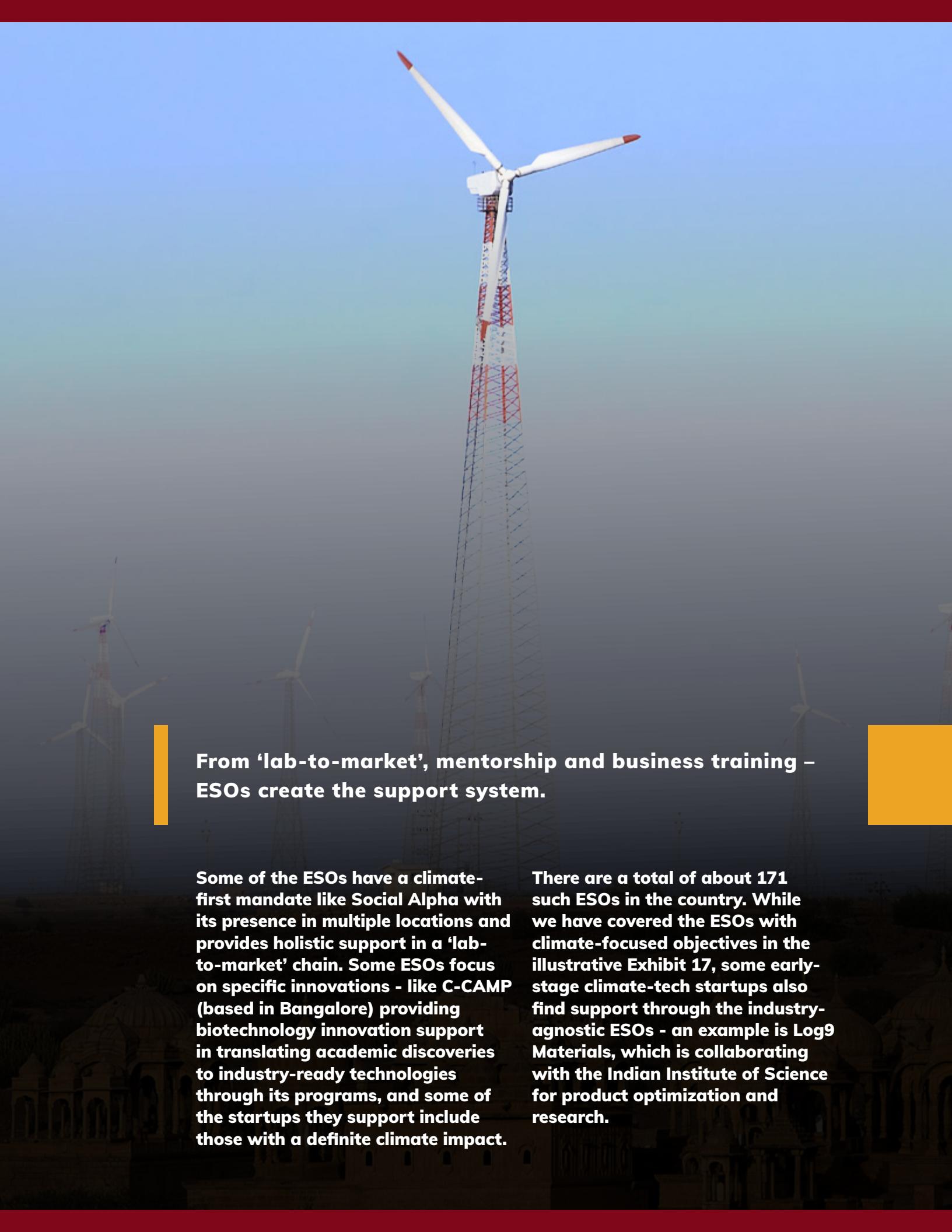
Exhibit 16: Indicative ecosystem

| Incubators and Accelerators | Think Tanks | | |
|--|--|--|---|
| | Debt | Angel Investors | Private Equity |
| HUABLE  CLIMATE COLLECTIVE Empowered by SOCIAL alpha     | <p>Debt</p> <p>    <small>TATA CLEANTECH CAPITAL LIMITED</small></p> | <p>Angel Investors</p> <p>     <small>India's 1st Integrated Incubator</small></p> | <p>Private Equity</p> <p></p> |
| Climate Focused VCs    | <p>Startups</p> <p>      </p> | <p>Other VCs</p> <p>           </p> | |
| Philanthropy    | <p>MacArthur Foundation </p> | <p>DFI/Banks/ Multilateral DFI</p> <p>      </p> | |
|    | <p>Corporate</p> <p>   </p> | | |

Climate-tech Startup Ecosystem in India

Entrepreneur Support Organisations (ESOs) are the keys to India's innovation hubs.

It takes a village to raise a child. There are a few cities that emerge as hubs of innovation for climate-tech startups with both - a high concentration of deals and the presence of Entrepreneur Support Organizations (ESO). These organizations include technology laboratories, incubators and accelerators, centres of excellence, research laboratories, and technology parks. The ESOs provide vital support to the startups in the pilot testing phase, scaling up, etc. through mentorship programmes, technological facilities, and sometimes even partnerships to help them across different stages of the lifecycle of the startups.

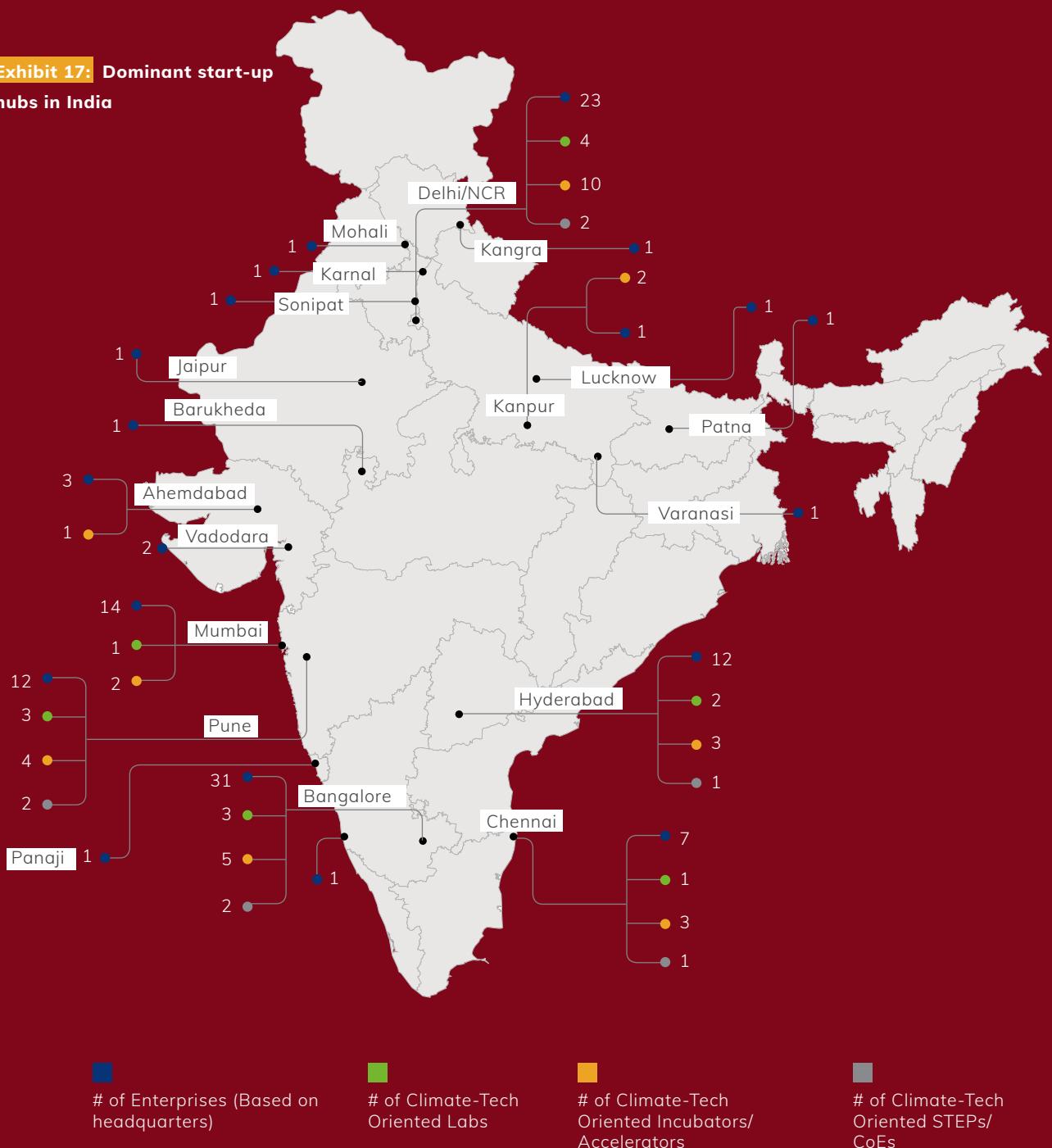


From 'lab-to-market', mentorship and business training – ESOs create the support system.

Some of the ESOs have a climate-first mandate like Social Alpha with its presence in multiple locations and provides holistic support in a 'lab-to-market' chain. Some ESOs focus on specific innovations - like C-CAMP (based in Bangalore) providing biotechnology innovation support in translating academic discoveries to industry-ready technologies through its programs, and some of the startups they support include those with a definite climate impact.

There are a total of about 171 such ESOs in the country. While we have covered the ESOs with climate-focused objectives in the illustrative Exhibit 17, some early-stage climate-tech startups also find support through the industry-agnostic ESOs - an example is Log9 Materials, which is collaborating with the Indian Institute of Science for product optimization and research.

Exhibit 17: Dominant start-up hubs in India





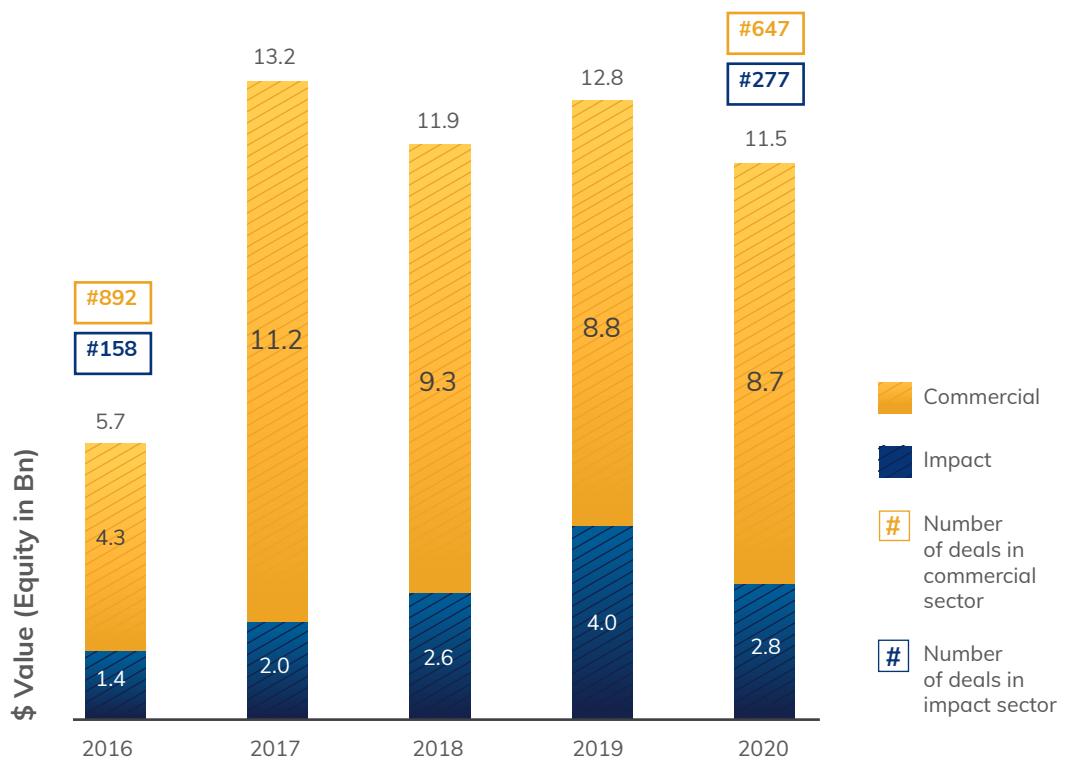
I. Overall Growth & Market Size-

India's early-stage startups have witnessed a capital inflow of nearly USD55 billion over the last five years; impact investments account for ~23% of the same.²⁵

In the last five years, India has witnessed significant capital inflow into the startup ecosystem. The average ticket size of these investments has grown from USD5.4 million in 2016 to USD12.4 million in 2020. Almost one-fourth (about USD12.8 billion) of this flow has been in impact-oriented sectors like financial inclusion, education, agriculture, healthcare, technology for

development, climate-tech, etc. The average ticket size in the impact space has seen a moderate increase from USD9.2 million in 2016 to ~USD10 million in 2020. The number of early-stage impact startups raising funds has gone up by 61%, showing traction in the impact sector.

Exhibit 18: Equity infusion in start-ups in India between 2016 to 2020 (in \$Mn) and the number of deals



- Due to the private nature of deals and the limitation around extracting only equity infusion in the overall start-ups' space in India, we have used Inc42 as a source for the overall investment numbers and reduced the impact-related numbers to arrive at the commercial investment numbers (value and volume).
- Refer to Appendix 1 for the methodology and data source of impact numbers



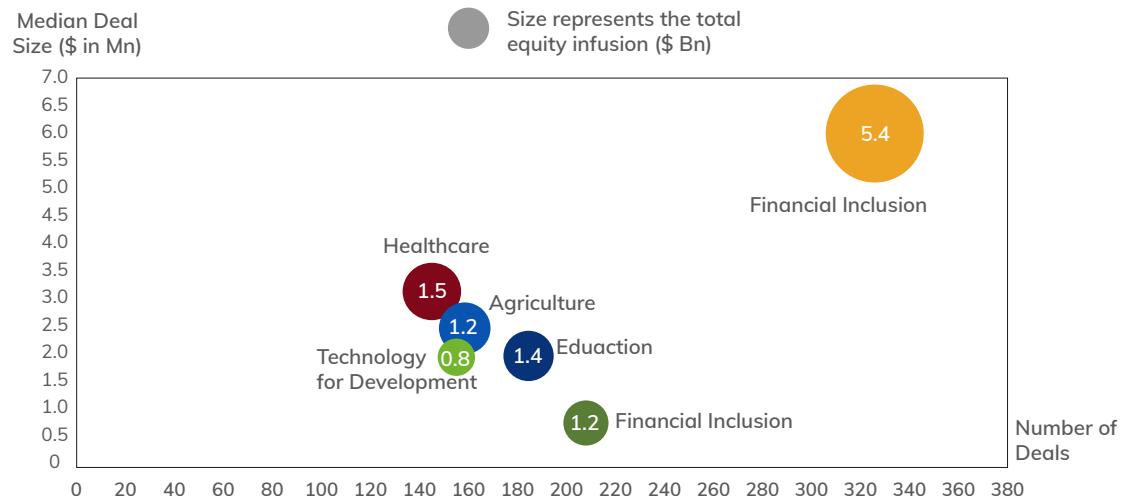
II. Financial Inclusion is Key-

Among the impact-oriented sectors, climate-tech deals account for 16% by volume and 9% by value.

Several social impact activities have been focused on poverty alleviation and improving the financial resilience of the population at the bottom of the pyramid, instead of issues like climate change. Financial inclusion witnessed the highest volume (26%) and value (43%) of deal flow over the last five years. The prolific activity in the space can also be attributed

to investors' ability to map and measure the impact performance data at scale.²⁶ Other impact-oriented sectors like impact-based agriculture, healthcare, education, technology for development, and others, individually are between 7-14% by volume and 7-12% by value.

Exhibit 19: Equity infusion within the impact space between 2016 and 2020



Source: Authors' calculations based on IIC Database



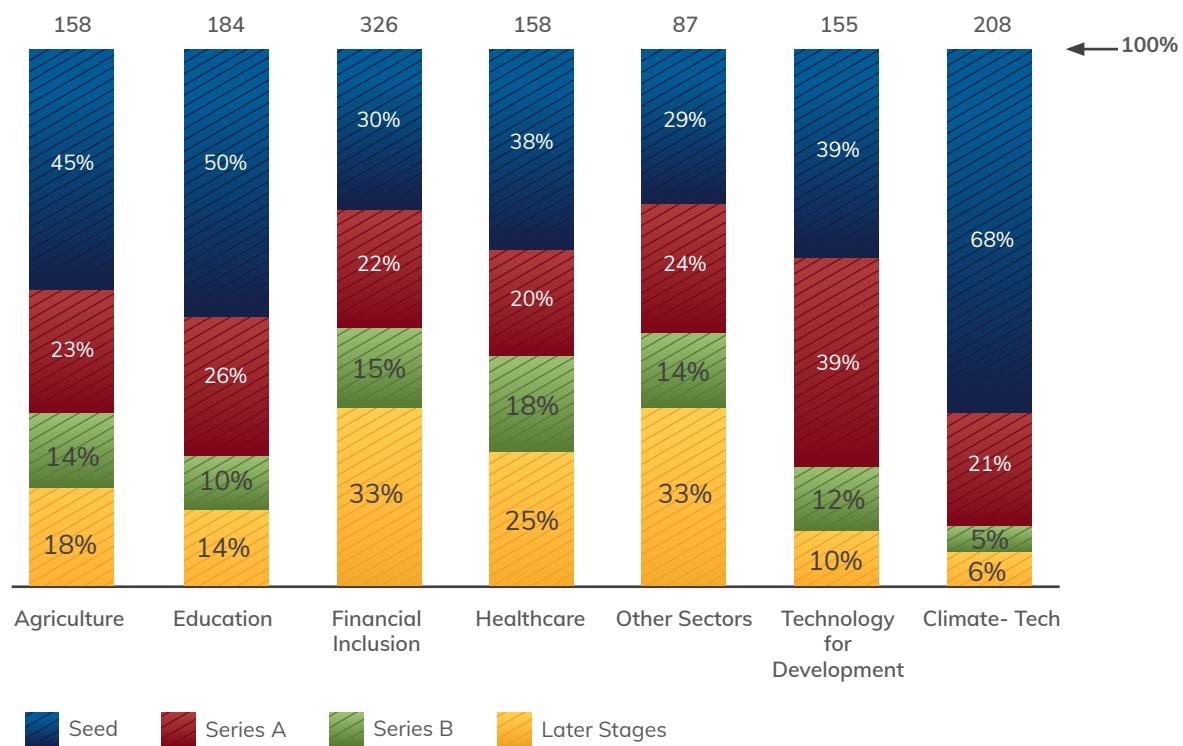
III. The Growing Startup Space-

Seed capital continues to be the dominant form of equity infusion for climate-tech startups, which are at a nascent stage yet.

Many other sectors have transitioned to a higher share of later-stage investments. The growth in these sectors can be attributed to a few over USD100 million investments in some established players like FreshtoHome and Ninjacart in the agriculture sector; Vedantu and Unacademy in the education sector;

Lendingkart, Khataook, MoneyTap, etc., in the financial inclusion sector; Pharmeasy and 1mg in the healthcare space.²⁷ The privately owned startups with valuations of over USD1 billion or Unicorns make way for any sector to flourish and the 'climate-tech' space is yet to see such a paradigm shift

Exhibit 20: Number of deals of equity infusion at different stages



Source: Authors' calculations based on IIC Database

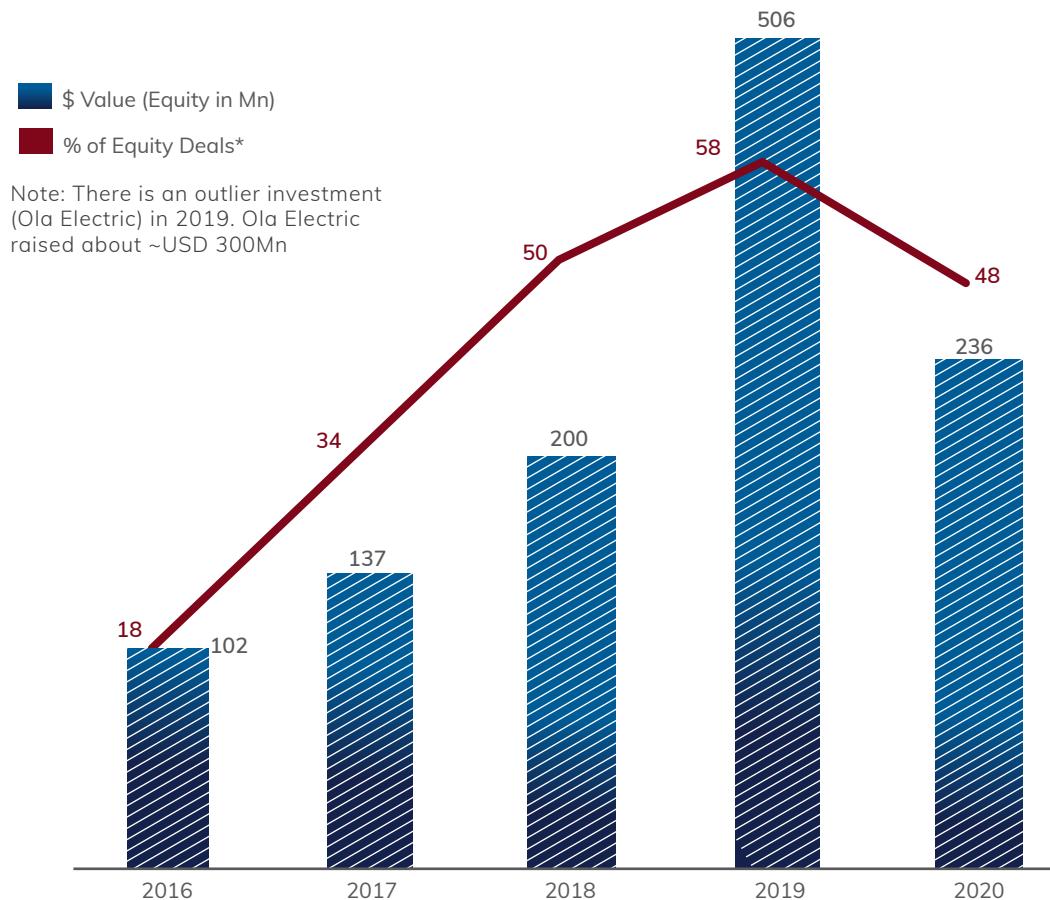


IV. A Brightening Horizon- The climate-tech space witnessed equity investments of ~USD1.2 billion from 2016 through 2020 in 120 early-stage startups.

While the sector was on an upward trajectory till 2019, with both equity infusion and volume of deals growing at a CAGR of 70% and 48%, respectively, it hit a roadblock in 2020 like many other sectors.²⁸ The average deal size reduced to USD4.9 million in 2020 from USD8.7 million in 2019. Overall, there have been 272 unique investors in this space that have been a part of over 200 funding rounds in the last five years for the early-stage climate-tech startups. The median deal size has increased from USD0.8 million in 2016 to

USD0.9 million in 2020. However, both investors and entrepreneurs remain optimistic about India's startup ecosystem. Overall deal activity recovered in H1 FY 21 by touching USD10.8 Bn capital flows across 614 funding deals with more than **2 dozen deals** in the agritech and energy sectors, including several which have a climate focus.²⁹

Exhibit 21: Evolution of Climate-Tech in India



Source: Authors' calculations based on IIC Database

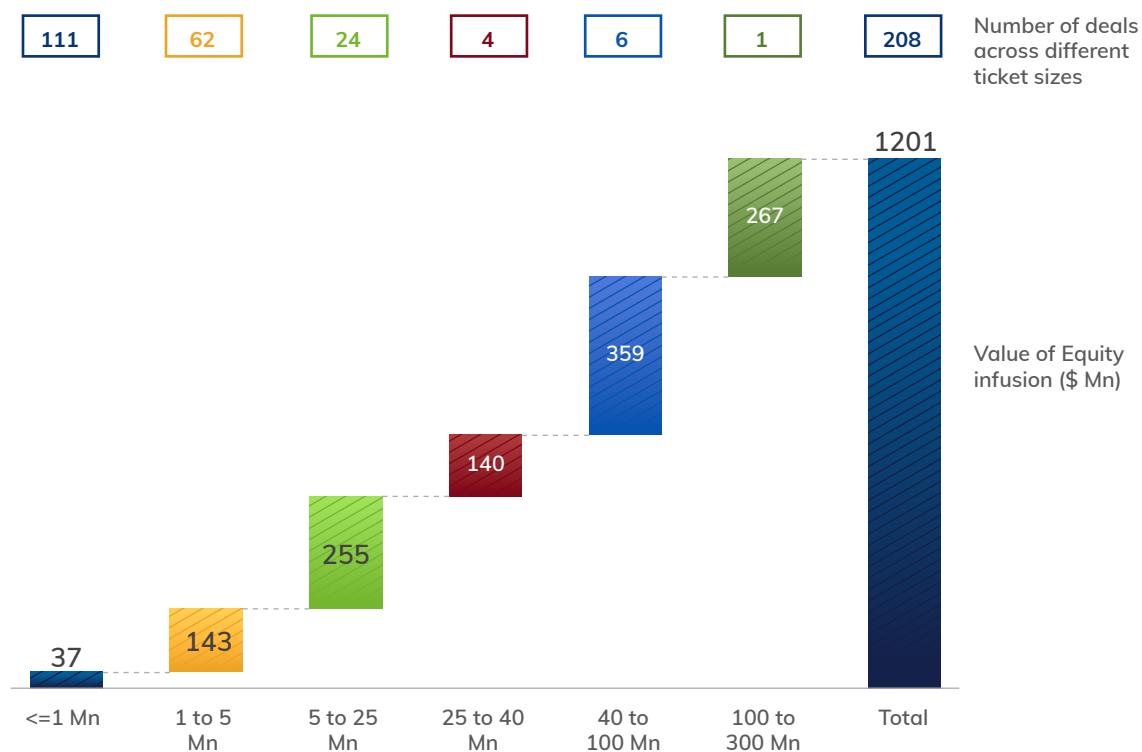


V. Small is Big!- Most deals (~83%) in climate-tech are <USD5 million with almost 53% being <USD1 million.

While accounting for 85% of the deal volume, these deals accounted for less than 15% of the total capital inflows into the space. This is driven by technical complexity, long gestation cycles (going from research to prototype, establishing proof of concept, taking the product from lab to market, etc.), and a dearth of 'risk

capital' at the Series A and B stages. Innovations are still at a relatively early stage as entrepreneurs test different solutions and products, and validate the product-market fit. The upside is that it is possible for investors to spur innovation and include climate-tech in their portfolio with relatively smaller cheques.

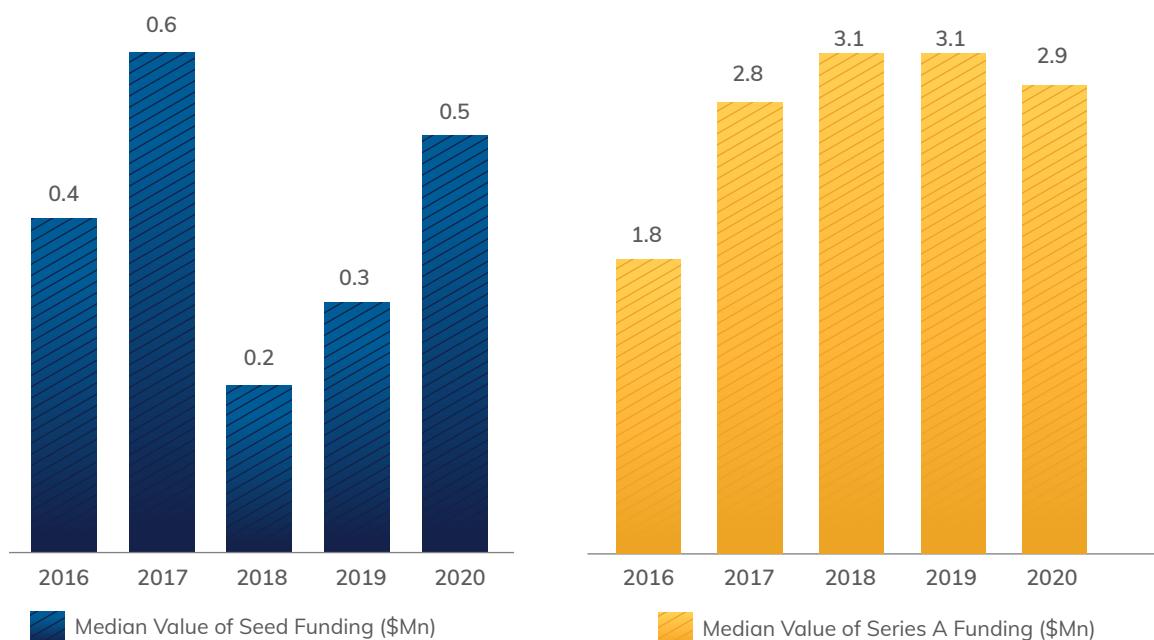
Exhibit 22: Break up of deals in different range of investment values

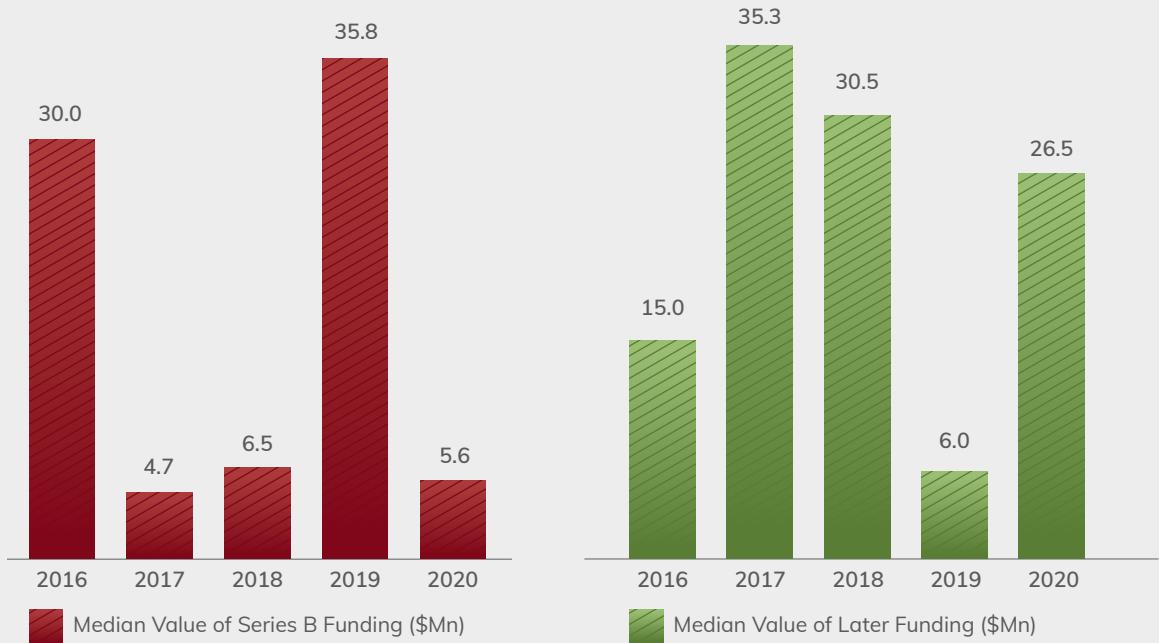


Source: Authors' calculations based on IIC Database

The median across the years at the different stages within the ecosystem has been consistent except for a couple of big-ticket investments at the Series B level.

Exhibit 23: Median value across different stages between 2016-2020





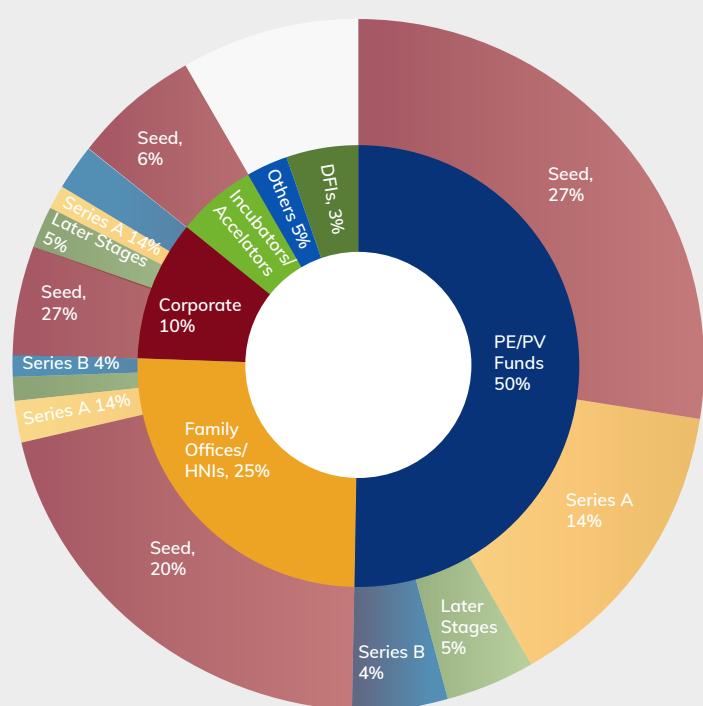
Source: Authors' calculations based on IIC Database



VI. A Slice of the Pie- VC/PE and family offices/HNI are the most enthusiastic supporters of early-stage climate-tech startups and funded ~75% of the deals in the space between 2016 and 2020.

Over 25 domestic and international PE and VC investors (including both commercial and impact-oriented investors) are active in India and have been a part of at least three different deals in the last five years. These investors are spread between commercial and impact investors. Seed capital is the most prominent stage of capital infusion followed by Series A funding across a diverse set of investors. Others include the Government, foundations, banks, and social enterprises, and comprise a very small portion of the whole pie.

Exhibit 24: Sources of equity infusions at different stages in the climate-tech space



Source: Authors' calculations based on IIC Database

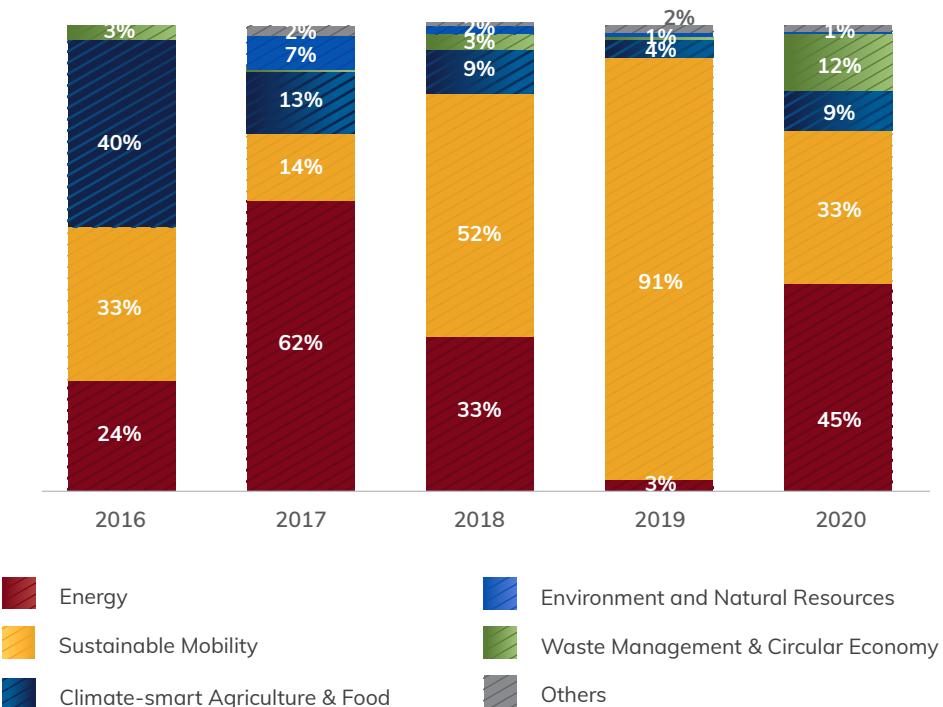


VII. Energy & Mobility Zoom Ahead- Similar to global trends, energy and mobility account for the largest share of deals by volume and value.³⁰

Almost 83% of the investment value across almost 130 deals within the climate-tech ecosystem pertains to these two sub-sectors in India. These sub-sectors are ahead on the maturity curve, driven by a favourable regulatory environment and the emergence of tech-enabled solutions.^{31,32} The impact from these two sectors is easy to capture and compare due to the usage of standardized frameworks that use

imperatives like the consumption of fossil fuels to measure GHG emissions.³³ These sub-sectors also accounted for a few big-ticket deals like Ola Electric raising USD267 million in a Series B fund-raise in 2019, making it one of the biggest deals in the climate-tech space in these five years.

Exhibit 25: Investment value (\$ Mn) and number of deals across different sub-sectors within climate-tech



Source: Authors' calculations based on IIC Database



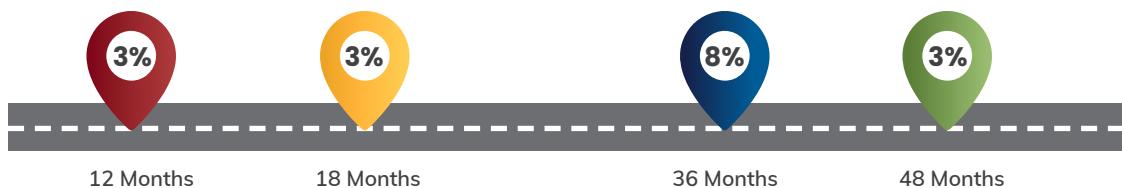
VIII. Aiming for the Top- Conversion from seed capital to series A is low, at about 17% compared to 29% internationally over a 3-year horizon.³⁴

Of the 36 deals that raised seed capital in 2016 and 2017, only six were able to raise Series A by 2020.

The proportion of entities raising only one round of funding is significantly high compared to entities that have raised more rounds of funding with only seven

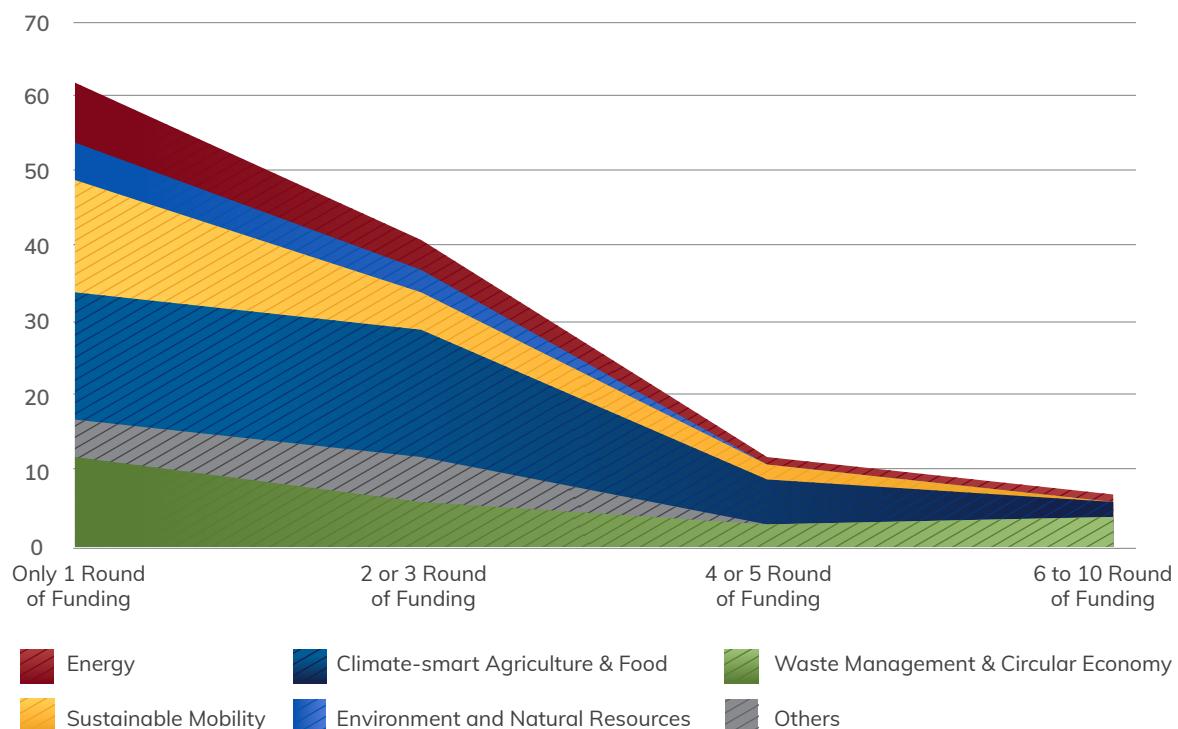
participating in the six to 10 rounds of funding, compared to the 62 entities receiving round 1 funding. Almost 84% of the 122 entities participated in up to three rounds of funding.

Exhibit 26: Time taken (in months) to move from Seed to Series A stage



Source: Authors' calculations based on IIC Database

Exhibit 27: Entities in different rounds of funding across sub-sectors within the climate-tech space



Source: Authors' calculations based on IIC Database

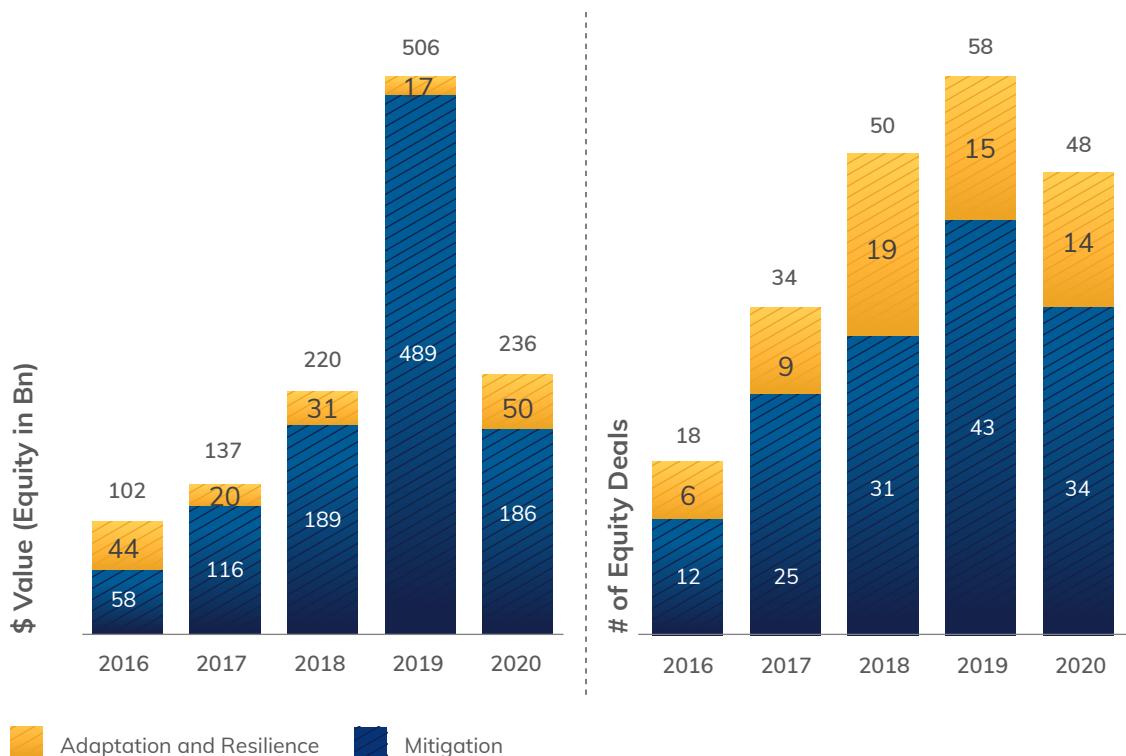


IX. Test of Resilience- The overall traction for deals towards solutions entailing mitigation of climate change is much higher compared to adaptation and resilience solutions as mitigation solution deals account for 86% of the equity infusion spread over 145 deals.

Energy and sustainable mobility sectors have been predominantly producing mitigation solutions because the carbon footprint in these sectors is high and adaptation is still in the early stages of innovation. Sectors like smart-agri, waste management and circular economy, and

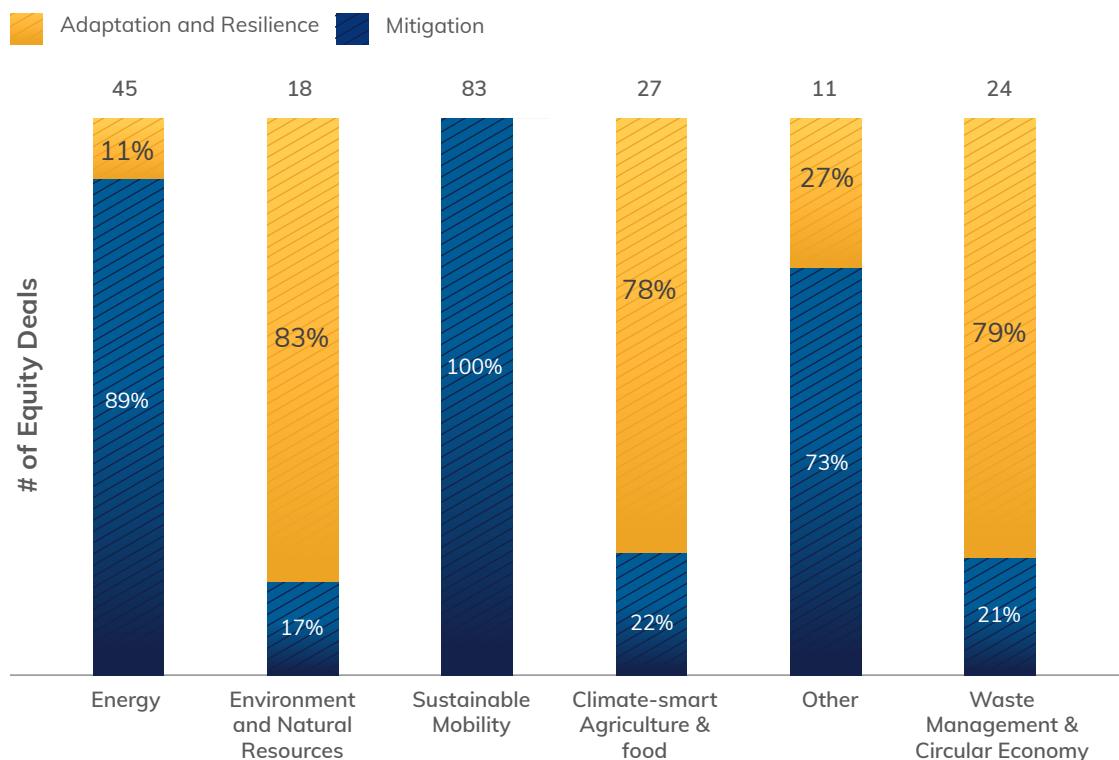
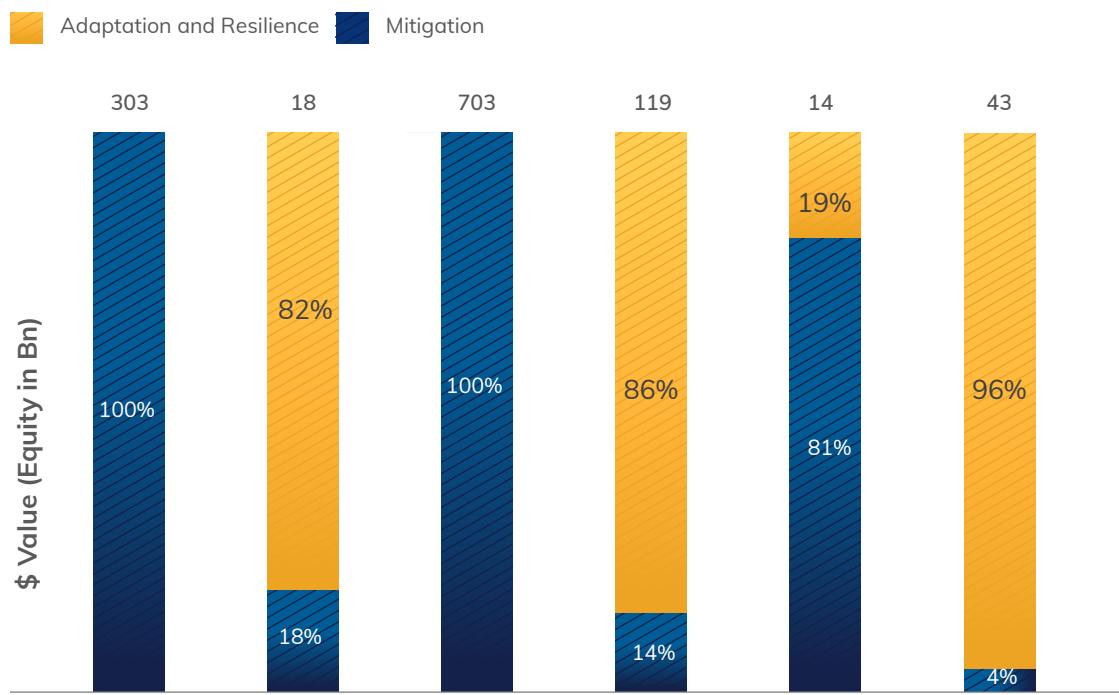
environment and natural resources, have seen a fair bit of adaptation and resilience solutions getting funded as adaptation requires more localized solutions in an unpredictable environment, which is more suitable for these sectors by design.³⁵

Exhibit 28: Segregation of Equity investment value and volume between climate mitigation and climate adaptation and resilience



Source: Authors' calculations based on IIC Database

Exhibit 29: Segregation of Equity investment value and volume between climate mitigation and climate adaptation and resilience for each sub-sector



Source: Authors' calculations based on IIC Database

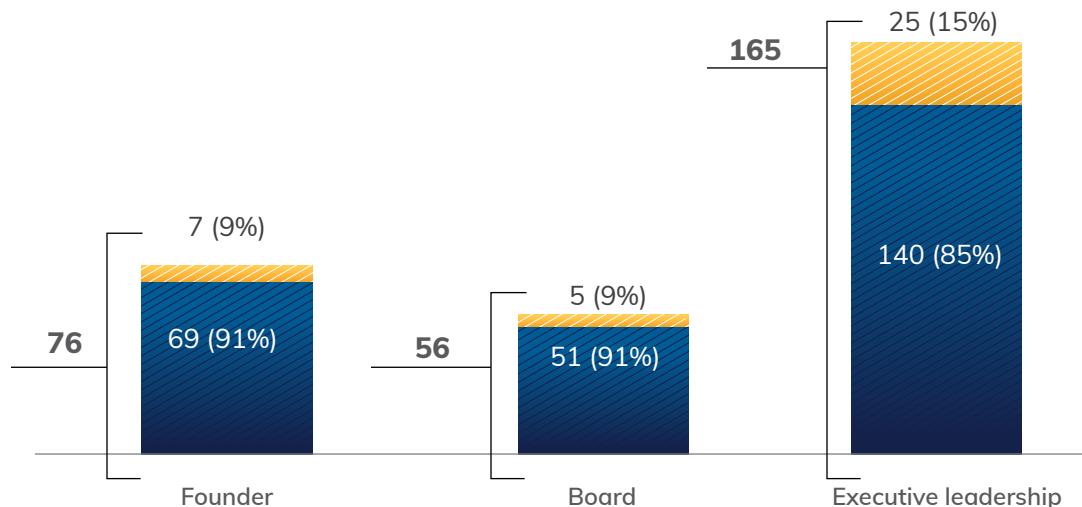


X. Femme Focus- In our analysis of over 40 startups in the climate-tech space that have raised a Series A and beyond funding in the last five years, only 9% were founded/co-founded by women.

This is low compared to the 14% women-founded/co-founded startups among the top 150 startups (as of 2019)³⁶; less than half compared to the 20% women-owned enterprises at an aggregate level in India³⁷.

The participation of women across the verticals increases as we move to the board and executive leadership positions in the climate-tech startup ecosystem.

Exhibit 30: The gender mix in the climate-tech start-ups that have raised Series A and above



Source: Authors' calculations based on IIC Database



XI. Prevalent Business Use-Cases- For startups that have raised Series A funding and beyond, there is a healthy mix across B2B and B2C use cases.

We expect this use case to continue to evolve as companies continue to refine their value proposition and better understand and codify their offering. 11% of companies have a mixed use case and are currently selling to businesses and/or consumers and/or government.

e.g. premium technology backed EVs are supplying to individual customers as well as to companies managing fleets. Share of the government as a key buyer is still low - likely given challenges startups face with higher regulatory burdens/cash flow issues in dealing with Government. This is a

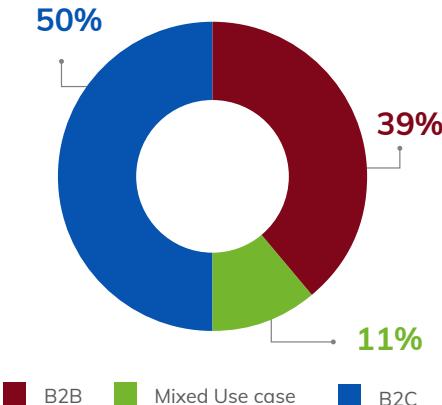
reflection of the growth stage of the sector - but as companies scale, the government may become an important customer as well.

Exhibit 31: The business model in the climate-tech startups that have raised Series A and above

Note:

- B2B - Enterprise selling an intermediate product or services to businesses for resale.
- B2C - Enterprises selling directly to the end user or consumer
- Mixed Use Case** - Enterprises selling to Consumers, Business or Government.

Source: Authors' calculations based on IIC Database

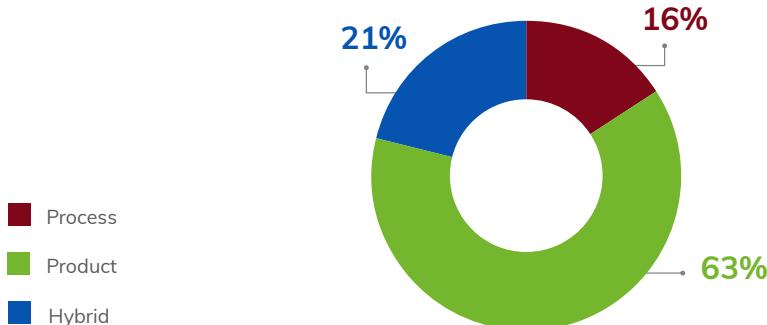


XII. Types of Innovation in Climate-tech- Almost two-thirds of the startups that have raised Series A and beyond, have showcased product innovation, while 16% are bringing improvements in the processes through innovative solutions or consulting services.

Nearly 30% of the enterprises that have raised Series A and beyond are developing innovative electric vehicles (like Ampere Vehicles, Etrio, Tork Motors, etc.) which attributes to the high share of product innovation companies. Business model innovation (a bi-product of product and process innovation) is still in early stages.

Companies working in this space will grow as the ecosystem develops. About 21% of the enterprises are providing hybrid innovations with a mix of product, process, and/or business innovation. (Please refer the definition of product, process, and business innovation from Chapter 1)

Exhibit 32: The different innovations in the climate-tech startups that have raised Series A and above



Source: Authors' calculations based on IIC Database

Sub-sector deep dive

05



ENERGY

The Indian energy outlook is robust. India is currently the third-largest energy consumer in the world and over the next 20 years India will require the addition of a power system the size of the EU's current power system. While energy use has doubled over the last two decades, India's per capita energy use is still lower than half the world average, implying that the latent energy demand is high.³⁸ Further, over 270 million people are set to join the urban population over the next two decades - requiring significant additions across generations to distribution.³⁹

I. More than 65% of India's GHG emissions can be attributed to the energy sector.⁴⁰

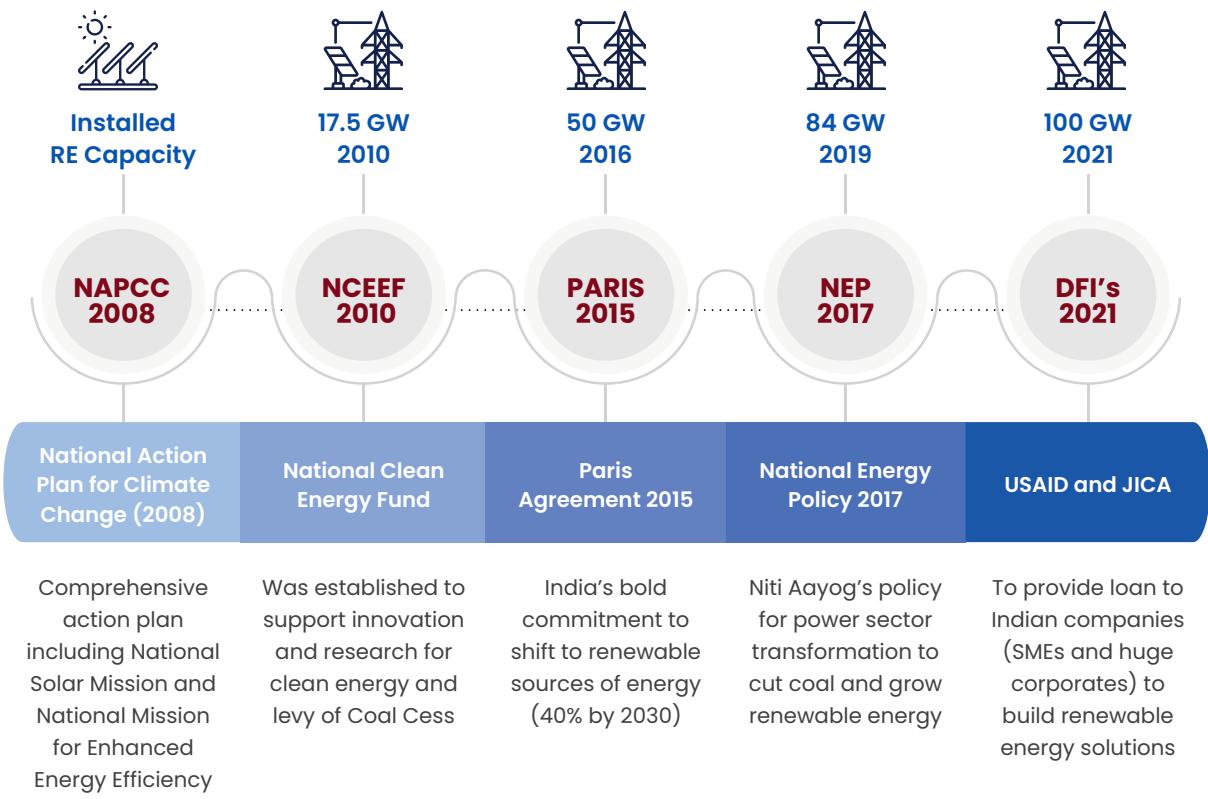
Even globally, the energy sector is the biggest contributor to GHG emissions; India's energy sector alone contributes 2.6% to global emissions (2018).⁴¹ Even as of 2021, about 52% of the electricity produced in the country is fuelled by coal.⁴² Given the high concentration of emissions arising from energy, it is imperative that we identify solutions to mitigate these to achieve net zero.

II. The sub-sector has witnessed a lot of activity over the last decade both in terms of policy changes and investments.

In 2008, the Government launched the National Action Plan for Climate Change, which included the National Solar Mission (promotion of use and development of solar energy) and the National Mission for Enhanced Energy Efficiency (push for reduced energy consumption through financing public-private partnership and system for companies to trade energy-saving certificates) along with other climate action programmes. Key policy interventions are highlighted in the Exhibit 33 below:

Today, India has 100 GW installed renewable energy capacity, which is almost 25% of the total installed power generation capacity in India. A positive policy environment, coupled with the ease of access to capital has catalyzed both utility-scale energy investments and a host of technology-led startups serving the existing large asset base of solar and wind projects.

Exhibit 33: Policy Intervention in the energy sub-sector



Source: Data from DST, MNRE, CBGA, NCBI, research

III. Action in India is comparable to global trends

Energy attracted ~8.2% or ~USD 4.9 billion of the total climate-tech investments between 2013 and 2019 in this space, globally.⁴³ VC investment has flown into startups operating in spaces such as renewable energy generation, high efficiency energy intensive electronics and smart monitoring/ management, and energy storage (thermal or electricity), and grid management, etc.⁴⁴

IV. Impact of Covid 19

India witnessed a 1.3% dip in the peak power demand in FY21⁴⁵ and supply chain disruptions due to restrictions on imports from China (almost 80% of solar cells are imported from China).⁴⁶ However, despite the initial setbacks, the sub-sector witnessed a steady inflow of capital and a 20% reduction in solar tariffs (from INR 2.5 in February 2020 to INR 2 in November 2020).^{47,48}

V. Despite a favourable policy push, the sub-sector continues to face varied and significant challenges

- Upfront investment cost remains comparatively higher for renewable energy projects (specifically wind) compared to coal-based plants (e.g. INR 60 million per MW for wind projects and over INR 40 million per MW for the coal-based plants)⁴⁹
- While generation has seen massive investments from both the public and private sector, structural issues across transmission and distribution continue to plague the sub-sector. The further liberalisation of the distribution sector, under way in certain states, is long overdue - and is expected to help the beleaguered state-owned utilities increase competitiveness and pare down their debt burden.
- Long cash flow cycles arising from the B2G nature of business also act as a barrier to attracting entrepreneurs.^{50,51,52} Perceived high risk and long gestation of projects make it harder for startups to attract venture capital.
- Power being a subject on the concurrent list, there is variability in both policy implementation and enforcement across states, making it difficult for the intended policy benefits to percolate to the ground level.^{53,54}
- In addition to the challenges listed above, the sub-sector still struggles to access reliable data for predictive analysis and pre-emptive solutions for the hardware in place; making way for startups to fill the gaps through some innovative solutions.⁵⁵



VI. Key Investment hypotheses – Smart Solutions

Clean Energy: Utility scale projects are better suited for project finance and/or private equity, and are not really in the VC mandate. However, there are early-stage investments being made in rooftop solar startups (Energy as a Service / EaaS companies, solar project financing platforms etc.). For this study, we have excluded such startups and focused on early-stage capital being invested into new disruptive clean energy generation technologies that are emerging in India - like green hydrogen generation, fuel cells for various energy needs (e.g., h2e Power has both solutions), conventional fuels from new feedstocks (e.g.: Sea6 Energy derives ethanol from seaweed).

Energy Optimisation: There are many innovative startups that support the large asset base of renewable energy (RE) projects, and VCs and other early-stage investors are well-placed to take on technological risks in this space. These include solutions like energy-data analytics, energy accounting, drone-based & GIS-based survey companies (e.g., AirProbe), robotic/automated cleaning for solar (e.g., Jetsons Robotics), automated mechanical/optical solar trackers as well as Operations & Maintenance (O&M) optimization and predictive maintenance. For this study, we are categorizing these types of innovations under this sub-segment, Energy Optimization. In addition to these, we also include startups in energy-efficiency (e.g., Ecolibrium Energy, SustLabs), building-energy management systems (e.g., Zenatix), smart-grids and smart-metering (e.g, winAMR) in this category.

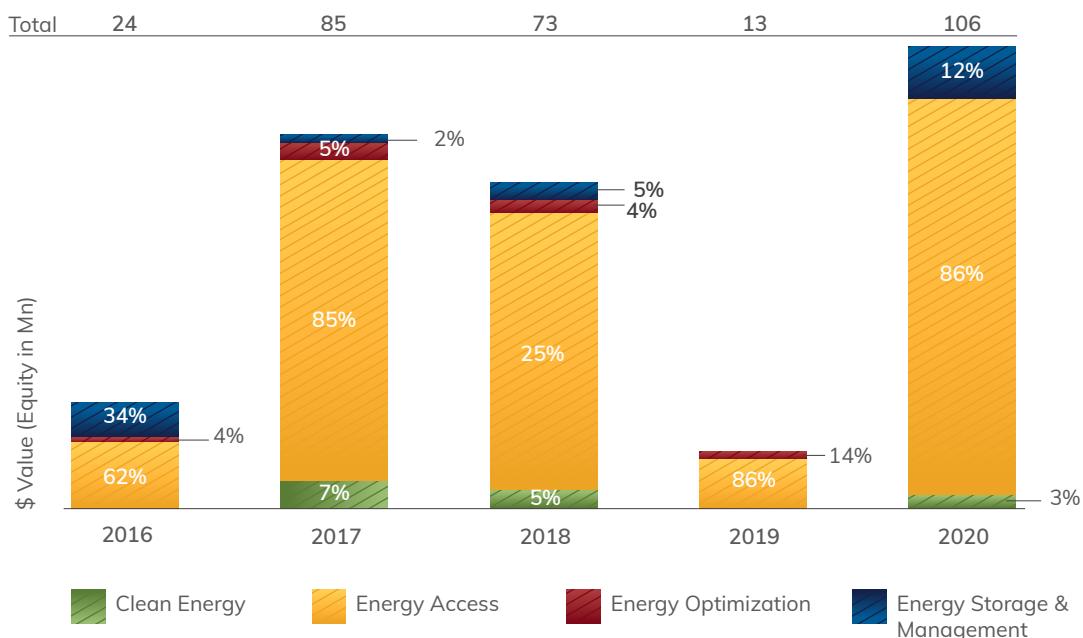
Energy Storage & Management: Another area of investor interest has been DeepTech smart hardware-software solutions for battery management (e.g., Ion Energy Labs) as well as novel materials & chemistries for energy storage and management - both electrical (e.g., Cygni Energy) and thermal energy storage (e.g., Tessol) – meant for various end-use applications.

Energy Access: Startups providing solar / biomass/ biogas powered solutions for energy access are viewed from a social impact lens and are not a typical focus sector for pure commercial investors. Instead, these startups (e.g, Greenlight Planet, Oorja Development Solutions) are largely backed by grant capital and/ or impact investments.

VII. More than 25 entities have raised capital to the tune of ~USD 301 million in 44 deals from 2016-2020.

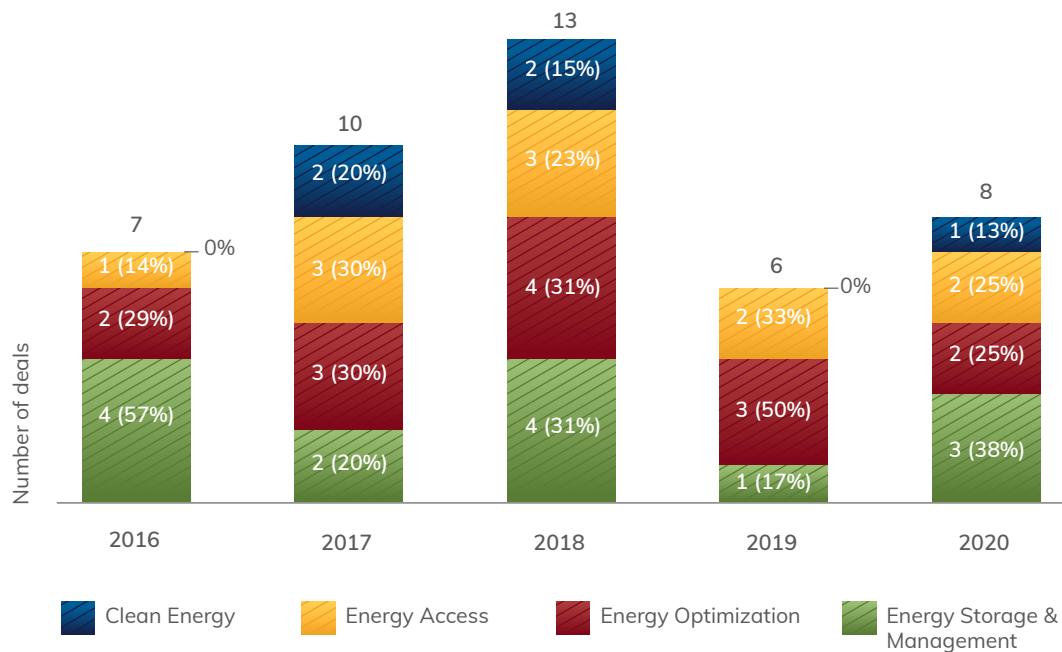
While energy access deals have attracted a higher share of capital, energy optimization and energy storage have witnessed greater deal flow. However, the average deal size for energy optimization and storage is much smaller compared to energy access. Dlight, Greenlight Planet India, and Husk Power System have raised over USD 15 million each. Infuse Ventures, Ankur Capital, FMO, IAN Fund, and SINE are some of the active investors in this space in India.

Exhibit 34: Capital infusion into energy deals in India, 2016-2020



Source: Authors' calculations based on IIC Database

Exhibit 35: Capital infusion into energy deals in India, 2016-2020



Source: Authors' calculations based on IIC Database



Energy Optimisation: These innovations have a hardware-software (IOT, AI/ML/ data analytics) play and investors have put in USD 10 million into such startups in India between 2016 and 2020.



Energy Storage & Management: These innovations are often integrated with AI/ML, smart data analytics and an energy management software stack. Investors have put in USD 26 million in the period 2016-2020, making this the second largest sub-segment in terms of quantum invested after Energy Access. In the Covid-year 2020, USD 12 million flowed into Energy storage startups in India

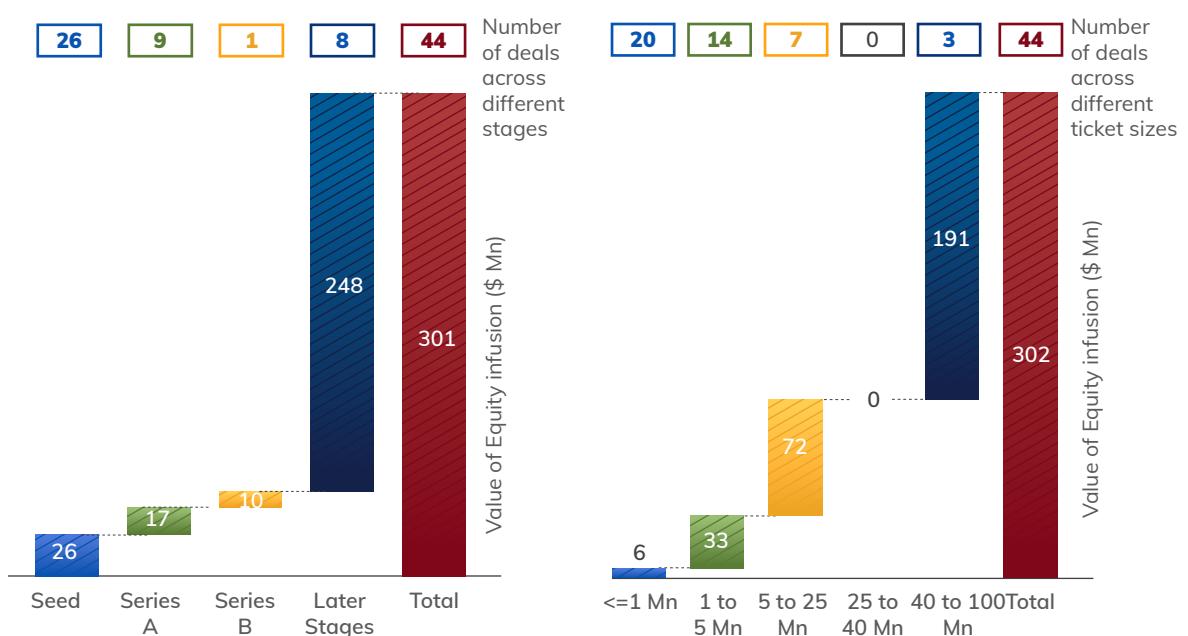


Energy Access: The total quantum invested in the Energy Access sub-segment is USD 252 million and this constitutes 83.6% of the total funding into the Energy sub-sector as a whole. To be sure, this funding includes capital expenditure for building energy access assets – however, the same type of capital invested in the utility-scale space (which in fact far exceeds that in the energy access space) has been excluded from this study, as mentioned previously.

VIII. Seed-stage funding sees largest number of deals

Seed-stage funding has seen the largest number of deals in the sub-sector between 2016 and 2020, with more than half the number of deals happening in the seed stages. The overall median deal size for the subsector is USD 1.2 million.

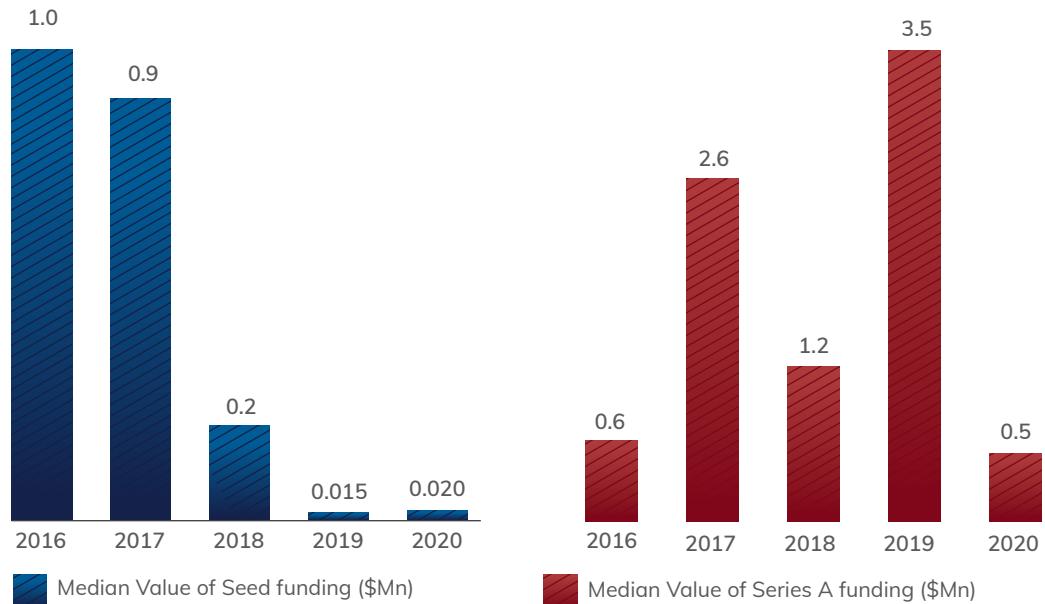
Exhibit 36: Deal across stages and ticket sizes (value and volume)



Source: Authors' calculations based on IIC Database

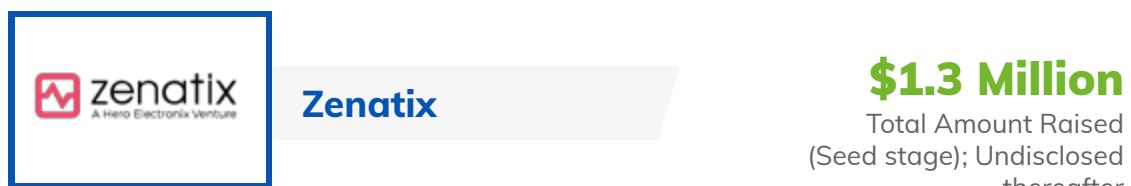
The median value across funding stages between 2016 and 2021. The number of deals beyond Series A is negligible and cannot be used to derive trends

Exhibit 37: Median value of deals across stages over the years



Source: Authors' calculations based on IIC Database

X. Case study



- 2013
- Founders Amarjeet Singh, Rahul Bhalla, Vishal Bansal
- Last Funding Stage Backed by Hero Group
- Sub Segment Energy Optimization

Business Model

Zenatix provides building automation solutions that drive data-powered asset performance and energy efficiency benefits. It installs end-to-end IoT solutions that connect all the energy consumption assets to a single cloud-platform that provides advanced analytics, insights and intelligent controls to help optimize energy consumption. The system also generates automated alerts in case of anomalies for timely maintenance and prevents asset downtime. The key use cases include retail stores, hotels, office spaces, industries and so on. Zenatix is now a part of Hero Electronix – Hero Group's venture into the technology space.



Innovation (Product innovation)

ZenConnect is a full-stack hardware light, software heavy, retrofit-ready and cost-effective installation that helps create connected infrastructures for a single site as well as geographically-distributed sites. The solution leverages its intelligent hardware, an AI-powered cloud system, and easy-to-use dashboards to create a single platform for energy management, centralized asset management, predictive maintenance, and digital ticketing workflows. The solution, based on wireless mesh technology, is simple to deploy and maintain.



Climate Impact

Zenatix's solution helps optimize energy consumption for energy efficiency benefits and therefore emissions reduction.

For Example: The company's quick service restaurant clients were able to reduce their energy consumption for up to 10%.

XI. Outlook – Future Ready

Innovations that enable better monitoring and use of energy will find greater adoption:

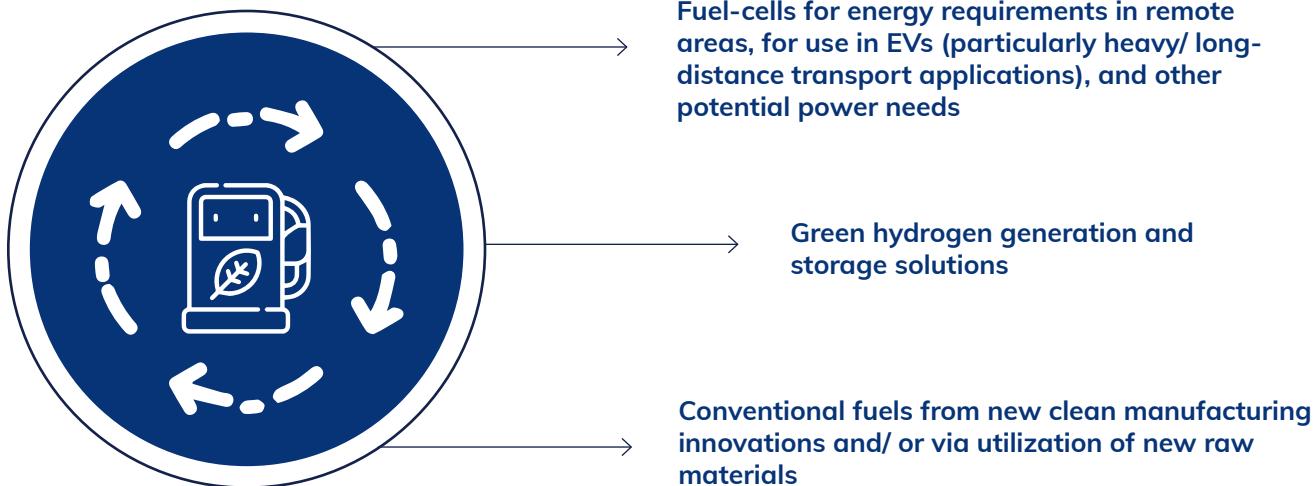
With changing dynamics in India's power sector, primarily driven by more renewable capacity being added, the introduction of EVs, as well as policies like delicensing of power distribution – innovations that enable better monitoring and use of energy (both at the grid and the end-consumer level), will be needed. On the consumer side, new hardware-software IoT and metering solutions backed by AI, ML, and data analytics layers specifically geared for smart-metering, fault detection and energy savings will continue to find avenues for scalable adoption and, therefore, will continue to arouse interest among investors. In addition, there will be a market for smart-grid solutions that help forecast power supply from distributed variable sources and integrate them smartly to match it to forecasted demand.

More demand for energy load management technologies: With an increasing share of renewable energy in India's power sector, there is more variable energy being pumped into the grid. Therefore, energy storage technologies that help manage peak power loads and balance the grid will find greater demand and attract greater investments.

Adoption of energy efficiency solutions will continue: As end-use energy prices increase, either due to increasing costs of energy supply and/ or time-of-use pricing models, energy efficiency solutions in the built environment will continue to find increased adoption among domestic consumers, and even more so among commercial and industrial consumers (as their higher tariffs cross-subsidize other consumers in India's regulated power sector). These innovations would again largely be technology-enabled solutions leveraging IOT, hardware, electronics, AI and ML, for use towards lighting, appliances, HVAC systems, etc.

OTC energy trading solutions are emerging: An emerging area of interest is an integrated technology solution for over-the-counter energy trading solutions (potentially enabled by block chain technology).

Deep-tech innovative clean energy solutions (e.g. hydrogen) are bubbling but need strategic capital to be deployed. Finally, certain novel solutions in the clean energy space have taken root in India over the past couple of years as well. Some of these are:



However, only a handful of startups with such emerging innovations in the energy sub-sector exist in India. Moreover, many investors view these innovations as inherently asset/ infrastructure-heavy and requiring longer gestation periods for maturity, given their deep-science nature. Given these constraints, early-stage capital for these innovations may come from strategic investors, impact investors, and/ or grant capital. Commercial VCs on the other hand may be interested if there are policy mandates/ drivers that provide certainty around growth prospects in a sustained and large market.

SUSTAINABLE MOBILITY

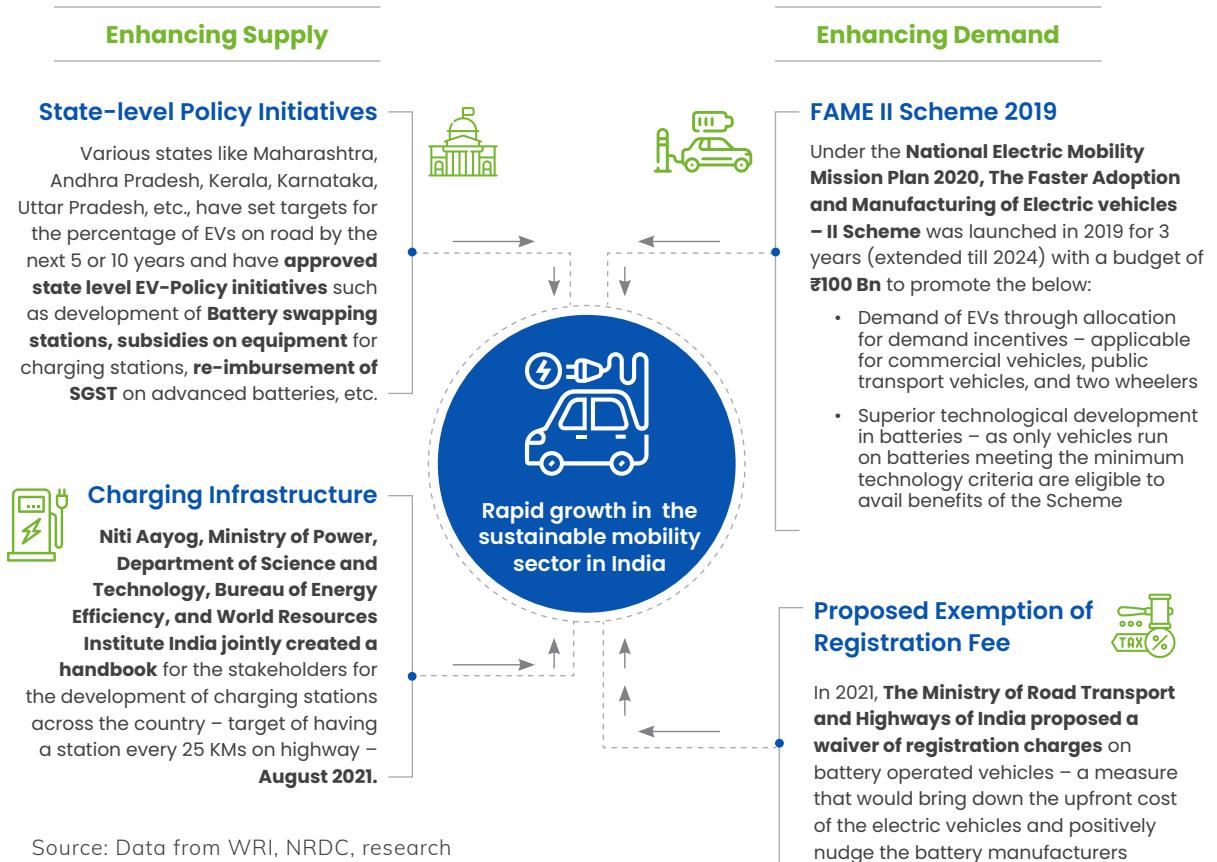
I. India's transport sector contributes to ~10% of the GHG emissions in India.⁵⁶

Ninety percent of these emissions are attributed to road transport.^{57,58} Almost 20 million cars were registered in India between 2006 and 2016 which is double the number of cars registered between 1950-2006⁵⁹ India's road transport traffic is expected to grow five times between 2011 and 2031. High demand for both public and personal transport will necessitate adoption of sustainable mobility options if India wants to become a low carbon economy.⁶⁰

II. A positive policy environment has been key to driving a shift towards sustainable mobility solutions.

The Government has adopted a mix of supply-side (state and national policies, subsidies, and tax relief) and demand-side (consumer incentives) measures to catalyse both innovation and capital deployment in the sub-sector. Since the current upfront cost of an electric car is more than the conventional petrol/diesel cars, policy-driven efforts such as

Exhibit 38: Demand-supply enhancing mechanism in sustainable mobility sub-sector



Source: Data from WRI, NRDC, research

lowering GST on the sale of EVs, EV chargers, and other raw materials for electric batteries, etc. are being implemented to make EVs more affordable and competitive.⁶¹

The Council on Energy, Environment and Water (CEEW) estimates that India's 2030 vision for e-mobility has the potential to

translate into EV sales to the tune of 102 million units, a 158 GWh battery capacity demand and a network of approx. 3 million charging points.⁶² This requires exponential growth in supporting infrastructure, considering there are only 1,800 charging stations as of March 2021 and about 5.2 million electric vehicles registered in India between 2018 and 2021.^{63,64}

III. Mobility has witnessed temporal setbacks due to COVID 19

The automobile sector, including EVs, have been impacted severely due to the pandemic as people stayed indoors and travel was restricted.⁶⁵ Global lockdowns also disrupted EV supply chains as raw materials for cells and motors were being imported from China.⁶⁶ Plummeting consumer demand and supply chain issues forced a few Indian EV players to scale back operations and undertake some layoffs in

their workforce (as illustration, the shared-mobility EV startup Bounce has had to lay off 130 employees in June 2020 and a further 200 employees in 2021).^{67,68} Despite the short-term setbacks, the Indian EV market is expected to make a fast recovery and is likely to grow at 26% through FY21-23 due to a strong policy push and high fuel prices.⁶⁹

IV. India lags its global peers when it comes to adoption of EVs

Globally, the number of electric cars on the road hit the 10 million mark in 2020.⁷⁰ Of these 10 million cars, almost 3 million electric cars were registered in 2020 alone.⁷¹ In China, a strong government mandate (EV to make up 40% of all auto sales by 2030) has led to it becoming a frontrunner

in this space with a fleet of 4.5 million electric cars.^{72,73} Even though India's EV sales are far behind the global benchmarks, a doubling of sales in the last three years - from ~69,000 EVs sold in FY18 to ~167,000 EVs sold in FY20 - shows signs of a positive momentum.⁷⁴



V. Key Investment Hypotheses – Unique Options

From our interactions with stakeholders, there is a clear emergent overlap between investor interest in the US and Indian mobility markets in terms of the kinds of innovations being supported – with investors in both markets displaying a specific focus on Original Equipment Manufacturers (OEMs) and solutions as a service play within the EV value chain.

1. Clean Mobility (EVs)

Despite being infrastructure heavy, EV manufacturing has been backed by investors – cutting across various vehicle categories such as e-bicycles (e.g., Batt:RE), e-scooters (e.g., Ampere Vehicles, Ather Energy), e-motorbikes (e.g., Tork Motors), 3-wheelers (e.g., Pi Beam), passenger cars (e.g., Strom Motors), cargo vehicle-platforms (e.g., E-Vage, Euler Motors, Celestial Mobility) etc.. Various use cases have also been supported, such as passenger commute and commercial logistics/ goods delivery. Both these trends are largely due to the potential of these OEMs being successful vehicle “brands”. Interestingly, many of the above startups manufacture various categories of platforms (e.g., E-Trio).

2. Clean Logistics, Fleets and Connected Vehicles

Startups in this space offer connected vehicle and fleet management solutions by blending IOT, GPS & data analytics layers with vehicle platforms. This helps track shipments and vehicle health through data-driven insights and optimizes fleet use.

a. Fleets and Connected Vehicles:

- EV ride hailing and shared mobility solutions (Lithium, Blue Smart Mobility, Smart E) have been backed by investors.
- Investors have also backed players operating at the intersection of electric mobility and fintech. These startups offer end-to-end services to customers through lease / rental models (e.g., eBikeGo, Yulu Bikes, Welectric, B-Live) for the first and last-mile commute needs – across both B2C (e.g., delivery executives and individuals) and B2B (e.g. last-mile delivery and logistics players) needs. The value propositions for customers include lower upfront costs, hassle-free maintenance, data driven insights through connected vehicle and fleet management solutions, and lower predictable operational costs. In addition, for commercial clients, these solutions help lower costs of converting and/ or modernizing existing fleets to smart connected EVs. In both (i) & (ii) above, startups sometimes have their own custom-built EV platforms through contract manufacturing partnerships, or simply develop a multi-brand fleet.

b. Clean Logistics:

- Some startups provide last-mile logistics as a service to companies (B2B) via in-house driver partners (e.g., Zypp). Just like in the case of (ii) above, this solution too is an asset light strategy for customers and, therefore, has seen interest from investors.



3. Novel Batteries, Fuel Cells, Charging, Components

Disruptive innovations in the sustainable mobility value-chain around batteries, charging infrastructure and components present an immense opportunity for investors:

a. Novel Batteries:

Startups that have received funding include those working with new materials and/or novel battery chemistries (e.g. Log9 Materials), as well as those that significantly enhance battery properties for mobility applications (e.g. Battery Smart)

b. Charging

Scalable charging solutions, whether platform-focused or agnostic, have been able to attract investment (e.g., Charge+Zone, EV Motors India). In addition, intelligent battery management systems that can monitor battery health and/or effectively improve the life and performance of batteries have attracted capital. Finally, battery swapping solutions (Battery as a Service e.g., Lithion Power) are also growing. Interestingly again, there are vertically-integrated startups in this space that provide multiple or all of the products and services above (e.g., EVRE, Numocity)

c. Component

A handful of startups (e.g., Bhorzvan Motors, EVI) that focus on providing custom component development services around power trains, motors, motor drives as well as battery packs have received investments.

In all of the above categories, a few of the startups partner with a contract EV manufacturer and bundle their own battery and charging solution into it. This makes it attractive to investors as upfront capital expenditures are lower and represent an asset-light business model.

VI. 21 sustainable mobility startups have raised ~USD 705 million of capital across 84 deals in the last 5 years - the largest share of capital inflow within the climate-tech space.

The sub-sector has witnessed some marquee deals like twenty-two motors raising USD 65 million in 2018 and Ola Electric raising USD 267 million in 2019. Some of the most active investors in this space in India include Hero MotoCorp, Blume Ventures, and Venture Catalysts.

Exhibit 39: Capital infusion into sustainable mobility deals in India, 2016-2020

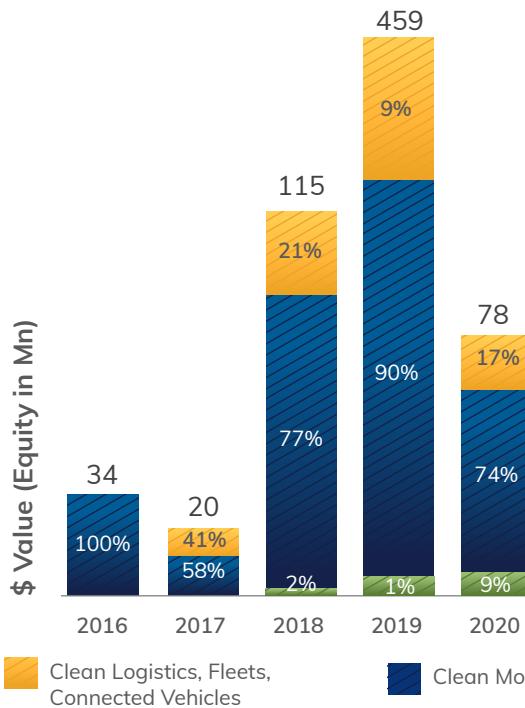
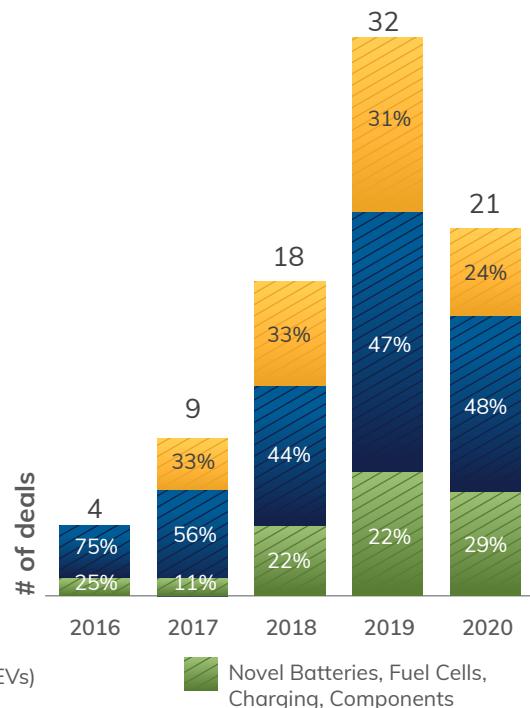


Exhibit 40: Capital infusion into sustainable mobility deals in India, 2016-2020



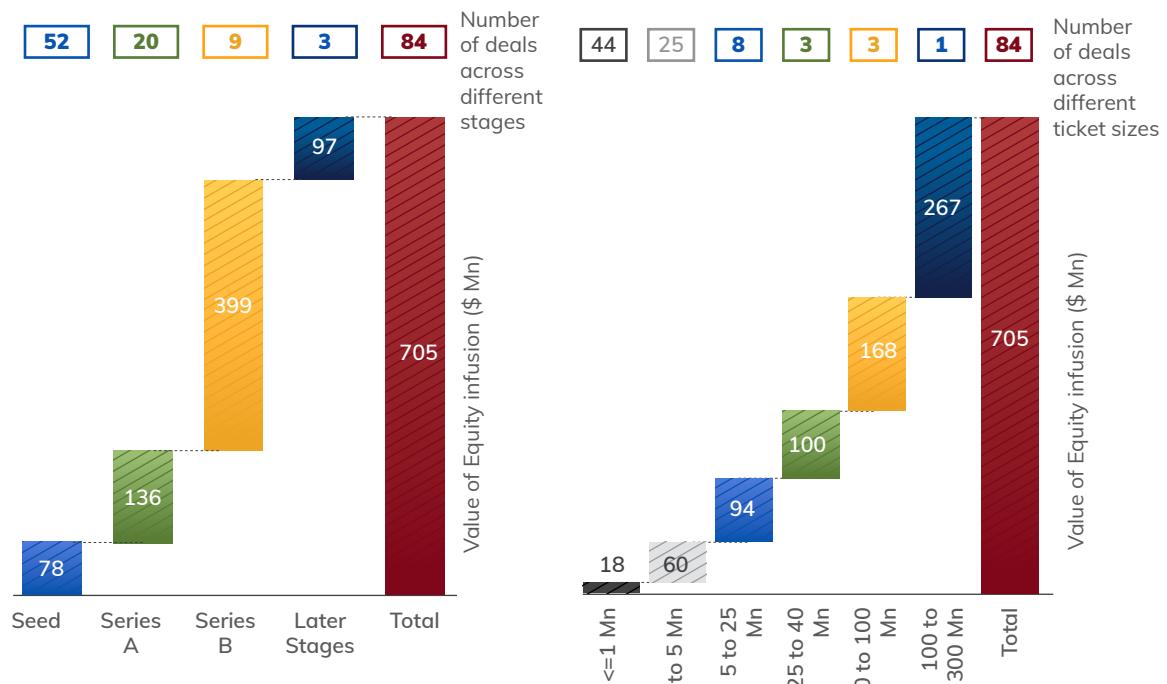
Source: Authors' calculations based on IIC Database

Clean Mobility (EVs): The sub-segment attracted 85% (USD 602 million) of the capital inflow and accounted for almost half the number of sustainable mobility deals. Some of these manufacturers work end-to-end in the EV value chain, even establishing dedicated charging infrastructure for their EV platforms and/or providing custom-built platforms with connected vehicle solutions for commercial clients. EV ride-hailing and/or shared mobility solutions have witnessed only a handful of deals. The lower number of deals could reflect both barriers to entry as well as risks seen by investors due to existing large players also foraying into the space with their own EV offerings. Both Clean Logistics and Novel batteries and Fuel cells saw an increase in the number of deals in 2019 and 2020 compared to the previous years. However, the quantum of funds invested in novel batteries, charging and components focused startups is quite low (USD 16 million), suggesting that some of the constituent segments within this space have only been able to attract small ticket sizes (perhaps due to their nascentcy).

VII. Unlike other Climate-tech sub-sectors, sustainable mobility has witnessed a larger share of enterprises transitioning to Series B and later stage funding.

Of the Series B and later stage deals in all climate-tech sub-sectors, those in sustainable mobility constitute ~50% (by volume) and ~64% (by value).

Exhibit 41: Deal across stages and ticket sizes (value and volume)

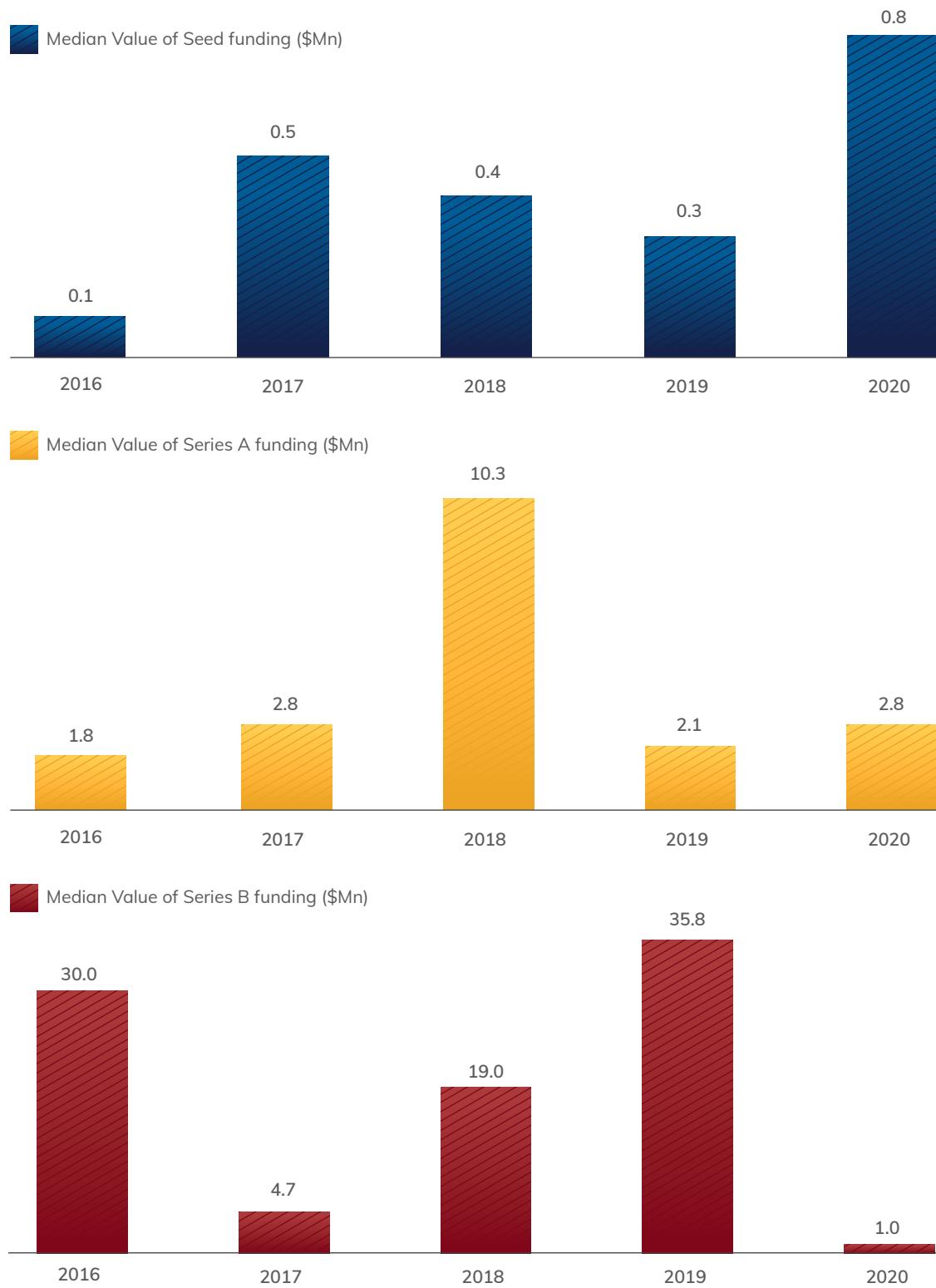


Source: Authors' calculations based on IIC Database



The median value across funding stages between 2016 and 2021

Exhibit 42: Median value of deals across stages over the years



Source: Authors' calculations based on IIC Database

VIII. Case study



Lithium Urban Technologies

\$19.3 Million

Total Amount Raised

2014

- Founders
Sanjay Krishnan,
Ashwin Mahesh

- Last Funding Stage
Series Unknown

- Sub Segment
**Clean Logistics,
Fleets, Connected
Vehicles**



Business Model

Lithium Urban Technologies provides Mobility as a Service to corporate clients. Its integrated service offering for employee transport is cheaper than Diesel or CNG fleets. As per Lithium, its fleet of Electric Cars and Buses is the largest electric vehicle fleet in the world outside China. In Oct 2020, Uber announced a partnership with Lithium to deploy 1000 electric cars (all sedans) across Uber Rentals and Premier in Delhi NCR, Mumbai, Bengaluru, Hyderabad and Pune.⁷⁵



Innovation (Product innovation)

Lithium's business model innovation provides an integrated solution with zero upfront capex structure, on-site technology teams, trained and certified drivers, integrated fleet management suite, productivity and CRM solutions, data-analytics stack, charging and energy infrastructure network, security features like tamper proof GPS and two-way in-vehicle activity recording, flat YoY budgets (with no escalations in prices). This presents corporate clients a solution that allows them to have a quick and easy transition to all-electric sustainable transport solutions.



Climate Impact

Lithium Urban Technologies estimates its fleet of vehicles to have covered 78,994,110 e-miles to date and 19,447 MT CO₂e abated. Further, a transition to sustainable mobility has led to instances where the client is interested in adopting other sustainable solutions as well.

“

EV is today what solar was 5-7 years ago. They will be successful and produce a few examples worth noticing. Small players will get consolidated by big players as the sector matures further

Kunal Upadhyay,
Co-Founder and Managing Partner,
Bharat Innovation fund

“

Technology risk is high in the EV space but people know EV is upcoming and hence people are comfortable now to invest in it. It's a known devil and has garnered comfort biases.

Karthik Chandrasekar,
Founder and Partner,
Sangam Ventures

”

IX. Outlook - Investor Focus

1. EV Manufacturing, an opportunity ahead

Given significant Government backing through enabling policies, sustainable mobility solutions and particularly EVs hold immense potential to disrupt the entire transportation sector. The following are some of the opportunities in the EV manufacturing space for startups:

- In both the passenger and commercial vehicle categories, innovations disrupting existing supply chains through customized component manufacture - motors, motor drives, powertrains, battery packs etc., will have strong growth potential.
- New entrants in EV manufacturing in the passenger vehicle category may face barriers due to presence of large OEMs or first movers, but there is potential to differentiate through unique offerings, particularly in the light vehicle category.
- Commercial EV manufacturers (particularly the LCV category – 3-wheelers, vans, light trucks) hold potential to scale-up significantly.

2. Strong investor momentum in energy storage and management for mobility applications

Novel battery materials and chemistries as well as smart battery management systems (either bundled by the battery manufacturer or a standalone solution for converting any battery to an intelligently monitored one) will continue to attract investor attention, given the scope for blending electronics/hardware with AI, ML etc.

3. Solutions for resolving infrastructure gaps hold potential

Smart/fast charging solutions and infrastructure deployment, despite being slightly more asset heavy, hold potential. This is driven by the nascent stage of the sub-sector and presence of very few players.

4. Changing behaviors/requirements from consumers can nudge the investors to divert funding

Shared mobility solutions for corporate employee transport needs may find interest among investors, especially if these interventions help modernize/ replace existing non-sustainable transport means and have integrated solutions for other value-added services like charging infrastructure support and tracking of vehicles among others.

5. Solutions that make EV adoption affordable and easy will continue to see traction

Startups that aim to lower the cost of adoption of EVs or help transition fleets through lease rental solutions face challenges, as OEMs and large logistics players have the capability to provide similar solutions. Nevertheless, nimble startups in this space could serve certain segments quite well – specifically, the logistics and delivery personnel market, driver partners of cab aggregator platforms and, last-mile 3-wheeler owners.

6. Startup activity in heavy vehicles may rise in the future

Long distance heavy transport for goods and/ or people movement covering clean marine, aviation and heavy trucking is very nascent in India. Hopefully, this space will see innovations and solutions especially given the government's recent push in this direction with the National Hydrogen Mission.

- Fuel Cells for EVs (as against batteries for EVs) will be of interest, particularly for long-haul heavy transport applications. Incidentally, Log 9 Materials is also developing an Aluminium Fuel Cell technology for use in long-distance transport.
- Solar-powered boats (e.g., by Navalt) may benefit from the market created by the Government's push on inland waterways for transport.

7. Sustained policy push on Hydrogen Economy will act as a tailwind for generating more investor interest

While vehicle platforms powered by fuel cells utilizing hydrogen (or other hydrocarbons) or other materials are still being researched and developed in India, other value-chain innovations like green hydrogen generation, and hydrogen storage solutions will be an area of interest to early-stage investors, especially given the recent policy announcements to develop a hydrogen economy.

CLIMATE-SMART AGRICULTURE & FOOD

I. Agriculture contributes to ~14% of India's GHG emissions⁷⁶

The agriculture sector is the largest contributor of the non-CO₂-related GHGs emission at a global level with the Indian agriculture sector alone accounting for ~1.5% of the global GHG emissions (2018).^{77,78} Agricultural practices across the value chain, right from crop selection, water usage, use of fertilizer and pesticides to crop cycles, have a direct impact on climate change, and cause depletion of soil fertility and health, yield, etc., ultimately affecting the magnitude and periodicity of droughts.⁷⁹ Intense unsustainable agricultural activities have led to the depletion of groundwater in India to an alarming level and 68% of the country is estimated to have low groundwater availability by 2025.⁸⁰



Nearly 70% of rural households in India are dependent on agriculture-based activities and due to unpredictable weather patterns and a high dependence on rain-fed irrigation, with depleting groundwater tables, a large population is extremely vulnerable to climate change.^{81,82}

II. Even though India is self-sufficient in staples like wheat, rice, sugarcane, pulses, etc., there are many gaps in the overall value chain.⁸³ These gaps emerge from the non-uniform nature of India's geography & climatic conditions, poor infrastructure and policy weaknesses which often lead to inefficiencies.

In 2008, as a part of the NAPCC, the National Mission for Sustainable Agriculture (NMSA) was established to focus on afforestation and water and soil health management. However, a mere 0.8% of the budget from the Ministry of Agriculture and Farmers Welfare (MoAFW) has been allocated to the NMSA over the years.⁸⁴ The focal point for most of the reforms in the agriculture sector has been on improving the livelihood of the farmers, whereas climate adaptation and mitigation have not been a priority. Hence, the climate-smart agriculture & food sub-sector is ripe for interventions from startups at different points in the value chain - from enhancing yields and quality, and/or creating innovative food products without being detrimental for the environment, while reducing inefficiencies and wastage.

Exhibit 43: Various structural gaps in the value chain of agriculture sector in India

| | |
|--|---|
| Poor situation of farmers  | <ul style="list-style-type: none">Small land holdings (almost 86% farmers with less than 2 hectares of land) and low per capita income making it hard for farmers to adopt hardware solutions/mechanization (CapEx) and better quality inputs (OpEx); High percentage of marginal farmers in India – focused on subsistence over climate mitigation |
| India's diverse topography  | <ul style="list-style-type: none">Diverse range of soil type and quality, weather conditions, water availability, etc. makes it difficult to emulate a model from one location to another ('one size fits all' solution is not possible)There is a need for tailor-made solutions that are devised keeping in mind the regional attributes |
| Infrastructure & Information - or the lack of it  | <ul style="list-style-type: none">Poor storage and logistics infrastructure – leading to post harvest food wastageLack of accurate predictive models for monitoring demand/supply, weather conditions, etc., leading to unpredictability in the sector – pushing farmers to stick to safe/standard essential crops |
| Knowledge Gap  | <ul style="list-style-type: none">Limited awareness among farmers leading to poor crop mix selection – for instance, reluctance in moving to crops like Ragi, bajra, etc. that require less Nitrogen based fertilizers compared to rice/wheat |

Source: Data from Bain and Company, ORF, research

III. While initially impacted agriculture recovered relatively quickly from Covid-19

The production of agri products was not adversely affected by the onset of Covid-19 in 2020 and the second wave in 2021 as the harvest was almost complete by April in both years.^{85,86} This reflects in the startup activities for the year 2020 as well, since climate-smart agriculture startup investments did not see a decline like other sub-sectors in 2020. However, due to restrictions on vehicular movement and closure of markets, there was an increase in the price of farm inputs like seeds, pesticides, etc. by 9% to 12%.⁸⁷ Lockdowns through 2020 led to a fall in demand due to the closure of hotels, restaurants, and other bulk purchasers of farm produce.⁸⁸ With the lockdown easing, the issues around agri-inputs and demand are re-balancing. However, structural challenges such as long supply-chain, lack of models for matching demand-supply, unhealthy inputs that deteriorate the soil quality and water tables, etc. call for more innovation, especially from startups.^{89,90}

IV. Key Investment Hypotheses – Saving the Green Cover

a. Climate-focused Precision Agriculture

Investors have backed innovations (e.g., Satyukt Analytics, FarmERP, Fasal, Krishitantra) with a strong technology play (across hardware-software) that offer climate-focused precision agriculture, monitoring and advisory services to farmers as well as other stakeholders in the agri value chain

b. Eco-Friendly Agri-inputs

Investors have been backing deep-science material innovations that help create eco-friendly agri-inputs (e.g, Telluris Biotech, Fibsol, Utkal Tubers, Seed Works). When investing in these innovations, the priority for investors is to identify commercially-viable manufacturing processes and the potential for income-enhancement of farmers through improved yields and / or reduced food loss, while climate impact is a secondary priority

c. Food Loss Reduction

Supply-chain innovations that provide better market-linkages (e.g., Waycool), carry out contract-based farming and/ or provide cold-chain solutions like cold storages and logistics (e.g., Ecozen, Inficold, Promethean Power Systems) for minimizing food loss are also being backed by investors

d. Organic Farming & Products

Organic produce is a niche but growing market in India, and there are food producers that are emerging to cater to the health-conscious consumer base. Investors have recognised the potential in this market and have backed such producers (e.g., Carmel Organics, Akshayakalpa, Wingreens), many of whom also have backward linkages with farmers to source organic produce and to encourage climate-friendly agricultural practices. However, it is pertinent to note that investors are primarily motivated by the potential of many such innovations to become large D2C/ B2C plays, and not necessarily the climate impact

V. Many countries including India have been experimenting with the implementation of Climate Smart-agri techniques⁹¹

Globally this sub-sector received USD 8.1 billion funding between 2013 and 2019 with the number of deals increased from 21 in 2013 to 162 in 2019.⁹² However, a lot of the global traction is attributed to alternate food technology such as plant-based meat, alternate protein, etc. (almost 46% of the deals in 2019) due to the increasing inclination towards veganism/vegetarianism, and awareness about the damage to the environment caused by the meat industry.⁹³ In contrast, there are not many companies in this space in India.

VI. 22 climate-focused agri startups have raised ~USD 120 million of capital in 27 deals in the last five years in India, making it almost 10% of the entire early-stage climate-tech ecosystem in terms of value of equity infusion

The eco-friendly agri inputs sub-segment has seen the most action, both in terms of capital and deal-volume, with one of the most prominent deals being Seed Works' raising ~USD 17 million in 2020 from GEF Capital Partners. Key active investors in this space in India include Omnivore and Acumen.

Exhibit 44: Capital infusion into climate-smart agriculture & food deals in India, 2016-2020

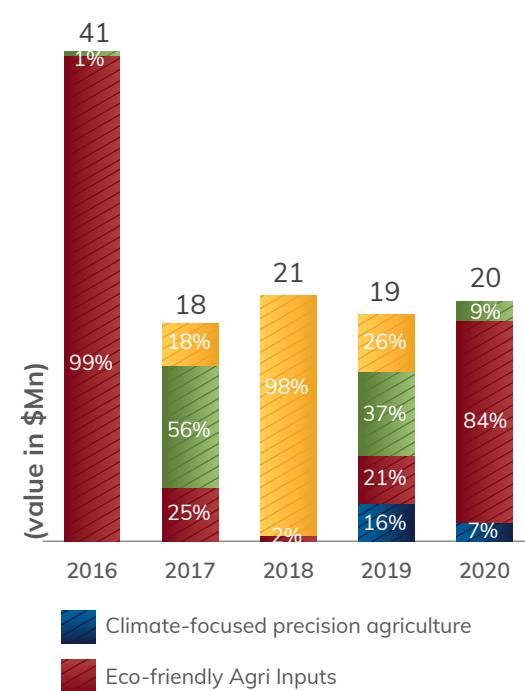
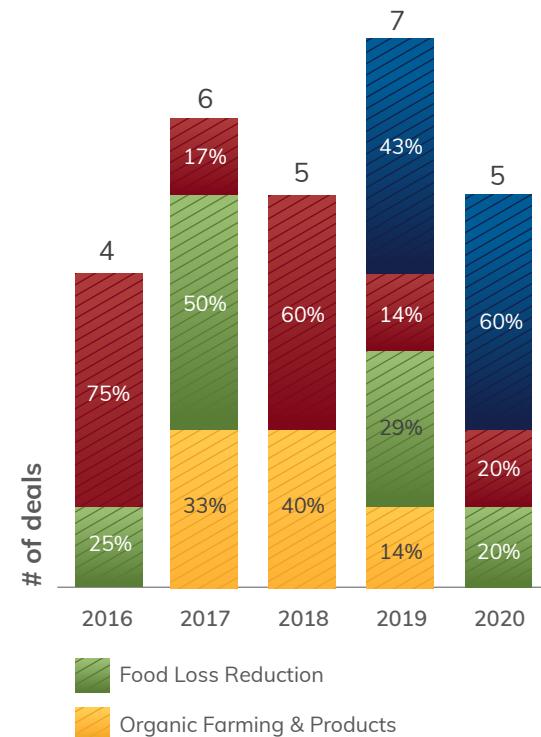


Exhibit 45: Capital infusion into climate-smart agriculture & food deals in India, 2016-2020



Source: Authors' calculations based on IIC Databases

High average deal value in Eco-Friendly Agri-inputs reflects the higher capital needed to develop and manufacture these products with requisite bio-safety, food-safety and other regulatory protocols in place. Investors have cumulatively invested USD 19 million in startups solutions for value chain inefficiencies and food loss reduction. Of these, the ones that improve resource-efficiency in the agri supply-chain (cold chains, efficient logistics) have a clear and definite climate impact and large future growth potential. Climate-Focused Precision Agriculture has seen the lowest early-stage funding of USD 5 million among all others in this sub-sector.

Since the majority of the farmers in India are smallholding ones, large-scale adoption of these solutions is a challenge that entrepreneurs are attempting to address.

Unlike most other sub-sectors within Climate-tech, the Climate-Smart Agriculture & Food sub-sector is dominated by Adaptation & Resilience (A&R) solutions. This arises from the fact that a large number of innovations in this space cut across various sub-sectors and it is complicated to attribute the direct emissions reductions to specific parts of the life-cycle.

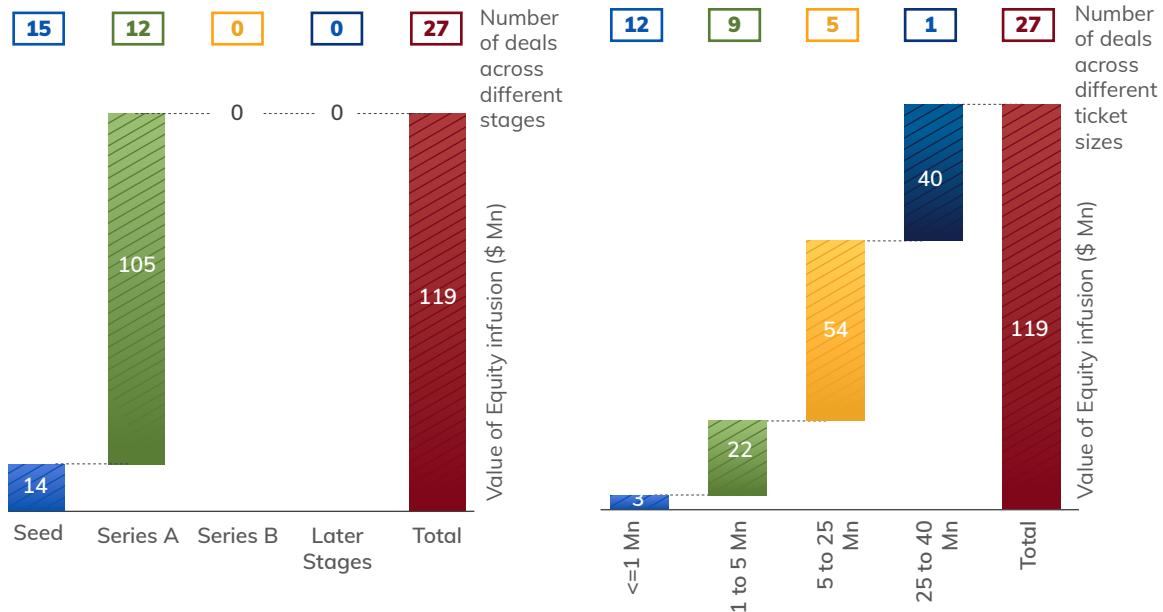
Further, the direct impact of many such innovations are on agricultural and agri-related communities - specifically by helping build their resilience and adaptation capacities.



VII. Seed-stage funding has seen the largest number of deals in the sub-sector between 2016 and 2020, followed by Series A as a close second. The overall median deal size across this sub-sector is USD 1.4 million

Funding beyond Series A in this sub-sector has not really taken off.

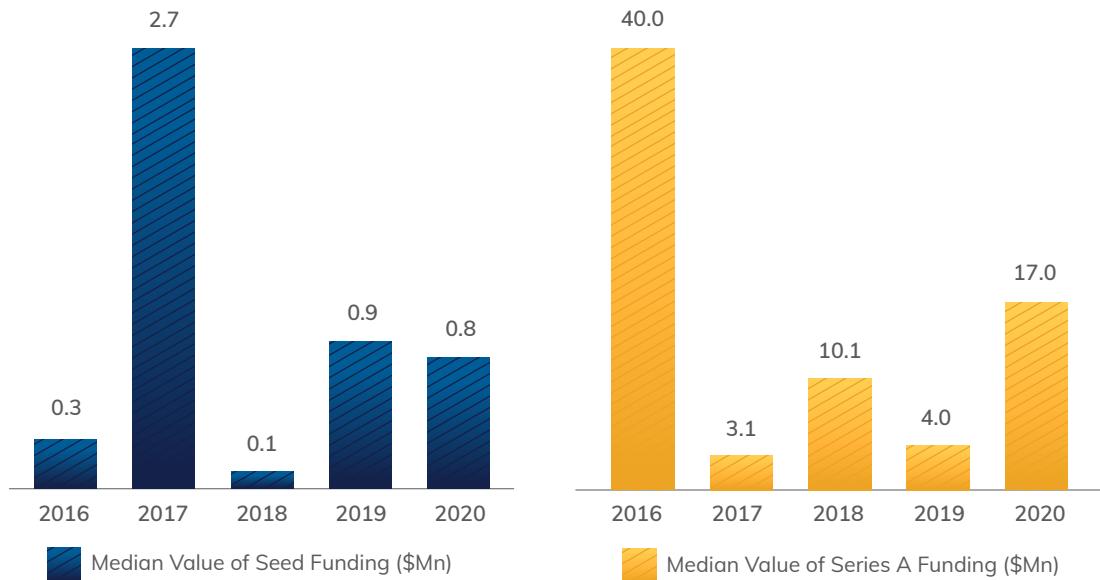
Exhibit 46: Deal across stages and ticket sizes (value and volume)



Source: Authors' calculations based on IIC Databases

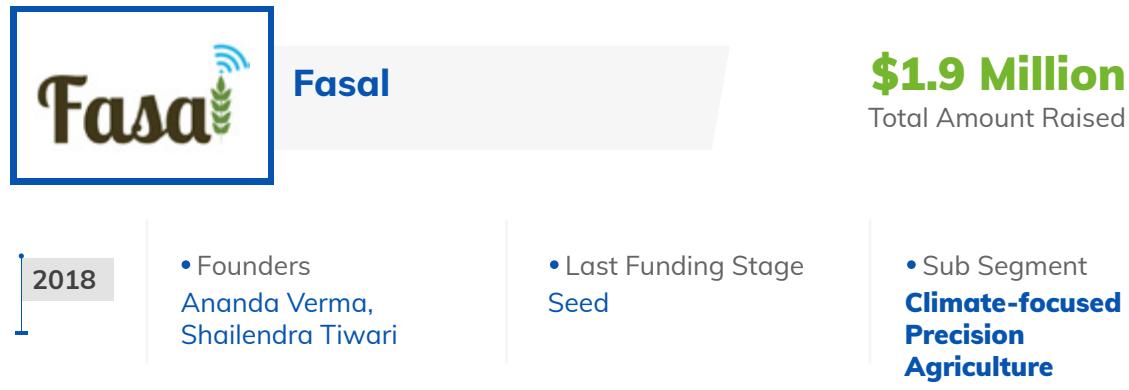
The median value across funding stages between 2016 and 2021

Exhibit 47: Median value of deals across stages over the years



Source: Authors' calculations based on IIC Databases

VIII. Case study



Business Model

Fasal is a farm-level crop intelligence system that provides farmers with farm level, crop-specific, crop-stage specific actionable data-driven insights to grow more and grow better. Fasal system uses IoT-based sensors using AI and Machine Learning to provide real-time actionable advisories to farmers in six different vernacular languages using the Fasal App. The Fasal system has built an end-to-end solution for ten crops, including grape, pomegranate, tomato, chilli, capsicum, with pilots running in the pre-harvest value chain for tea, coffee, orange, banana, and apple.

Innovation (Product innovation)

Fasal's solution gives farmers greater control by providing timely alerts related to irrigation, pest and disease, fertilizer sprays and micro-climatic environment around the farmland. IoT based sensors help farmers better predict irrigation cycles, soil sensors advise on timing and rate of crop-specific irrigation; specialized sensors gauge micro-climate conditions that are more useful to the farmers than weather forecasts in maximizing the crop yield.

Climate Impact

The “crop-based approach,” helps increase productivity; reduces water, fertilizer, and pesticide use; controls adverse ecological impacts; lowers river and groundwater contamination from farm chemicals and minimizes food loss/ wastage. Fasal claims to have increased crop yields by 30-40 per cent, reduced pests and diseases by 50-60 per cent and saved about 3 billion litres of water from irrigation.

“

Scaling sectors in geography dependent sectors like agriculture is more challenging relative to energy and EV sub-segments. Even on the consumer side, demand for organically grown produce needs to increase significantly for supply to transition from their existing practices.

Paraag Sabhlok,
Acumen

“

To implement the solutions in different regions, the enterprises need to collaborate / partner with the local stakeholders to build trust and familiarize the farmers with the products / solutions because farmers are reluctant to rely on models with unknown results.

Mark Kahn,
Omnivore

”

IX. Outlook – Search for The Perfect Model

1. While early-stage investments in Climate-Smart Agriculture have been following the growing trend in AgriTech as a whole, for many startups the potential for faster growth is still unrealized

Agri startups in general face longer timelines for growth and exits due to inherent challenges with adoption and scalability, and these challenges are exacerbated for climate-smart products and services, as these need significant awareness and behavioural changes among stakeholders in the agri value chain. This makes it less attractive for later-stage investors to make follow-on investments in such startups. Therefore, dedicated pools of early-stage capital from committed and patient investors who understand the climate-smart agriculture and food sub-sector (i.e. bilateral and multilateral agencies, as well as the government) may help catalyse interest among both risk and follow-on capital, and lead to sustained investments in the space.



2. Need to look at blended finance models as well as end-consumer financing solutions for sub-segments

Among Climate-smart agriculture innovations, the capital-intensive and asset-heavy ones with decentralized deployment models need longer timelines than most others. These include for example, climate-focused precision agriculture solutions for farms and cold-storages at the farm-gate. The challenges associated with mobilizing and scaling up adoption among farmer communities for such solutions are significant. Yet, these are the challenging but important innovations that need support in an already difficult sub-sector. For these, beyond-patient capital at the early-stages, blended finance models as well as end-consumer financing solutions will be critical in achieving the scale that India requires.

3. There are some green-shoots in deep-science material innovations, with startups developing alternative proteins like lab-grown and plant-based meats, as well as proteins extracted from eco-friendly agri-crops

Such startups are exploring both B2B and B2C plays in this space. Given India's economic growth and increased protein demand over the next decades, this should be an area of growth.

4. Another area of interest for investors are disruptive deep-science innovations creating animal or human nutrition products and additives, through unique raw materials like waste GHGs, seaweeds, agro-waste and others

The priority for investors here is to identify a high-growth technology that can scale in the feed & nutrition market, with climate impact being a desirable bonus. Such innovations can use different types of raw materials (waste streams or fresh raw material), hence in those cases they solve both waste as well as feed & nutrition challenges. This in fact allows such startups to access a wider pool of directed capital. Note that for this study, we classify innovations using waste streams under the Waste Management & Circular Economy sub-sector.

In the near-term, sub-segments like climate-focused precision agriculture, supply chain solutions and eco-friendly inputs specifically aimed at creating operational efficiencies, reducing food loss and improving yields; as well as innovations that can disrupt the animal/ human nutrition and/ or additives market will continue to drive investor interest.

ENVIRONMENT & NATURAL RESOURCES

I. India is the fifth most polluted country in the world and home to 21 of the 30 most polluted cities in the world

Multiple factors contribute to the high air pollution in Indian cities including electricity generation, transportation, heavy industry manufacturing, periodic burning of agricultural residue, construction activities, etc.^{94,95} Apart from polluted air, India also faces an acute water pollution problem; 80% of fresh water in India is polluted due to almost 40 million litres of wastewater, raw sewage, and the garbage being released into rivers, lakes, and oceans every day.⁹⁶ The Ganges is among the top 5 most polluted rivers in the world and has the maximum concentration of microplastics in any river in the world.^{97,98} With 18% of the world's population and only 4% of the freshwater sources of the world, it is projected that nearly 40% of India's population may not even have access to clean water sources by 2030.^{99,100,101}

II. Even though initiatives like the National Water Mission have been established under the National Action Plan for Climate Change (2008) to solve issues of water pollution, they are far behind targets¹⁰²

Other initiatives include action plans for water conservation like the Jal Jeevan Mission (a Centre-state collaboration) and the National Clean Air Programme for the reduction of ambient air pollution. There is also a strong focus on developing technologies for Carbon Capture, Utilization and Storage (CCUS). India is collaborating with 23 members of Mission Innovation on R&D projects with the intention of achieving near-zero CO2 emissions in industries like energy, steel and cement.^{103,104,105} Since these policies have been framed in the last few years, their true impact is yet to be observed. Hopefully, these will create opportunities for private sector enterprises to bring in innovative solutions to create a change in the way we consume and manage natural resources.

Exhibit 48: Various recent policy initiatives to control pollution and conserve resources

National Clean Air Programme

Established in 2019 with the view to receive to reduce Particulate Matter 2.5 emission by 20-30% by 2024 by intervention in 102 identified cities through technical assistance, collaborated approach, etc

Jal Jeevan Mission

Launched in 2019 with the vision to make safe and adequate drinking water available through taps by 2024 and manage water conservations; received ₹500 Bn allocation in Union budget 2021-2022

Carbon Capture Utilization and Storage

In 2018, Department of Science and Technology and Department of Biotechnology joined called for R&D projects with Mission Innovation countries to establish CCUS technologies

India Cooling Action Plan

Launched in 2019 with a 20 year horizon to reduce emissions from cooling requirements through sustainable technologies and providing thermal comfort to all

Source: Data from MOEF, Shakti Foundation, IEA, research

III. Key Investment Hypotheses – Banking on the Core

The Environment & Natural Resources sub-sector within Climate-tech covers a wide-range of innovations that have a direct impact on water, air and the ambient environment. This sub-sector also includes innovations that lead to a reduction in GHG emissions through carbon capture (for utilization or sequestration), or even a decrease in pollution. In the forestry and sustainable land-use space while we haven't considered larger project-based solutions, there are technology-led early-stage startups that are likely to experience growth, and become increasingly attractive to investors.

a. Air Pollution and Ambient Environment

Examples of the types of innovations that investors have supported include solutions to monitor and clean indoor air (e.g., Clairco), air purification solutions (e.g., AirOk Technologies), innovations converting Black Carbon from diesel gen-set exhausts to ink (e.g., Chakr Innovation), as well as data-harvesting and data analytics solutions (e.g., Ambee).

b. Clean Water

A large proportion of the innovations supported in this category are solving drinking water challenges in India. Purification technologies for drinking water (e.g., Aquvio, InnoDI), treatment solutions for wastewater streams from various sources (e.g., Membrane Filters India, EcoStp), as well as new clean water distribution (e.g., Janajal) or product solutions (e.g., Pyotam) have all found investor backing.

c. Water Management and Conservation

Include water metering solutions combining IOT, data analytics, AI/ML layers for water conservation and managing water use within households, commercial spaces and industrial sites

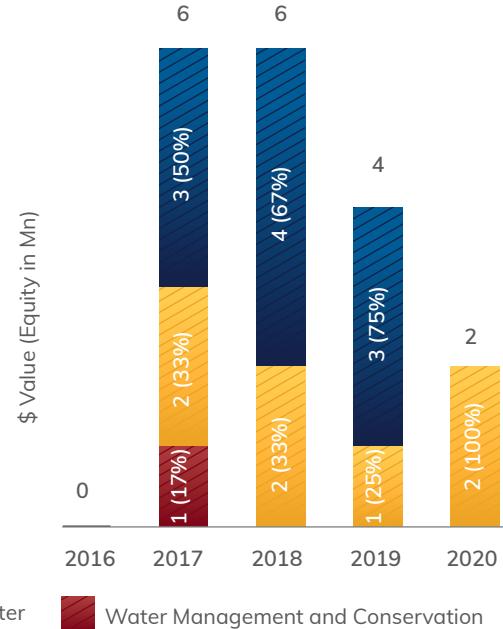
IV. More than 10 environment and natural resources startups have raised ~USD 18 million of capital in 18 deals in the last 5 years in India

Air Pollution and Ambient Environment innovations: Witnessed both the largest number of deals, as well as the most capital invested (USD 8 million) between 2016 and 2020. The Clean Water sub-segment witnessed a cumulative investment of USD 7 million in the period 2016-2020, which is a close second among various sub-segments. The Water Management and Conservation sub-segment has seen just one deal (Smarter Homes) between 2016 and 2020. Some of the challenges in this space include barriers to entry for new entrants as larger players already cater to industrial clients, challenges of working with municipal bodies that control the urban water supply in India, as well as the inherent issues with scalability when catering to SMEs and individual household consumers (i.e., cost barriers and no clear mandates to drive adoption among these consumer categories).

Exhibit 49: Capital infusion into environment & natural resources deals in India, 2016-2020



Exhibit 50: Capital infusion into environment & natural resources deals in India, 2016-2020

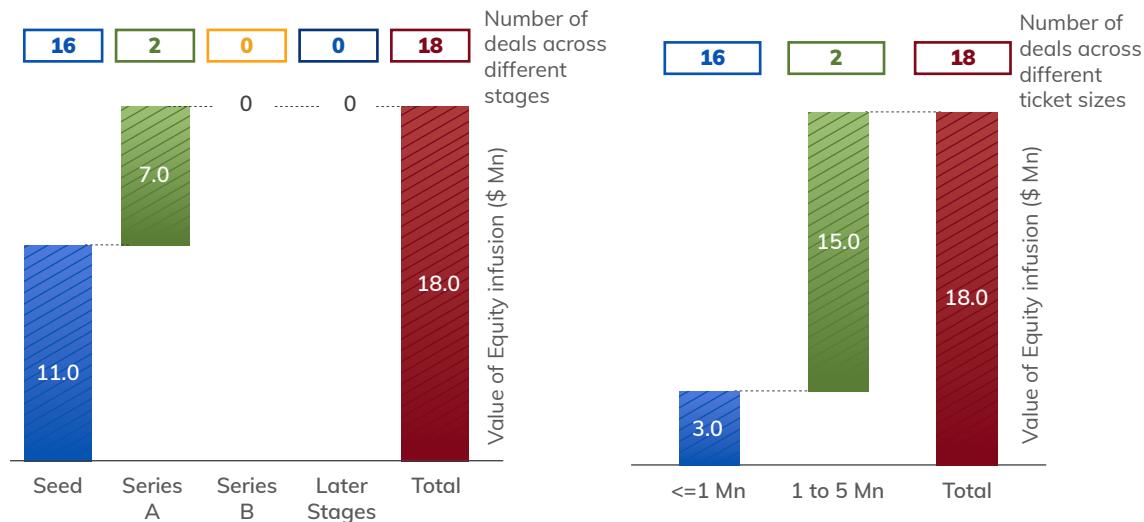


Source: Authors' calculations based on IIC Databases

V. Seed funding is the dominant stage of funding for the entities in this space with only 2 deals at the Series A stage

The majority of investments are less than USD 1 million in size as innovations are gradually building up in this space.

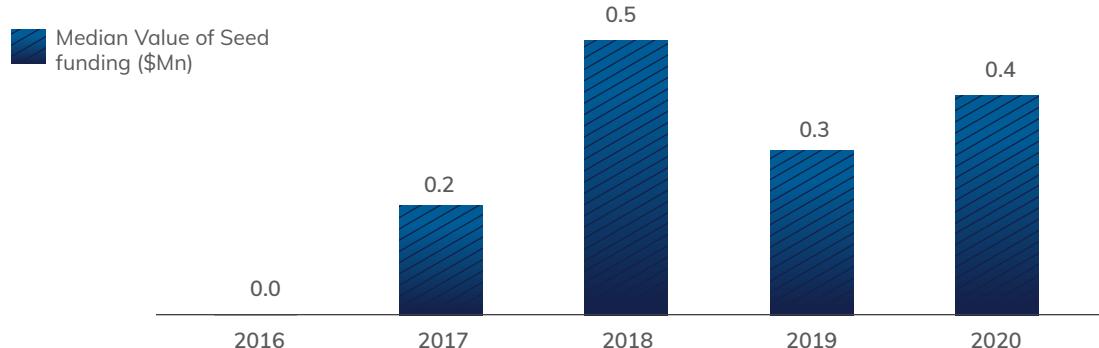
Exhibit 51: Deal across stages and ticket sizes (value and volume)



Source: Authors' calculations based on IIC Databases

Exhibit 50 below shows the median value across the seed funding stage between 2016 and 2021. The number of deals in subsequent stages is low and not enough to derive trends.

Exhibit 52: Median value of deals across stages over the years



Source: Authors' calculations based on IIC Databases

VI. Case study



Chakr Innovation

\$3.34 Million

Total Amount Raised

2016

- Founders
Kushagra Srivastava,
Bharti Singhla

- Last Funding Stage
Series A

- Sub Segment
Air Pollution & Ambient Environment



Business Model

Chakr Innovation has developed a retrofit emission control device that captures up to 90% of the particulate matter from exhausts of diesel generators right at source.



Innovation (Product innovation)

Chakr's product, Chakr Shield, captures pollution (black carbon) at the source, thereby preventing it from being airborne, inhaled or settling on the ice caps and causing radiative forcing. The solution requires fractional energy consumption to operate, has low maintenance needs and has a product life of up to 12 years.



Climate Impact

The technology can capture over 90% of particulate matter emissions from the exhaust of diesel generators without causing any adverse impact on the diesel engine. The estimated GHG reduction by global adoption of this technology is likely to be 10.5 million tonnes by 2027.

VII. Outlook – Adding Value

1. Due to the looming air pollution crisis in most major cities in India, customer demand for indoor clean air solutions is growing

There are also increased (though uneven) regulatory mandates on checking air-polluting sources. As a result, entrepreneurs are stepping in with innovative solutions and investors are continuing to back such startups (e.g., Devic Earth provides unique AI powered pulse RF energy to clear air pollutants and the solution is scalable for use in small indoor spaces as well as large cities).

2. Indian cities face an acute water crisis, and, therefore, water-use management and conservation innovations (particularly for household use) will see growing demand¹⁰⁶

However, without strong mandates and/ or measures to bring down cost to consumers, the adoption of such solutions will remain limited. Solutions geared for SME manufacturing sites and/ or business clusters may present similar challenges in adoption and scalability, with a lack of clear enforceable mandates. Large industrial clients will, however, continue to adopt innovations that can reduce their operational expenses related to water use and management. Solutions targeted at Government water utilities (B2G) are taking root in India as well, but are beset with long and uncertain procurement cycles – and without a committed and focused push from the government at the state and central level, these have significant risks in commercial scalability.



3. Technology enabled or software-first forestry and afforestation solutions in offing

Solutions that help monitor forest-cover loss/ deforestation through technology enabled software-first and intelligent software-hardware approaches and/or those that help accelerate climate-friendly land use through commercial asset-light interventions will see greater interest from investors, given their overall importance in climate mitigation.

4. At present not many startups are working on carbon capture solutions in India, but they are expected to grow

Solutions that capture CO2 & other GHGs and utilize them to create value-added products and/ or sequester them for long durations have a direct emissions reduction impact. Recognising that net zero targets require us to extract from the atmosphere what has already been emitted is important. There are a growing number of startups that accomplish this in other geographies outside India - but such startups have not yet attracted any significant funding in India. However, we expect this to be a potential growth area, as India still has a large number of thermal power plants and polluting industries expected to run for a few decades more. As an illustration, StringBio in India is focused on utilizing waste gases like methane and CO2 (from landfills and other streams) to create animal and human nutrition products, biodegradable plastics, bio-cosmetics and bio-based agri inputs, thereby solving multiple challenges. Such diversity in feedstock and outputs in fact allows such startups to access a wider pool of directed capital.



WASTE MANAGEMENT & CIRCULAR ECONOMY

I. India's annual material consumption is expected to double from 7 billion tonnes in 2015 to 14.2 billion tonnes in 2030¹⁰⁷

While in Europe, 70% of the consumption materials get recycled, India recycles only about 20% of its consumption materials.¹⁰⁸ More than 50% of the waste produced in India ends up in landfills due to inefficient waste management systems, and these landfills emit methane and carbon dioxide creating hazardous breathing conditions.^{109,110} India has only about 2% of the world's landmass and is expected to surpass China to become the most populated country by 2027; a take-make-dispose linear economy model is unsustainable for India given the pressure on resources.^{111,112}

II. Covid-19 has made waste handling even more precarious in India

As bio-medical waste gets mixed with household waste in the form of surgical masks, face shields, gloves, PPE kits, etc. - an estimated 46,000 tonnes of Covid-19 waste was generated by May 2021.^{113,114} While the Central Pollution Control Board has taken action by introducing guidelines for managing and handling Covid-19 waste, a paucity of data makes it hard to conclude how effective these measures have been.¹¹⁵

III. Despite positive intent, implementation of effective waste management practices has been difficult in India

due to structural, financial and capacity issues at the local Government levels (ULBs, Gram Panchayats and Zila Parishads).¹¹⁶ A new set of comprehensive Solid Waste Management Rules (2016) were introduced amending the original rules from 2000.¹¹⁷ These cover municipal level management and guidelines ranging from segregation at source, to waste treatment and processing.^{118,119} However, almost 80% of the municipal budget for solid waste management is allocated to the collection and transportation of waste streams, and thus there are limited resources left for the treatment and processing of the waste - ultimately leading to untreated/unprocessed waste added to landfills.¹²⁰ Gaps and inefficiencies such as fragmented supply chains, lack of source segregation and collection, waste treatment processing etc., in India create a huge untapped opportunity for startups.

IV. Key Investment Hypotheses – Wealth in Waste

Given the extent of the challenges, multiple startups have started building innovative solutions towards creating a circular economy.¹²¹ Investors have been backing innovations across sub-segments like waste collection & handling, generating value from waste, and proprietary technologies for manufacturing upcycled/ recycled products. More recently, Extended Producer Responsibility (EPR) regulations have made available incentives for entrepreneurs to develop solutions and services to cater to customer demand in this segment.

a. Waste Collection & Handling

Most startups in the space provide services for post-consumer waste collection and pick-up, built on soft-technology platforms (e.g., Lets Recycle, Bintix, Junkart, TheKabadiWala) that in some cases combine IoT, algorithms and analytics to measure, track and control waste from collection to recycling (e.g., Citizengage, Recykal). Among these, the innovations that focus on large customers (like corporate offices, industrial sites, commercial spaces, large residential complexes) compete against incumbent service providers by increasing process efficiency using data & analytics. These solutions are also able to bundle EPR services and certificates for waste-diversion and emissions reduction.

b. Waste Management & Recycling

Startups that have proprietary in-house recycling technology solutions and are creating upcycled/ recycled products for commercial, industrial or household use (e.g., Banyan Nation, Lucro Plastecycle, Dalmia Polypro) have been backed by investors. Interestingly, these startups have developed an internal capability for direct collection to secure their waste feedstock, in addition to partnering for supply.

c. Waste to Value

A handful of startups that use deep-science innovations to help convert waste streams (agro-waste / industrial waste/municipal solid waste/ other waste) to value-added products like bio-plastics, food/ feed products (e.g., Krimanshi), energy and fuels (e.g., Carbon Masters, Green Joules) and other household/ personal use products (e.g., Phool) have also been of interest to investors. Here too, startups again have both in-house collection systems and/ or partnerships with external waste management firms and non-profits for their waste-stream raw materials.

V. 14 Waste management and circular economy startups have raised ~USD 43 million of capital across 24 deals in the last 5 years in India

This space is in a nascent stage with the median deal value being USD 0.4 million. Even globally, the transformative circularity focused deals are in a nascent stage with only about 32 deals happening between 2013 and 2019.¹²² However, the space is building momentum in India, with almost a third of the deals from the last five years happening in 2020 alone. Some of the active investors in this space in India include Aavishkaar Capital, Circulate Capital, and IAN Fund.

Exhibit 53: Capital infusion into waste management & circular economy deals in India, 2016-2020

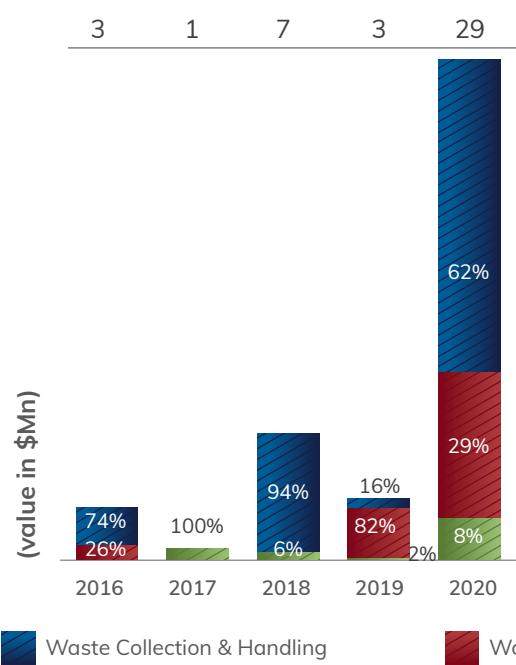
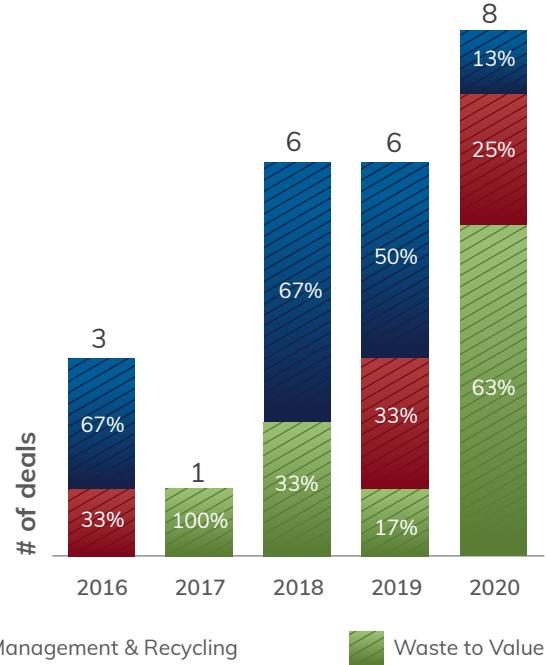


Exhibit 54: Capital infusion into waste management & circular economy deals in India, 2016-2020



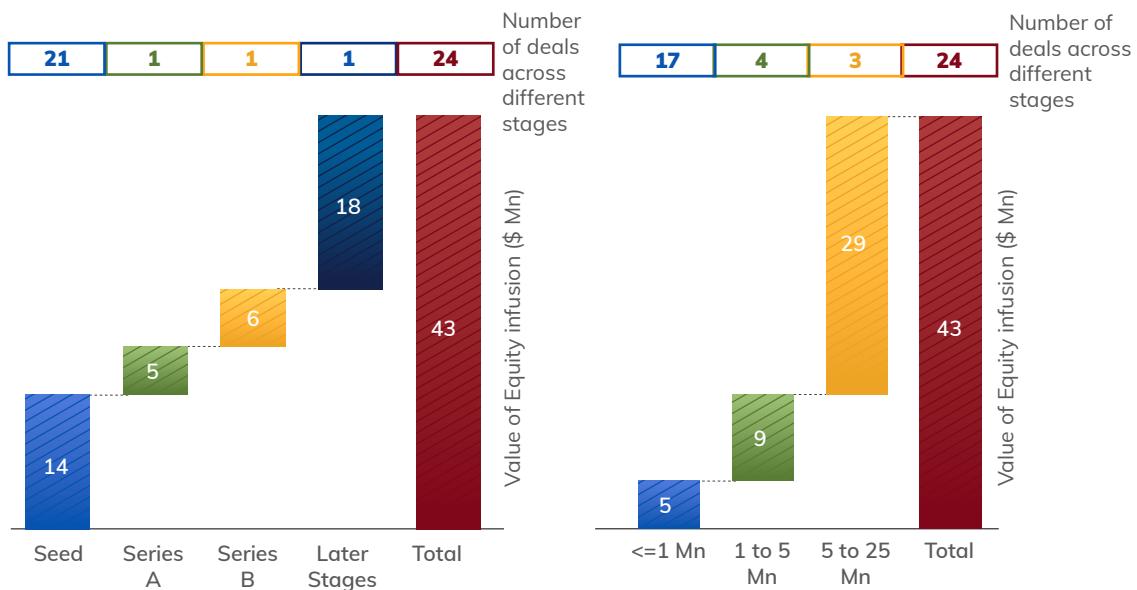
Source: Authors' calculations based on IIC Databases

The Waste Collection & Handling sub-segment has witnessed the maximum capital inflow. Interestingly, the traditional challenges of an unorganized and fragmented supply chain in the waste sector are no longer seen as a major risk (especially where waste is collected directly from large waste producers), and this sub-segment has seen the largest quantum of funds invested (USD 28 million). All four startups in Waste to value, that have received investments, use proprietary microbe and/ or bio-based approaches to convert waste to value-added products. However, the overall quantum of funds invested in this sub-segment is the lowest (USD 3 million), given the fact that these are novel technologies and/ or business models.

VI. Like most other Climate-tech sub-sectors, Seed funding is the dominant funding stage in terms of the volume of deals.

Let's Recycle raised USD 18 million in 2020 and is one of the marquee deals in the waste and circular economy sub-sector.

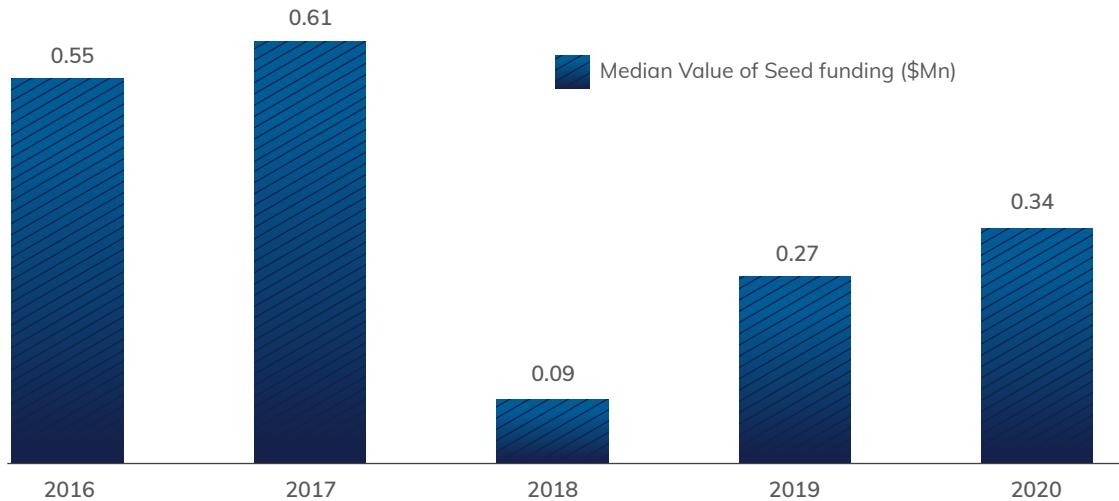
Exhibit 55: Deal across stages and ticket sizes (value and volume)



Source: Authors' calculations based on IIC Databases

The median value across the seed funding stage between 2016 and 2021 - The number of deals beyond seed funding are too few to derive any trends.

Exhibit 56: Median value of deals across stages over the years



Source: Authors' calculations based on IIC Databases

VII. Case study



Lucro Plastecycle

Undisclosed

Total Amount Raised

2012

- Founders
Ujwal Desai
(Co-founder)

- Last Funding Stage
Series A

- Sub Segment
**Waste
Management &
Recycling**



Business Model

Lucro is in the business of plastic waste management (flexible and rigid plastic waste) to create recycled/upcycled products. It focuses on closing the loop on post-consumer plastic waste through collection, segregation, washing, cleaning, recycling and manufacture of high quality products and packaging made from recycled plastic. The startup partners with organizations across private and public sectors, providing added traceability, helping them reuse plastics and enabling them to meet their sustainability goals. It serves customers across multiple categories like FMCG, F&B, automotive, home, retail, textile, electronics, institutions, agriculture and others. Lucro's units have 10000mtpa total waste collection capacity, 10000mtpa recycling plant capacity and 6,600 mtpa manufacturing plant capacity.



Innovation Process innovation, business model innovation)

1. Lucro's trademarked process Plast-E-CycleTM allows it to be present across collection, segregation, processing of granules, product design and manufacture. This end-to-end approach in the waste value chain gives it unique control on material coming in, designing custom products and catering to a wide variety of sectors and applications. Its products include recyclables (Re-PRO), compostables (Eco-PRO) and durables (DuraPRO).
2. Lucro has developed a blockchain based waste tracking software (currently available commercially) called Satma CETM that helps close the loop on waste. It is designed to track and monitor waste from pick-up to recycled product manufacture using QR codes.
3. Lucro has developed its own de-inking process and de-odorizing machine to help increase the value of post- consumer waste that comes into its facilities.



Climate Impact

Recycling & upcycling of post-consumer plastic to make new products helps reduce greenhouse gas emissions by lowering energy consumption as it avoids the higher GHG emission virgin plastic manufacture would produce. Further, the solution reduces the plastic waste reaching landfills and oceans since the startup's focus is on post-consumer waste.

VIII. Outlook – Asset Light Models the Winners

1. Existing issues in the sub-sector will attract solutions and investors

The Waste-management & Recycling and Waste to Valuesub – Several segments in India face challenges associated with unorganized and fragmented supply chains, the need for setting up in-house collection mechanisms to secure waste raw material streams, as well as the presence of a large number of small and large players in the recycling business. However, investors are willing to back innovations that have a technology-enabled or deep-science play with proprietary in-house technologies that can organise existing supply chains and markets, or make use of hitherto unutilized waste-streams.

2. Investors favour some level of aggregation

In the Waste Collection & Handling sub-segment, startups with technology-enabled services are able to address the inefficiencies in the existing (largely) informal and unorganized ecosystem. Investor comfort is enhanced when startups have contracts with large waste producers - like commercial spaces, industrial sites and big residential complexes.

3. Asset light models to find space in this sub-sector

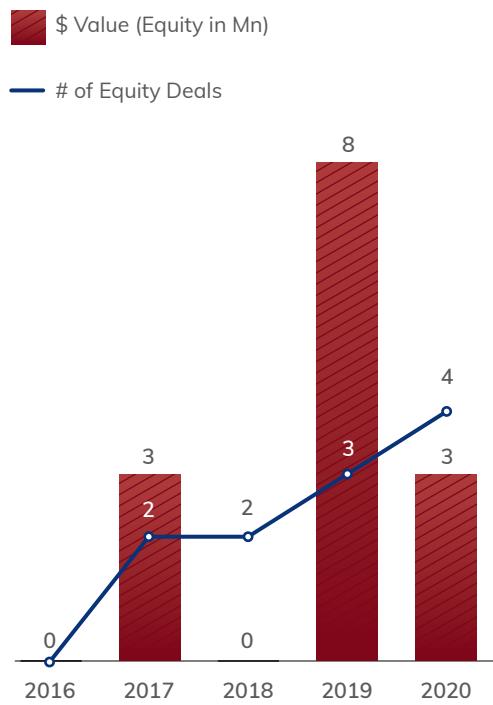
Among technology-enabled plays, startups working on innovations leveraging data-analytics and IOT to track and monitor waste diverted from landfills may find a scalable path through EPR-focused services to provide credits, emissions reduction certificates etc., and may be of interest to investors that are focused on a software-first approach.

OTHERS

I. Funds have also been raised by enterprises outside the earlier five categories. These organizations have collectively raised about USD 14 million in 11 deals between 2016 and 2020

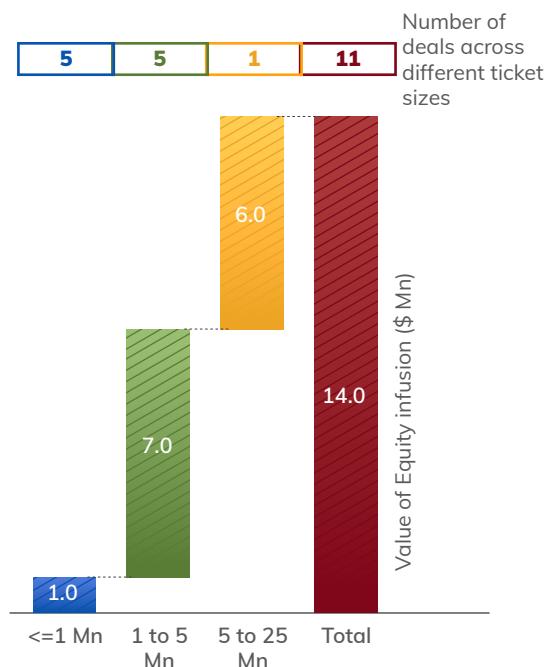
These innovations cut across sectors, and are solving problems through technology-enabled and/ or software solutions; solutions blending IoT, data harvesting, and data analytics that help consumers make informed decisions and take actions on climate change; and new advanced materials that replace environmentally-damaging ones being used currently. Owing to the nascent stage of many of these innovations, all the deals in this space are at the seed stage with a low average ticket size when compared to other climate-tech sub-sectors. Even globally these themes are still nascent with only 20 deals in the climate and earth data generation companies in a comparable period.¹²³

Exhibit 57: Capital infusion into other climate-tech deals in India, 2016-2020 (value and volume)



Source: Authors' calculations based on IIC Databases

Exhibit 58: Deal across ticket sizes (value and volume)



Source: Authors' calculations based on IIC Databases

II. These enterprises provide solutions that can aid organizations in making pivotal decisions at different levels of the value chain

Exhibit 59: Cross-cutting innovations at various levels in other climate-tech sub-sector

|  Information and Analysis stage |  Optimization stage |  Shift |
|--|---|---|
| <p>Some start-ups are providing assessment of different indicators of climate change through data analytics and intelligence-</p> <p>Example</p> <p> Blue Sky Analytics</p> | <p>Enterprises are creating aggregation platforms and AI based automated solution to improve efficiencies of the organizations in the climate-tech space-</p> <p>Example</p> <p> HABER</p> | <p>There are enterprises working on developing eco-friendly alternatives that can be easily adopted by users-</p> <p>Example</p> <p> proklean[®] CLEANER WORLD. BETTER WORLD.</p> |

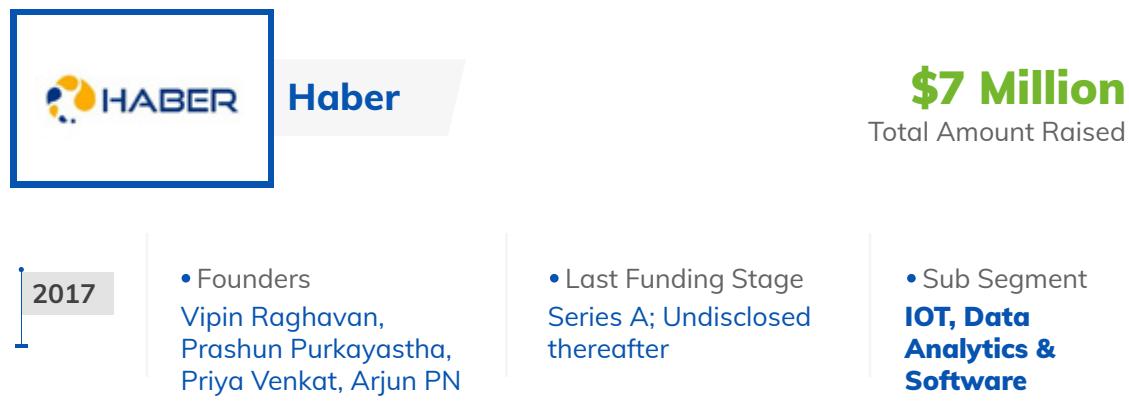
a. IoT, Data Analytics, Software

Innovations in this sub-segment largely include cross-sectoral solutions that are underpinned by enabling technologies such as IoT, AI and ML. Startups in this space have seen a total of USD 12 million invested between 2016-2020. Examples of startups in this space include Faclon Labs, Haber Water Technologies, Distributed Energy and Ayasta. Another notable startup that has received funding is Blue Sky Analytics, which builds environmental datasets and indicators by collating information from various sources (satellites, ground-based data, etc.) to generate data-driven insights to aid decision-making.

b. Advanced/new materials

A total of USD 2 million has been invested in the advanced and new materials sub-segment across just three deals between 2016 and 2020. There will be a growing demand for eco-friendly products and materials that replace existing ones that have a damaging effect on the environment, and with a lifecycle environmental impact lower than those in use currently (e.g., Proklean, Bambrew).

III. Case study



Business Model

Haber provides real time, AI-driven industrial automation to maximize plant efficiency and output. The company focuses on the manufacturing industry and its portfolio includes automation services for chemical dosing and process control across different applications at paper mills, sugar mills, distilleries, breweries, independent institutions, and mining. The secure cloud-based platform integrates data collected through sensors across the plant and controls mechanical, operational, and chemical parameters.

Innovation (Process innovation)

eLIXA is an integrated platform for process, utilities, and water systems that provides data-driven visibility in the form of intuitive dashboards, analysis, and scorecards available enterprise-wide in real-time from anywhere to enhance production and efficiency. It helps customers tackle water-stress and reduce energy and waste footprint.

Climate Impact

The product is estimated to help save over 4.1 million metric cube of water and avoid 360,000 tCO₂e emissions annually.

IV. Outlook – The Road Ahead

- 1. New sustainable and eco-friendly materials and products that replace incumbent ones that damage the environment or health will garner interest from investors, provided they can demonstrate both commercial and environmental benefits for end-use applications across the life-cycle**

Globally, there are multiple innovations in the advanced material space where start-ups are creating alternate materials for construction activities. These solutions lead to low upfront emissions during the construction and low operational emissions generation from the cooling/lighting of the building. More than ten overseas start-ups have raised funds in this space including firms like Katerra, NODE, Ecobee, etc.¹²⁴ - however, Indian startups have witnessed limited deal activity so far.

- 2. Technology-enabled data or digital solutions cutting across various climate impact use-cases will have a clear growth story**

Especially those that are intelligently able to mesh electronics, hardware, IoT, AI and ML to generate data-driven insights.

- 3. Driven by increased global attention to responsible investing, there will be an increased interest among investors to look for climate-focused fintech solutions**

Climate Fintech (also called Green/ Sustainable Fintech) refers to solutions at the intersection of Climate, Finance, and Technology. These solutions are technology-enabled digital platforms that help institutions and individuals spend, save and invest in ways that put the planet first. Some examples of Climate Fintech innovations emerging in other geographies include - Stripe Climate (which helps online businesses redirect a part of their proceeds towards technologies that reduce carbon footprint), Cooler Future (building a retail stock investing app focused on climate impact), Trine (helps users invest in clean energy in emerging markets), and Aspiration (helps users round up their purchases to the nearest dollar and plants trees with the change). Driven by increased global attention to responsible investing and financing (UN PRI) and hence a greater push down by large asset owners to financial institutions, there will be increased interest among investors in climate-focused Fintech solutions.

Emerging Innovations





The Green Dream Becomes a Reality

While India has fared well in the areas of clean energy adoption (like solar and wind), to accelerate sustainable development, there is an immense need to channelize support towards climate-focused innovations that can clean-up a broader range of sectors that contribute to climate change.

The need is, therefore, for disruptive innovations that are either technology-enabled, deep-science focused, that work at the intersection of various sciences and/ or are deep-tech in nature. These emerging innovations, as we would like to call them, could disrupt value chains and supply chains, improve operational and/ or resource efficiencies, replace non-environment friendly products, create sustainable processes, help mitigate emissions, improve adaptation and

resilience of people & communities and/ or help take informed climate-friendly actions and decisions.

The following **Exhibit 60** presents a broad range of illustrative examples that capture the kind of emerging climate-tech innovations in India (the list is by no means exhaustive). More efforts are needed to have a larger number of such innovations emerge out of India that can have a global adoption potential.

Exhibit 60: Select examples of emerging climate-tech innovations in India

| | | | |
|----|---|--|--|
| 1. |  Blue Sky Analytics | Blue Sky Analytics | <u>Description</u> |
| |  Incorporation year 2018 |  Latest Funding Stage Seed | <p>A geospatial intelligence startup that uses information from satellite and ground-measurements to build environmental datasets and indicators by leveraging AI and enabling informed decisions and actions against air pollution, water-crisis, heat index, environmental degradation and more.</p> |
| |  Sector Others |  Sub-Segment IOT, Data Analytics, Software | |
| 2. |  CARBON MASTERS | Carbon Masters India | <u>Description</u> |
| |  Incorporation year 2012 |  Latest Funding Stage Series A | <p>The startup's product called Carbon Lites - a renewable natural gas - is produced through anaerobic digestion (AD) in which organic wet-waste (a landfill waste) collected from various sites is combined with micro-organisms. Carbon Lites burns longer and stronger than alternatives like LPG and is 100% carbon neutral in use. The fuel can help cook (being sold to restaurants), can power cars or trucks and also run generators. Further, the by-product of manufacturing is enriched organic manure.</p> |
| |  Sector Waste Management & Circular Economy |  Sub-Segment Waste to Value | |
| 3. |  Devic Earth | Devic Earth | <u>Description</u> |
| |  Incorporation year 2018 |  Latest Funding Stage Pre-Series A | <p>The first to utilize pulsed radiofrequency (RF) energy commercially for mitigating air pollution. Their simple and cost-effective air pollution control equipment is scalable for various spaces - indoor/ outdoor, small/ large - like homes, offices, industries/ factories, events and even cities. Their products can tackle both indoor gases and particle pollutants.</p> |
| |  Sector Environment & Natural Resources |  Sub-Segment Air Pollution & Ambient Environment | |

4.



Distinct Horizon

Incorporation year
2015

Latest Funding Stage
Data not available

Sector
Climate-Smart
Agriculture &
Food

Sub-Segment
Climate-focused
Precision Agriculture

Description

Has developed a tractor-powered Urea / Fertilizer Deep Placement applicator that strategically deploys urea briquettes into the soil. This helps reduce urea dosage by up to 40% compared to the conventional urea broadcasting method, with potential for 0.5 MT of CO₂eq of GHG emissions reduction per Ha per season. Additional benefits are reduction in water pollution by fertilizer run-off and leaching, thereby building soil health.

5.



EF Polymer

Incorporation year
2018

Latest Funding Stage
Seed

Sector
Climate-Smart
Agriculture & Food

Sub-Segment
Eco-friendly
Agri Inputs

Description

Has developed and piloted 100% organic super absorbent natural water retention polymer cum fertilizer that's fully biodegradable. The polymer helps reduce water and fertilizer requirement, improving yields and profits. Their product Fasal Amrit is made using bio-waste from juice shops and it can enhance soil health by providing micronutrients, maintain moisture content and help in the growth of microbes.

6.



EVage

Incorporation year
2019

Latest Funding Stage
Seed

Sector
Sustainable
Mobility

Sub-Segment
Clean Mobility (EVs)

Description

Manufactures commercial EVs and lowering the costs through creation of an 'Exoskeleton Structure' - which will serve as an affordable common architecture for various EV platforms - SUVs, vans, delivery vehicles or even trucks. Their aim is to reduce the complexity in EV manufacturing.

| 7.  | | Evo Foods | | Description |
|--|---|---|--|---|
|  | Incorporation year 2019 |  | Latest Funding Stage Pre-Seed | Creating a brand of clean plant-based alternatives to animal products by using advanced plant biochemistry and deep food science. Their first product is plant-based liquid egg. Through their own proprietary research, the team identified two plant proteins extracted from legumes that provide the same level of taste, texture, and nutrition similar to a traditional egg. |
|  | Sector Climate-Smart Agriculture & Food |  | Sub-Segment Alternative Meats, Proteins | |
| <hr/> | | | | |
| 8.  | | Gegadyne Energy | | Description |
|  | Incorporation year 2017 |  | Latest Funding Stage Series A | Develops quick charging batteries through patented advanced nano material composites - which help in improving energy storage capacities and provide higher cycle life. The end-use applications of these batteries are from EVs to Consumer Electronics to Grid Energy Storage Solutions to Telecom Towers to Off-grid Energy Access. |
|  | Sector Energy |  | Sub-Segment Energy Storage & Management | |
| <hr/> | | | | |
| 9.  | | Green Joules | | Description |
|  | Incorporation year 2018 |  | Latest Funding Stage Series A | Utilizes an innovative manufacturing process where agro and agro-industrial waste is used as raw material to produce 'Drop-In' bio-fuels that meet standards of Diesel and LPG and that have negligible life-cycle GHG footprint. Moreover, all by-products in the manufacturing process can get consumed across various end-use applications like agriculture, construction materials etc. |
|  | Sector Waste Management & Circular Economy |  | Sub-Segment Waste to Value | |

10.



h2e POWER

Description

Incorporation year
2011

Latest Funding Stage
Seed

Sector
Energy

Sub-Segment
Clean Energy

Uses proprietary electrolyzer cell technology for production of low-cost green-hydrogen, syngas, green ammonia, other value-added alcohols/ fuels and high-value waxes. Also offers other solutions like, waste (various types of landfill waste) conversion to hydrogen/syngas and power generation (utilizing fuel cells) for reliable and durable electricity and heat supply in kW to MW applications for residential/ commercial / industrial use.

11.



Ion Energy

Description

Incorporation year
2017

Latest Funding Stage
Seed

Sector
Energy

Sub-Segment
Energy Storage & Management

Offers an advanced battery management system (BMS) and intelligence platform that improves the life and performance of lithium-ion batteries powering EVs and energy storage systems. Their software-first, full-stack approach blends advanced electronics, machine learning and AI. It's a unique electronics platform-as-a-service (PaaS) model that provides transparency in technology, 30-40% savings in costs and enables customers to buy or build custom BMS models.

12.



Log9

Description

Incorporation year
2015

Latest Funding Stage
Series A

Sector
Sustainable Mobility

Sub-Segment
Smart Batteries, Fuel Cells, Charging, Components

Uses its core competency in graphene nanotechnology to develop advanced energy storage technologies from electrode materials - cell to pack level. Their Rapid Charging Battery packs solve the challenges in adoption for 2W and 3W electric vehicle platforms. The startup is also in the process of developing an Aluminium Fuel Cell technology targeted towards electrification of long-haul heavy vehicles.

13. 

Nexus Power

Description

 Incorporation year
2019

 Latest Funding Stage
Data not available

 Sector
Energy

 Sub-Segment
Energy Storage & Management

The startup is developing proprietary technology utilising nano materials from crop residue to formulate battery compositions that have fast regenerative properties and that allow the charge to remain longer for EV applications. The entire process follows Bio-Mimicry and Industrial Ecology concepts and does not leave out waste, making the batteries fully recyclable. The technology is planned to be made scalable to create batteries for use in applications from consumer electronics to EVs.

14. 

POWEReasy

Description

 Incorporation year
2015

 Latest Funding Stage
Data not available

 Sector
Energy

 Sub-Segment
Energy Optimization

Provides retrofit IOT-enabled devices for building owners and managers to monitor and identify 20 electrical faults and conditions (a unique device / possibly the only device in the world that can identify the root cause of critical issues like arcing, harmonics, earthing faults and neutral loss). The solution helps in fire prevention, power conditioning and preventive maintenance - leading to energy savings.

15. 

Prescinto

Description

 Incorporation year
2016

 Latest Funding Stage
Seed

 Sector
Energy

 Sub-Segment
Energy Optimisation

Offers an AI-powered platform that collects solar plant data, applies data science models to identify causes for underperformance, suggests work orders to plant crew to enhance generation from the renewable energy assets for owners and helps improve operational efficiency, thereby maximizing financial returns.

16.



Proklean Technologies

Description

Incorporation year
2009

Latest Funding Stage
Series Unknown

Sector
Others

Sub-Segment
Advanced/ New Materials

Harnesses the power of pro-biotic microorganisms to produce bio-degradable, industrial, commercial and household use cleaning products that replace harmful chemicals. The manufacturing process adopts a circular and sustainable approach - using raw materials from renewable sources, and processing them using low energy methods. The industrial products save millions of litres of water and energy annually and the consumer products are better in performance compared to its chemical counterparts.

17.



Satyukt Analytics

Description

Incorporation year
2018

Latest Funding Stage
Seed

Sector
Climate-Smart Agriculture & Food

Sub-Segment
Climate-focused Precision Agriculture

Uses proprietary algorithms that process multi-satellite imagery integrated with various on-field, weather, and market data points to provide crucial insights on farm-health, water resources, crop-health, weather forecast and other risk-monitoring aspects through their secured SaaS platform. The platform also bundles advisory and provides agricultural data and services to various stakeholders (B2B) in the agricultural sector, thus minimizing crop loss while optimizing yield.

18.



Sea6 Energy

Description

Incorporation year
2010

Latest Funding Stage
Series A

Sector
Energy

Sub-Segment
Clean Energy

Offers an Ocean operating system - Ocean Biomass farming (seaweed production and infrastructure), Ocean Bioprocessing (harvesting microbes / components using biotechnology etc), as well as Ocean Solutions (products like eco-friendly agri-inputs, bio-degradable plastics, animal feed/ nutrition, food additives and bio-fuels). Their primary focus though is on deriving ethanol fuel from seaweed to replace non-renewable fossil fuels.

19.



String Bio

Description

Incorporation year
2013

Latest Funding Stage
Series Unknown

Sector
Environment & Natural Resources

Sub-Segment
Carbon Capture, Utilization or Storage

Works at the intersection of biology, engineering and chemistry to use waste green house gases (GHG) like methane and CO₂ as raw materials to manufacture animal/ human nutrition products, eco-friendly agri-inputs, safe cosmetics, bio-degradable packaging etc. The manufacturing process is effectively carbon-neutral / carbon negative

20.



Telluris Biotech

Description

Incorporation year
2015

Latest Funding Stage
Series A

Sector
Climate-Smart Agriculture & Food

Sub-Segment
Eco-friendly Agri Inputs

Offers novel nematicides that are environmentally safe, non-toxic, and highly effective against plant-parasitic nematodes that are estimated to damage around 12.4% (USD 157 billion) of the world's major crops annually. Has also developed eco-friendly Plant Growth Promoters (PGPs)

Investor insights – enablers & barriers in climate-tech



Over the last decade, commercial investors have predominantly focused on supporting large renewable (solar and wind) infrastructure projects in India.¹²⁵ However, more recently, innovation-focused climate-tech startups have also started attracting investor interest, owing to an evolving context that reflects three key themes.

First, macro factors such as rapidly increasing urbanization and its associated problems such as pollution (air/water), waste accumulation and disposal, etc., propelling demand for innovative solutions.

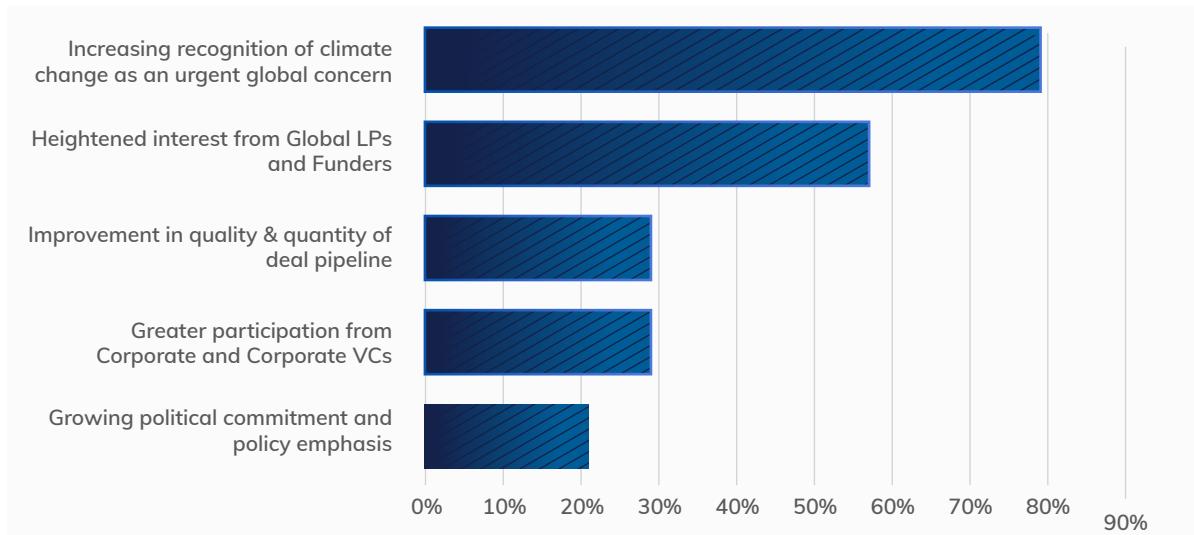
Second, increasing installations of low-carbon energy technologies¹²⁶ (e.g., solar and wind) that now present a huge asset-base for startups to service.

Third, a more conducive policy environment, which aids positive investor sentiment. All of these are supplemented by critical enabling factors for a startup ecosystem to develop—increasing digitalization (which is making it easier and less expensive to build a startup), and a burgeoning talent base of entrepreneurs and technical specialists to support them. This has also been corroborated by our interviews and surveys of 33 investors.

Enablers

In the context of the climate-tech investing ecosystem in India, investors have highlighted key enabling factors: increasing realization around the need for climate action, growing interest from global investors, the emergence of innovative deal pipelines, and growing participation of corporates.

Exhibit 61: Key enablers or drivers in the climate-tech ecosystem for investors



Note: n=33, multiple options accepted, hence n>100%

I. Almost 79% of the investors surveyed are of the view that the increasing recognition of climate change as an issue of urgent global concern is becoming instrumental in prioritizing early-stage climate-tech investments.

As the consequences of a changing climate become more visible, both by their increased frequency and intensity, investors have begun to acknowledge the critical need for climate action driven by changing investment mandates and goals. In this

context, venture capital firms see their role in discovering and supporting innovations that can have a rapid and outsized positive climate impact.

II. About 57% of the investors surveyed said that an uptick in interest from Global LPs and Funders is also nudging domestic investors towards climate-tech investing.

The growing attention on climate action by some of the leading international asset owners, particularly development finance institutions (DFIs), sovereign funds, large philanthropies (LPs) and corporations have helped influence climate-tech investments in India considerably. These actions are encouraging more and more domestic asset managers to prioritize capital allocations for climate. An example of this is the partnership between the Foreign Commonwealth and Development Office, the Government of UK and the State Bank of India to support SMEs in high-

impact climate action and sustainability via provision of equity financing¹²⁷. Similarly, USAID's loan portfolio guarantee programme in partnership with Rabobank Foundation, Ananya Finance and Samunnati are all important initiatives that will ease access to financing for Indian SMEs engaging directly or indirectly in sustainable businesses, across climate-efficient agriculture, forestry and other low-emission land uses¹²⁸

III. Nearly 21% of the investors surveyed emphasized growing political commitment and policy emphasis as a key driver for improving climate-tech investor sentiment.

Some of the sectors, be it sustainable mobility or waste management have benefited from policy support, but greater traction is needed in other sectors such as agriculture, environment and pollution, energy storage, management and optimization etc.

“ Government support can promote growth and innovation within a particular sub-segment or industry. For instance the recent traction seen by the waste management segment in the climate ecosystem can very well be attributed to government policy efforts such as Extended Producer Responsibility.

Sandeep Murthy, Partner, Lightbox

IV. On the supply side, there are similar favourable trends; 29% of the investors surveyed reported an improvement in both the quantity and quality of the deal pipeline in the last 3-4 years.

The enhanced capital allocations from the Government and international funders (LPs/ donors) have contributed to the emergence of climate-focused incubators. Consequently, a notable portion of the investors are now seeing promising climate entrepreneurs emerge from universities and incubators¹²⁹ and a smoother deal flow.

V. About 30% of the investors surveyed are of the opinion that Corporates & Corporate VCs have played a significant role in boosting the demand for new, low-carbon technologies and products.

Relatively mature climate-tech sub-sectors, such as sustainable mobility, have attracted investments from corporate houses, such as Tata Motors, Bajaj Auto Ltd, Mitsui & Co., etc., into early-stage Indian startups. As investors, corporates are well-positioned to provide scale-up support to early-stage climate-tech startups through R&D support, pilots and go-to-market channels, while themselves gaining access to innovative technology and talent, in addition to any equity positions in the startups¹³⁰. Some successful exits by Indian climate-tech startups—such as, the investment in Zenatix by Hero Electronix, and the acquisition of Ampere Vehicles by Greaves Cotton—have further reinforced the corporate venture-investment thesis, and affirmed the role of corporates in providing risk capital to support startups in their growth.

Barriers

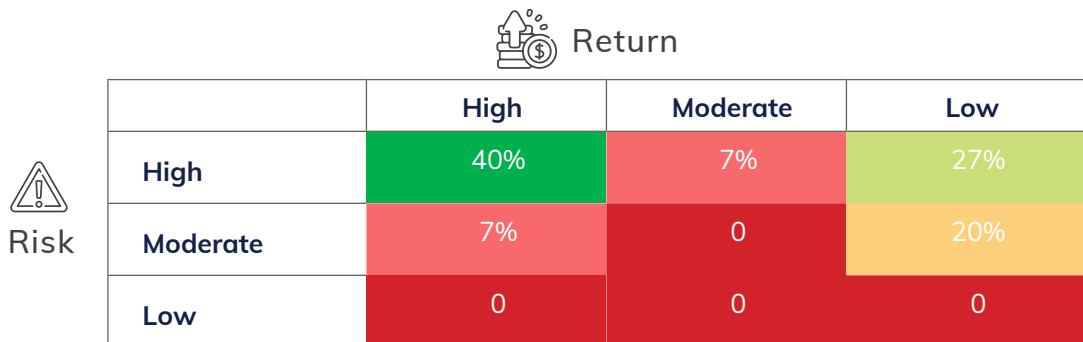
In the context of the climate-tech investing ecosystem in India, investors have highlighted key barriers around the nascent nature of the ecosystem—lack of patient capital, lack of standardized taxonomy, and a high cost of technical due-diligence.

I. Given the perceived risk-return profile of climate-tech startups, nearly 50% of the GPs view lack of patient capital in the early-stages as one of the biggest impediments preventing a large number of disruptive climate innovations from getting off the ground.

- a. About 54% of the investors surveyed perceive returns in the climate-tech sector to be low to moderate.

The general sentiment among LPs is that the deep tech startups (such as those that predominate climate-tech) have an unfavourable risk-return profile—expected returns that are sometimes at odds with the significant inherent technical and business-model risks. Further, it was highlighted repeatedly, that LPs tend to access deals through their own (read: non-climate focused) networks, thus continuing the cycle of limited exposure to and understanding of deep tech sectors. Therefore, for commercial VCs without a dedicated climate-tech focus, this partially diminishes the attractiveness of climate-tech investments.

Exhibit 62: Perception of risk-return from climate-related assets



Note: n=33, multiple options accepted, hence n>100%

- b. Limited history of successful exits in the sector was echoed by 24% of the surveyed investors**

In the absence of precedents of multi-x returns on exits, LPs view long-gestation startups (and especially those with a hardware-focus) unfavourably.¹³¹ Somewhat related was an insight from one of the DFIs interviewed, who expressed discomfort with taking technology risk, and as a consequence limiting their participation to only growth-stage deals.

- c. Other factors that limit the ability of GPs to deploy suitable capital for climate-tech include the return expectations set by their LPs, and this is further compounded by a limited flexibility on fund-tenor**
- d. Globally, the vast majority of LPs who have invested in climate-tech funds include large pension funds, sovereign funds and university endowments. Typically, these funds have long-duration horizons and are better suited to provide long-term patient capital to specialized funds that invest in early-stage startups. However, the investors surveyed perceive that there are few such domestic LPs in India, and the overseas ones are still not deploying their capital in sufficient volumes - so this remains a gap for Indian VC and PE firms.**

“

Climate Tech innovation ecosystem requires new ways of assessing venture risk and early targeting of solutions with an impact-first approach to underwriting. Unfortunately the risk-capital is in short supply, specially for the deep science and engineering innovations in this space. Moreover, a comprehensive approach to financing climate-tech innovation requires a clear understanding of green premium to undergo this transition for each sector, and the long-term and multi-stage patient capital to support venture development. This is possible only through a blended capital approach - where government, foundations and private sector collaborate to create the enabling ecosystem and capital pools.

Manoj Kumar, Founder & CEO, Social Alpha

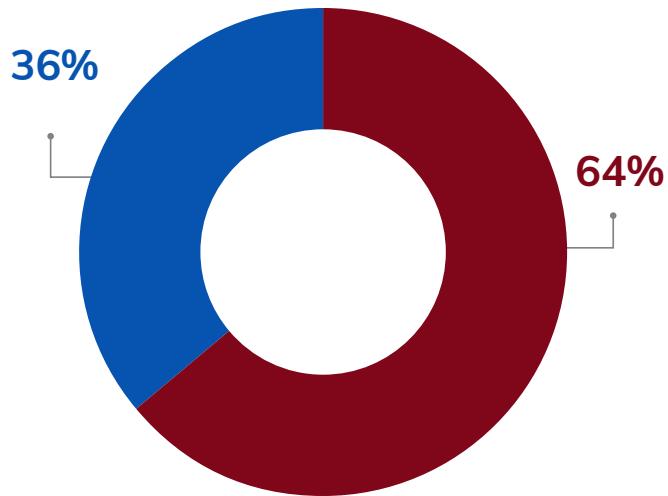
”

II. About 64% of the investors reckon that due-diligence and portfolio management of climate-related startups require significant additional effort in comparison to other tech-based startups.

The developing ecosystem for climate-tech investments in India has persisting talent and knowledge gaps, be it in domain expertise for due-diligence or professional services such as specialized investment banking support. Conducting due diligence on science-based technologies developed by startups requires expert evaluation, time and resources.

The investors we interviewed hinted at this ‘cost of investing’ being significant, and some even averred that the effort may ‘not be worth the time’ given the stage of the sector and its inherent complexities. Extending this, it is natural among VCs to be more comfortable with investing in startups that are adjacent to mature incumbent market segments—for instance, startups that are in and around solar, EV, AI, etc., especially those with SaaS business models, are generally favoured by VCs.

Exhibit 63: Due diligence & portfolio management for climate-tech startups



■ Yes, it requires significant effort and capacity

■ Requires minimal additional effort

Note: n=33, multiple options accepted, hence n>100%

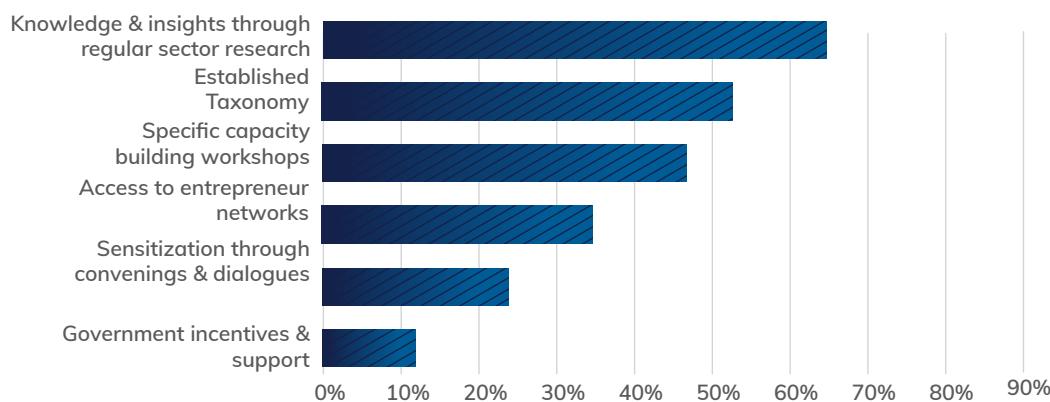
III. About 30% of the investors surveyed attribute the lack of a standard, harmonized taxonomy in the Indian context as a deterrent.

Lack of clear definitions and taxonomy have often led to investors using different lenses to measure impact—including ESG, sustainability and climate-impact—and do so sometimes interchangeably in their investment thesis. Hence, in spite of a positive investor intent on achieving climate and sustainability goals, a uniformly accepted and standardized climate-tech investing lens is missing. This is explored in more details in Chapter 8.

IV. A significant majority of investors view limited sector understanding as a barrier

This also leads to limited engagement by investors with startups from the climate-tech space. Consequently, a significant majority (65%) of the investors identify 'regular sector research' as an intervention that could help enhance climate-tech investments. Establishing a common taxonomy (53%) and capacity-building workshops (47%) are other interventions seen as important in mainstreaming climate investments.

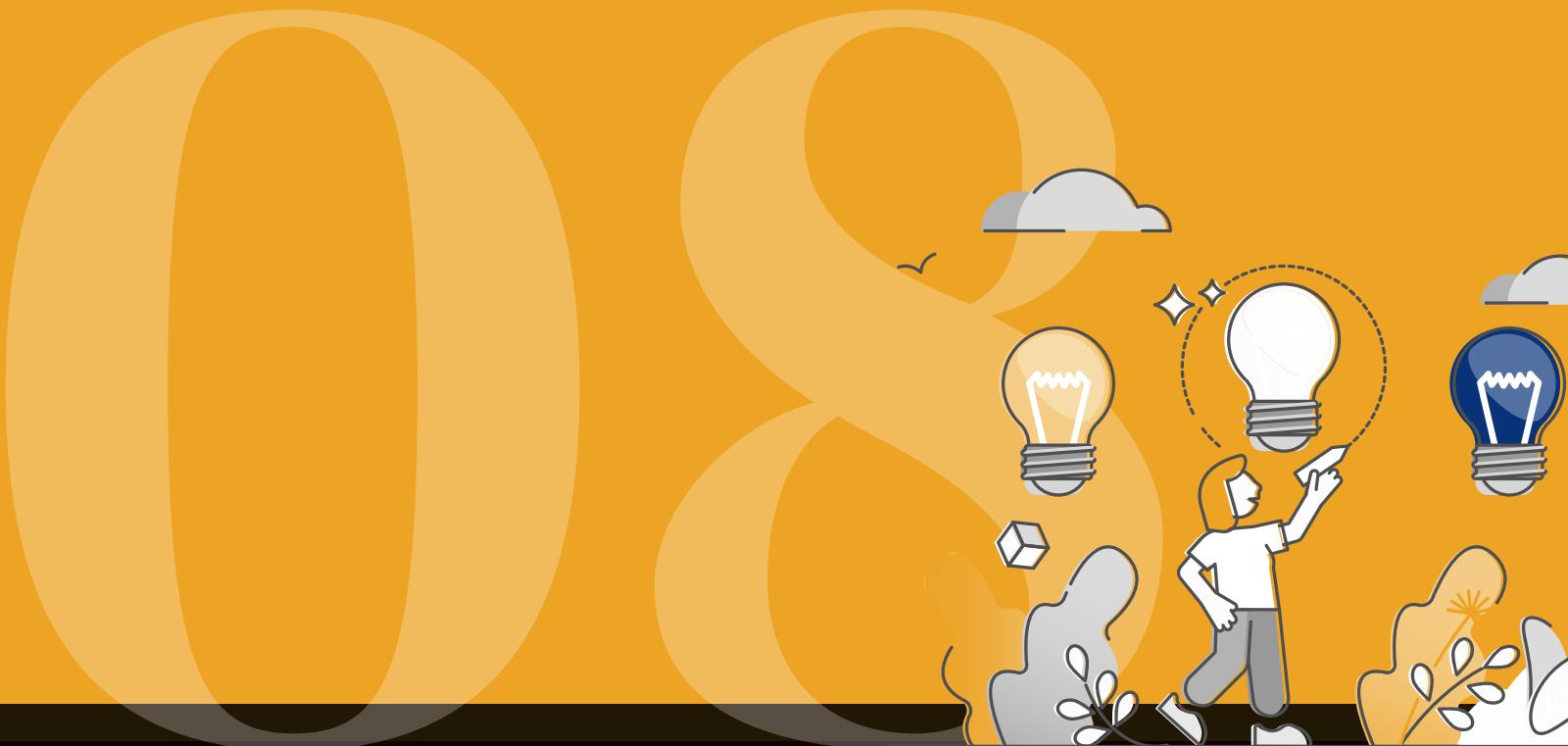
Exhibit 64: Interventions to improve climate-tech investments in India



Note: n=33, multiple options accepted, hence n>100%

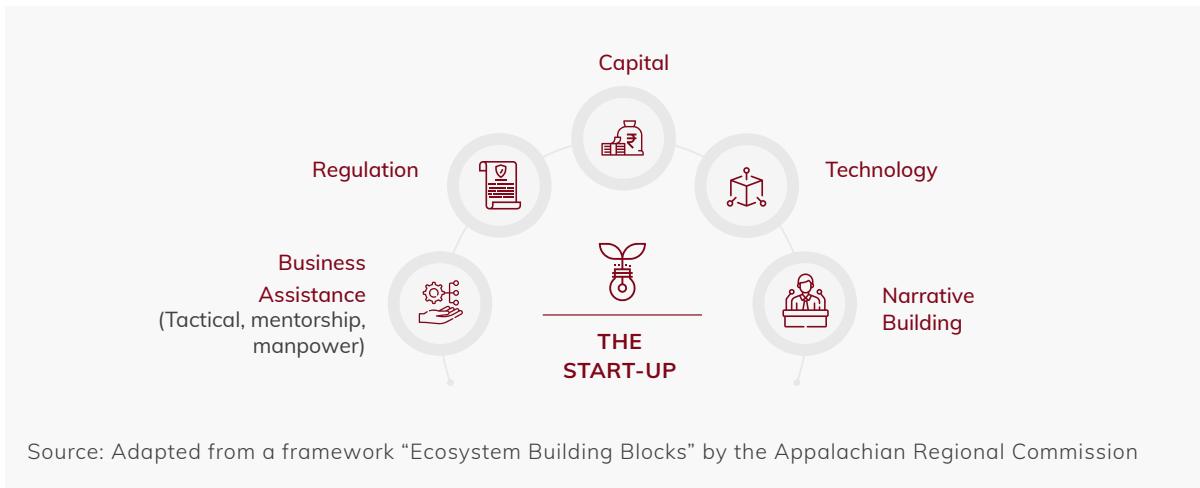
On a positive note, 71% of the investors surveyed opine that, although nascent, the ecosystem for climate-tech investments in India has strong potential for growth.

Entrepreneur insights: enablers & barriers in climate-tech



Entrepreneurs are at the centre of the climate startup ecosystem. This chapter explores the barriers, enablers, and interlinkages that drive the growth, scale and the success of the ecosystem through the entrepreneurs' lens.

Exhibit 65: Key enablers for startups



In the India climate startup context, entrepreneurs have highlighted key strategic challenges around funding, narrative building (specifically on a common taxonomy and articulating impact), regulation (a need for greater policy nudges for climate action) and technological support for product development.

Exhibit 66: Top challenges faced in scaling up for climate-tech startups in India



Funding

Nearly 90% of the entrepreneurs surveyed spoke about challenges pertaining to funding.

Climate-tech entrepreneurs surveyed highlighted that a “lack of patient risk capital” was one of the key challenges that they were facing. Almost 45% of the entrepreneurs surveyed also shared that challenges around funding were worsened by “stringent return expectations”. Some of these challenges such as the risk return profile, product development timelines etc are driven by the nature of climate-tech startups itself. These challenges have been witnessed globally.

A study published by MIT in 2016 found that clean tech (a large share of climate-tech) companies were ill-suited for traditional venture capital models because they required significant capital, had long development timelines (much beyond the five years typically needed by funds), had lower returns, and struggled with future corporate acquisitions¹³²

An RMI report from 2020 also highlighted similar challenges for climate-tech: “Climate-tech requires long-term capital, but VC is a short turnover asset type—e.g., requiring a 10x return in less than 10 years—so target returns on investment for long-term projects are unfeasible. Even when entrepreneurs could monetize their developed projects, these earnings are often realized far down the project timeline for new projects or new technologies.”¹³³

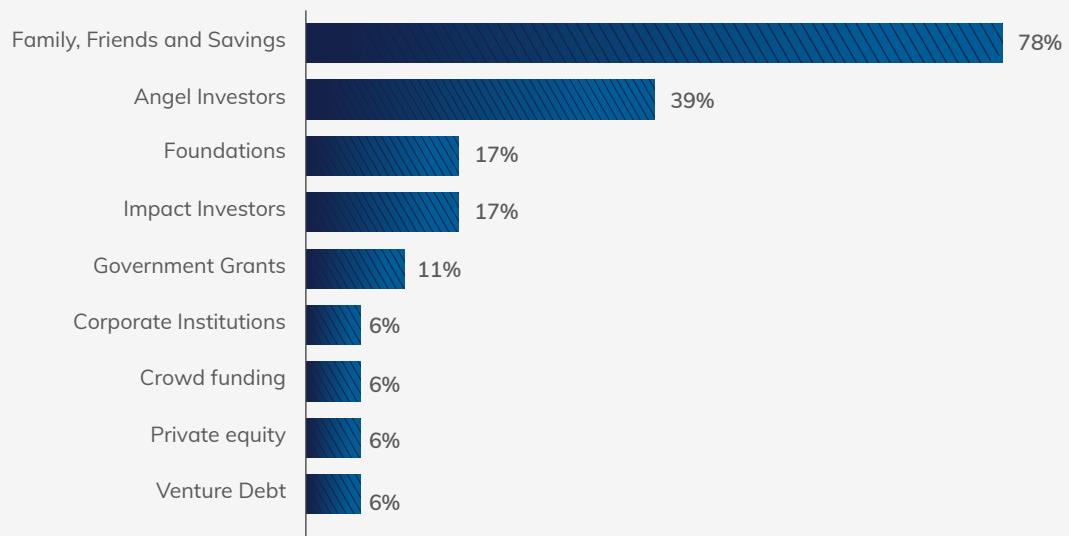
These challenges are evidenced in the Indian context when we observe the sources of capital for entrepreneurs surveyed for this report. Nearly 78% of the entrepreneurs surveyed tapped into “friends, family, and savings” for capital, 39% into “angel networks”. Less than 17% of the entrepreneurs surveyed found themselves leveraging more institutional sources, e.g., impact investors, PE/VC, or even grants.

While we explore the paradigm and challenges faced by funders more closely in The Investors’ Perspective, it’s worth noting that ~61% of entrepreneurs surveyed found that the challenges around fundraising could be tackled through deeper knowledge of the sector and understanding among funders.

Similarly, entrepreneurs also articulate about other challenges to funding, for instance policy—**almost 28% of the entrepreneurs surveyed found an “unsupportive policy framework” to be a critical hurdle for securing funding. Several entrepreneurs describe climate action to be a public good, and feel that “willingness to pay” can only be driven by policy mandates.**

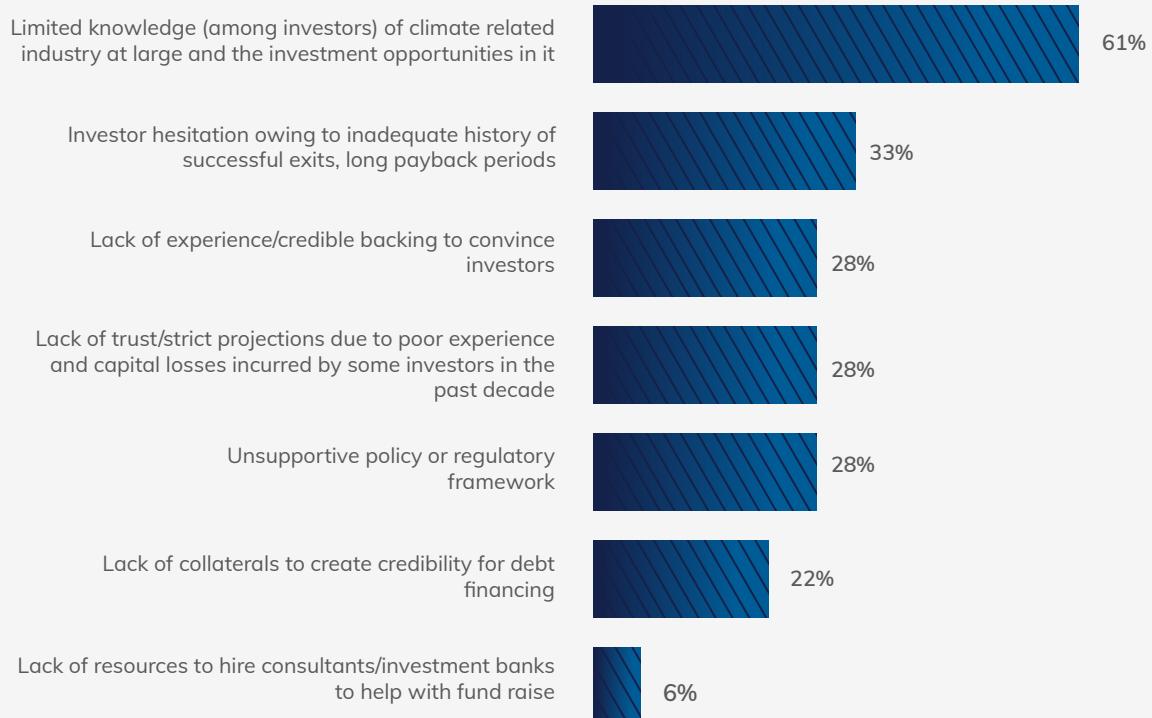


Exhibit 67: Sources of funds tapped and Figure



Note: n=32, multiple options accepted, hence n>100%

Exhibit 68: Major challenges faced by company in procuring funding



Note: n=32, multiple options accepted, hence n>100%

Other challenges around narrative building, impact measurement that are critical to fund raising are explored separately as they are cross cutting and influence other facets of firms too.

Narrative Building

We have explored narrative building from two aspects—first, the mainstream narrative and second the ecosystem narrative:

I. The dominant media narrative is driving customers to be more interested in climate change—yet this isn't necessarily translating into a willingness to pay.

There has been an increasing awareness towards climate change. A global survey conducted in 2020 by Capgemini suggested that nearly 88% of consumers want to be able to make a difference in saving the planet for future generations¹³⁴. A WEF study conducted by IPSOS (of over 20,000 people across 28 countries) found that India was one of the countries where consumers (~88%) were most willing to make changes to counteract climate change.¹³⁵ Yet, the interest, in making a difference, doesn't always translate into a willingness to pay for these products.

In a study conducted by Kantar for its Asia Sustainability Foundational Study, interviews with 1,000 customers across India's major cities revealed that even though 48% consumers prefer to back companies that are committed to doing good e.g. actively pursuing sustainability issues—yet 77% said that their intent did not translate into action and that they would rather save money in real world actions.¹³⁶

This was reflected in interviews with founders and funders in the context of both B2B and B2C customers. For instance,

Akshay Singhal the Founder of Log9 Materials, an Indian nanotechnology company operating in the areas of energy storage solutions for Electric Vehicles, AI-Fuel Cells, Oil-spill absorption and Filtration solutions said “Currently, companies are not suitably incentivized to pay a green premium on products, because they have to answer their shareholders on increased costs that can affect market positions.”

This may be a transitory problem, reflecting the current growth stage of climate-tech. The 'green premium' might simply exist because first, the negative externalities have not yet been internalised; and second, the production of low-carbon products still has to achieve economies-of-scale.

In many climate-tech sectors, as we are reaching economies of scale, products are becoming cost competitive with existing/incumbent ones, without any upstream support or subsidies. E.g., Proklean, a startup that uses probiotic technology to make environment-friendly cleaning products, is now available on commercial online marketplaces at competitive prices.

II. Challenges around “willingness to pay” may also partially emerge out of difficulties in linking the daunting climate narrative to the work of climate-tech startups.

Thirty-nine percent of the entrepreneurs surveyed mentioned that there were challenges around “winning customer trust, sales expansion and marketing”. This may be because climate impact is hard to articulate and the specific activities of startups could be hard to connect to the climate crisis directly.

This has also been echoed by entrepreneur interviews in startups working to drive information or create insights without “direct” or “ascrivable” value, e.g., organizations working in weather-based insurance, or information analytics.

III. The narrative in the ecosystem is also shifting towards sustainability – however, the founders noted that this may not translate into support for early state climate-tech startups in the immediate-term

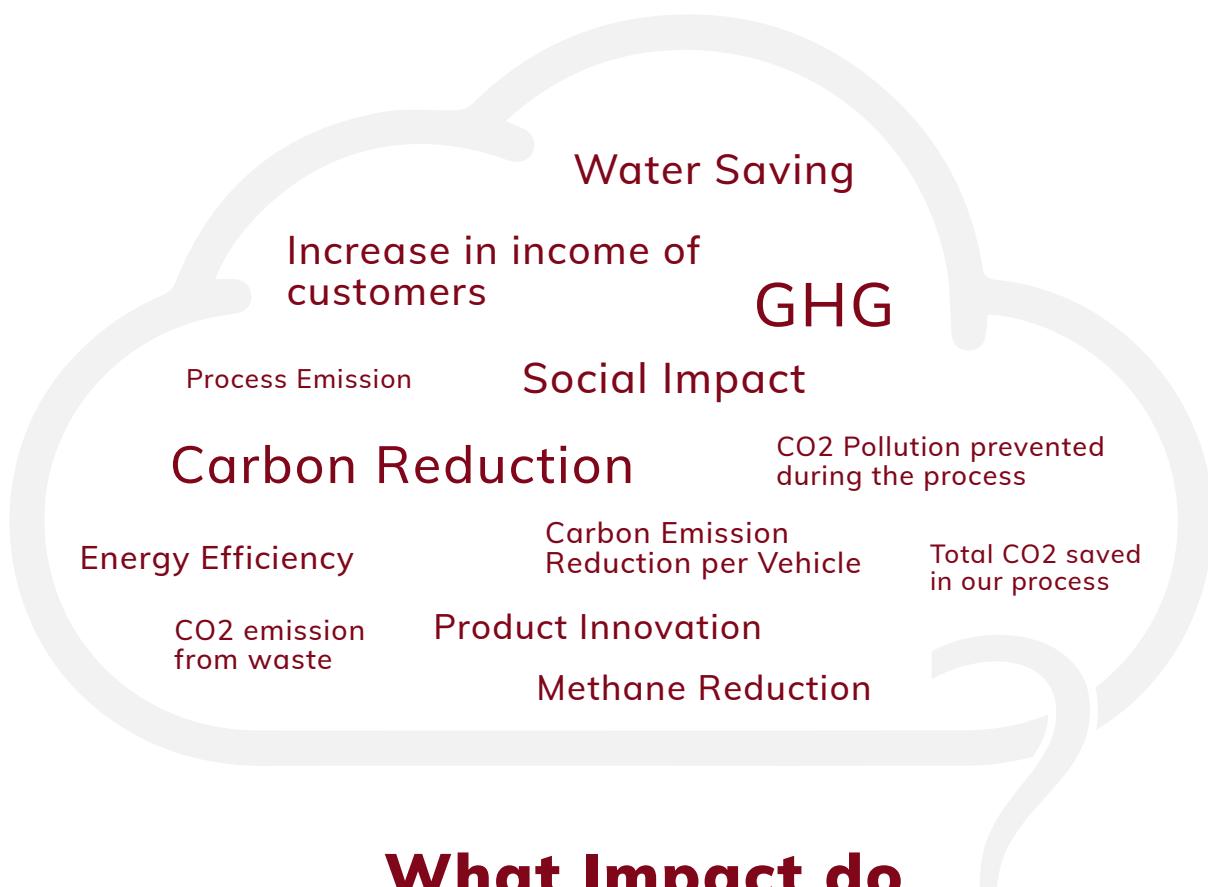
The 2020 and 2021 letter by Blackrock Global CEO Larry Fink to CEOs globally has given very clear directions to markets in this regard. Blackrock is one of the most influential investors (with USD 10.5 trillion of assets under management) and holds considerable sway over how other investors behave.

By asking companies to disclose “how their model will be compatible with a net-zero economy” Blackrock also is also sending a strong signal to the global investor community¹³⁷. This narrative has trickled down to the Indian finance sector. In May 2021, SEBI announced that India’s top 1000 companies would need to file disclosures on their sustainability responsibilities.¹³⁸ Despite this, a few startups noted that downstream ESG disclosure requirements do not necessarily translate into specific support for early-stage climate-tech startups and the problem is exacerbated for hard-tech startups.



IV. Yet, the need to clarify impact persists—nearly 67% of entrepreneurs surveyed found that “effort towards a common taxonomy” would be one of the most useful strategic interventions that could be made.

There are several norms around climate disclosure – the Task Force on Climate-Related Financial Disclosures, the Sustainability Accounting Standards Board, and a diverse range of other ESG frameworks. Yet, these are all meant for large established firms, and there aren't standardized norms or practices that can be adopted by small companies. This makes it difficult to articulate impact which then makes it challenging to raise funds. In the diagram below we illustrate the subtle differences and nuances from a sample of the 32 founders we surveyed & interviewed to measure impact.



Technology

Sixty-one percent of the entrepreneurs surveyed have described a key challenge around “technology stabilisation, operations and manufacturing at scale”. We deconstruct three key challenges around technology that plague entrepreneurs:

I. Timelines for climate-tech solutions are long and patchy

This is specifically true about deep technology solutions that drive innovations around areas like carbon capture, nuclear power etc which take years to move from R&D to demonstration to deployment. Breakthrough Energy Ventures, one of the leading funds working towards net zero emissions by 2050 has recognized these challenges and has changed the timeline for their fund from 10-12 years to 20 years.¹³⁹

II. No clear “go-to-market pathways”

Nakul Kukar, the Founder of Cell Propulsion, says “The real challenge is how do you adequately assess and anticipate the money needed for a minimum viable product?”

In other markets, such as the web and software, there are tried and tested operating procedures for reaching product/market fit. “These established approaches provide roadmaps to success, allow teams to stand on the shoulders of the many giants before them, and serve to communicate their progress to later-stage investors and other stakeholders more clearly—a lingua franca for their market.”¹⁴⁰ To that extent there is not yet a playbook for climate-tech startups—though ESOs the world over are working on creating these.

III. Strong dependencies on broader ecosystem factors

There are ecosystem factors at play that are influencing the wide acceptance of the technology. Forward and backward linkages take time to establish for adoption to really accelerate. For instance, startups working on sustainability mobility in India say there is a need for amplified support to build the battery and charging infrastructure, as well as the energy infrastructure—only after this can consumer demand hope to ramp-up.

Nakul Kukar from Cell Propulsion says “As an EV manufacturer based out of Bengaluru, we now think it's better to be placed near an automotive cluster as this will provide us easier access to supply chains and vendors.”

Regulation

I. The present compliance framework for startups is challenging

The India Start Up Hub was launched in 2015 under the Department of Promotion of Industry & Internal Trade (DP&IT) to enable the startup ecosystem to thrive. It focuses on three key pillars—

- simplification and handholding (to ease compliance burden);
- funding and incentives (funding); and
- incubation industry style partners (business assistance). ¹⁴¹

While this is one among several policy initiatives undertaken by the Government - the current regulatory environment remains complex. Despite ranking 77th of 190 countries in the "Ease of Doing Business", India is also 137th of 190 countries in the World Bank's 'Starting a Business' Ranking Index.¹⁴² There are several complications that have been documented – e.g. registration, taxation, exit, etc.

Climate startups face all these challenges, and some additional ones based on the sector of operation. For instance, startups working in agriculture and food will need to liaise on bio-safety, food safety protocols, earn Organic product/Organic farm certifications. Startups working in electric mobility, in addition have to comply with the regulatory aspects of the energy sector (Electricity Act, NEP, NAPCC, state versus central policies) and need to manage homologation and certification requirements designed for an industry dominated by much larger companies.

II Startup entrepreneurs are keen on strong policy mandates to drive climate action

Almost 56% of the founders surveyed believe that a "regulatory nudge" for greater climate action will be critical for the climate-tech ecosystem. This was articulated by a few of the founders as linked to fundraising as well.

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Initiatives like the National Clean Air Program¹⁴³ launched in 2018 by MOEFCC with an objective of reducing air pollution in 122 cities, have played a key role in the adoption of pollution control technologies and driving investment towards climate tech with a better visibility of the market and customers.

Bharti Singhla, Founder, Chakr Innovation

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Business Assistance

This includes three components: tactical support (legal and managerial services, technical services which support the development of products or services, marketing, networking support etc), talent, and mentorship. Challenges around these themes were articulated from time to time by founders in both the survey and the interviews.

I. Some entrepreneurs highlighted the need for tactical support

Almost 28% of entrepreneurs surveyed stated that “Limited support on product development, as well as ancillary services like IPR, financials, etc” was a key barrier to growth. The ~39% of entrepreneurs surveyed also stated that “access to technical assistance on innovation/patents, legal/financial advice etc” would be most useful for climate-tech startups in India.

II. Challenges around “finding and retaining” the right talent were also stated by only a few entrepreneurs (~22% entrepreneurs surveyed)

This is crucial because there is more of an interest and appetite towards working in technology-based solutions than there was even a decade ago. IIM Ahmedabad is one of India’s premier educational institutes.

In 2010, 11% of the class was hired into roles in IT, online services, engineering/technology etc. In 2020 this share had doubled to ~22% of the class.¹⁴⁴ We find a strong talent pool in our own base of companies - among 68 founders (across 38 companies that had raised Series A funding and beyond), 60% had engineering degrees and 35% plus had MBAs.

Tony Pan, Co-Founder & CEO of Modern Electron, articulates this trend in the global climate startup context: “There’s been an increased interest in working on climate challenge. We’ve been able to attract a high level of quality talent in our company, even if the tech giants are more competitive on salary.”

III. Some organizations spoke of a need for mentorship, which was highlighted more closely in the context of innovation, R&D and technology

About 22% of the entrepreneurs surveyed thought of “Easier access to mentoring at product development, go-to-market stages” as a critical challenge for climate-tech startups in India. Only ~11% entrepreneurs surveyed highlighted “a lack of mentorship and strategic guidance” as a challenge for scaling up climate-tech startups in the space. One hypothesis is that there is sufficient business support for growing startups—the entrepreneur support ecosystem is relatively vibrant, and includes labs, incubators/accelerators, as well as scientific research and technology parks.

This ecosystem has been showcased in Chapter 4

An examination of 38 companies (that had series A funding and beyond) further affirmed that the business ecosystem for startups is well supported. Among the startups examined, nearly 30% of the 88 board members had an MBA. At the same time, the scientific or technical domain expertise, so critical in the climate space, may be lacking, and entrepreneurs would need to find ways to attract such experts to join their startups in senior leadership roles.

Pulkit Srivastava, the Co-Founder of EVage says, “A hardware-focused sector like EV manufacturing sees a full product/ technology development lifecycle and, therefore, entrepreneurs from a finance background, who are exposed to such a space, need adequate awareness, education and mentoring on the technology aspects of the solution and the sector at large.”

Less than six board members (of 88) had advanced academic degrees, e.g., PhDs, which would support deep tech solutions. These founders may need to plug into a more global ecosystem for support since less than 6% of the accelerators/incubators are focused on climate.¹⁴⁵

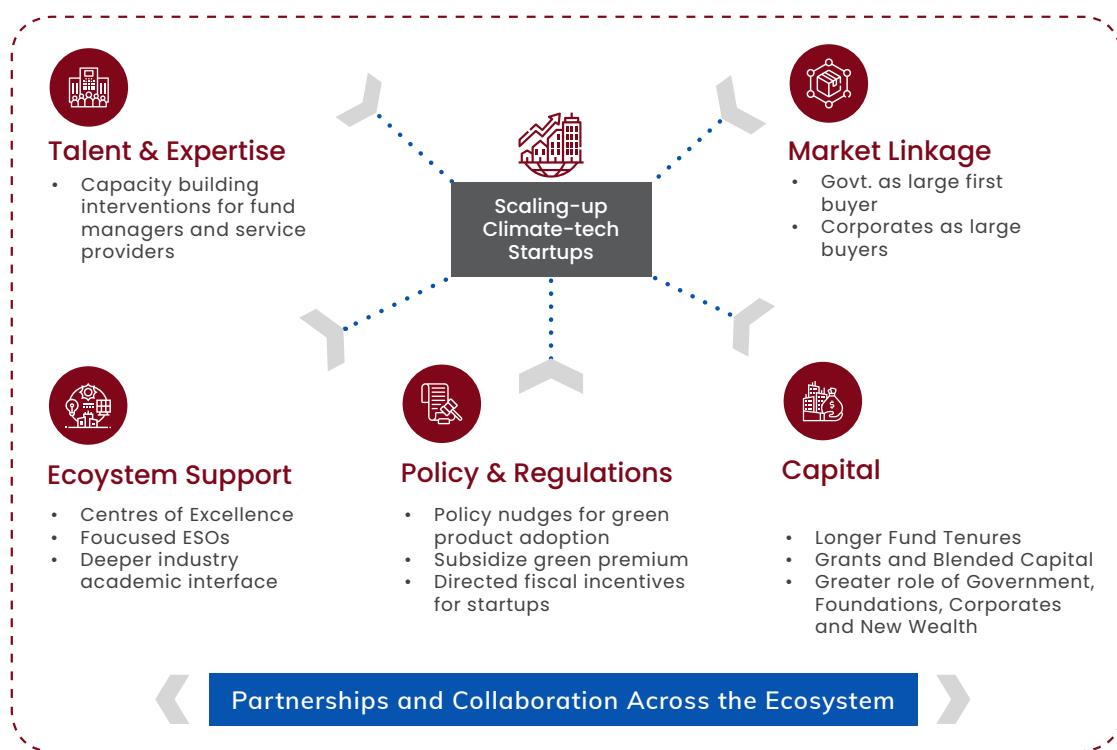


Recommendations



Through this study we have explored the technical infrastructure and entrepreneur support ecosystem focused on climate-tech in India. We have identified the enablers driving investments in climate-tech as well as the barriers to follow-on funding rounds and faster scale-up. The perspectives of entrepreneurs and investors on what can help accelerate flow of capital to climate-tech have also been captured. While the increasing focus and interest in climate-tech among various stakeholders is promising, these green shoots of innovation support and investment need to be nurtured to help climate-tech investing become mainstream. A larger flow of capital to sustainable and scalable climate-tech innovations will deliver benefits to the environment, and support India in achieving its sustainable development goals. To nurture and scale more such innovations and startups, given their hardware-heavy, cross-sectoral nature as well as typical operations within regulated environments, siloed approaches are not sufficient. It's necessary to leverage the power of global networks and multi-stakeholder partnerships so that India builds a disruptive climate-tech innovation base that includes solutions not only aligned to local needs but also those that can find global adoption.

We have identified actions and interventions around five key levers—(i.) Early-stage startup ecosystem, (ii.) capital, (iii.) talent & expertise, (iv.) market linkages and (v.) policy & regulations. The role of networks and partnerships cuts across all these levers.



EARLY-STAGE STARTUP ECOSYSTEM



1. Technical Labs & Infrastructure

In recent years, there has been a spurt in the allocation of resources from the government for technical labs and research facilities, innovation and entrepreneurship development centres, Science, Technology & Entrepreneur Parks (STEPs) as well as biotech parks.^{146,147} However, in order to turbo-charge the culture for invention and innovation, which underpins the climate-tech revolution globally, we need dedicated **Centres of Excellence (CoEs)** to support deep science and deep tech innovations within the ambit of climate-tech. Be it novel materials, new chemistries, new products and solutions (created by working at the intersection of various sciences), deep technology products and services—all of these can benefit from dedicated domestic technical labs that help push forward these innovations across various technology Readiness Levels.¹⁴⁸ A CoE can host dedicated infrastructure, have in-house technical experts and mentors, convene networks of domain experts and thereby enable prototyping, testing, technical validation, technology readiness for commercialization, and market linkages, ultimately leading to a better pipeline for early-stage investors. While there are CoEs in various fields in India, a majority of these have a broader interest in science and technology innovations that cut across sectors and only provide a part of the support needed for early-stage innovations and researchers, specifically technical validation typically. Dedicated, 'sector focused' technical infrastructure therefore is needed that is closely aligned with the needs of climate-tech startups and innovations, geographically well-distributed and more easily accessible to the innovators. Government, private universities and research institutions of repute could anchor such CoEs that will build focused technical capacity, industry-academia interfaces and allow deep-science research, rapid prototyping, testing and certification in sub-sectors such as clean energy, climate-smart agriculture, clean mobility and others.



2. Industry-Academia Interface

Additionally, creating a **robust industry-academia** interface will go a long way in ensuring that more research from universities and research centres gets commercialized. Today, there is greater acknowledgement of the need to set-up industry-academia interfaces adapting from the successful model used by IIT Madras Research Park, India's first university-based research park^{149,150}. However, in addition to the set-up of research parks, programmatic approaches here would help, for example, creating a **structured engagement accelerator** for researchers to work with industry to bring more lab-scale climate-tech innovations to market.



3. Incubators & Accelerators

Entrepreneur support organizations like incubators and accelerators enable early-stage startups to refine their business models, commercialize their innovations through access to networks and mentors and, thereby, better preparing these organizations for early-stage investments. The sector has witnessed support from both government interventions as well as private sector accelerators. Government interventions include Technology Business Incubators (TBIs) connected to academic institutions, multiple schemes and programmes offered by the Department of Science and Technology (DST) and Biotechnology Industry Research Assistance Council (BIRAC) and Atal Innovation Mission. Climate-tech startups, however, need specialized support—mentors who have key relationships and a deep understanding of the sector; global networks of technical hubs with deep domain experts who can provide targeted business and technical advisory. As we captured early on in the report, only a handful of Indian ESOs have a dedicated climate-tech focus that can offer such support (or parts of it). Moreover, the incubators are concentrated in metros and tier-I cities with prominent academic institutions. For a country of India's size and diversity, we need to support innovators who can solve multi-dimensional climate change problems unique to local contexts by distributing this incubation infrastructure more uniformly across states and cities.

Specialized ESOs (including incubators/ accelerators) are important, therefore, to create the enabling conditions for more climate-tech innovations to grow and scale-up through networks of experts, mentors and technical partners; linkages with dedicated CoEs for access to technical labs and testing facilities (as part of lab-to-market platforms); as well as programmes for engagement with customers (e.g., corporates, utilities) for piloting and/or deployment.

CAPITAL



1. Patient Capital

Climate-tech as a sector is innately hardware-driven and in many cases innovations in one sub-sector cut across multiple sub-segments and at times across sub-sectors. Given this complexity, climate-tech innovations in general, have longer gestation periods for product development and hence there is an inherent need for patient capital that can match these timelines. The existing VC ecosystem, however, works with shorter fund-tenors (typically 8–12 years, depending on sector and geographic focus).¹⁵¹ However, with growing LP realization on the climate-imperative, there is an opportunity for VCs to incorporate the climate lens more centrally into its investment strategy and to initiate more suitable fund structures that are better aligned to the needs of the sector.

Government-backed FoF structures (e.g., SIDBI FoF) and/or direct investment funds (e.g., SBI NEEV Fund), as well as funds by corporate VCs (e.g., Total Carbon Neutrality Ventures) are encouraging signs; the sector needs many more of these.

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Patient capital is needed to help evangelize the space, especially within new tech verticals where a longer gestation may be needed. Family offices, whose capital is quite patient, should ideally come in here—and their objective should be to stay as long as the entrepreneur is trying their best to meet the goal post

ALI FIDVI, Investment Principal, Refex Capital

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2. Grants

At the lab/idea stage, sizable risk capital in the form of government grants or philanthropic capital is needed to support researchers and innovators in product development, prototyping and technology validation. Much needed and focused programmes and schemes like those from DST (e.g., Technology Mission Programme on Water and Clean Energy) and BIRAC (e.g., SPARSH EIR scheme for waste-to-value innovators) could be further bolstered so that capital provided is aligned to the needs of the early-stage innovations in various climate-tech sub-sectors and sub-segments rather than the current 'one-size fits all' approach.



Grants are needed to support promising startups at the incubation/testing phase, which is the most critical stage in the scale-up journey of a startup. Dedicated buckets, which are focused on climate sub-areas, with slightly clearer distinction, are needed for the industry to pick momentum and scale.

SHIVA SHANKER, Vice President, Ankur Capital



Further, the recent amendments in regulations that allow a certain portion of the CSR funds to be deployed into incubators connected with government and academic institutes (e.g., Renew Power Center of Excellence), presents an opportunity for corporates to support climate-tech focused ESOs and/or set-up their own climate-tech focused centres (e.g., Shell E4) and, thereby further bolster their climate actions under ESG imperatives.



3. Blended Capital

In addition to patient capital there is a need for blended finance structures. **Appropriate, well-designed blended finance and/or affordable debt structures** can help in de-risking private investments¹⁵² and thereby overcoming the crucial hurdle of high cost of capital (in the case of debt) or return expectation (in the case of equity). For example, US-based Prime Coalition employs catalytic funding mechanisms via grants, recoverable grants and programme-related investments to support disruptive climate ventures¹⁵³. For this, it partners with individuals,

foundations, family offices and corporate giving programmes to place capital via its Prime Impact Fund into breakthrough climate innovations. In the Indian context as well, capital allocators like foundations, family offices and DFIs can play a significant role in facilitating innovative financing facilities and crowding-in other relevant actors, such as incubators, investors, go-to-market institutions, such as corporates, into the climate-tech sector.

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Foundations and angels can only provide a small quantum of capital on their own. Hence, we need more innovative structures to leverage the risk capital from foundations and angels, and help bundle it with larger pools of capital from PE, VC and other funding sources. Here is an example of an innovative structure using subordinated capital where we are working hard with a DFI LP to reduce risk for traditional LPs to participate in the climate-tech VC space.

- Instruments: First loss equity/ guarantees; repayable and convertible grants; viability gap funding
- Mobilization: This concessional capital will significantly enhance both the likelihood and speed of a climate-tech project/ fund being brought to implementation, thereby facilitating the participation of other commercial investors alongside the DFI in such projects/ funds

**SHYAM MENON, Partner & Co-Founder,
Bharat Innovations Fund**

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4. Role of New Wealth

A Morgan Stanley survey in 2017¹⁵⁴, of active individual investors found that 86% of Millennials are interested in sustainable investing, or investing in companies or funds that aim to generate market-rate financial returns, while pursuing positive social and/or environmental impact. Further, the survey found that millennials are twice as likely as the overall investor population to invest in companies targeting social or environmental goals; 75% of them believe that their actions can influence climate change and about 61% had made at least one sustainable investment in the preceding year¹⁵⁵. Over the next couple of decades, baby boomers are set to pass on USD 30 trillion, the largest intergenerational wealth transfer in history, to their Generation X and Millennial descendants. As millennials grow their wealth through earnings and inheritance, it presents a tremendous opportunity for directing

investments towards climate-tech innovations. With the changing preferences and priorities of a new generation of investors, the family wealth managers and financial advisors to HNIs and UHNIs will also need to play a more active and responsible role in presenting climate-tech investment opportunities to their clients.

TALENT & EXPERTISE

Cultivating relevant talent and technical expertise is indispensable to the growth of the climate-tech sector. While a lot of emphasis by investors and fund allocators presently is placed on the qualifications, experience and diligence of the entrepreneurial talent, there is also a **need for investors to also help build greater capacity**. This could be through qualified and experienced professionals in-house (for example, Operating Partners in late-stage funds), and/ or through ecosystem partnerships and extended global networks to access expertise to undertake technical due-diligence and portfolio management. Such capacity building would also help entrepreneurs tap into wider and newer pools of capital. Overall, this would enable ecosystem support organizations and capital providers to start inculcating the climate-tech lens more proactively in their investment strategies.

MARKET LINKAGES

Finding a set of committed first customers for early-stage climate-tech innovations has always been a challenge as customers (especially in B2B) find that many of the climate-friendly products tend to be more expensive than their conventional counterparts, and the customers are reluctant to pay this 'green premium'. For certain sub-sectors within climate-tech, particularly the hardware heavy ones, **the government can play a role by creating demand-side incentives** (for e.g. being a large first buyer), thereby helping reduce the green premium of new & more efficient technologies through aggregation. For example: the bulk procurement strategy of Energy Efficiency Services Ltd. (EESL) for LEDs, energy efficient Room ACs with more climate-friendly refrigerants, as well as EVs for government customers helped aggregate demand and thus lowered the costs of adoption of such climate-friendly technologies. The Bureau of Energy Efficiency (BEE) Star labels (energy efficiency rating) for appliances, also created discernible signals for customers to make pro-climate purchasing decisions.

Corporates also have a strong role to play here by being first customers and/ or helping climate-tech startups to set-up pilots for commercial validation, either in partnership with climate-tech focused ESOs or via in-house programmes. Startups can also leverage the vast network of corporations and industries by catering to

real-world problem statements from such customers. The government's AGNII programme, for example, over the last 1.5 years has received use-cases and problem statements from corporations, with some of them directly/ indirectly related to climate change mitigation.¹⁵⁶

Finally, climate-tech startups also need to **widen their outreach, marketing and communication efforts** from a life cycle climate impact quantification as well as commercial benefits perspective so as to generate more focused and committed customer as well as investor interest.

POLICY & REGULATIONS



1. Government Efforts

Government efforts through focused policies and initiatives like 'Startup India' and 'Make in India' have given a fillip to the innovation culture in the country with about 40% of the 500+ incubators and accelerators being added in just over the last five years¹⁵⁷. This could be further enhanced through focused policies and schemes for climate-tech researchers and innovators that incentivize them to become entrepreneurs. Focused policy and vision from the government to support and set-up the much-needed dedicated infrastructure we pointed out earlier (see **Chapter 4**), such as CoEs at institutes of repute (possibly through PPP mode) as well as specialized programmes that help make existing infrastructure (STEPs, TBIs, biotech parks, scientific labs, etc.) more accessible to climate-tech entrepreneurs will go a long way in lowering the barriers to entry for researchers and innovators into a sector that's already difficult.



2. Policies & Regulations

Policies and regulations from the government can also play a role in either nudging and incentivizing climate action among institutional customers and/ or encouraging individual customers to adopt green products, solutions and services. Some examples of policies that have enabled this are Extended Producer Responsibility (EPR) laws for waste management, the Perform Achieve and Trade (PAT) scheme for incentivizing reduction of energy consumption as well as BEE's star labelling program that has

helped create more awareness among individual customers on picking energy efficient products with an emphasis also on the long-term commercial and economic benefits. While policy frameworks are in place or are being bolstered as a response to the climate crisis, a stricter implementation is the need of the hour across various sub-sectors within climate-tech. Additionally, the FAME policies have taken a visionary approach to hand-hold a nascent sector and to provide incentives for creating a critical mass of infrastructure, suppliers and adopters. More such policies are needed that can incentivize a greater number of entrepreneurs with disruptive innovations in nascent sub-sectors and sub-segments within climate-tech like Environment & Natural Resources (particularly Carbon Capture for various end-products/ services cutting across sub-sectors), Climate-smart Agriculture & Food (e.g., eco-friendly agri-inputs that are better than chemical alternatives for both yields and the environment, alternative proteins, feed and nutrition products) as well as more impetus to the Energy sector (especially nascent technologies like Fuel Cells, novel Energy Storage technologies, Green Hydrogen etc.).

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Founders today have decided that they aren't waiting for permission as they attempt to solve large and important problems. This is a laudable evolution of the culture of innovation in India. Nevertheless, without the support from the rest of the ecosystem, they alone cannot bring about systemic change. Private capital has consistently supported entrepreneurship and will certainly participate in the climate-tech flywheel. Government can also play a pivotal role in accelerating the growth of the climate-tech space in India—both from a capital as well as policy/ strategy perspective.

**PRANAV PAI, Founding Partner & Chief Investment Officer,
Zone4 Capital**

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3. Directed Fiscal Incentives & Tax Depreciation Benefits

Finally, directed fiscal incentives and tax depreciation benefits for climate-tech solutions, will also help a sector with a lot of hardware-heavy and deployment-focused solutions.

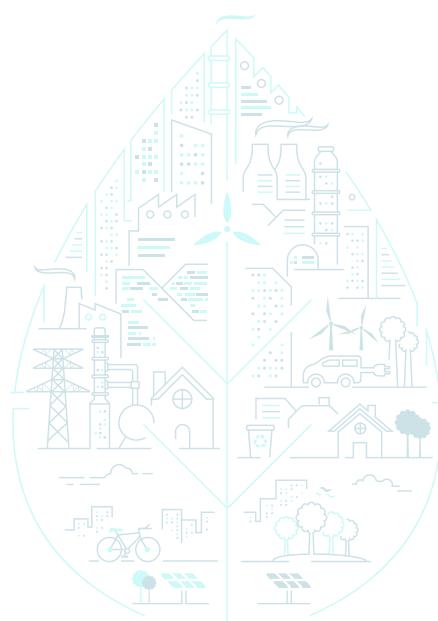
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This is the best time for further increasing research and innovation in new and sustainable technologies. We should do so with a spirit of cooperation and collaboration.

”

Shri Narendra Modi

Prime Minister of India



Early-stage climate-tech startups in India: Investment Landscape Report 2021

APPENDIX 1:

The IIC Research team uses the following filters to decide whether the enterprise will be tagged as an impact enterprise or not:

1. Mass market focus: key stakeholders (clients, suppliers) are low (EWS/LIG) or middle income (MIG)
2. For profit business – focused on innovation and scalability – no not-profit or hybrid models
3. Focus on basic service delivery to the underserved population (access and affordability)
4. Focus on providing livelihoods or income enhancement for low-income clients or suppliers
5. Impact intentionality: impact as stated objective and/or measured by firm or impact investor

If the enterprise meets one or more of the above criteria, it has been included in the database and then categorized into one of the key impact sectors based on its business model.



APPENDIX 2:

| Sr. no. | List of Investors / ESOs | Sr. no. | List of Entrepreneurs |
|---------|--------------------------------------|---------|---|
| 1. | 3one4 Capital | 1. | ANI SCRAP PRIVATE LIMITED |
| 2. | Aavishkaar Group | 2. | Blue Sky Analytics |
| 3. | Accion | 4. | Carbon Masters |
| 4. | Acumen | 5. | Cell Propulsion |
| 5. | Ankur Capital | 6. | Chakr Innovation |
| 6. | Artha Impact (Rianta Capital Zurich) | 7. | Drishya AI Labs Inc. |
| 7. | Blue Ashv | 8. | Drmz System Innovations Pvt Ltd |
| 8. | C-CAMP | 9. | EVage |
| 9. | Chiratae Ventures | 10. | Go GreenEOT Pvt Ltd. |
| 10. | CIIE/Infuse Ventures | 11. | Goenvi Technologies Pvt Ltd |
| 11. | Elevar Equity | 12. | Gramcover |
| 12. | FMO Ventures | 13. | H2E Power |
| 13. | Green Artha | 14. | HiPER (High Performance Engineering and Research Pvt. Ltd.) |
| 14. | Habitat for Humanity International | 15. | Hydrogreens Agri Solutions |
| 15. | Ikea Foundation | 16. | Intech Harness Pvt Ltd |
| 16. | LeapFrog Investments | 17. | Lithion Power |
| 17. | Lemelson Foundation | 18. | Lithium |
| 18. | Lightbox | 19. | Log9 Materials |
| 19. | Micelio Fund | 20. | M/S SURAJ SOLAR ENTERPRISE |
| 20. | Omnivore | 21. | Monter Technologies |
| 21. | Quest Ventures | 22. | OORJAgam India Pvt Ltd |
| 22. | Raintree Family Office LLP | 23. | POWEREasy |
| 23. | Refex Capital | 24. | Prescinto |
| 24. | Sangam | 25. | Proklean Technologies |
| 25. | Sequoia | 26. | Pyotam |
| 26. | Shell E4 | 27. | S4S Technologies |
| 27. | Social Alpha | 28. | smv green solutions |
| 28. | Somerset Indus Capital Partners | 29. | String Bio |
| 29. | Take-a-Stake Fund | 30. | Telluris Biotech India |
| 30. | Think Ag | 31. | Temperate Technologies |
| 31. | UBS Optimus Foundation | 32. | Tessol |
| 32. | Venture Souq | | |
| 33. | Village Capital | | |
| 34. | Villgro | | |

APPENDIX 3: Detailed Information

| Sr. no. | Term to be defined | Definition | source |
|---------|-----------------------------------|--|---|
| 1 | Air pollution | The presence of contaminant or pollutant substances in the air that do not disperse properly and that interfere with human health or welfare or produce other harmful environmental effects. | http://data.un.org/Glossary.aspx?q=pollution |
| 2 | Angel Investors | Angel investors predominantly invest in pre-seed or seed funding rounds in early-stage or start-up companies in exchange for an equity ownership interest. | https://www.forbes.com/sites/allbusiness/2015/02/05/20-things-all-entrepreneurs-should-know-about-angel-investors/?sh=a88ff42c1aa5 |
| 3 | Carbon sinks | Pool (reservoir) that absorbs or takes up released carbon from another part of the carbon cycle. For example, if the net exchange between the biosphere and the atmosphere is towards the atmosphere, the biosphere is the source and the atmosphere is the sink. | http://data.un.org/Glossary.aspx?q=carbon+sink |
| 4 | Circular Economy | An economy that is restorative and regenerative by design. In a circular economy economic activity builds and rebuilds overall system health. The concept recognizes the importance of the economy needing to work effectively at all scales – for big and small businesses, for organizations and individuals, globally and locally. It is based on three principles: (i) Design out waste and pollution; (ii) Keep products and materials in use; (iii) Regenerate natural systems | https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail |
| 5 | Climate- Smart Agriculture | Climate-smart agriculture (CSA) is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support the development and ensure food security in a changing climate. | http://www.fao.org/climate-smart-agriculture/en/ |
| 6 | Climate- tech | “Climate tech” encompasses a broad set of sectors that tackle the challenge of decarbonizing the global economy, with the aim of reaching net-zero emissions before 2050. This includes low-to-negative carbon approaches to cut key sectoral sources of emissions across energy, built environment, mobility, heavy industry, and food and land use; plus cross-cutting areas, such as carbon capture and storage, or enabling better carbon management, such as through transparency and accounting. (Historically Climate tech has been referred as clean tech by the investors) | https://www.pwc.com/gx/en/services/sustainability/publications/state-of-climate-tech-2020.html |
| 7 | Clean Energy | Clean energy is derived from renewable, zero emission sources that do not pollute the atmosphere when used. Green energy refers to energy derived from natural sources. While renewable energy is from resources that won't run out like wind, solar, geothermal, hydropower, tidal energy etc. There is a subtle difference between these three energy types even though they are often spoken of as being the same. Hydropower is renewable but some do not consider it as green for example. Further, new energy sources like green hydrogen (as against non-green hydrogen) are also considered as clean energy. For this study, we have bucketed all energy types under the head “Clean Energy”. | https://www.twi-global.com/technical-knowledge/faqs/clean-energy |

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| 8 | Energy access | Refers to household level access to a minimum level of electricity and safer/ more sustainable (i.e., minimum harmful effects on health and environment as possible) cooking and heating fuels and stoves; access to modern energy that enables productive economic activity (e.g. mechanical power for agriculture, textile, rural businesses and other industries); as well as modern energy provision for public services (e.g. electricity for health facilities, schools and street lighting). | https://www.iea.org/articles/defining-energy-access-2020-methodology |
| 9 | Energy efficiency | Energy efficiency simply means using less energy to perform the same task – that is, eliminating energy waste. | https://www.eesi.org/topics/energy-efficiency/description |
| 10 | Energy storage | To capture energy and effectively deliver it for future use. Energy storage technologies offer several significant benefits: improved stability of power quality, and reliability of power supply among others. There are several methods for storing energy such as mechanical (harnessing kinetic/ gravitation, electrical, chemical, electrochemical, thermal, hydropower etc. This study doesn't consider large-scale infrastructure type solutions like Hydropower. Further, startups with energy storage innovations purpose built for mobility are categorized separately from those that could be used across multiple end-use energy applications. | https://www.sciencedirect.com/topics/engineering/energy-storage-technology |
| 11 | Environment and Natural Resources | Natural and environmental resources generally describe all the elements available in nature that are used or can be used in the economic system. These can be: physical such as soil, water, forests, fisheries, and animals, minerals (e.g. copper, bauxite, etc.); gases (e.g. helium, hydrogen, oxygen, etc.); and abstract such as landscape, good air, clear water, and so forth. | http://www.fao.org/3/y4256e/y4256e04.htm |
| 12 | GHG emissions | Greenhouse gas (GHG) emissions refer to the sum of GHGs that have direct effects on climate change and are considered responsible for a major part of global warming: carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF ₆) and nitrogen trifluoride (NF ₃). | https://www.oecd.org/environment/environment-at-a-glance/Climate-Change-Archive-February-2020.pdf |
| 13 | Green finance | Green financing is to increase the level of financial flows (from banking, micro-credit, insurance, and investment) from the public, private and not-for-profit sectors to sustainable development priorities. A key part of this is to better manage environmental and social risks, take up opportunities that bring both a decent rate of return and environmental benefit, and deliver greater accountability. | https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/green-financing |
| 14 | Climate Finance | Climate finance refers to local, national or transnational financing—drawn from public, private and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change. | https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance |

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| 15 | Impact investing | Impact investments are investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return. Impact investments can be made in both emerging and developed markets, and target a range of returns from below market to market rate, depending on investors' strategic goals. | https://thegiin.org/impact-investing/need-to-know/?gclid=CjwKCAjw_o-HBhAsEiwANqY-hp1AFbuawveZ4TYtA2xCuR-Q8QTzW1KVVAMBUkzgG-zYePdzk9QqyYfYBoCziQQAvD_BwE#what-is-impact-investing |
| 16 | Private Equity | Private equity (PE) refers to an asset class in which investors purchase the illiquid equity (or equity-like) securities of operating companies. This equity is not publicly traded, but instead held in private hands. In exchange for their capital, PE firms take ownership stakes that range from a concentrated minority through to majority ownership in a company. | https://documents1.worldbank.org/curated/en/336471468155132454/pdf/WPS6827.pdf |
| 17 | Upcycling | Upcycling is a process in which used materials are converted into something of higher value and/or quality in their second life. It has been increasingly recognised as one promising means to reduce material and energy use, and to engender sustainable production and consumption. | https://www.researchgate.net/publication/299559229_A_Review_on_Upcycling_Current_Body_of_Literature_Knowledge_Gaps_and_a_Way_Foward |
| 18 | Startup | Startups are young companies founded to develop a unique product or service, bring it to market and make it irresistible and irreplaceable for customers. Startups are rooted in innovation, addressing the deficiencies of existing products or creating entirely new categories of goods and services, thereby disrupting entrenched ways of thinking and doing business for entire industries. | https://www.worldbank.org/en/news/feature/2017/07/10/sustainable-mobility-for-the-21st-century |
| 19 | Sustainable Mobility | Sustainable mobility would include a better provision of infrastructure and services to support the movement of goods and people built around four pillars - (1) equitable access; (2) security and safety; (3) efficiency; and (4) pollution and climate-responsiveness | https://www.worldbank.org/en/news/feature/2017/07/10/sustainable-mobility-for-the-21st-century |
| 20 | Venture capital | Venture Capital (VC) firms invest in the private securities of operating companies. VC firms are known for investing in early-stage companies that are typically riskier in nature than the investments made by their Private Equity counterparts. Often VC firms invest in companies in sectors that are related to technology or innovation, although they may also back businesses in other verticals. | https://documents1.worldbank.org/curated/en/336471468155132454/pdf/WPS6827.pdf |
| 21 | Waste management | Characteristic activities include (a) collection, transport, treatment, and disposal of waste, (b) control, monitoring, and regulation of the production, collection, transport, treatment, and disposal of waste and (c) prevention of waste production through in-process modifications, reuse, and recycling. | http://data.un.org/Glossary.aspx?q=waste+management |
| 22 | Water pollution | Presence in the water of harmful and objectionable material - obtained from sewers, industrial wastes, and rainwater runoff - in sufficient concentrations to make it unfit for use. | http://data.un.org/Glossary.aspx?q=water+pollution |
| 23 | Carbon capture and management | Carbon capture, utilization, and storage (CCUS), also referred to as carbon capture, utilization, and sequestration is a process that captures carbon dioxide emissions and either utilizes to create new products or stores it so it will not enter the atmosphere. For this study, we are including innovations capturing other GHGs and converting/ storing them also into this category. | https://www.energy.gov/carbon-capture-utilization-storage |

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| 24 | Climate mitigation | As there is a direct relation between global average temperatures and the concentration of greenhouse gases in the atmosphere, the key for the solution to the climate change problem rests in decreasing the amount of emissions released into the atmosphere and in reducing the current concentration of carbon dioxide (CO ₂) by enhancing sinks (e.g. increasing the area of forests). Efforts to reduce emissions and enhance sinks are referred to as "mitigation". | https://unfccc.int/topics/mitigation/the-big-picture/introduction-to-mitigation |
| 25 | Climate adaptation | Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. In simple terms, countries, and communities need to develop adaptation solutions and implement action to respond to the impacts of climate change that are already happening, as well as prepare for future impacts. | https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean |
| 26 | Climate resilience | Climate resilience is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate. Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks. | https://www.c2es.org/content/climate-resilience-overview/ |
| 27 | Family Office | Family Office is the 'ecosystem' that a family builds around itself to get organized, manage their assets, and enable them to enjoy their lifestyles. Depending on the family's needs, this could encompass investing in the financial portfolio, leading business transactions, tending philanthropic interests, or managing multiple households – including paying the personal chef or pilot. | https://home.kpmg/xx/en/home/insights/2019/11/the-emergence-of-the-family-office.html |

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