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# Climate Entrepreneurship in Developing Economies

Supporting Entrepreneurs Tackling Climate Change



Aspen Network of  
Development Entrepreneurs



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## THE LEMELSON FOUNDATION

This report offers a landscape of the existing knowledge base on support for climate entrepreneurs in emerging markets, the opportunities that entrepreneurship creates regarding adaptation and mitigation, and insights into the priorities and challenges the sector faces in this impact area. This report, along with ANDE's additional work in the areas of climate and environment, is the result of a partnership supported by The Lemelson Foundation. As part of this partnership, ANDE will continue to expand its work in this area through engaging in additional research and sharing learnings for the sector.

# EXECUTIVE SUMMARY

Entrepreneurs in developing economies are vital to addressing climate change and promoting sustainable and resilient development. Developing countries will experience some of the worst climate impacts, and they also hold enormous potential for encouraging mitigation and adaptation on local and regional levels. Yet, entrepreneurs in developing economies face distinct challenges and barriers when it comes to addressing climate change. This report is intended to serve as an overview of the current literature on the intersection of entrepreneurs and climate action, as well as a call to action.

## ***Part I – Climate and Entrepreneurship Overview***

Businesses can address climate change by promoting mitigation of climate change drivers or adaptation to climate change impacts. Two approaches for entrepreneurs to advance mitigation or adaptation are through developing and deploying new technologies or facilitating the local adoption of existing solutions. Entrepreneurs have opportunities to drive both mitigation and adaptation through these approaches in multiple stages of the value chain.

## ***Part II – Climate Entrepreneurship in Developing Economies by Sector***

Climate entrepreneurs span a wide range of sectors, but certain sectors may offer particularly strong potential for entrepreneurs to play a significant role in mitigation and adaptation. These include:

- Agriculture and Food Systems
- Energy
- Environmental and Natural Resources

## ***Part III – Barriers, Needs, and Trends***

This section lays out the barriers, needs, and trends in climate small and medium enterprise (SME) growth, focusing particularly on financing and capacity development.

Financing is difficult to access for climate-focused entrepreneurs, especially in the early stages of business growth. Entrepreneurial ecosystems can be weak in developing economies, and banks often require high collateral for loans. Venture capital is scarce in developing economies, but given the potential high impact of climate ventures, impact investing can be an important source of financing. However, many financiers are unfamiliar with the risks and benefits of climate technology or climate-related business models, making them hesitant to invest. Creating new types of financing tools with blended finance and distributed risk will be key to attracting investment in climate entrepreneurs.

Capacity development for climate entrepreneurs through incubators and accelerators offers promise if these services are designed correctly and adapted to the specific regional context in which they are operating. Education, training, and networking are often the core of incubation and acceleration models. Networking, especially in many developing economies, can present challenges, as ties between domestic and international partners may be weak. Domestic networks in developing economies can have critical gaps between climate technology developers and industry, or between current businesses and climate solutions. There is limited evidence and documentation on specific program designs that have proved successful in creating positive outcomes for climate entrepreneurs. This lack of evidence is an important gap for those attempting to create new programs and support for this segment.

## ***Part IV – Existing Programs for Climate Entrepreneurs***

There are a handful of notable programs to assist climate entrepreneurs in developing countries that have piloted new ways to adapt their models to local contexts. Each provides lessons on best practices, but we need more pilots of more approaches to substantially scale the ecosystem of support for entrepreneurs who can contribute to climate mitigation and adaptation.

### ***A Call to Action***

There is an incredible need – and opportunity – for entrepreneurs to engage around ways that support climate adaptation and mitigation. Some barriers they face in developing economies may be addressed through support programs that are adapted to the region and have broader offerings including education, training, networking, and enhanced access to financing. However, with only 25 such accelerators and incubators currently in existence outside industrialized countries, climate incubators and accelerators are too few and far between and too little studied to authoritatively define best practices. Still, they represent a critical way to help climate entrepreneurs where entrepreneurial ecosystems are weak. Increased knowledge sharing between institutions that have active climate incubators and accelerators will bolster the effectiveness of future models and generate increased interest in establishing more climate business assistance programs. Additionally, policies that both foster these entrepreneurs, as well as reduce the barriers they face, will play a crucial role in growing this sector – and, if we're lucky, averting catastrophic climate change.

# INTRODUCTION & RESEARCH MOTIVATION

The Paris Agreement of 2015 represented the most comprehensive worldwide commitment to collectively address climate change in an effort to limit temperature rise to 2 degrees Celsius above pre-industrial levels. Taken together, the national commitments made were not ambitious enough to reach that goal – let alone the 1.5-degree Celsius temperature rise that scientists have since recommended as the target threshold.

The United Nations' Sustainable Development Goals (SDGs), also adopted in 2015, have been widely embraced as key international targets for achieving healthy societies, healthy economies, and a healthy planet. While government intervention and investment are vital to achieving the goals of climate change mitigation and equitable development, the world cannot achieve these goals without the private sector.

In particular, entrepreneurs in developing economies have an important role to play in developing and adopting climate-friendly innovations. This report summarizes the current literature on how entrepreneurs can most directly address climate issues, broadly outlines the sectors where entrepreneurs in developing economies have significant opportunity for climate impact, and discusses support mechanisms and existing programs for climate-focused entrepreneurs. This desk study reviews current literature, provides the outlines of a critical call to action, and lists resources for further reading.

# PART I: CLIMATE AND ENTREPRENEURSHIP OVERVIEW

There are two overarching strategies needed to address climate change: mitigating climate change drivers and adapting to climate change impacts. Climate change *drivers* are processes that increase the amount of Greenhouse Gases (GHGs), which trap heat in the atmosphere or reduce the planet's natural ability to sequester those GHGs. Climate change *impacts* are the ecological and physiological changes that take place on the planet and the resulting social and health consequences of those changes to which we must adapt.<sup>23</sup> Both are critically important to address.

The GHGs most relevant to the small business sector are carbon dioxide and methane; while CO<sub>2</sub> is more pervasive and traditionally has received the lion's share of attention, methane has roughly 25 times CO<sub>2</sub>'s heat-trapping power. Methane is one of the main climate change contributors from the agriculture sector (the other contributor being deforestation to create additional farmland). Methane is released via the burps or flatulence of ruminants – primarily cattle. Due to methane's potency, livestock is responsible for an estimated 14.5 percent of global GHGs.<sup>69</sup> Meanwhile, short-lived climate pollutants (so-called because they don't stay in the atmosphere for 100 years, as CO<sub>2</sub> does) are relevant to the urgent need for better access to clean cooking technology. One such short-lived pollutant is known as black carbon, which can absorb 1 million times more solar energy than CO<sub>2</sub><sup>75</sup>. Black carbon is a component of particulate matter, which is particularly dangerous to human respiratory health because of its tiny size and a byproduct of the fires used to cook the meals of nearly half of the world's population who lack access to clean-burning fuels and clean cooking technology.<sup>76</sup>

# CLIMATE CHANGE MITIGATION

Climate change mitigation is defined as a human intervention to reduce the sources or enhance the sinks of greenhouse gases.<sup>20</sup> Below is a table of sample mitigation efforts, their climate relevance, and examples of related mitigation activities for businesses.

Figure 1: Climate Change Drivers, Effects, and Potential Mitigation.

Climate Change Driver	Effect on Climate	Examples of Sectors or Activities Responsible	Examples of Potential Mitigation Activities
<i>Increased heat-trapping greenhouse gas (GHG) emissions</i>	Contributes to the greenhouse effect in the atmosphere which warms the planetz	Industry and construction	Lower-emissions industry or building processes
		Energy generation	Generation of energy from renewables such as solar, wind, ocean, or geothermal sources
		Energy inefficiency	Enhanced energy efficiency technologies and buildings
		Livestock production	Improved livestock practices, such as methane capture or reduction
		Agricultural practices	Improved agricultural practices
		Transportation	Electric or hybrid vehicles
		Waste management	Improved waste management practices
<i>Reduction of planet's natural GHG sequestration capacity</i>	Limits the ability of the planet's physical and biological systems to absorb excess GHGs, leading to more GHGs remaining in the atmosphere	Deforestation	Afforestation and/or maintenance of forest
		Other land conversions	Maintenance of high-carbon landscapes such as wetlands
		Agricultural practices	Climate-smart agricultural practices
<i>Decreased albedo effect</i>	Loss of light-reflecting surfaces and build-out of dark, heat-absorbing surfaces lead to further warming	Loss of ice cover	Reflective technologies for land or water cover and/or reduction in particle emissions
		Urban build-up, roads, and asphalted or dark areas	Use of light-colored, reflective materials in construction
			Use of shading devices, such as tree planting

Source: Author's compilation

Many entrepreneurs are looking to develop goods and services that are relevant to customers and provide low-carbon alternatives to incumbents. There are also a number of climate adaptation business models around restoring landscapes and selling the resulting net carbon to businesses looking to offset their carbon footprints.<sup>27</sup>



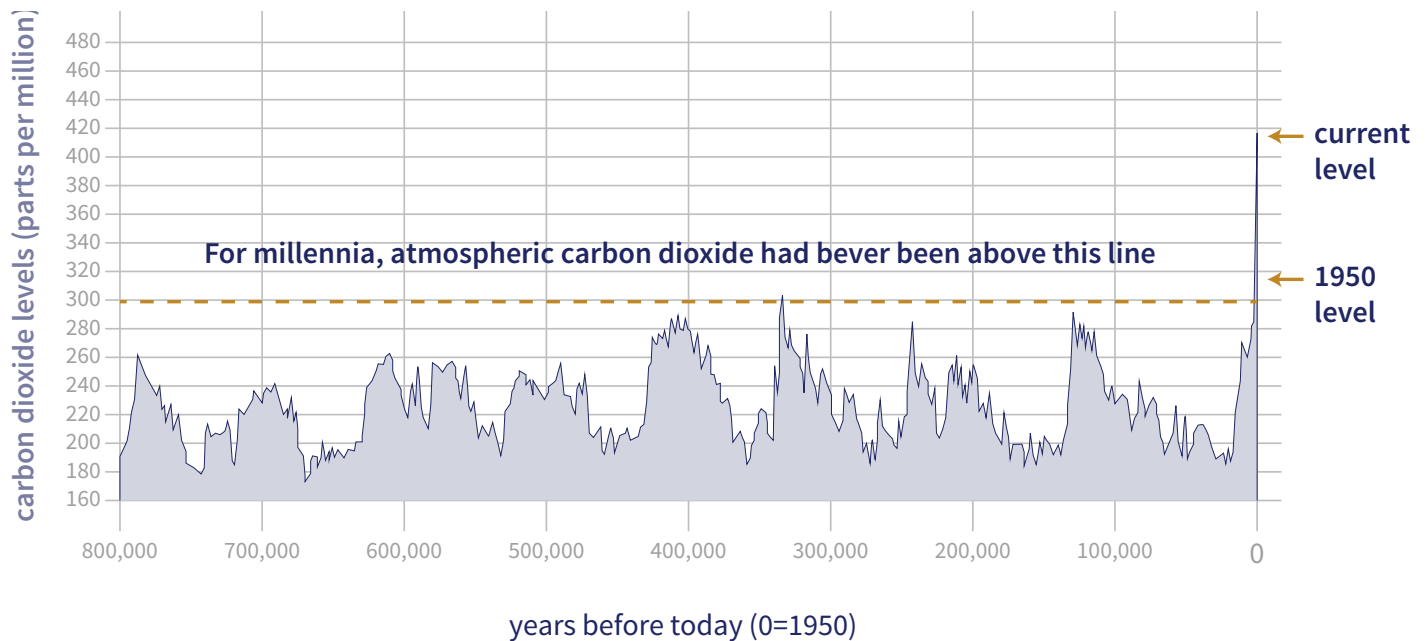
# CLIMATE CHANGE ADAPTATION

The world is already facing climate impacts today, which will only increase over time. Even if GHG emissions were to stop today, the high levels already in the atmosphere would drive increasing heat and climate impacts for decades yet to come.

In 2016, atmospheric concentrations of CO<sub>2</sub> passed 400 parts per million (ppm) for the first time in several million years, having risen with increasing speed from the pre-industrial level of 280 ppm, as more and more carbon fueled greater economic growth. The global average amount of carbon dioxide hit a new record high in 2019 at 409.8 ppm. At the current rate of growth in CO<sub>2</sub>, levels could hit 500 ppm within 50 years, putting us on track to reach temperature boosts of potentially more than 3 degrees Celsius (5.4°F) — a level that climate scientists say would bring extreme weather and sea-level rise that would endanger global food supplies, cause disruptive mass migrations, and even destroy the Amazon rainforest through drought and fire.

Keeping atmospheric carbon below 450ppm, which is required for limiting temperature rise to 1.5 degrees C, will require ambitious action from developed and developing countries alike. Many of the G20 and other countries representing more than half of global GDP have made commitments to reach net-zero emissions targets by mid-century, and have ratcheted up their targets under the Paris Agreement, helping to make up for the initial shortfall in ambition. China has announced a net-zero target for 2060. However, large and growing emerging economies, such as India, are already major emitters; and others, such as Nigeria, could become high emission countries by 2050 if they don't adopt a low carbon development strategy today.





Figure 2: Carbon Dioxide over 800,000 Years



Source: [NOAA via climate.gov](https://www.climate.gov)

The need to adapt to an already climate-changed and changing world will be an unavoidable part of the future. See Figure 3 for what that those climate change impacts could look like and what adaptation solutions exist.

Figure 3: Climate-related impact drivers, examples, and possible adaptation solutions

Climate-related impact drivers	Sector	Examples of projected climate change impacts	Examples of adaptation solutions	
			Climate Adaptation Intelligence	Climate Adaptation Products and Services
 Extreme temperature	<b>Agriculture</b>	<ul style="list-style-type: none"> <li>• Reduced crop yields and quality resulting from higher temperatures and/or less precipitation</li> <li>• Reduced crop yields in irrigated agriculture due to reduced availability of irrigation water</li> <li>• Crops losses due to extreme weather events</li> </ul>	<ul style="list-style-type: none"> <li>• Climate monitoring and forecasting</li> <li>• Temperature regulation technologies for livestock</li> <li>• Remote sensing-based drought monitoring tool</li> <li>• Crop data and analytics platform with mapping interface</li> </ul>	<ul style="list-style-type: none"> <li>• Drought tolerant crops</li> <li>• High precision laser land leveling to reduce runoff</li> <li>• Pressurized irrigation technologies using sprinkler, drop, mini-sprinkler, or high-efficiency drop systems</li> <li>• Parametric insurance</li> </ul>
	<b>Coastal zones</b>	<ul style="list-style-type: none"> <li>• Damage to assets from more intense and frequent extreme weather events</li> <li>• Flooding due to sea level rise and storm surges</li> <li>• Reduced of domestic, commercial, or industrial water due to saltwater intrusion</li> <li>• Erosion due to rising sea level</li> </ul>	<ul style="list-style-type: none"> <li>• Early warning systems for extreme coastal weather events</li> <li>• Satellite imagery for monitoring and impact assessment</li> <li>• Sea-level processing software</li> </ul>	<ul style="list-style-type: none"> <li>• Geosynthesis (e.g., geotextiles and geomembranes)</li> <li>• Constructed wetlands and artificial reefs</li> </ul>
 Extreme precipitation	<b>Health</b>	<ul style="list-style-type: none"> <li>• Changes in the geographic range, seasonality, and incidence of vector- and water-borne diseases</li> <li>• Reduced labor productivity due to heat stress</li> <li>• Increased respiratory illness due to heat stress</li> </ul>	<ul style="list-style-type: none"> <li>• Disease surveillance systems</li> <li>• E-Health e.g. remote diagnostics, health and disease surveillance systems for outbreak detection</li> </ul>	<ul style="list-style-type: none"> <li>• Long-lasting insecticidal nets</li> <li>• Rapid diagnostic tests</li> </ul>
	<b>Transport</b>	<ul style="list-style-type: none"> <li>• Damage to road network/ rail network/seaports due to extreme weather events</li> <li>• Interruption of transport networks due to extreme weather events</li> <li>• Flooding and inundation of transportation infrastructure due to rising sea levels</li> </ul>	<ul style="list-style-type: none"> <li>• Intelligent transportation systems to e.g. monitor road conditions, address hazards in real time, moving traffic away from areas experiencing a natural disaster, point first responders to identify priority intervention areas</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme heat/cold resistant paving material</li> <li>• Active motion-dampening systems</li> </ul>
 Damaging cyclone	<b>Water supply and management</b>	<ul style="list-style-type: none"> <li>• Reduced surface-water availability due to changes in precipitations</li> <li>• Reduced surface water quality due to e.g., saltwater intrusion</li> <li>• Increased flooding due to extreme weather events</li> </ul>	<ul style="list-style-type: none"> <li>• Water monitoring and modelling (e.g. water resource mapping)</li> <li>• Hydrological forecasting system</li> </ul>	<ul style="list-style-type: none"> <li>• Water storage and harvesting</li> <li>• Water saving technologies/ water loss reduction technologies e.g., smart water meters, pressure control equipment</li> </ul>
 Sea level				

SOURCE: Adaptation SME Accelerator Project

## CLIMATE RESILIENCE

While adaptation and mitigation form the backbone of the discussions around climate and green businesses, another important concept is resilience. Referring to a system’s ability to “bounce back” from disruptions, or adapt to changing conditions, the concept of resilience is taking center stage in climate action. Adaptation contributes to resilience, but resilience is composed of many more factors. Both urban systems and ecosystems need resilience urgently as chronic stressors change climatic conditions and more acute disruptions like storms and wildfires continue to increase. Technology can drive resilience in urban systems as cities may need distributed power grids or better energy storage to mitigate risks from power outages during severe weather events, or permeable pavement and enhanced stormwater systems to limit flooding. In ecosystems, conservation, restoration, proper land management, and biodiversity promotion are all important to maintaining resilience and ensuring the continued provision of ecosystem services.

## DECARBONIZATION SOLUTIONS

Innovative business solutions that help decarbonize the economy are sometimes referred to as “cleantech” or “Greentech,” and more lately increasingly as “climate tech.”<sup>1</sup> These terms cover a range of products, technologies, processes, and services that decrease the natural resource inputs needed, reduce emissions generated, and/or create a more beneficial environmental outcome than traditional methods. However, technology solutions, though appealing to Silicon Valley, rarely address the equity and climate justice dimensions of climate change, which nonetheless require consideration; “climate tech” alone is no silver bullet.

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1 <https://www.greenbiz.com/article/climate-tech>

Figure 4: Climate Solution by Innovation Stage

Solution category	Energy supply	Transportation	Buildings	Agriculture, forestry, and other land use	Industry
<b>Commercially viable or near commercially viable solutions</b>	<ul style="list-style-type: none"> <li>• Silicon-based photovoltaics</li> <li>• Onshore wind power</li> <li>• Lithium-ion batteries for short duration (&lt;4 hour) storage</li> <li>• Power system optimization software solutions</li> <li>• Demand responses and consumer engagement solutions</li> <li>• Ice-based thermal energy storage</li> <li>• Generation 3+ nuclear power</li> </ul>	<ul style="list-style-type: none"> <li>• Light- and medium-duty electric vehicles</li> <li>• Sugarcane feedstock biofuels</li> <li>• Composite materials for vehicle lightweighting</li> </ul>	<ul style="list-style-type: none"> <li>• LEDs</li> <li>• Residential cold climate heat pumps</li> <li>• Building automation and control technologies</li> <li>• Efficient window technologies and coatings</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced sensing solutions</li> <li>• Crop resource optimization technologies</li> <li>• Crop waste recycling</li> <li>• Forest management and reforestation</li> <li>• Anaerobic digestion</li> <li>• Biotechnology assisted animal breeding</li> <li>• Genetic modification of crops</li> </ul>	<ul style="list-style-type: none"> <li>• Low-grade industrial heat production</li> <li>• Combined heat and power systems</li> </ul>
<b>Nascent solutions</b>	<ul style="list-style-type: none"> <li>• Carbon capture and sequestration</li> <li>• Generation 4 nuclear energy technologies</li> <li>• Fuel cell technologies</li> <li>• Long-duration energy storage solutions (&gt;4 hours)</li> <li>• High-efficiency, low-cost transmission</li> <li>• Offshore wind power</li> <li>• Next-generation photovoltaics</li> </ul>	<ul style="list-style-type: none"> <li>• Low carbon hydrogen production and storage</li> <li>• Hybrid or electric heavy-duty vehicle drive trains</li> <li>• Algal or cellulosic biofuels</li> <li>• Fuel cell vehicles</li> <li>• Advanced combustion engines</li> </ul>	<ul style="list-style-type: none"> <li>• Hyper-efficient building envelope technologies</li> <li>• Hyper-efficient refrigerant and freezing</li> <li>• Wide bandgap semiconductors</li> <li>• Transparent photovoltaic window coatings</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon-neutral fertilizer production processes</li> <li>• Livestock methane capture</li> <li>• Synthetic meat production</li> <li>• Vertical farming techniques</li> <li>• Genetic engineering for sustainable food production</li> </ul>	<ul style="list-style-type: none"> <li>• Industrial process-integrated carbon capture</li> <li>• Low-carbon cement production</li> <li>• Low-carbon steel and aluminum production</li> <li>• High-efficiency industrial motors</li> <li>• Thermoelectrics, rectennas, and other waste heat recovery technologies</li> </ul>
<b>Unexplored solution spaces</b>	<ul style="list-style-type: none"> <li>• Biomass energy with carbon dioxide capture and storage</li> <li>• Fusion energy</li> <li>• Solar geoengineering</li> </ul>	<ul style="list-style-type: none"> <li>• Next-generation transportation solutions (e.g. “hyperloops”)</li> <li>• Third- and fourth-generation biofuels (solar fuels)</li> </ul>	<ul style="list-style-type: none"> <li>• Space-based living and terraforming</li> </ul>	<ul style="list-style-type: none"> <li>• Non-fuel-based ammonia production</li> </ul>	<ul style="list-style-type: none"> <li>• Non-fossil petrochemical production</li> <li>• Carbon-negative cement</li> <li>• Space-based mining</li> </ul>

Source: Stanford Social Innovation Review (2018)

## INNOVATION AND LOCAL ADOPTION

Climate entrepreneurs can drive climate solutions through innovation (the generation of new technologies, processes, or models to mitigate or adapt), or through facilitation (spreading existing adaptation and mitigation measures through business models that allow for local uptake of technology or practices). This is not always an ‘either/or’ for business models, as many entrepreneurs may be both innovating and adapting some new technological element, while also facilitating local uptake.

## ENTERPRISE SEGMENTS AND MARKETS

It is important to consider how different segments of entrepreneurs will intersect with climate issues differently. Generally speaking, entrepreneurs can fall into two basic categories. Those that generally align with ANDE’s concept of “small and growing businesses” (SGBs)<sup>\*2</sup>, and are oriented towards innovation and growth, are often referred to as “opportunity,” “transformational” or “growth entrepreneurs.”<sup>33</sup> These entrepreneurs may be involved in developing or adapting cutting edge technologies to reduce energy or resource needs. Alternately, entrepreneurs that are focused only on providing a steady income stream and do not seek growth are often referred to as “necessity” or “subsistence” entrepreneurs and make up the vast majority of micro- and small businesses (e.g., market vendors, tailors, and the like).

Both segments of entrepreneurs are important to consider in the context of climate change, particularly since SMEs and SGBs cut across all sectors of the economy. Given ANDE’s focus on SGBs, this report is centered more around growth- and innovation-oriented entrepreneurs and the ways in which they can develop and disseminate climate-friendly and services. However, it is important to keep in mind the broader landscape of SMEs as critical for adopting the technologies and practices that emerge from these developments. Enterprises of all sizes can take steps to mitigate their own emissions or adapt to climate change in their local contexts. For instance, there is tremendous opportunity in many places to reduce reliance on petrol generators (for more, see the Off-Grid section below in Part II).

An [SME Climate Hub](#), supported by the International Chamber of Commerce, the We Mean Business coalition, and others, offers tools and resources for SMEs looking to cut their carbon footprint through their own operations, and through their supply chains. Noting that SMEs represent 90 percent of business globally, employing 2 billion people, the hub aims to support SMEs taking climate action by removing the barriers they face in doing so — whether curbing emissions in their own business or getting green solutions to market — and helping unlock valuable incentives.

There are also important distinctions to consider in terms of the local markets in which these businesses operate. In many developing economies, innovation and technology entrepreneurship is focused in cities where universities, research institutes, and labs can collaborate.<sup>54, 43</sup> In rural areas, supports are fewer and further between and it’s harder to be a growth-oriented entrepreneur. There, the opportunities at the nexus of climate and entrepreneurship are more likely around training and funding for subsistence or smallholder farmers to create small businesses that help them grow financially and adapt to changing ecosystem conditions that affect their livelihoods.<sup>44, 32</sup>

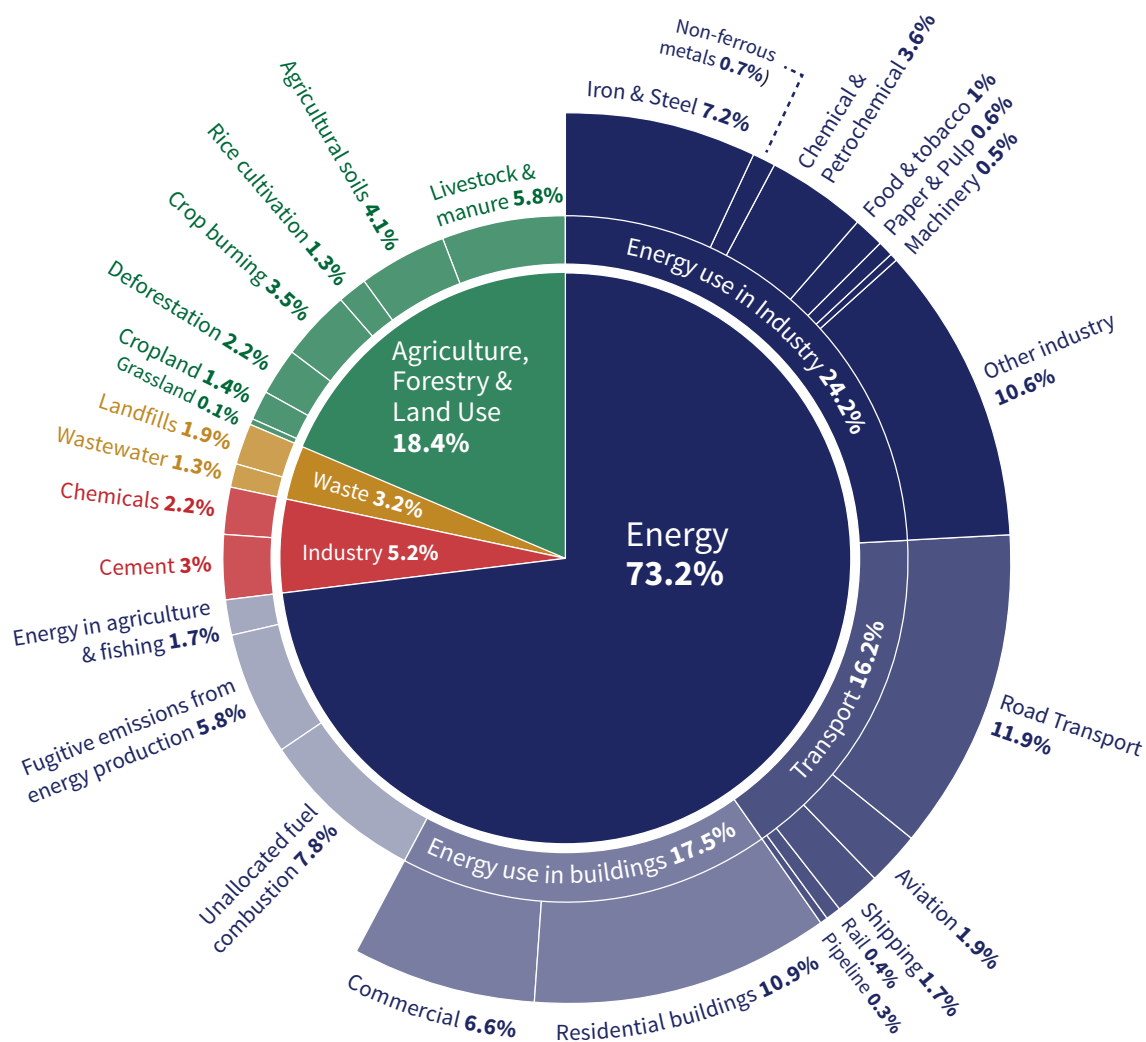
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2 Small and Growing Businesses (SGBs) are defined by ANDE as commercially viable businesses with five to 250 employees that have significant potential, and ambition, for growth. Typically, SGBs seek growth capital from US \$20,000 to US \$2 million.

# PART II: CLIMATE ENTREPRENEURSHIP IN DEVELOPING ECONOMIES BY SECTOR

There are many ways to divide the sectors of “climate entrepreneurship” throughout the world. In almost every sector, there are processes, technologies, or models that could be modified to have less environmental impact and become more adaptable to increased uncertainty from climate change. However, there are major sectors that have huge opportunities for innovation and change of practices that can make some of the biggest impacts on the fight against climate change. Below is a pie chart from the World Resources Institute (WRI) showing the major sources of emissions, which is crucial for understanding mitigation priority areas.

Figure 5: Global Greenhouse Gas Emissions by Sector, 2016 <sup>24</sup>

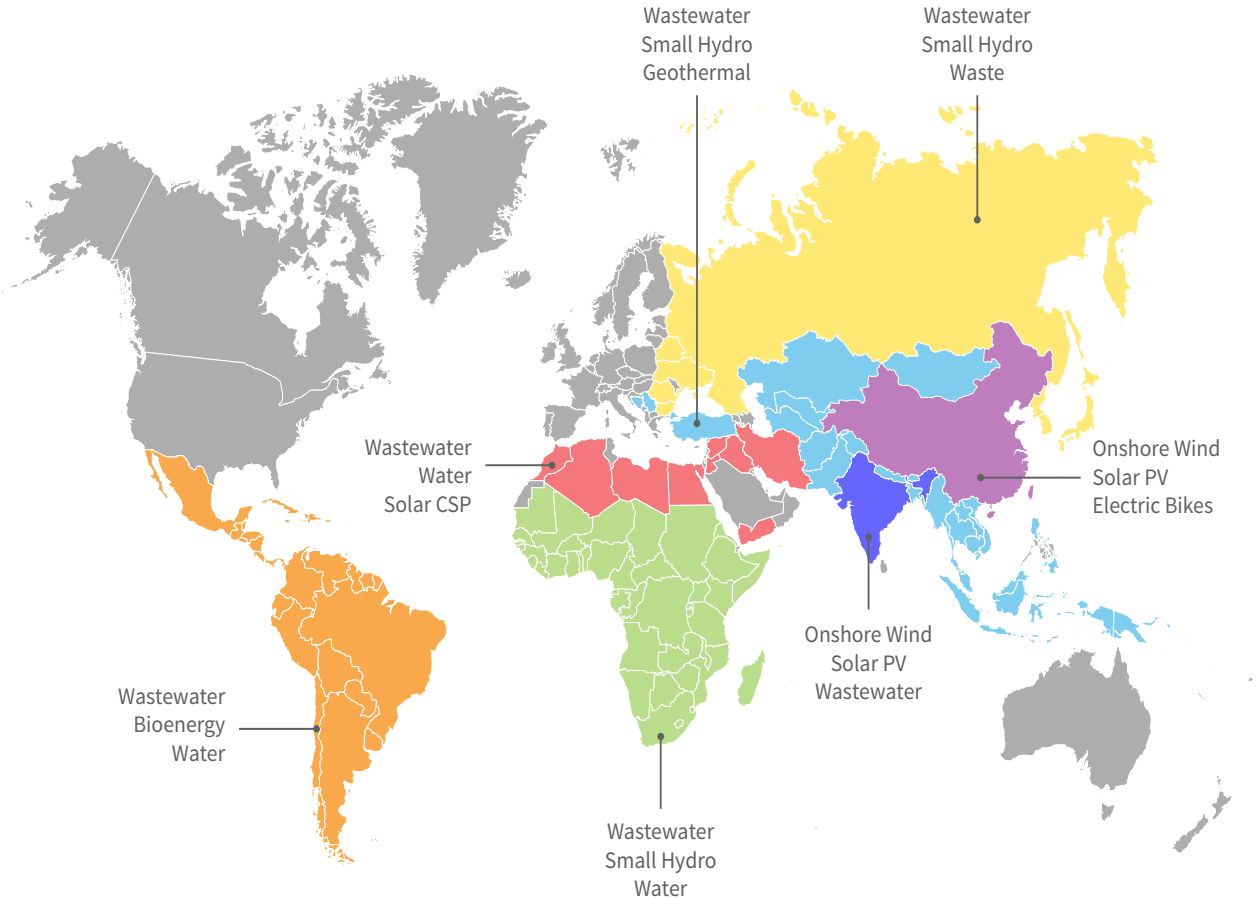


Source: WRI Our World in Data.

As seen above, energy generation and use are, by far, the leading causes of emissions, followed by agriculture, forestry, and land-use, then industry. While this chart is helpful for understanding where broad mitigation action must take place, examining adaptation and entrepreneurs' roles in each sector requires a deeper understanding of each country's context.

Quantifying the number of climate entrepreneurs in developing economies, or their presence in each sector, is difficult. A 2016 International Finance Corporation report projected that there would be US \$23 trillion of climate investment opportunities in developing economies between 2016 and 2030.<sup>14</sup> A 2014 report from the World Bank's InfoDev, predicted a US \$1.6 trillion opportunity for SMEs in the climate sector.<sup>59</sup> The following map from InfoDev shows top technology opportunities for SMEs by region – noting that solar costs have dramatically declined since the map was made, and a map today would therefore likely show solar more often in the top three.

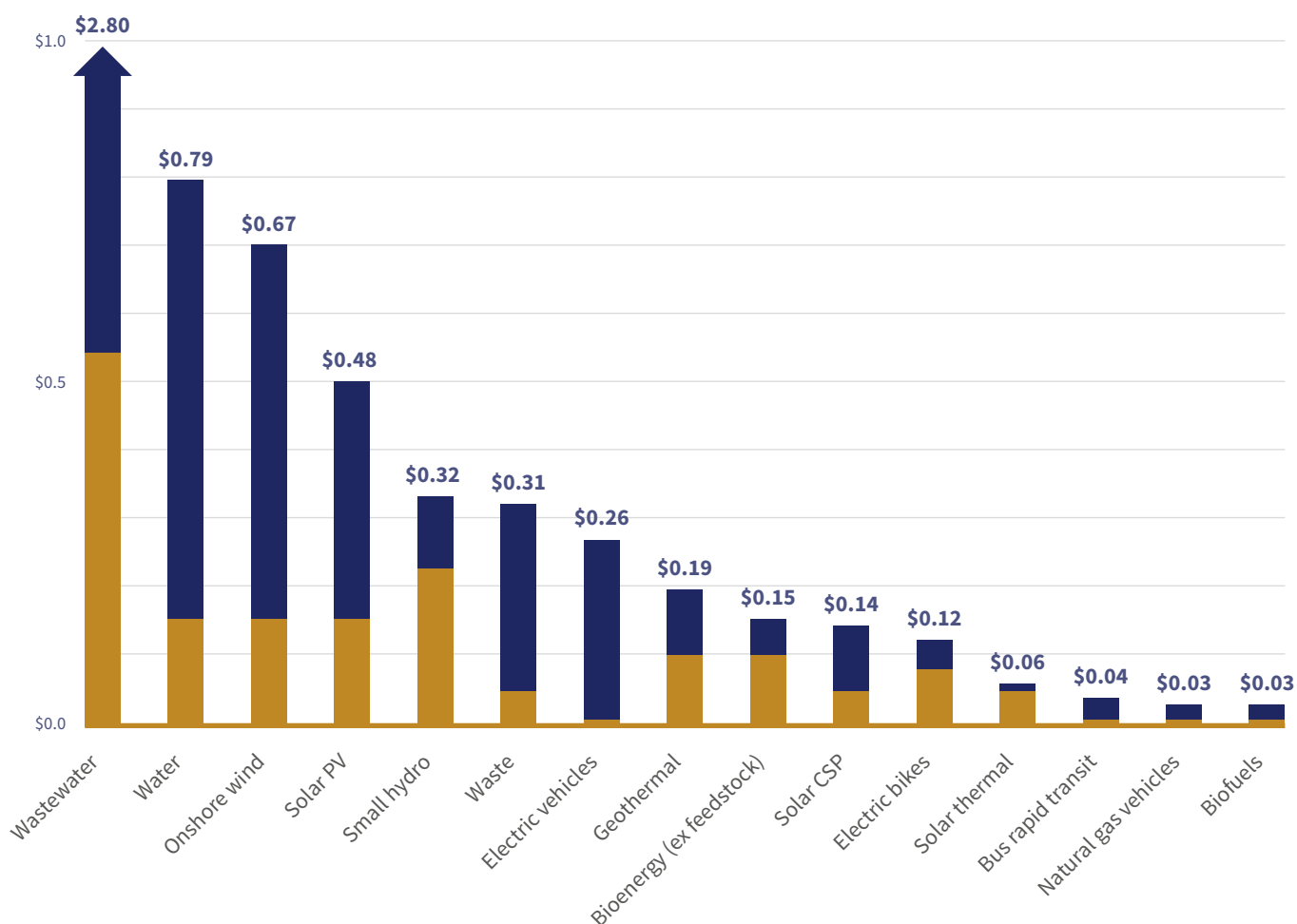
Figure 6: Top three regional opportunities for SMEs<sup>59</sup>



Source: World Bank Group. (2014). Building Competitive Green Industries: The Climate and Clean Technology Opportunity for Developing Countries. <https://openknowledge.worldbank.org/handle/10986/20684>

InfoDev's 2014 report also breaks down market size and SME share for fifteen technologies in developing markets. They estimate market sizes through 2023, with the top five opportunity areas falling into the sectors of water (including wastewater) and energy. However, the report only covers water, waste, energy, and transport technologies and does not include the sectors of agriculture, forestry, and other land use, although it does acknowledge these as top mitigation and adaptation priorities.<sup>59</sup>

Figure 7: Market size through 2023 for 15 clean technologies in developing countries (USD trillion)<sup>59</sup>



Source: World Bank Group. (2014). Building Competitive Green Industries: The Climate and Clean Technology Opportunity for Developing Countries.

As seen in the graph, wastewater, water, and several renewable energy technologies appear to have some of the highest market shares by SMEs. These technologies, as well as agriculture and food systems, are covered in the following sections, which provide overviews of the sectors found to have the highest climate impact potential and best opportunities for entrepreneurs and SMEs. The first three categories represent somewhat larger-scale infrastructure than the fourth, Solar PV, which is a market that has seen incredible growth over the past decade, with many SGBs selling pico-solar lights and solar home systems, a market that has dramatically expanded. That sector has grown from near zero a decade ago to reaching some 420 million users around the world, according to the off-grid solar industry’s latest market trends report.<sup>67</sup>

Meanwhile, about 1.5 billion people around the world theoretically have grid access, yet live day-to-day with “broken” electricity grids and experience blackouts for hundreds and sometimes thousands of hours a year. For this population, reliance on distributed diesel and gasoline-powered back-up generators, or BUGs – a term coined by the IFC in a 2019 report<sup>64</sup>– is a common stopgap measure. According to an Access to Energy Institute (A2EI)/Dalberg report, given poor grid access in Nigeria, 22 million small gasoline generators are being used to power households and small businesses. This presents a tremendous opportunity for SMEs, as effective substitutes for small gasoline generators, such as solar systems, can tap into a US \$12 billion-a-year market in Nigeria alone.<sup>65</sup>



# AGRICULTURE AND FOOD SYSTEMS

Agriculture is arguably one of the most crucial areas for climate entrepreneurship in developing economies. Accounting for as much as 25 percent of the GDP of some developing countries and 19 to 29 percent of global greenhouse gas emissions, agriculture —along with forestry and land-use change—is economically and ecologically key to addressing climate issues.<sup>5,16</sup> It is also on the front lines of climate change as changing precipitation patterns, extreme weather events, pests, and disease already pose enormous challenges to smallholder farmers.<sup>5</sup> Additionally, global demand for food may rise by 60 percent in coming years, meaning the world will need to grow more food crops than ever before.<sup>5</sup>

## *Climate Priorities for the Agriculture & Food Sector*

- Increase agricultural productivity regardless of changing climate
- Minimize food loss
- Reduce inputs and system inefficiencies
- Reduce methane emissions from livestock (primarily cattle)
- Increase landscape carbon sequestration

Adaptation in agriculture may require changing planting and harvesting seasons based on weather patterns, increasing water storage and irrigation for uncertain rainfall, or finding or creating more productive seeds and inputs. Some mitigation areas include reducing the emissions produced by agricultural activity, reducing emissions from chemical fertilizers, increasing landscape carbon sequestration by changing practices, and reducing land conversion from natural habitats to agriculture and biofuel crops, especially palm oil. Beyond the farms themselves, there is considerable opportunity in the value chain and in food processing and distribution to reduce emissions from production, transport, and food waste.<sup>29</sup> With livestock being important emission contributors through methane, innovative ways to modify cattle's diet to reduce the methane content of their burps – such as through the addition of seaweed which appears to be promising – become critically important. For the most part, however, solutions like alternative proteins have not yet gained much traction outside industrialized countries.

Players working in agriculture in developing economies have a heavy focus on facilitating the spread of adaptation solutions. Rural communities tend to have less access to adaptation solutions such as rainwater harvesting, irrigation systems, early weather warnings, improved seeds, and improved soil management – although the use of fertilizer itself is a mixed bag (while raising crop yields, it contains nitrous oxide, a potent greenhouse gas). Business models that reduce barriers to accessing these solutions for rural entrepreneurs could boost food security, local income, and ensure resilience for the agricultural sector in the face of compounding climate change.

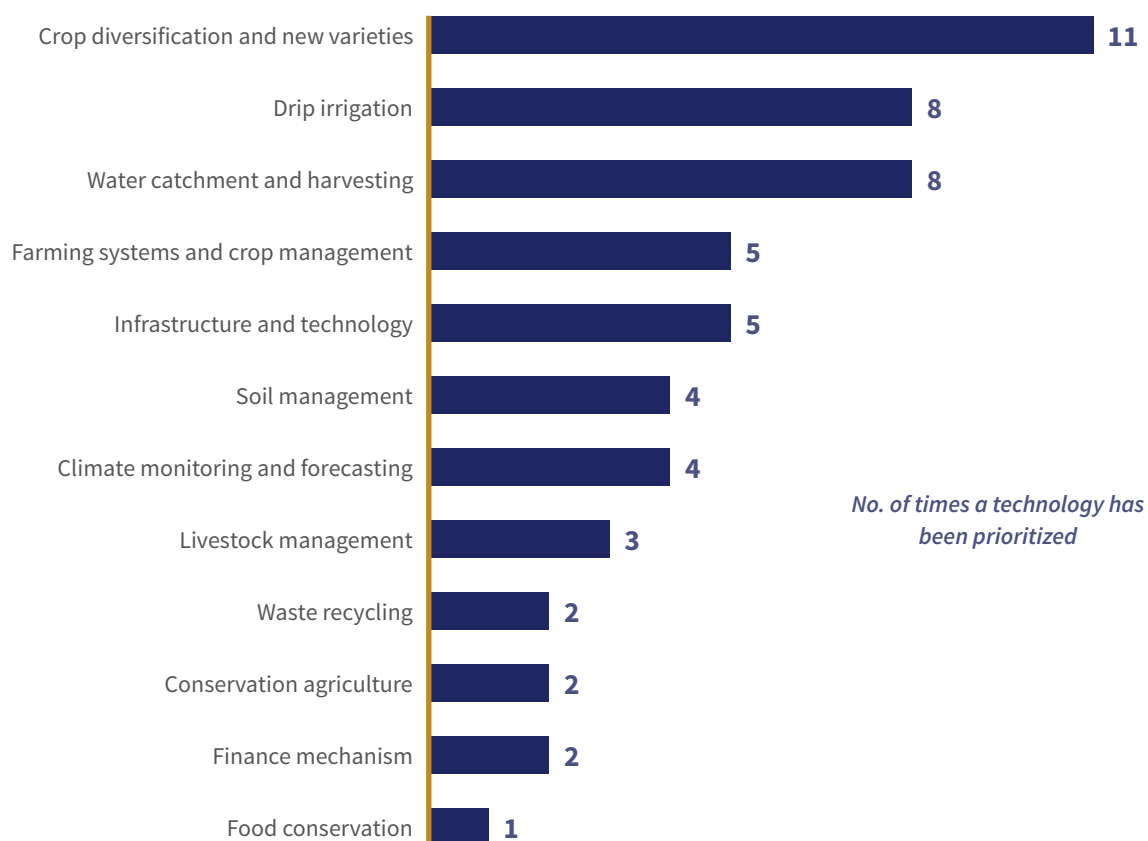
**148 countries** include climate-related agriculture goals in their Nationally Determined Contributions (NDCs).<sup>17</sup>

There were over **1,442 venture capital deals** in agritech and food tech in 2018, with over half of the deals in North America, followed by China and India.<sup>48</sup>

**Over one-third of all food is wasted** – food waste contributes about 11% of all GHG emissions.<sup>28</sup>

**In 2018**, global investment in agritech was **\$17 billion**, rising 40% from the year before.<sup>48</sup>

Figure 8: Agriculture Sector Adaptation Solutions



Source: [UNEP DTU Partnership and UNFCCC \(2018\)](#). The Study provides evidence from 21 countries’ climate technology priorities, identified in Technology Needs Assessments & Technology Action Plans prepared between 2014-18.

Many growth entrepreneurs have found opportunities in the “agritech” sector, which is focused on improving land productivity or decreasing farm labor through technological advances. While not all agritech advances climate adaptation or mitigation efforts, many aspects of agritech do have a high potential to help farmers do their work better. For example, drone monitoring, mobile phone apps, remote sensors connected to the internet of things (IoT), and improved mapping have all made it easier for agricultural producers to improve their operating efficiency.

Sizing the market of climate-smart agriculture practices – an emerging term for practices that address climate change issues in agriculture - is difficult, as these practices are too varied to track comprehensively.<sup>60</sup> However, agritech is an increasingly popular investment sector, and investments are easier to track. The agriculture and food technology sector, including climate-smart agriculture, was valued at US \$4.7 billion in 2019, an almost four-fold increase in just one year, from 2018.<sup>19</sup> Some of the largest opportunities in climate agritech appear to be in Sub-Saharan Africa and India. Investment in India’s agritech sector was US \$245 million in 2019 and was projected to more than double within two years, although much of that may have been via large corporates rather than in the SGB sector.<sup>42</sup>

Many investors are interested in funding more agricultural sustainability but need better ways to manage their risk.<sup>19</sup> As many developing economies hasten to bring productivity and adaptation to their agricultural sectors, multilateral development banks (MDBs) have financed considerable adaptation measures through governments, with private recipients accounting for just 22 percent of the funding disbursed in 2019.

# ENERGY

The most important sector for climate change mitigation is energy. Energy production and usage were responsible for over 73 percent of global emissions in 2016.<sup>24</sup> This sector is extremely broad, but cleantech investments have played a large role in growing the sector and entrepreneurs will continue to see significant opportunities across emerging economies.

## *Climate Priorities for the Energy Sector*

- Reduce emissions from energy generation and use
- Increase renewable energy production
- Reduce energy lost through inefficiencies
- Increase energy access, especially electricity access (the equity agenda)
- Maximize energy storage potential

## *Renewable Energy*

Renewable energy technologies are diverse and vary in power capacity and environmental impact, depending on the region. Geothermal and small-scale hydropower represent smaller overall market shares, but in certain geographies represent significant opportunities for entrepreneurs. Large hydropower plants, although still in use in many regions, have fallen out of favor due to the devastating impacts they have on ecosystems and communities when large areas are flooded for reservoirs.

Solar and wind energy represent the largest current potential opportunities in renewable energy, with China and India leading the sector among developing economies. In 2016, these two countries contributed 50 percent of the additions to the world's solar energy production capacity and added significant wind power capacity as well.<sup>17</sup> Brazil is also an important renewable energy producer; however, its focus has been biomass, which has more debatable climate benefits but is widely prevalent in Latin America, particularly ethanol from sugarcane.<sup>43</sup> Solar photovoltaics and wind accounted for 86 percent of renewable energy capacity added in the year 2020, although the overall capacity added was down due to the COVID-19 pandemic putting many projects on hold.<sup>24</sup> Both the solar and wind industries have seen rapid declines in the cost of technology and infrastructure, making them economically viable – indeed, less expensive than fossil fuel incumbents. Solar PV costs declined by 58 percent between 2010 and 2016 and hardware costs are likely to continue declining, though soft costs (regulatory, labor, and policy dimensions) haven't seen the same declines. Utility scale PV now can deliver energy for less than three cents per kilowatt-hour, which is substantially less than the 13 cents per kilowatt-hour average grid electricity price U.S. customers pay.<sup>17</sup>

The International Energy Agency estimates that the renewable energy sector could be worth between US \$7 trillion and US \$11 trillion by 2040.<sup>17</sup> The chart below lays out the IFC's projections for investment by region in each of the major renewable energy segments.

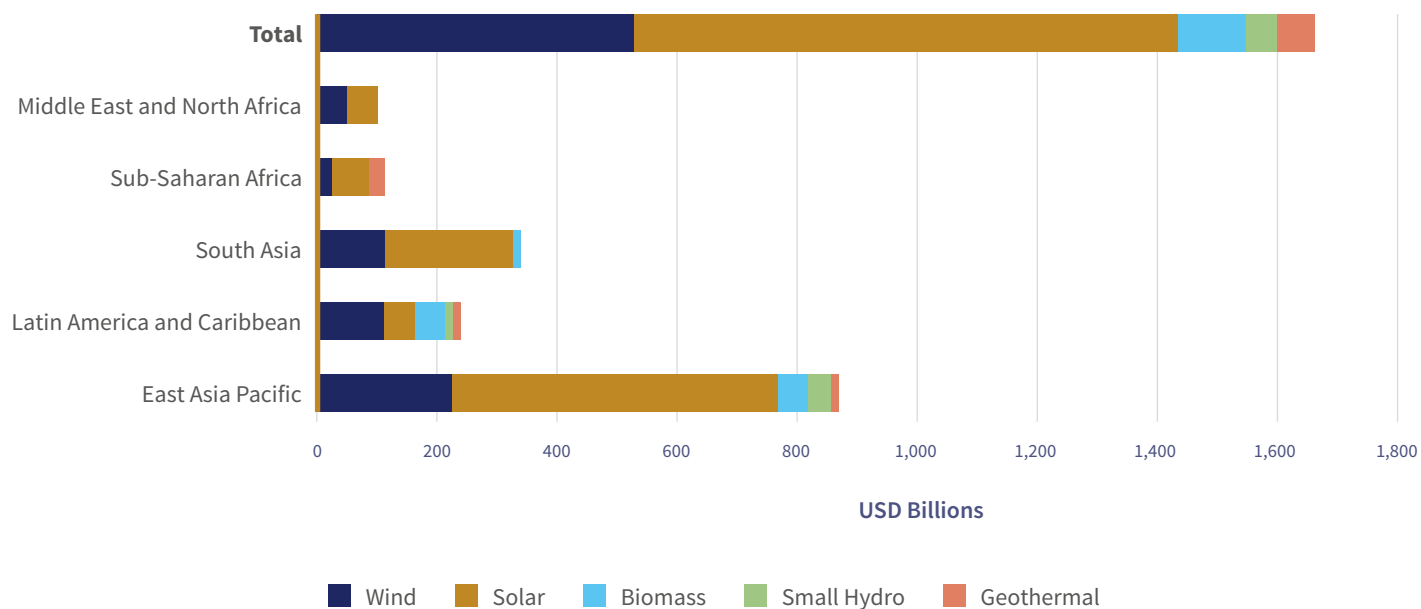
**Over 100 countries** have listed renewable energy improvements in their NDCs; 31 mention off-grid solar and storage.<sup>17</sup>

Wind and solar have more than **\$6 trillion** in investment potential before 2040. More than half this potential is in the Asia-Pacific Region.<sup>17</sup>

Emerging market energy storage investment will grow from **\$2.5 billion in 2016 to \$23 billion in 2025.**<sup>17</sup>

Solar photovoltaics and wind energy production made up **86%** of renewable energy capacity added in 2020.<sup>63</sup>

Figure 9: Renewable Energy: Climate Investment Potential in USD Billions, 2016<sup>17</sup>



Source: Creating Markets for Climate Business: An IFC Climate Investment Opportunities Report. (2017). IFC.

While renewable energy technologies have attracted significant attention, there is also a large potential for innovation and advancement in energy storage, energy efficiency, and energy infrastructure, as well as an evolving biofuels industry. While this represents an enormous range of technologies and solutions, a few areas of particular relevance for developing economy entrepreneurs are described below.

### Efficiency

Upgrading energy infrastructure and efficiency are key energy sector components. New technologies for energy efficiency in appliances, industrial processes, and buildings are being constantly pioneered, although industrialized countries dominate technology development in this area.<sup>61</sup> Efficiency is also a critical pathway for delivering energy access, as the greater the service a user can get from an appliance in an off-grid or mini-grid context where electrons are constrained and therefore expensive, the greater the level of “energy services” that household can access. A number of governments, philanthropies, and development partners have joined together to advance efficiency innovations for off-grid devices under the [Efficiency for Access Coalition](#) to accelerate clean energy access through high-performing appliances, such as lights, fans, televisions, refrigerators, and solar-powered irrigation pumps.

### Buildings

Buildings and their construction together account for 36 percent of global energy use and 39 percent of energy-related carbon dioxide emissions annually, according to the UN Environment Program<sup>63</sup>. To meet the goals of the Paris Climate Agreement and limit global temperature rise to 1.5 degrees Celsius, the built environment’s energy intensity—a measure of how much energy buildings use—will have to improve by 30 percent by 2030.

Energy efficient building modifications (“retrofits”) or construction techniques (“green build”) already offer opportunities for entrepreneurs in developing economies. While two-thirds of the buildings that exist today will still be around in three or four decades, much of the building stock required by 2060 has yet to be built – and will be built in developing country cities as urban populations there are projected to soar. By 2060, two-thirds of the expected global population of 10 billion will live in cities. To accommodate this tremendous growth, additions to the global building stock of 2.5 trillion square feet (230 billion m<sup>2</sup>) of new floor area are anticipated, doubling it by 2060. This is the equivalent of adding an entire New York City every month for 40 years.<sup>74</sup> This new building stock

must be designed to meet zero-net-carbon standards – again, a tremendous opportunity for entrepreneurs who can innovate around building design and materials or construction processes. The IFC has projected US \$3.4 trillion in investment opportunities in several developing economies through 2025 alone.<sup>17</sup>

### **Off-Grid**

The off-grid solar sector has grown rapidly over the past decade and is now a US \$1.75 billion annual market serving 420 million users, with further growth predicted, though the COVID-19 crisis has at least temporarily derailed this growth trend. In a pre-pandemic business-as-usual scenario<sup>67</sup>, the off-grid solar sector will serve 388 million people with the most basic level of electricity access by 2030, but this growth will be insufficient to achieve universal access targets. To sustain the business-as-usual scenario over the next five years, the sector needs US \$1.7 billion to US \$2.2 billion in external investments from 2020 to 2024. To actually achieve universal access, the off-grid solar sector would require between US \$6.6 billion and US \$11 billion in additional financing. Of this total need, US \$6.1 to US \$7.7 billion will need to come from investments into off-grid solar companies, and up to US \$3.4 billion represents public subsidies to bridge the affordability gap.

As the sector matures and as productive use of off-grid solar solutions such as solar water pumps, cold storage, and other products servicing public institutions become natural expansion areas, companies are increasingly focused on the financial sustainability of their business models and the need to demonstrate profitability and increase transparency around impacts. A popular business model for off-grid renewable energy delivery in developing economies is through “pay-as-you-go” technologies, often used in off-grid solar, but also applicable in other areas. A company will install household systems or build nearby solar or hybrid mini-grids and allow users to pay only for the energy they use (often through mobile payment systems), reducing upfront costs to the consumer and allowing more “base of the pyramid” customers to access energy.<sup>17</sup> Commonly using smart meters, this model not only provides renewable energy access but encourages efficient and economical use of energy by recipients. South Asia and Sub-Saharan Africa have seen some of the strongest growth in off-grid energy models.<sup>17</sup>

### **Storage**

A historical limitation of solar and wind energy has been the inability to access that energy when the sun is down or the wind is not blowing. Batteries and other energy storage technologies have made important technological advances and achieved significant cost reductions. The global market size for energy storage was US \$59 billion in 2019, projected to grow to almost ten times the size in fifteen years, reaching US \$546 billion by 2035.<sup>35</sup> The biggest projected growth is anticipated in lithium-ion battery storage, especially as individual battery capacity increases.<sup>63</sup> This in turn enables the scaled-up use of such batteries in electric vehicles, and demand for EVs pushes up demand for materials used in batteries. By 2030, battery electric vehicles are assumed to reach an average driving range of 350-400 kilometers, corresponding to battery sizes of 70-80 kilowatt-hours, according to the International Energy Agency’s 2020 Global EV Outlook. In developing economies, China, India, and Southeast Asia are projected to see some of the strongest growth in markets for electric vehicles and storage.<sup>63</sup>

### **Biofuels**

Biofuels – and particularly second-generation biofuels, which are produced using agricultural byproducts – have seen success with start-up business models, especially in rural areas, but are experiencing a downturn. COVID-19 has caused a decline in biofuel demand.<sup>63</sup> The transportation biofuel market is on track to shrink by 13 percent in 2020, and biofuels, in general, are down by a comparable amount.<sup>63</sup> A post-COVID-19 boom may occur, particularly if promises of green recovery investments are realized, but favorable policies for biofuels have declined as well, likely due to inexpensive oil prices in certain regions.<sup>63</sup> There is also increasing electrification of vehicles which may contribute to decreased demand.

# ENVIRONMENT AND NATURAL RESOURCES

This category of activities encompasses how natural resources are managed, including the management of waste, recycling, water, and carbon sequestration. While all are important areas, ecosystem management and water and wastewater seem to be the most relevant for entrepreneurs in developing economies.

## *Climate Priorities for the Environment & Natural Resources Sector*

- Increase sequestration of carbon through natural and human-made solutions
- Reduce the amount of untreated wastewater entering ecosystems
- Improve business models based on ecosystem restoration and sustainability
- Decrease the amount of waste that cannot be reused or repurposed

## *Water and Wastewater*

Water and wastewater are interlinked issues critical for both climate adaptation and mitigation. Climate impacts are generally predicted to cause increased uncertainty or irregularity in precipitation events throughout the world, making secure water systems essential for adaptation.<sup>62</sup> Some regions may experience longer and harsher droughts, followed by heavy storms while other regions may see less or more precipitation overall.<sup>62</sup> Some regions, like the western coast of South America, are currently dependent on run-off from mountain glaciers as critical water sources, but as temperatures rise, those glaciers will disappear or produce less water. Lower precipitation may cause water access shortages while higher precipitation may over-run ecosystem and infrastructure capacity, causing flooding which can contaminate water as well as exacerbate disease spread and economic hardship. Around 2.2 billion people throughout the world do not have access to safe, clean water and 4.2 billion lack safe sanitation services.<sup>56</sup> The COVID-19 pandemic has exacerbated these challenges, as hand washing and cleaning have been a critical virus mitigation pathway.<sup>47</sup>

There are opportunities for entrepreneurs in water-related areas such as clean water provision, sanitation services, water monitoring, water efficiency technologies, and wastewater recycling. Water security through ecosystem restoration or conservation is addressed in the “Ecosystems” section below. Water concerns, especially water storage, harvesting, modeling, and monitoring are among the top priorities for developing economies looking to enhance their climate adaptation solutions.<sup>52</sup> Additional water sector adaptation priority areas for developing countries can be found in Figure 10 below.

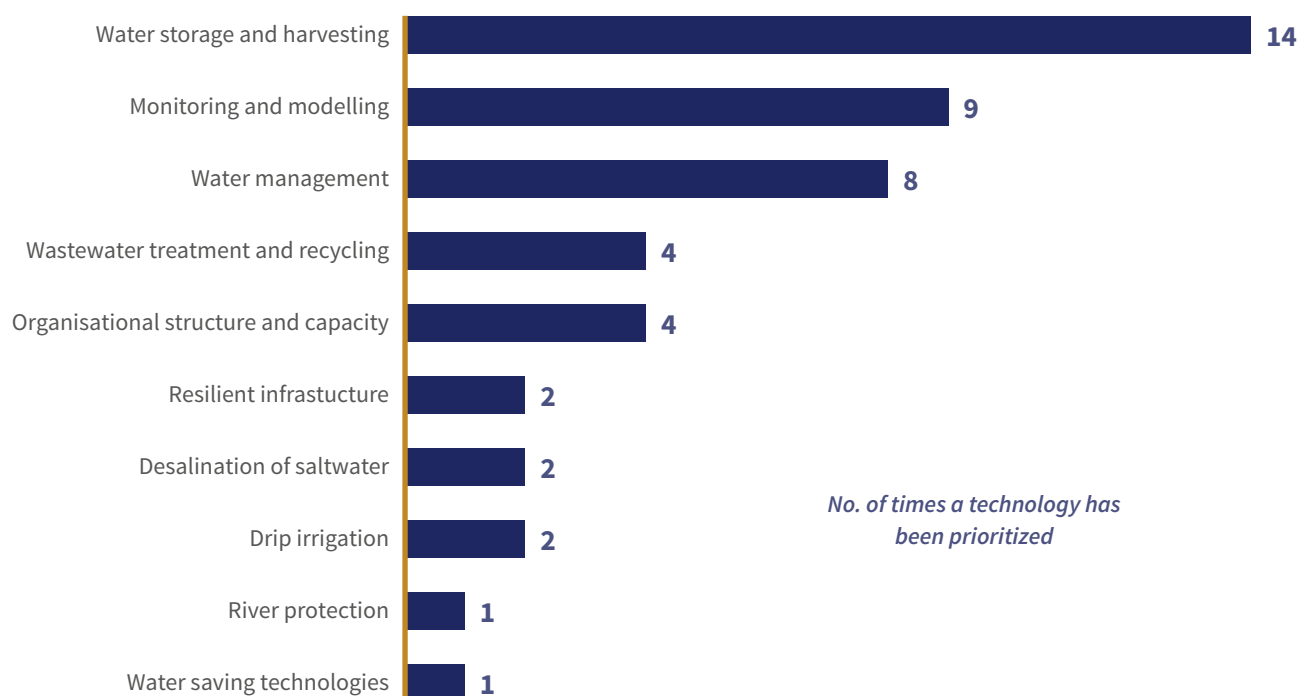
Water sector goals are mentioned in over 100 country NDCs.<sup>17</sup>

Water investment by the private sector totaled **\$5.3 billion** in 2015.<sup>17</sup>

**Over 150 countries** mention forest protection or restoration in their NDCs.<sup>15</sup>

The global carbon offset market, reliant on forests, may be worth **\$200 billion** by 2050.<sup>57</sup>

Figure 10: Water Sector Adaptation Priorities



Source: [UNEP DTU Partnership and UNFCCC \(2018\)](#). The Study provides evidence from 21 countries’ climate technology priorities, identified in Technology Needs Assessments & Technology Action Plans prepared between 2014-18.

With water being closely linked to ecosystems, health, agriculture, and the economy, it is no surprise that it is a priority investment area and has been found to be a successful investment strategy. The World Health Organization found in a global study that the social return on investment in water projects was US \$5.50 for every one dollar invested.<sup>36</sup> However, private investment in water and sanitation is still too low throughout the world.<sup>17</sup>

According to a study by IDB Invest, the Inter-American Development Bank’s private sector-focused arm, Latin America and the Caribbean will need to double their private sector investment if they are to reach the SDG6 goal of “Ensuring availability and sustainability of water and sanitation for all” before the end of the century.<sup>40</sup> Global private sector water investment in 2015 was US \$5.3 billion, but a World Bank report on private sector water investment in developing economies identifies a declining trend in the last few years.<sup>40</sup>

InfoDev’s 2014 report on SME opportunities in developing economies outlines wastewater as having the largest market share for SMEs, with water technology as being third, only behind small hydro, as shown in the introduction of Part II.<sup>59</sup> Out of a predicted market for wastewater technology of US \$2.8 trillion through 2023, InfoDev predicts over US \$500 billion of that market share to be held by SMEs in developing markets. The predicted SME market share of water technology, which excludes wastewater, over the same time horizon was around US \$150 billion out of a total market size of US \$790 billion.<sup>59</sup> One of the reasons that wastewater presents such a sizable opportunity is that water can be recycled to be used again, or the byproducts of water treatment can be converted to a number of profitable uses such as biogas or compost for soil.<sup>17</sup> These are in addition to the traditional pursuit of cleaning water sufficiently to be returned to the environment safely and avoiding the health and ecosystem costs of untreated sewage.<sup>17</sup>

## ***Ecosystem Conservation and Restoration***

The benefits of restoration, agroforestry, and ecosystem carbon sequestration are extensive, and institutions are increasingly looking to fund conservation and restoration, especially of high-carbon ecosystems like forests and wetlands. Carbon offsets—investing in ecosystems that retain carbon to net out carbon emissions elsewhere—have grown widely in popularity and the market may be worth US \$200 billion by 2050.<sup>60</sup> Reforestation has been shown to be one of the lowest-cost carbon removal solutions available.<sup>6</sup>

This has led to a rise in the number of businesses that make their revenue from the restoration of degraded landscapes, monitoring and measuring activities, carbon sequestration, agroforestry practices, or ecotourism.<sup>27</sup> Conservation nonprofits, governments working to restore their lands, and businesses attempting responsibility have also created a market for professionals skilled in assessing, restoring, and monitoring the health of conservation areas. In forests, carbon pricing has spurred an increase in companies dedicated to quantifying the amount of carbon sequestered in trees and other ecosystem elements (which is purchased by companies offsetting their emissions). Additionally, extractive industries like mining or oil drilling may be forced to restore areas they no longer use—work which they will need to contract out to restoration professionals. These activities can be grouped into ecosystem-based businesses and are often strongly driven by entrepreneurs.<sup>27</sup>

There are no estimates yet of the size of the global ecosystem restoration economy, as the sector is quite new.<sup>27</sup> However, in the United States alone, the ecosystem restoration economy was estimated at US \$9.5 billion in direct economic output per year in 2015, with US \$15 billion in indirect benefits.<sup>27</sup> Initiative 20x20 and the African Forest Landscape Restoration Initiative have mobilized commitments of over US \$2 billion from investors toward forest restoration in their portfolios in Africa and Latin America. <sup>27</sup> These investors will need to partner with the private sector to realize these commitments.

The sector has many opportunities for entrepreneurs in developing economies, as these are often areas with high-value forests that need personnel who understand the local area. WRI and The Nature Conservancy identify so-called “restoration entrepreneurs” as crucial to testing new technologies, practices, and business models on the ground. <sup>27</sup> Entrepreneurs can take advantage of new technologies that are bringing down the cost and effort required for forest monitoring and planting, and subsistence SMEs have opportunities in agroforestry or ecotourism. The Boticário Group Foundation for Nature Protection in Brazil, and other conservation-focused organizations, are tapping into this space and supporting entrepreneurs, as they realize that when local economies are dependent on a healthy forest, communities and ecosystems thrive. <sup>27</sup>



# OTHER SECTORS

Another source of insight in sector-specific climate financing comes from the joint reports released by a consortium of multilateral development banks (MDBs). With data from the African Development Bank, Asian Development Bank, Asia Infrastructure Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank, Islamic Development Bank, and World Bank, the joint reports from 2016 to 2019 show trends in the MDBs’ financing of different mitigation and adaptation sectors.

As shown in these charts, the MDBs’ largest adaptation financing sectors were “energy, transport, and other built environment and infrastructure”, “water and wastewater systems”, and “institutional capacity and support” in 2019. Their largest mitigation financing sectors were transport, renewable energy, and energy efficiency.

Figure 11: MDB Climate Adaptation Finance in USD Millions, 2016-2019 <sup>1,2,3,4</sup>

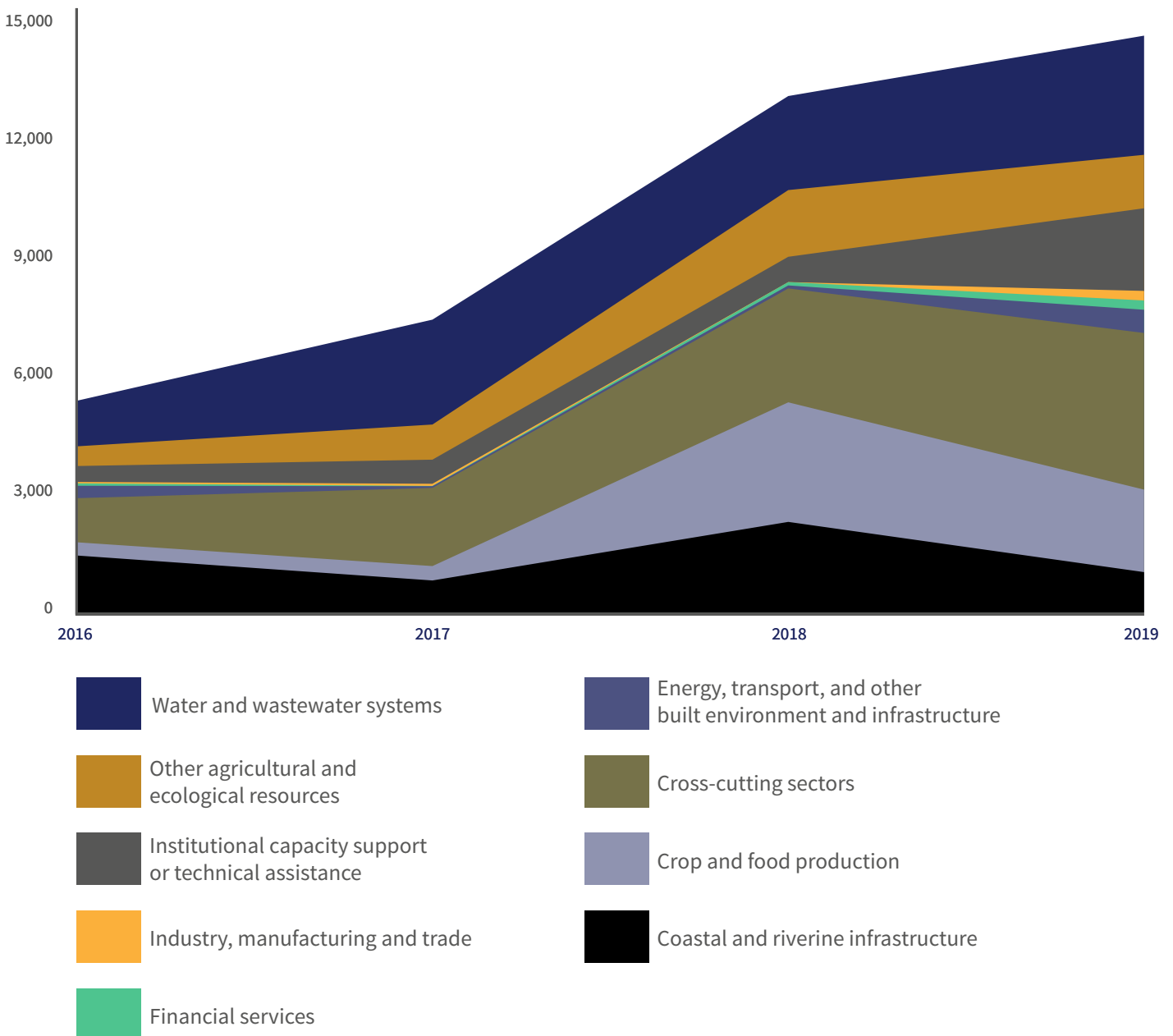
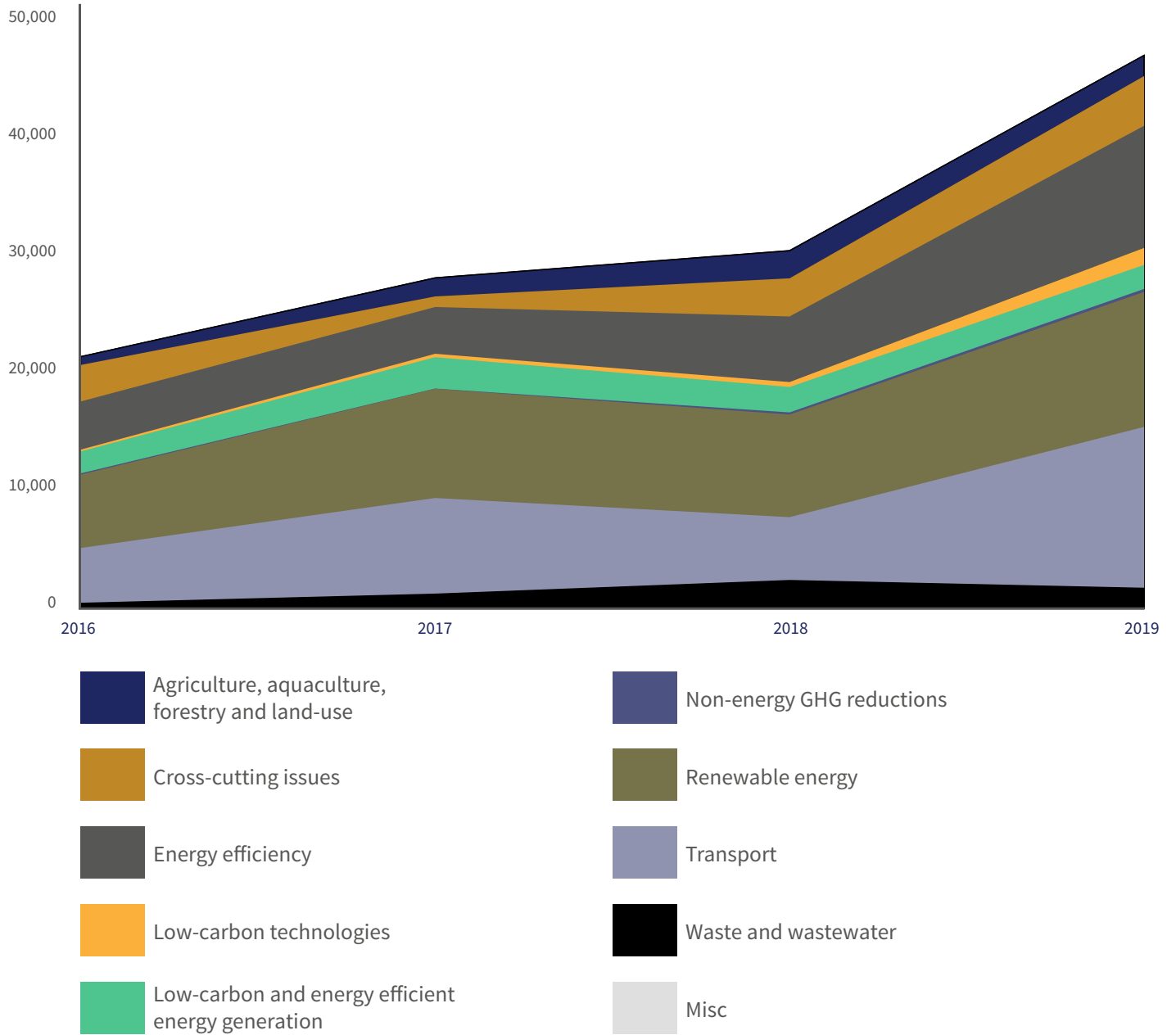


Figure 12: MDB Climate Mitigation Finance in USD Millions, 2016-2019 <sup>1,2,3,4</sup>



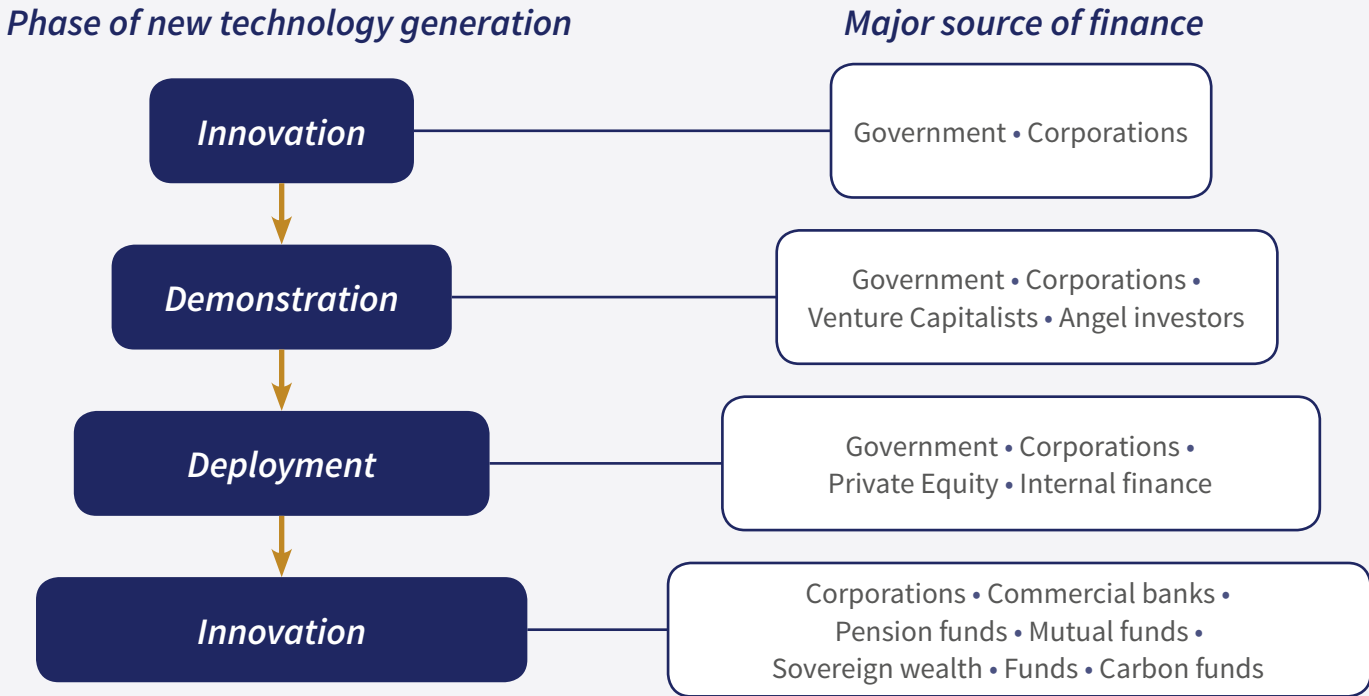
# PART III: BARRIERS, NEEDS, AND TRENDS

## FINANCE

Access to finance is a major barrier for climate entrepreneurs in developing economies. Climate technology and innovation, while often highlighted by global institutions, represent a substantial risk for traditional investors, who are more comfortable with proven technology. Early-stage finance to help smaller tech innovators scale is especially difficult.<sup>54</sup> Technology development and commercialization is already a risky investment, and markets for climate technologies may be subject to change by a country’s policy environment, creating added risk.<sup>41</sup> Additionally, **different sources of finance are necessary at different stages of a climate entrepreneurs’ growth, so a lack of any one type of financing will create a barrier.**

The UN Technology Executive Committee Report on Climate Incubators and Accelerators lays out the sources of funding for climate technology entrepreneurs in different growth stages (see Fig. 13). Climate ventures are often invention-based, involving some form of “hardware” development or deployment, as opposed to the software-based enterprises that tend to be favored by traditional early-stage venture investors. This means that there is a need for highly risk-tolerant R&D financing up front, followed by patient early-stage capital for piloting and demonstration, and then more scalable forms of capital for deployment and commercialization.

Figure 13: Phases of climate technology entrepreneurship and major current sources of finance



Source: UNFCCC. (2018). Climate Technology Incubators and Accelerators.

There are many types of financial instruments for climate finance, and taking advantage of appropriate financing mechanisms is important. To better understand how climate funding is accessed in developing economies, the following graphs show mitigation and adaptation finance from some of the largest multilateral development banks. The two figures below break down the multilateral development banks' climate financing by type of instrument used.

Figure 14: MDB Climate Adaptation Financing by Instrument, 2016-2019 <sup>1,2,3,4</sup>

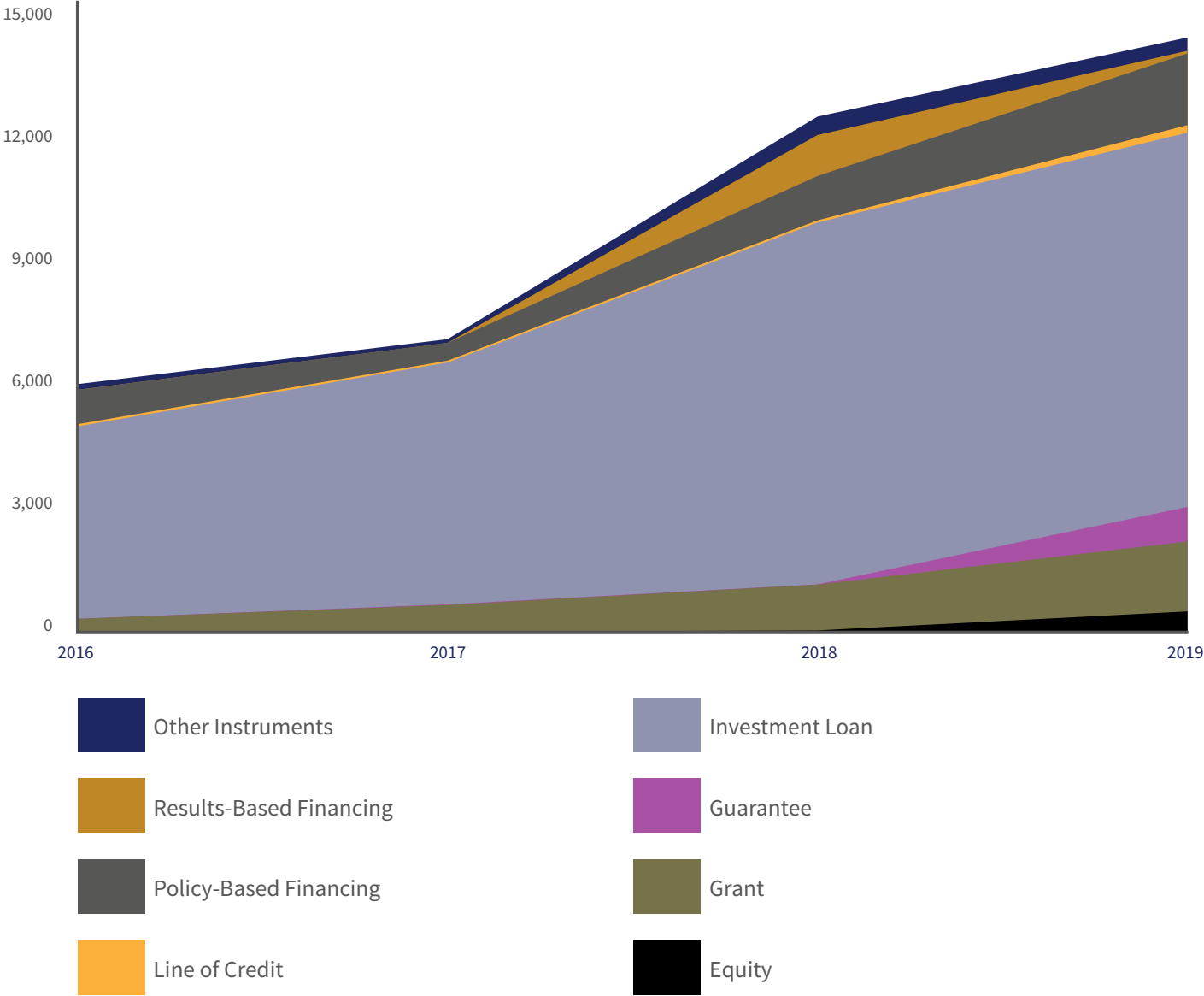
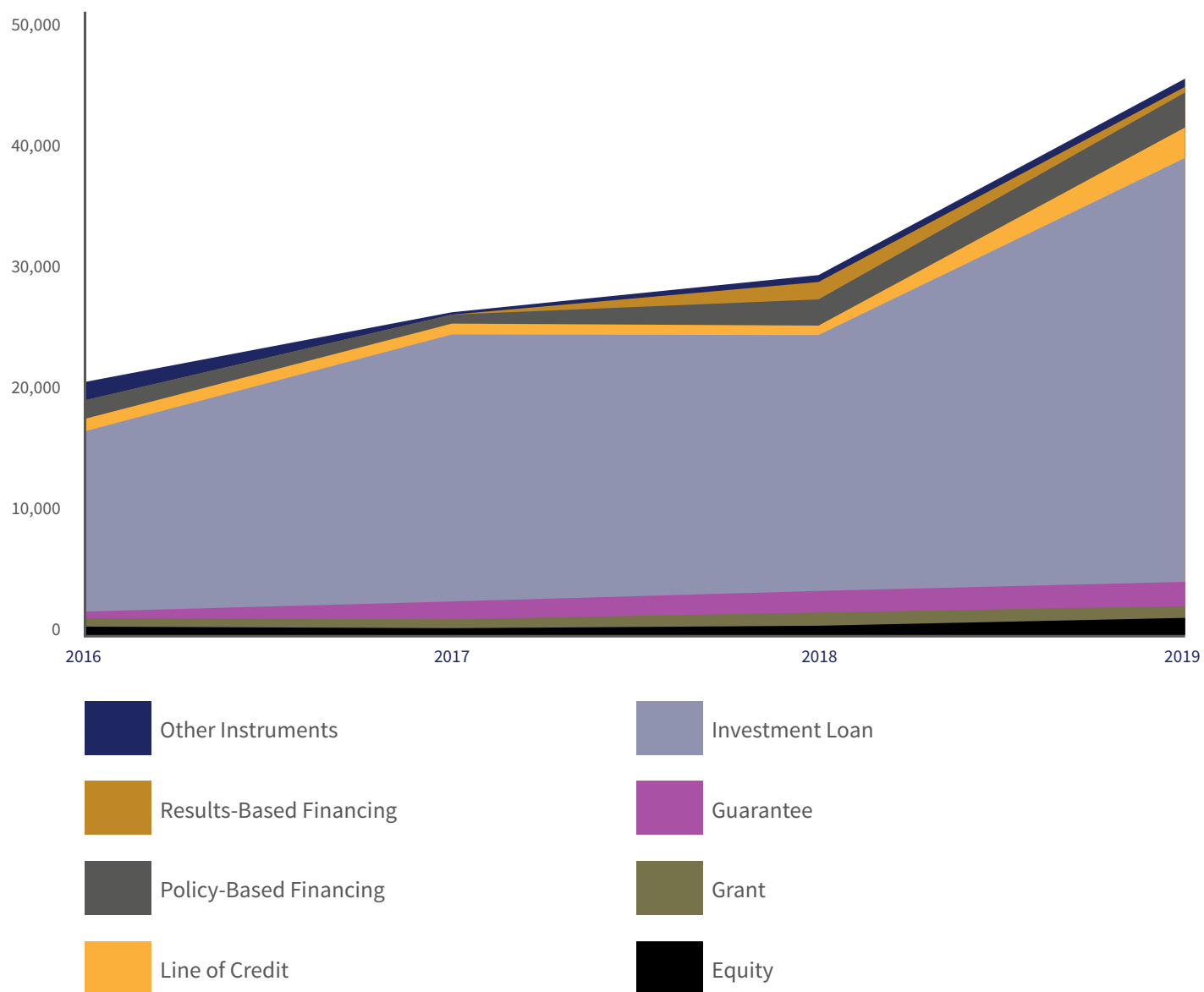


Figure 15: MDB Climate Mitigation Financing by Instrument, 2016-2019<sup>1,2,3,4</sup>



As evidenced by these charts, loans represent the largest proportion of climate financing from MDBs. MDB financing mostly targets governments; that said, it represents a significant pool of capital that could potentially be deployed or leveraged in support of climate entrepreneurs.

**Achieving transformational change in climate change mitigation and adaptation will require a combination of enhanced international cooperation and trillions of “climate-smart” private investments, which in many cases will need to be channeled through blended public and multilateral financing schemes.**

### *Multilateral Climate Funds*

Global climate funds have emerged in response to the paucity of climate-oriented funding available. The two largest are the Climate Investment Funds (CIF) and the Green Climate Fund (GCF). The CIF is a partnership between several multilateral development banks that focuses on clean technologies, climate resilience, energy access, and sustainable forests. With US \$8 billion, they provide long-term, low-cost, and large-scale financing to lower the risk of climate investing.<sup>13</sup> The GCF is similarly sized, with US \$7.2 billion of committed financing. It was established by 194 governments to spur investment in low-emissions development in emerging economies.<sup>30</sup> Better data and transparency are critical as it remains unclear how much of this funding is being used by, or targeted for, SMEs or entrepreneurs.

## Private Investment

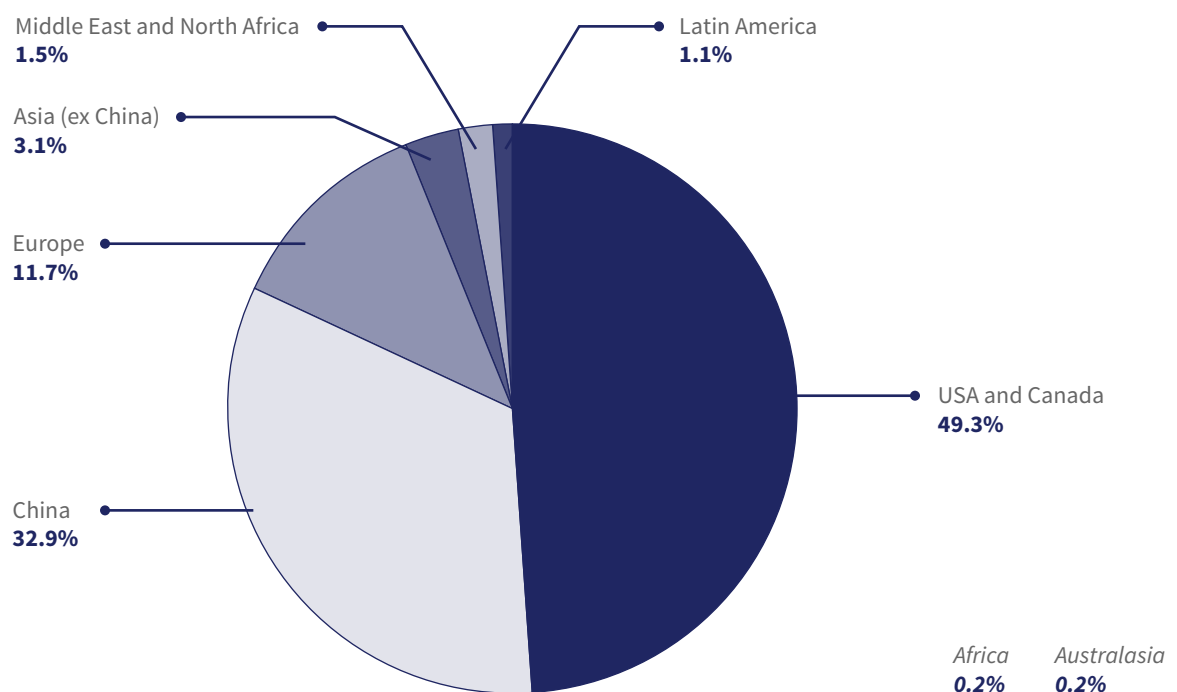
Climate investment opportunities in developing economies need more ways to attract larger pools of private finance -- in particular, *patient* capital, meaning capital that can be put to work for longer time horizons. Risk and uncertainty are inherent in climate investments, and the average investor remains uncertain how to assess risks and returns.<sup>14</sup> Since policies around climate action can be uncertain and changing at the national level, the benefits of investing in climate solution-oriented businesses becomes uncertain too, creating an added layer of risk.<sup>54</sup> This has proven to be a barrier to private investment, especially in areas where clearer and less risky investment alternatives exist.

Accessing low-cost capital in developing economies is challenging, especially at the beginning stages of business growth, which makes it difficult for entrepreneurs to get their businesses off the ground<sup>54</sup>. Access to bank loans in developing markets is also difficult, as banks view small and early-stage businesses as risky and most of these enterprises cannot meet bank needs for collateral<sup>18</sup> – challenges that are only exacerbated by the high upfront capital needs of climate technology ventures.

Decarbonization solutions related to mobility and transport, heavy industry, and GHG capture and storage were the fastest growing segments in a 2020 analysis of climate technology investment trends by PricewaterhouseCoopers<sup>72</sup>, followed by food, agriculture, land use, built environment, energy, and climate and Earth data generation. Meanwhile, venture funding is coming from a wide variety of sources, with investors ranging from more traditional VC firms and venture funds specializing in sustainability, to corporate investors including energy majors, global consumer goods companies and big tech, government-backed investment firms, and private equity players getting exposure to deals earlier.

The analysis of these investment flows by region highlights just how little of the “climate tech” investment is going to developing countries. With more than three-quarters going to the United States, Canada, and China, less than 5 percent goes to Asian countries other than China, as well as Latin America, Africa, and Australasia *combined*.

Figure 16: Breakdown of venture investment into climate tech startups, by region



Source: Pricewaterhouse Coopers, 2020.

The most promisingly lucrative investment opportunities attract commercial capital easily. But what about all the other enterprises with a big and possibly transformative idea, but without a slam dunk business case – what support is available to them? What we see missing is the greater participation of philanthropic and public sector actors providing substantial concessional capital (at lower rates than commercial capital). This support would give a broader set of possible solutions, driven by a broader set of enterprises, the chance to experiment and learn and prove themselves - essentially the space to find their footing.

### ***Impact Investing***

The field of impact investing, which considers measurable social and environmental returns alongside financial returns, appears to be rising to the challenge of private climate investment.<sup>54</sup> The increase in impact investing over the last decade indicates an important change in the consciousness of financial institutions and makes impact investment an increasingly important source of funding to leverage for SME growth in climate adaptation and mitigation.

The global market for impact investing has grown from US \$50 billion in 2010 to almost US \$1 trillion in 2020.<sup>34</sup> According to the 2020 annual survey from the Global Impact Investing Network, the top two categories in which impact investing fund managers are looking to grow their allocations are in food and agriculture as well as energy, with over fifty percent of fund managers aiming to increase their investments in those sectors.

The Global Impact Investing Network's 2020 survey included climate impact investing as its own section, and 68 percent of institutions surveyed reported that they invest in climate action.<sup>34</sup> Within these investments, more than two-thirds reported that they invested in adaptation to physical changes caused by climate change, while more than four out of five fund managers held investments in mitigation activities.<sup>34</sup> A notable 37 percent of fund managers reported that they made climate investments in response to client requests, which highlights the opportunity for anyone with an investment account to push their account managers to align their investments with their values.<sup>34</sup> Nonetheless, impact investments tend to flow to social impact in developed or emerging economies; the least developed countries, with their greater risk profiles, are too often left behind.

### ***UN Capital Development Fund***

The UN Capital Development Fund is unique in that it has a mandate to invest in LDCs, and it has done remarkable work building the foundations of local economic development in countries like Uganda and Nepal. UNCDF takes a transformative impact financing approach to promote service delivery, infrastructure investment, and local economic development, the value of which stays in the local area. In working with local governments, domestic banks, and local businesses, UNCDF designs, pilots, and tests out financing mechanisms and business models in both public and private sectors that support locally designed public investments and revenue-generating capital investment projects.

### ***Philanthropies' Program-Related Investments***

The investment landscape is seeing a growing ecosystem of capital, addressing the many different needs of innovators in the sector. And it's not just venture capital anymore. With "program-related investments" from the philanthropic sector, foundations are able to leverage their endowments to take a more patient approach and align their investments with their missions. A PRI can come in the form of a loan, equity investment, or guarantee made within a foundation's endowment, in pursuit of its charitable mission rather than to generate income.

### ***Public Investment***

To determine opportunity areas for climate entrepreneurs to build on public investments, it can be helpful to examine a country's Nationally Determined Contribution (NDC) to the Paris Climate Agreement, as the NDC document provides insight on where the government intends to prioritize public investing, laying the groundwork for entrepreneurs and private investment. One hundred and ninety-two countries have submitted their NDCs to the UNFCCC<sup>15</sup> Each country's NDC outlines their priority sectors to reduce emissions and adapt to climate change

impacts; they are now searchable through [WRI's Climate Watch Data portal](#). Although not legally binding, a country's NDC provides insight into how the government intends to prioritize investment and development.

Another way to understand where public investment is likely to go is to look for a country's endorsement of the UN Sustainable Development Goals (SDGs). Public as well as private institutions reference the SDGs often. A table of all 17 SDGs can be found below - those with the most significant climate implications have been given dotted borders.

Figure 17: The Sustainable Development Goals



### ***Climate Finance Innovation Needed***

To address the gaps in financing and shortcomings of existing financial mechanisms, there is need for innovations in funding targeting climate entrepreneurs in developing economies, beyond the status quo reach of capital. New financial instruments can reduce risk by creating concessional or “blended public and private investment” and distributed risk. Using new financial tools to shift how investors allocate risk and decrease opportunity cost can unlock private investment.<sup>54</sup>

Such tools are being developed and piloted by organizations like the Global Innovation Lab for Climate Finance and the World Bank Group in order to attract private finance to climate investment. The Lab for Climate Finance has projects such as peer-to-peer lending for renewable energy SMEs in India (Loans4SME) and a blockchain crop insurance instrument in sub-Saharan Africa, among many other examples.<sup>46</sup>

## **CAPACITY DEVELOPMENT**

### ***Incubators & Accelerators for Climate Entrepreneurs***

Incubators and accelerators have been essential to launching technology entrepreneurship since their development in the United States. However, relatively few incubators and accelerators have been designed for the needs of climate-focused entrepreneurs, and particularly the dual challenges inherent in much of the cleantech sector – high upfront capital costs and high regulatory uncertainty -- especially in the contexts of developing economies which often lack strong entrepreneurial ecosystems.



While incubators and accelerators offer great boosts to entrepreneurs – ANDE’s Global Accelerator Learning Initiative (GALI) finds that, on average, one dollar in program costs corresponds with an additional US \$1.70 in short-term funding for ventures – long term financial viability of these institutions can be difficult. Very few in developing economies can support themselves with the money generated from their ventures. Incubators and accelerators in developing economies often rely on public or philanthropic funding<sup>53</sup>.

It is also difficult to create incubator and accelerator models that work well in developing economies that may have weak entrepreneurial ecosystems – as GALI has found, success rates of ventures coming out of accelerators in developing economies lag those in the U.S. and Europe. Many accelerator models are not designed for climate technologies which may have longer incubation periods and a longer road to profitability compared with the information and communications technology sector from which accelerator models arose<sup>53</sup>.

Additionally, in developing economies, where risk may be higher and returns smaller, many incubators and accelerators take no equity from the entrepreneurs they accept in order to encourage a broader range of applicants.<sup>37, 50</sup> While this is important to reach a variety of entrepreneurs, it also makes the incubators and accelerators reliant on grants, or other outside funding. Unfortunately, there is a lack of studies on where and how climate-specific incubators and accelerators have been successful, which is an impediment to further investment.<sup>55</sup>

Due to these and other challenges, only an estimated two percent of all incubators and accelerators focus on climate technology.<sup>54</sup> The table below shows the number of climate technology-focused incubators and accelerators worldwide as of 2017.

*Figure 18: Estimated number of climate technology incubators and accelerators globally, 2017*<sup>54</sup>

North America	24
Europe and Central Asia	20
Asia and the Pacific	12
Africa	11
Latin America and the Caribbean	2
<b>Total</b>	<b>69</b>

*Source: UNFCCC. (2018). Climate Technology Incubators and Accelerators.*

Latin America and the Caribbean have the fewest number of climate-focused incubators and accelerators, while North America and Europe and Central Asia have the highest. **Removing industrialized countries and Central Asia, we see that the remaining regions – accounting for much of the developing world – are host to only 25 climate-focused incubators and accelerators.** This accentuates the absence of support mechanisms for climate entrepreneurs outside of industrialized countries.

### ***Educating and Training Climate Entrepreneurs***

The need for education and training in climate entrepreneurship generally falls into two categories: (a) general business education and training or (b) climate business education and training. Determining which focus is more critical for the local context of a program is a key early step.

In some rural regions of developing economies, farmers and other small business holders are deeply aware of how climate change is impacting their lives.<sup>21, 44</sup> They see how heat or rain patterns are changing and know how they need to adjust their practices or infrastructure. However, they lack the business education as well as the financing

needed to make these changes. Basic business education and assistance gaining access to banks, microloans, or other funding can empower rural entrepreneurs to make small scale but crucial modifications to their businesses. These changes can be deeply impactful in their communities to help them adapt to climate change and increase community resilience. These entrepreneurs may be best served by small scale business training in their communities and government-backed finance.

There may also be eager growth-oriented entrepreneurs who are ready to scale up their ideas but lack knowledge of climate change drivers and impacts necessary to develop responsive business models.<sup>37</sup> **These types of entrepreneurs need not only an understanding of how they can mitigate or adapt to changing climate but also access to resources of how other businesses and regions have created climate innovation.**

### ***Network Development for Climate Entrepreneurs***

Network development is also an important constraint for climate entrepreneurs. While networks and connections to peers, suppliers, capacity builders, and funders are important across all sectors, the connection between entrepreneurs and academia is particularly important.

In some regions, such as Latin America, investment in cleantech research and development through universities is robust. However, these technologies may never leave academia, as a lack of industry connections with university researchers and students means that the cleantech they develop may not take full advantage of industry opportunities and commercial applications. This may mean that technologies developed in these settings remain less practical and hard to commercialize.

In some regions or countries with lower domestic innovation outputs, entrepreneurs may be well poised to facilitate the adoption of a climate technology but lack the means to purchase or study existing technologies from other countries that could help them. In these cases, international networking within sectors will help entrepreneurs break into or scale up their businesses.

Finally, given the importance of policy frameworks and public investments in facilitating climate entrepreneurship, engagement with government is also important. **Connecting climate entrepreneurs, investors, and capacity builders with advocates and policymakers can help ensure that the needs of the sector are represented in policy discussions and decisions.**

### ***Women's Economic Empowerment***

Globally, the number of women engaged in entrepreneurial activities is growing steadily, although Sub-Saharan Africa and the Middle East lag behind other regions.<sup>79</sup> The International Finance Corporation estimates that a \$300 billion gap in financing worldwide exists for formal, women-owned small businesses, and more than 70 percent of women-owned SMEs have inadequate or no access to financial services. This of course has implications for women with climate solution ideas; they won't have the same access as male peers to resources and opportunity to build their ideas into a sustainable, let alone growing business.<sup>80</sup>

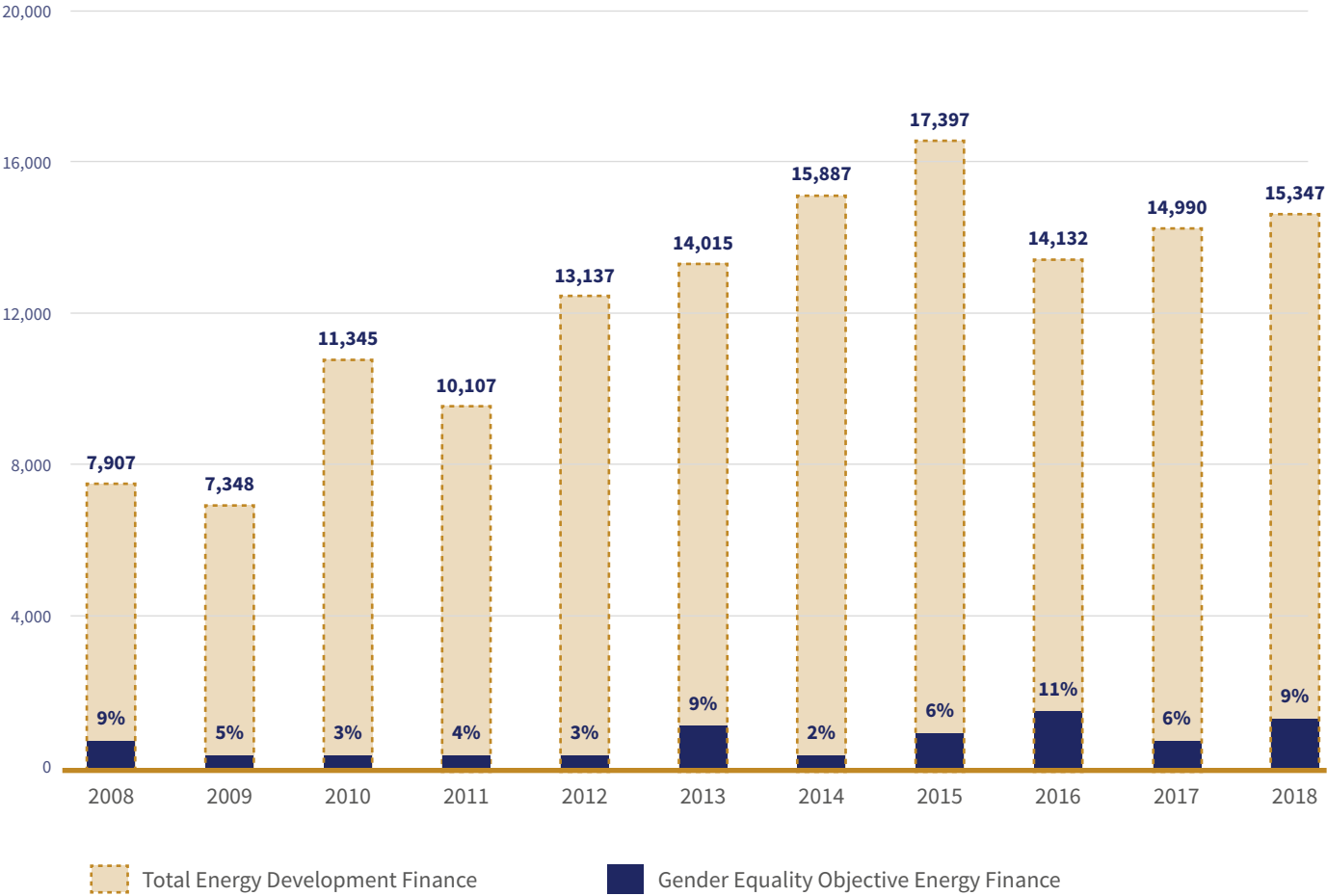
While financing targeted to the needs of women-led businesses is key, evidence shows that support beyond financing is critical to women's economic empowerment. Support for women-led startups that combines finance *and* business training is more effective than either one on its own. Tackling broader gender barriers—for example, addressing improvements in health and education, gender-based violence, childcare, land and property rights, and rural electrification—are equally important. Organizations looking to support climate-focused entrepreneurs must look at the challenges to be surmounted through a gender lens, and then design interventions that are gender-responsive (leveling the uneven playing field), or even gender-transformative (changing attitudes about gendered social roles as a program goal).

Across the climate solutions space, entrepreneurship in decentralized energy (primarily small solar lights with batteries) has been a visible arena for both empowering women and advancing clean energy services.

The off-grid lighting sector – shown by the experience of Solar Sister in Uganda and Nigeria, Frontier Markets in India, and ENERGIA more broadly – has proven its ability to generate income for women, especially at the base of the energy ladder but also farther up the value chain. We need to see even more business model innovation and not allow ourselves to be content with the tokenism of a few early successes.

Sustainable Energy for All’s latest report in their *Energizing Finance* series proposes a framework for donor countries to improve the accuracy and consistency of their reporting around finance for projects with a gender equality objective.<sup>3</sup> According to figures tracked by the OECD, international development finance for energy projects with gender equality objectives has increased somewhat over the last decade but remains a small share of total finance, as shown below.

**Figure 19: Energy sector development finance with gender equality objective (USD million) and as percent of total (2008-2018)**



Source: Energizing Finance, Understanding the Landscape 2020.

**SDGs, Social Inclusion, and the Last Mile**

In its role marshaling progress toward SDG7 (access to energy services), Sustainable Energy for All has historically pushed to keep in the spotlight those at the so-called “last mile” - those least likely to be reached by existing energy access business models due to being remote, poor, or marginalized. The inclusion agenda is central to the SDGs, and SDG13 (urgent climate action) is no different. For the global goals to be achieved, no one can be left behind. Always, it is critical to ask, what voices are not being heard?

3 More on the framework available to download here: <https://www.seforall.org/publications/energizing-finance-understanding-the-landscape-2020>

# PART IV:

# EXISTING PROGRAMS FOR CLIMATE ENTREPRENEURS

International institutions have been piloting programs throughout developing economies to assist in the growth of climate-focused businesses. These programs are focused not only on proving business growth models but also on testing the appropriateness of technology for a specific culture or context.<sup>59</sup> Although detailed information about effectiveness is hard to find, the following examples outline the model and lessons learned from the most visible of these programs.

## CLIMATE TECHNOLOGY PROGRAM

InfoDev is a multi-donor program housed at the World Bank that supports entrepreneurs in developing economies, working through various support mechanisms, including the Climate Technology Program, to connect entrepreneurs with the knowledge, funding, and markets they need to grow their businesses.

One such support mechanism is a network of [Climate Innovation Centers \(CICs\)](#) in developing economies. The CICs focus on locally appropriate technologies and integrate with larger region-wide programs in settings where entrepreneurial ecosystems are not robust. The goals of each CIC have been to facilitate the development and demonstration of climate technology; assist the development of markets; offer support services to local firms; facilitate access to finance; help develop conducive policy and regulatory frameworks; and general networking and capacity building.<sup>12</sup> A total of seven CICs have been established, including in Ethiopia, Ghana, Kenya, Morocco, India, Vietnam, and the Caribbean. The Kenya CIC, for example, has focused on four sectors: agriculture, bioenergy, renewable energy, and water, and has supported over one hundred startups and small companies through incubation, acceleration, and connection with outside services and funders.

In Ghana, CTP's [Climate Venture Facility](#) has partnered with a local impact investment firm to launch Wangara Green Ventures. In addition to managing the fund, the local partner has a mandate to support SGBs with strong climate impact, job creation, and financial return potential and invest US \$50,000 to 500,000 through equity and quasi-equity instruments as well as provide technical assistance to portfolio companies

## LAND ACCELERATORS

The World Resources Institute has created a series of accelerators for entrepreneurs in the business of restoring land, with a particular emphasis on forests. Part of their [Global Restoration Initiative](#), these “Land Accelerators” focus on Africa, South Asia, and Latin America. The program includes a bootcamp and focused mentorship to help entrepreneurs pitch products to investors. All participants also join the [Land Accelerator](#) network of knowledge sharing and monitoring. These accelerators are the first of their kind to address the needs of restoration entrepreneurs. In order to keep barriers to entry for the accelerators to a minimum, there is no fee for entry and the accelerators do not take equity.<sup>50</sup> A total of 28 companies, out of over 600 applicants, have completed the Land Accelerator Africa program, with successful outcomes such as winning new grants, securing new loans, pivoting focus to ensure competitiveness, and restructuring for better organization.<sup>50</sup> Program alumni report restoring 92,500 hectares of land and creating 2,500 jobs.<sup>51</sup> One challenge is that the land accelerator model does not yet appear to be financially self-sustaining.

# SUSTAINING COMPETITIVE AND RESPONSIBLE ENTERPRISES

The International Labor Organization (ILO) has a decade of experience with its [Sustaining Competitive and Responsible Enterprises \(SCORE\)](#) program. While not explicitly climate-focused, SCORE provides global technical assistance that supports SMEs to grow to create jobs through sustainability and productivity. Its flagship intervention, SCORE Training, is designed to bring about long-lasting improvements in supplier practices by highlighting the link between productivity and workplace practices: a win-win for employees and employers. Supported by the governments of Norway and Switzerland, focus countries include Tunisia, Ethiopia, Ghana, Bolivia, Colombia, Peru, India, Myanmar, Viet Nam, China, and Indonesia. Mainstreaming gender equality is a key to the SCORE vision of a better and more inclusive world, and ILO is working toward this on many fronts, including encouraging the presence of women among staff trained and the certified trainers, and ultimately increasing the number of women entrepreneurs.

## NATIONAL PLATFORMS

There are a few fledgling examples of platforms supporting climate-focused enterprises at the national level. In India, for example, the [GoMassive Earth Network](#) has set up a platform to syndicate early-stage investments in pollution reduction and climate technology. While still in its early days, the platform has attracted a variety of prominent Indian investors. Since 2018, GoMassive has also run its own incubator focused on sustainability startups.

## NEW MODELS NEEDED

Overall, there is space for many more programs aimed at catalyzing growth in climate entrepreneurship in developing economies. The above examples contribute important information and are beginning to outline best practices in their regions with potentially more general takeaways, but further evaluation and analysis is needed to draw out best practice learnings.

The U.S. model of incubators and accelerators has influenced the concept for these programs everywhere, though they were designed mostly for software applications. Software or smartphone apps tend to have more in common with each other, on a basic level, than with climate technologies or climate business models. The disparate businesses – anything from energy efficiency to water harvesting – within a climate incubator cohort makes knowledge sharing less fruitful. Sector-specific incubators and accelerators, such as the Land Accelerators focused on restoration, may be an approach toward addressing this problem.

One promising new program to aid climate adaptation entrepreneurs is the [Adaptation SME Accelerator Project \(ASAP\)](#), which was formed to support entrepreneurs addressing climate adaptation needs. ASAP has a three-step plan to enhance global climate entrepreneurship: (i) classify SMEs that address climate adaptation issues, (ii) build a supportive network, and (iii) enhance accelerator models to best address climate SME needs. As of mid-2020, ASAP had completed its first phase of development; its progress deserves to be tracked.<sup>52</sup>

Much more exploration in a broader range of contexts must be done, and more global institutions must devote resources toward encouraging on-the-ground innovation and growth for climate entrepreneurs.

# A CALL TO ACTION

With less than a decade left to achieve the Sustainable Development Goals and build lasting progress under the Paris Climate Agreement, the world must move beyond a business-as-usual, incremental approach to climate action. This will require unprecedented collaboration between the donor community and national governments, development finance institutions, and private investors to align all financing urgently and target the development and support for thriving entrepreneurship ecosystems that support small business development and growth across a broad range of climate-relevant sectors.

As we know, entrepreneurs can be powerful agents of change, adding value and improving their communities – from the micro level to the macro – as they reduce inefficiencies, boost economic development, and create jobs. Notwithstanding the negative impacts of the climate crisis, it presents countless opportunities for entrepreneurs to play a role in the design and construction of the future low carbon, climate-resilient world that's required. There are adaptation and mitigation opportunities in almost any sector, above and beyond the ones that received deep-dive treatment in this paper – not to mention the many sectors that haven't yet been imagined. And we can deliver gender benefits at the same time, by focusing on both climate action and gender equality in support of small business development.

As national governments work to respond to the COVID-19 pandemic, they should commit to domestic policies that prioritize sustainable solutions as part of a “green” recovery. Donors and development finance institutions (DFIs), meanwhile, should deploy a wider range of instruments to manage, share, and reduce risk, while working more closely with governments and the private sector to mobilize investment in climate solutions.

Too few ecosystem supports exist for entrepreneurs with climate change solutions – with climate appearing as a focus for **only two percent of incubators and accelerators worldwide**. Within that already tiny slice, incubators and accelerators in *developing* countries – **roughly 25 in total** – are far too few and far between to catalyze the innovation and scale-up of new climate solutions to successfully bring the net-zero emissions world by mid-century, now less than three decades away.

How will societies thrive in a 1.5 degrees warmer world – if we succeed in limiting global temperature rise to only that? Even if global temperatures on average rise just 1.5 degrees, the Global South is expected to experience an outsized share of the warming. For all committed to continued economic development in developing countries even as the world warms, this is an urgent call to action.

With this in mind, below are key actions stakeholders should take to support climate entrepreneurs to play their most effective role in addressing climate change:

1. **SCALE-UP.** We need to create far more ecosystem supports for entrepreneurs with innovative climate change solutions in developing countries – particularly across Sub-Saharan Africa, Asia-Pacific, and Latin America.
2. **ADAPTATION.** We need more climate business support programs that focus not only on mitigation, but on *adaptation* – particularly critical in the Global South, which is facing, and will continue to face, the worst climate change impacts.
3. **PATIENT CAPITAL.** We need ecosystem support models to incorporate more patient capital, reflecting the longer pathways to profitability for many low-carbon climate solutions.

4. **LEARNING.** We need more resources dedicated to evaluating what has and has not worked within developing country climate business support efforts in the past, such that the sector can learn from experience.
5. **ECOSYSTEMS.** We need to accelerate the development of incubators and accelerators in developing countries where entrepreneurial ecosystems are less mature and where entrepreneurs will need support to access strong connections with established institutions both domestically and internationally.
6. **ADVOCACY & TECHNICAL ASSISTANCE.** In designing such incubators and accelerators, we should consider including a policy advocacy arm and/or creating partnerships with climate advocacy groups in order to help national governments improve their entrepreneurial ecosystems for climate technology.
7. **GENDER EQUALITY.** Gender equality should be a central plank in our collective vision and mission statements, toward the goal of closing the entrenched gender gap in the small and growing business sector. Approaches that respond to existing inequalities between men and women entrepreneurs and equitable allocation of capital are required if we are to ensure that the benefits of our efforts are equally shared throughout target communities.
8. **CAPITAL INTENSITY.** Where appropriate, we should initially look for opportunities to encourage innovations that are easily scalable and can succeed with low capital intensity, such as resource demand mapping or internet-of-things technologies. But the slower-to-scale approaches that have tremendous local value should also not be neglected in the mix.
9. **DESIGN INPUT.** New incubator and accelerator models should be designed with public *and* private input, to adapt them appropriately to the local context in developing economies. The design should reflect lessons learned from pilot projects and existing programs.
10. **GREEN FINANCE.** Green financing models need to be adapted to better serve early-stage entrepreneurs. Green banks need to look at how they serve the SGB sector with low cost of capital financial tools and instruments.
11. **TRACKING IMPACT.** We need to develop – and adopt - tools that support SGBs to measure and track their climate impacts affordably and allow them to monetize an equitable share of the benefits of carbon finance.
12. **NEXUS OPPORTUNITIES.** We need to explore the challenges and opportunities that we as a sector face at the intersection of multiple imperatives: climate action, gender equality, shared prosperity, and enterprise development.

**We need to take bold action toward realizing this vision.  
Together, we can be the difference.**

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