The State of Climate Tech 2020

The next frontier for venture capital

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Foreword

Even as the COVID-19 pandemic holds society's attention, the pressing challenge of climate change remains.

With a view out beyond the current pandemic, arguably the greatest innovation challenge humankind has ever faced is staring us in the face: the world has 10 years to halve global greenhouse gas emissions and avoid global warming of above 1.5°C, an amount beyond which scientists warn dangerous impacts will kick in.[1] To achieve this, every sector of the global economy needs to transform in just over two business cycles. Before 2050 the global economy needs to be at 'net zero' carbon emissions. Some of the technologies and solutions critical to enable this transformation are proven but need rapid commercialisation. Others are still in a lab. Many are not yet even conceptualised.

Entrepreneurs – the instigators of innovation and transformation – are critical players in making the art of the impossible, possible. They are a proven cohort for bringing novel technologies and disruptive approaches to industry, and in doing so inventing a new future. Markets as diverse as Internet search, e-commerce, smartphones, ride-sharing and electric vehicles (EV), have become mainstream through the success of founder-led companies backed, at some point, by venture capital. Together with the early stage investors that pump in the funds to enable scaling of these new approaches and technologies, they will be key to transforming sectors to a net zero future.

The reality of the startup world, however, is that venture capitalists look for companies that have massive commercial viability, can monetise solutions as quickly as possible, and hit returns measured in multiples not percentage points. This world is not driven by impact, but by investing opportunity.

There is a history here: 'Clean Tech' remains a dirty word for many venture capitalists, who lost out in the boom and bust of the late 2000s. Are founders and their backers suffering from 'once bitten, twice shy?'

Roll forward twenty years, as we demonstrate in this report, 'climate tech' is emerging, with promising signs of high quality entrepreneurs tackling more scalable businesses, enabled by supportive venture capital. We see a new generation of investments that covers a broader range of sectors, and distinctively has (in the main) lower startup costs and clearer paths to scale. The first class of climate tech unicorns[2] have emerged – with companies like Tesla, Beyond Meat, and Nest showcasing how disruptive companies delivering critical sustainability gains can also become billion-dollar brands.

In PwC's inaugural release of what will be an annual look at the state of climate tech investing, we have brought together a first-of-its kind analysis of the startup ecosystem critical to addressing climate change. Partnering with Dealroom, we look at seven years of global startup, from 2013 to 2019, investing market data to evaluate how much capital is going to climate tech ventures, which segments attract the most capital, who is investing, where the biggest gaps in capital exist and why. We have asked some of the leading founders and investors in the market for their views of what the data tells us.

The big headline is that early stage investment into climate tech is growing fast. Over the past seven years, total funding for climate tech companies, rate of startup creation, and the average size of funding has continued to rise. For perspective, this research shows that in 2013 the early-stage venture funding for climate tech companies was about $418 million. However, in 2019, total venture funding increased to $16.1b, a more than 3750% increase. This is on the order of 3 times the growth rate of VC investment into AI, during a time period renowned for its uptick in AI investment.

1 IPCC Special Report on the impacts of global warming of 1.5°C (IPCC, 2018)

2 The standard definition of a unicorn is a privately held startup valued at more than US$1 billion

Investor participation in climate tech is fundamentally different to the noughties clean tech era. Climate tech funding seems to be coming from every corner of the market. More traditional venture capital firms are today at the table, growth stage investors including government backed asset managers and Private Equity players are getting involved in earlier stage deals to get exposure, and corporate players from oil majors and global consumer goods companies to Big Tech are playing important roles as strategic investors to scale approaches.

The COVID-19 pandemic has not slowed investment activity. Since the crisis hit, major firms have pledged billions of dollars into this including Amazon's $2 billion 'Climate Pledge' venture fund, Microsoft's $1 billion Climate Innovation Fund, and Unilever's €1 billion climate funds.[3] In addition, close to 300 companies now have a commitment to achieve net zero emissions before 2050.[4] Every commitment represents a demand signal—a new customer—in the market for a solution that helps them achieve that call. In many cases, the solutions are not yet available, and will need to be delivered by technologists and startups over the coming decades.

Still, despite the substantial growth rates we find in this market as a whole, it is a nascent sector. Capital, for example, remains thin rather than bountiful. Founders talk of a shortage of choice of investor, and investors are finding strong deals but are keen to see this segment attract more of the best founders. Whilst the policy and regulatory environment is moving in the right direction, companies pioneering the high-risk capital-intensive breakthrough technologies still struggle to get through the valley-of-death and be market competitive without policy incentives.

The bottom line is that demand for climate tech is only going to accelerate. With global corporations, investors, and governments pledging to transition to net zero value chains, portfolios and jurisdictions, they are all betting on climate technology breakthroughs to be found, scaled and to transform industries and society. Demand is not yet at a stampede but the market is heating up and it's time for all stakeholders to help back the innovations the world really needs.

Dr. Celine Herweijer
Global Leader, Innovation & Sustainability, Partner, PwC UK

Azeem Azhar
Senior Advisor to PwC UK, and Founder, Exponential View

3 See announcements from Amazon, Microsoft, and Unilever, respectively.

4 See Science Based Targets for example. Other companies have also pledged to become net zero before 2050, but may not have signed up to the Science Based Targets group.

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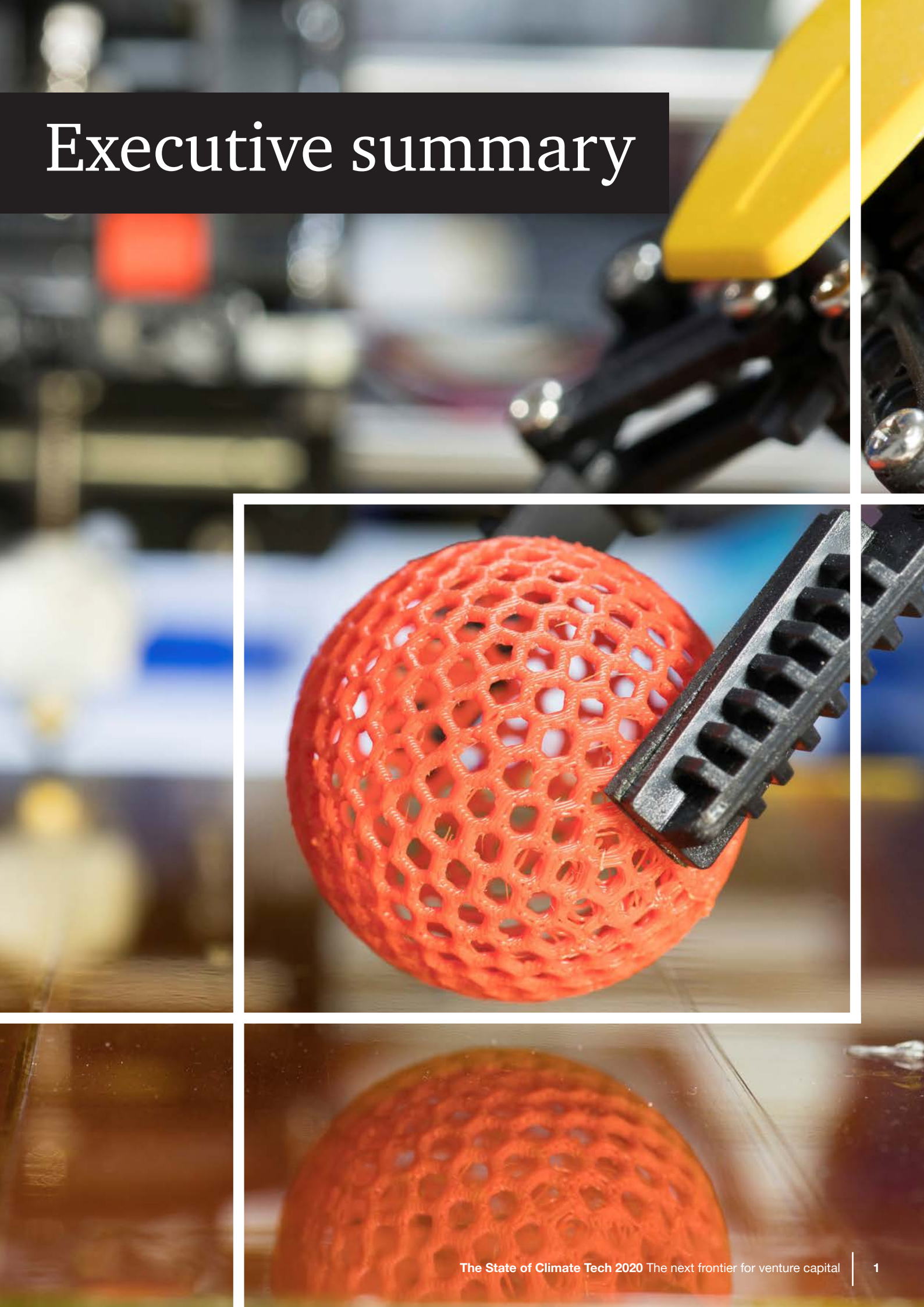
Executive summary



Executive summary

The world of venture capital has seen huge changes over the past decade. Ten years ago there were fewer than 20 known unicorns in the US[5]; there are now over 200[6]. Annual investment of global venture capital has increased more than fivefold over the same period, rising to $264 billion by 2019. This investment has been dominated by the tech sector harnessing digital frontiers to disrupt traditional industries – including cloud computing, mobile apps, marketplaces, data platforms, machine learning and deep tech.[7] It is an ecosystem that acts as the birthplace for innovation and brands that can shape the future of consumerism, sectors and markets.

As COVID-19 has taken hold of the world, the question of whether venture capital, and early stage investing more broadly, is backing and scaling the innovations our world really needs has never been more pertinent. Life science and biotech investing is an asset class perhaps most resilient and relevant to the short-term impact of COVID-19, but there is another impact-critical investment area that is emerging as an increasingly important investment frontier: climate tech.

This research represents a first-of-its-kind analysis of the state of global climate tech investing. We define what it is and show how this new frontier of venture investing is becoming a standout investing opportunity for the 2020s. Representing 6% of global annual venture capital funding in 2019, our analysis finds this segment has grown over 3750% in absolute terms since 2013. This is on the order of 3 times the growth rate of VC investment into AI, during a time period renowned for its uptick in AI investment.[8]

Looking forward can climate tech in the 2020s follow a similar journey to the artificial intelligence (AI) investing boom in the 2010s? The substantial rates of growth seen in climate tech in the late 2010s, and the overarching need for new transformational solutions across multiple sectors of the economy, suggests yes. The stage appears set for an explosion of climate tech into the mainstream investment and corporate landscape in the decade ahead.

What is climate tech investing?

'Climate tech' encompasses a broad set of sectors which tackle the challenge of decarbonising the global economy, with the aim of reaching net zero emissions before 2050. This includes low-to-negative carbon approaches to cut key sectoral sources of emissions across energy, built environment, mobility, heavy industry, and food and land use; plus cross-cutting areas, such as carbon capture and storage, or enabling better carbon management, such as through transparency and accounting.

The investment opportunity of climate tech: a moment in time

There is arguably no greater innovation challenge for today's founders, technologists, industry leaders and investors: the world has 10 years to halve global greenhouse gas emissions before we reach 1.5°C of global warming, beyond which scientists warn that dangerous impacts will kick in.[9] To achieve this, every sector of the global economy needs to transform and radically decarbonise in just over two business cycles. Many of the technologies and solutions critical to enable this 'net zero' transformation need rapid commercialisation, with many more needing to be accelerated out of the lab or even conceptualised.

> Every sector of the global economy needs to transform and radically decarbonise in just over two business cycles.

5 A Decade of 'Unicorns'Ends With a Little Less Magic (WSJ, 17 Dec 2019)

6 MoneyTree Report (PwC/CB Insights, Q2 2020)

7 The Decade in Technology and Venture Capital: Looking Back on the 2010s (Nnamdi Okike, Dec 2019)

8 Source: PwC and Dealroom analysis

9 IPCC Special Report on the impacts of global warming of 1.5°C (IPCC, 2018)

The number of countries, cities, businesses and investors that have committed to transition to net zero emissions before 2050 is creating a snowball-effect demand signal for net zero breakthroughs. This is just one of several trends which are driving increased investments and heightened investor interest in climate tech, including:

- **New and cheaper technologies:** technology advances and infrastructure investment have shifted the cost curve down, and powerful new technologies – like AI, cloud, blockchain, and advanced sensors – are not only enabling solutions to be optimised and scaled, but are offering entirely new business models.
- **Greater consumer demand:** sustainability is the new disruptor for the consumer goods segment, with consumers demanding more from brands and sustainable products starting to demonstrate higher growth rates than their non-sustainable rivals.[10] A new class of 'climate tech unicorns' such as Tesla, Nest, Oatly and Impossible Foods have also emerged showcasing the viability of disruptive approaches in the consumer market that deliver substantial sustainability impact.
- **More supportive policies and regulations:** with over one hundred countries committing to net zero emissions economies before 2050, we can expect to see continued and rapid strengthening of policymaking over coming years, including carbon pricing, subsidies, standards, bans and phase-outs, public finance mechanisms and green infrastructure investment.
- **Growing corporate demand:** close to 300 major global companies[11] (and rising weekly) have made net zero before 2050 pledges, since the push for this target began in mid 2019.
- **Increases in investment:** investors that represent over $45Tr assets under management (AUM) have signed on to drive action on climate change across their portfolios, from portfolio decarbonisation to climate risk disclosure and the use of shareholder levers.[12]

Key takeaways and recommendations

What are the key takeaways from the data on the state of the investment landscape?

1. Startups leverage capital well and don't need trillions to make a difference.
2. Talent is starting to align with breakthrough technologies and innovative business models. Where this happens, investors are lining up and we see an increasing number of larger funding rounds with high potential deals.
3. The growth rate of climate tech from 2013 has been sizable, with more than 3750% increase over the 7 year period (2013-2019).
4. But circa $60 billion as of 2019 is too low given the scale of the challenge, and more early stage investment needs to be stimulated, and the area needs to attract and support more top founders.
5. There are non-financial barriers, from talent to regulations, which might get in the way of firms having as much of an impact as needed.
6. Individual great founders can make an outsized difference in climate action. The startups they create will take some time to reach scale however, and so the startups creating most impact in this business cycle (over the next 5-7 years) will likely be those founded in the 2010's.

10 Research: Actually, Consumers Do Buy Sustainable Products (Harvard Business Review, Jun 2019)

11 See Science Based Targets for example. Other companies have also pledged to become net zero before 2050, but may not have signed up to the Science Based Targets group

12 See Climate Action 100+

$60B

VC invested in climate tech between 2013-19

84%

compound annual growth rate
(approx. 3750% increase between 2013-19)

1200+

climate tech startups identified

In 2019
$16B

of VC was invested in **590** climate tech deals
(representing 6¢ of every VC dollar in 2019)

Regional findings

Top 3 Regions

1. North America:
$29B

3. Europe:
$7B

2. China:
$20B[13]

Top investment hubs

1. San Francisco Bay
2. Shanghai
3. Beijing
(including mobility)

1. San Francisco Bay
2. Boston
3. Berlin
(excluding mobility)

Area with the most funding: Mobility and Transport

63%

...of total climate tech investment

$37B

Total invested in this area

151%

Compound annual growth rate (CAGR)

Unicorns

43

Climate tech startups valued at $1B+

30

...of which Mobility and Transport startups

(Figures have been rounded for brevity)

Investors

2700 (approx)

Unique investors identified

10

Investors with 3+ deals per year on average

78%

Investors with 2 or fewer climate tech deals in total

13 Our data coverage is stronger in European and North American markets, and this analysis may therefore be a conservative estimate of the relative levels of Chinese investment and of overall investment.

Introduction

Introduction

Why climate change is the defining crisis of the next decade

The world is in a race to limit climate change. The events of the past year have put on stark display the deep-rooted vulnerabilities of the global economy to a systemic global shock. With the global shut-down and crippling human and economic impact from COVID-19, we've seen a preview of just how powerfully the natural world can impact our lives, economy, and broader society.

The United Nations (UN) Secretary-General has labelled climate change 'the defining issue of our time'.[14] In response, the world has increasingly committed to 'net zero' greenhouse gas emissions. The 2015 Paris Agreement saw world leaders agree to limit a global temperature rise by the end of the century to well below 2°C, and to pursue efforts to limit the temperature increase even further to 1.5°C. Since then, over 120 nations – representing nearly half the world's GDP ($39 trillion) – have set or are proposing to set a net zero target before 2050 which is aligned to the 1.5C threshold.[15] This has been supported by an upswell of business action, with close to 300 global companies making the commitment to transition to net zero emissions before 2050.

Even so, actual progress to net zero has been slow. **PwC's Low Carbon Economy Index** analysis shows that the world is moving at just a fraction of the decarbonisation rate required, and a seven-fold increase in the rate of climate action is needed to keep warming to 1.5 degrees – beyond which we face dangerous climate impacts.[16] There is, therefore, a huge gap between the rhetoric of the 'climate emergency' and the reality of an inadequate global response. The startup world has a critical role to play in bridging this gap: there is a key window over the 2020s to channel the best entrepreneurs, and crucial venture capital, into developing the transformational solutions needed to decarbonise our industries.

In a time of disruption, such as the one the world finds itself in now, the temptation for investors and corporates is to try and return to the way things were. It would be wrong to think the supply chains, the working practices, and the investment decisions of the past are the right ones for the future, however. Organisations need to rethink and reconfigure to set themselves up for the greatest chance of sustainable growth in the future. The role of startups in resetting and reconfiguring for an inclusive net zero future is vital.

Critically, while net zero commitments are growing – from nations, cities or major global companies – many of these commitments are part-way contingent on bets that technological/ business model breakthroughs for some of the tougher emissions reductions will arrive or scale in time. This is where the role of the startup is pivotal.

Startup founders across the globe have already begun turning their attention towards the huge challenge of decarbonising our economies, with recent years seeing palpable growth in the number of founders and investors looking to tackle the fundamental problem of climate change. The main focus is on preventing greenhouse gases, in particular CO_2, from being released into the atmosphere, and some more novel approaches are also focussing on eliminating or capturing these gases that cause climatic changes.

This 'resurgence' in innovation, startup formation, startup growth and investment we are currently witnessing is coalescing in an area that is increasingly being referred to as 'climate tech'.[17] This umbrella term typically encompasses:

- approaches towards low-greenhouse gas (GHG) energy generation and storage, transport, the built environment, industrial processes, and food and land use;
- shifts towards less resource-incentive business models, including circular models of consumption or micro-mobility;
- better resource usage through analytics and data; and
- active carbon capture and storage.

14 Secretary-General's remarks on Climate Change [as delivered] (United Nations, Sep 2018)

15 ECIU Net Zero Tracker (Retrieved August 2020)

16 The Low Carbon Economy Index 2019 (PwC, 2019)

17 See for example: Where's Silicon Valley's investment in climate tech? (Marketplace, 17 Sep 2019); Is Climate Tech Different Enough From the Cleantech of Old? (Bloomberg, 13 Feb 2020);and Why 'climate tech' is the new cleantech (GreenBiz, 5 Feb 2020)

Is climate tech the new clean tech?

We call this epoch a 'resurgence' because, famously, there was a widely recognised boom in investment in the 'clean tech' sector between 2006 and 2011, which quickly turned into an investment bust. The 'clean tech' boom (and bust) saw venture capitalists plough $25 billion of venture capital into the sector and lose roughly half of it in a handful of years[18], which put many investors off clean energy investing for the rest of the 2010s.

In this new wave however, climate tech is much more than the clean tech of old. It is a broader concept that focuses on decarbonisation across all sectors of the economy, not solely the energy sector. This is a deliberate decision and pivot, which reflects the underlying complexity and scale of the climate challenge.

Achieving net zero will require a shift away from fossil fuels as the first mover, as well as decarbonisation of our mobility systems, a rethinking of food, agriculture, land use, retail and consumption more broadly, deep changes to our approach to the built environment, novel industrial processes and materials. It will not be sufficient merely to hope for technical innovation in batteries or biochemistry; but instead the ultimate solutions will require a broad range of approaches and novel business models to trigger behavioural changes in consumers and enterprises alike. Furthermore, scalable and safe carbon removal technologies will also need to play an important role.

Why now for climate tech?

Climate tech is also happening at a very different 'moment in time' than the clean tech movement. Key changes include:

- **New and cheaper technologies are available.** Technology advances and infrastructure investment have shifted the cost curve down and are enabling solutions to be optimised and scaled, as well as offering entirely new business models. The exponential growth of emerging technologies is allowing us to do things in fundamentally new and different ways – whether with advanced materials, AI, advanced computing, blockchain, connected devices, or bio-tech. These solutions can help decarbonise industries at a much more rapid pace and scale. PwC/Microsoft analysis suggests that just AI, and in just 4 sectors of the economy, could reduce annual global emissions by 2.4 gigatons of CO_2e in 2030. This is equivalent to the emissions of Australia, Canada and Japan combined, and would represent an overall reduction in carbon intensity of 4.4 – 8.0% relative to business as usual.[19]

- **Consumer demand for sustainable business practices has rocketed.** The first generation of 'climate tech unicorns' have emerged, with companies including Tesla, Nest, and Beyond Meat showcasing the importance of disruptive consumer brands that also deliver substantial sustainability impact.

> 'The events of the past year have put on stark display the deep-rooted vulnerabilities of the global economy to a systemic global shock.'

18 Venture Capital and Cleantech: The Wrong Model for Clean Energy Innovation (Gaddy et al., MIT Energy Initiative, Jul 2016)

19 How AI can enable a sustainable future (PwC/Microsoft, Apr 2019)

- **Regulators are increasingly taking action on net zero.** The regulatory setting has transformed. The world now has a global deal on climate,[20] which is in turn ratcheting carbon pricing, and rapidly strengthening national policies, regulation and legislation, including over one hundred countries committing to become net zero by 2050. Contrast this with the less supportive policy environment and heavy reliance on government subsidies that characterised clean tech only a decade ago.

- **A robust corporate demand signal now exists,** including net zero commitments from close to 300 major global corporations over the past 12-18 months.[21] These pledges include major corporate greenhouse gas emitters that require transformative solutions to make net zero a reality, including BP, Iberdrola, Shell, Total, Maersk, Rio Tinto, Daimler, Nestle and Oneworld member airlines committed to becoming net zero emissions businesses before 2050. To meet this ambition, companies are not just looking to develop or buy new decarbonisation solutions, but also to invest in disruptive corporate venture capital plays. Recent months have seen corporations such as Amazon, Microsoft, Unilever, Rio Tinto launch billion dollar plus investment funds focused on net zero solutions [see Box 1].

- **Investment is growing.** Money today is flowing rapidly into assets labelled green or climate-positive, with over $45Tr AUM (close to half tracked AUM, and counting) committed to portfolio decarbonisation targets and/or investing in low-carbon funds and holdings. Combine this with the first wave of climate tech unicorns and wider success stories setting the stage to attract even greater levels of investment in the area, and attract the entrepreneurial talent to deliver even more success stories for the sector. Alongside growing institutional investor pressure to decarbonise investments, specialist funds are increasingly being established to chase the alpha in climate tech. For example, Chamath Palihapitiya, CEO and Founder of Social Capital, announced one of the largest pledges to invest in sustainability from a credible mainstream VC.

This confluence of factors has resulted in a vibrant and self-reinforcing ecosystem, presenting a better and more stable environment for startups to thrive than the heyday of the clean tech boom. We anticipate this trend to pledge dedicated early stage capital to the climate challenge will continue, both as investors recognise the scale of the challenge, the strengthening demand signal for solutions, and the growing investment opportunity and policy enabling environment.

Box 1: Recent venture funding announcements support new wave of climate tech

Recent reports have outlined the multi trillion-dollar investment opportunity presented by combating climate change with technology.[22] Corporations and investors are taking notice. In recent months, Amazon has committed to launching their Climate Pledge Fund, $2 billion in venture capital aimed at clean energy ventures; Jeff Bezos, Amazon's chief executive, pledged $10 billion to fight climate change through the creation of the Bezos Earth Fund, making him the largest single US climate change donor; Microsoft has announced a $1 billion Climate Innovation Fund, and Unilever has pledged to invest €1 billion in a new dedicated Climate & Nature Fund, focused on nature restoration and carbon sequestration. In addition, generalist VCs have announced that they are now seeking climate tech related opportunities, including Sequoia Capital, Founders Fund, Khosla Ventures, Kleiner Perkins and Union Square Ventures.

Why a thriving startup ecosystem matters

We need faster, bolder innovation in climate tech, and startup innovation can help deliver this. The startup/venture ecosystem is geared up to deliver fast-growing, highly scalable companies with a technological edge, which is exactly what is needed now for climate. The special recipe is the combination of human capital with novel technologies, often wrapped in business models which challenge or disrupt the status quo. For example, companies like Apple, Amazon, Google, Genentech, Uber and Tesla have created or transformed industries, markets, and daily behaviour, in under a decade since their inception.

20 The Paris Agreement (UNFCCC, 2015)

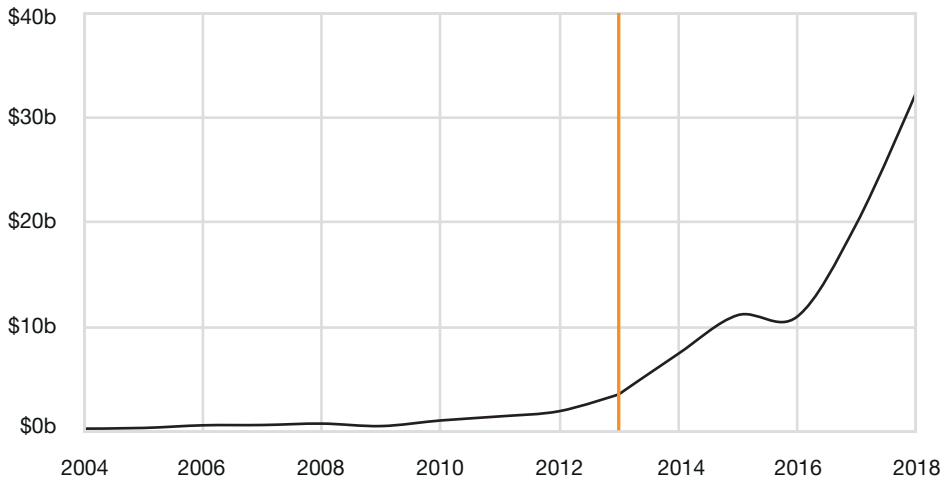
21 See the Science Based Targets initiative, for example

22 There's a Trillion Dollar Investing Opportunity in Green Innovation, Bill Gross Says. Here's How. (MarketWatch, 2nd Jul 2020); and Climate Smart Growth Could Deliver 26 Trillion USD to 2030, Finds Global Commission (UNFCCC, 5th Sep 2018)

Startups are not a silver bullet, however, and there are limitations to what can be achieved from this ecosystem. Startups can succeed in a given domain at a biting point when the technology is not intractable nor is it completely widespread. For example, touch screen computing firms failed in the early 1990s because the component technologies were neither robust, nor cheap enough. Today, touch screen devices are ubiquitous. Startups also succeed when there is an established infrastructure upon which novel services can be built. eBay and Amazon, for example, were built on top of a multi-decade government-led investment in the global internet infrastructure. On the other end of the spectrum, startups often struggle in infrastructure plays or businesses that are highly capital intensive. Finally, the startup world is a game of outsized and 'fat-tailed' outcomes, winners regularly take all and exceptions to the rule are not common.

Startups may play a key role in certain aspects of tackling the climate crisis, even if activity today is comparatively modest. They often presage the widespread availability of new products and services. The founder's art is in connecting technology plausibility with a latent demand signal in the market. The incentives for founders and the venture capitalists who support them are structured to help them explore uncertain areas with potentially large markets and high returns. The capital fuels the talent to create new products and services, driving adoption in the market, and demand for complementary products.

Annual VC investment in AI startups



Source: Dealroom.co analysis

Climate tech parallels with the AI investment boom?

The boom in AI investing may provide some insight on both how quickly the startup ecosystem can contribute to making technologies widely available, and the critical role of different investment types. Prior to 2011 VC investment levels in AI startups were negligible with the first wave in AI mainly funded by government sources and the big tech platform players. But a breakthrough in a key area of research, machine vision, was the trigger that the technology had matured sufficiently to enable application proliferation. In 2013, around $3 billion of venture capital had been invested in AI companies. By 2018, the level had increased ten-fold to $32 billion.[23] Such investments drove the availability of AI technology in the broader economy, with VCs, governments and enterprises all joining venture capital deals. IDC Group estimated that large enterprises spent $5 billion on AI technologies in 2016; by 2019, that had increased to $37.5 billion.[24]

Early stage funding by large enterprises reflects a growing buy-in to the transformative benefits of AI applications, and its criticality for competitive positioning and value creation. Climate tech applications will need to do the same.

As the saying goes, history does not repeat itself, but it often rhymes. We cannot perfectly apply this model to climate tech, which covers a broad and heterogeneous set of challenge areas and technologies with different states of maturity. But we do see some parallels that can help us understand the sorts of places where founders and different investor types might play, and how those endeavours might scale to have useful contributions to the net zero transition.

23 Source: Dealroom.co analysis

24 See Worldwide Spending on Artificial Intelligence Systems Will Be Nearly $98 Billion in 2023, According to New IDC Spending Guide (IDC, 4th Sep 2019); and Worldwide Spending on Cognitive and Artificial Intelligence Systems Forecast to Reach $12.5 Billion This Year, According to New IDC Spending Guide (Business Wire, 3rd Apr 2017)

Three key criteria that drive suitability for venture capital investment are the:

- **Abatement feasibility in a given sector:** to what extent are technology solutions technically feasible, applicable at scale, and cost effective for a carbon reduction sector-specific solution?
- **Capital efficiency in the sector:** do solutions require significant amounts of upfront capital to prove the model?
- **Value creation potential:** do applications create material value creation benefits for large enterprises, from operating model enhancements, to product/service customer growth, brand optimisation, or optimised balance sheets including capex gains or tax efficiencies?

Propositions which are capital efficient, technically feasible to apply and scale, and showcase a clear value creation proposition lend themselves to fast growth ventures and heightened investor interest. Examples include efficient shared mobility, sustainable new consumer goods brands, consumer bundling of existing renewable power capacity, and precision agriculture technologies.

Where solutions are feasible but large amounts of capital are required, for example solar photovoltaic (PV) generation, it is likely that these capital requirements will be met by project or other non-VC sources of finance. However, startup opportunities might emerge in analytics, optimisation, marketplace or distribution in these challenge areas.

Technically risky challenge areas that are still in the R&D phase (including many in the so-called hard-to-abate sectors) require higher levels of investment and valuation in early rounds. In general, government funding and corporate funding from relevant big industry players searching for transformative solutions are important backers for such ventures. Some, however, may be unsuitable for venture capital depending on how far from building and testing they are.

Alternative proteins are one area where the breakthroughs were made using venture funding, while in comparison, carbon sequestration and nuclear fusion technologies are still in relatively nascent stages of investment, with enterprises and governments acting as critical strategic partners and investors. The area where there is the least clear path for startups to play is where the technological path is unclear and capital efficiency is low. Testing large scale geothermal or geoengineering approaches, for example.

There's been a significant cultural move towards accepting climate change as a risk, driven by the children of the 90's really influencing their families. This generation cares about the sustainability play, and how corporations are addressing this through their supply chains. Brands need to be addressing climate change, or they'll suffer.

Technology is increasingly affecting every industry. AI will be a large contributor to sustainability, and necessity is the mother of investment'

Vinod Khosla
Founder, Khosla Ventures

Approach

Approach

What is climate tech?

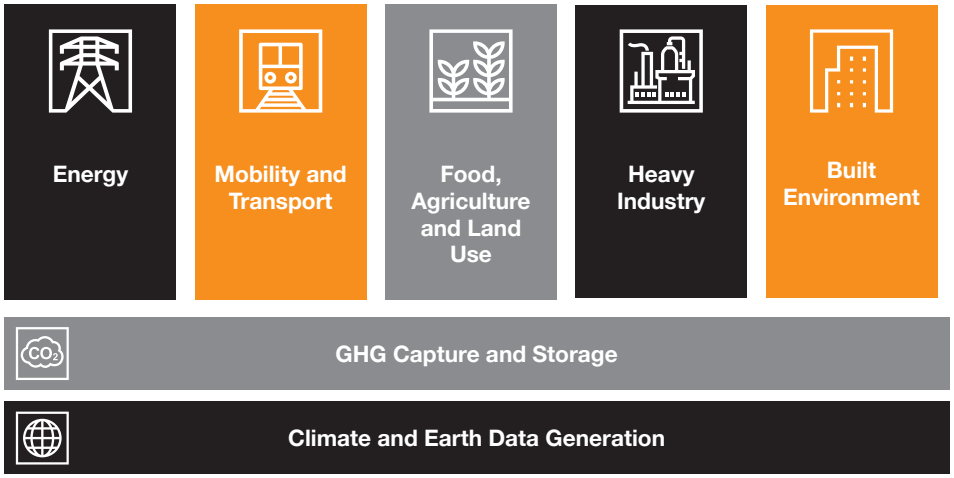
Climate tech is defined as technologies that are explicitly focused on reducing GHG emissions or addressing the impacts of global warming, while climate tech startups are companies which are applying those technologies. The term climate tech is purposefully broad in order to incorporate the broad swathe of technologies and innovations being used to address GHG emissions and the broad array of industries where they are being applied.

Categorising climate tech startups by challenge area

Governments, businesses, and international organisations have a deliberate focus on reducing GHG emissions across all sectors of the economy. There are, however, **five key sectors** which contribute the majority of emissions, and which remain key 'challenge areas'.

PwC has grouped our climate tech solutions in alignment with these challenge areas. In addition to these 'vertical' areas, we have included two 'horizontal' challenge areas, reflecting themes where we see significant potential for sector-agnostic solutions to emissions reduction.

Together, these **seven challenge areas**, shown in the diagram to the right, encompass our 'universe' of climate tech solutions. Each of these seven challenge areas are broken down into specific **net zero levers** – for example, alternative proteins, vertical farming, and agricultural biotech – which are explained in further detail in the Appendix. These challenge areas are designed to broadly follow the industry classifications set out by the Intergovernmental Panel on Climate Change (IPCC) and which are typically used when discussing emissions reduction.[25]



How has PwC produced the data to support this report?

The initial dataset was provided by Dealroom.co, a global data platform gathering information on startups, investors, and deals. Based on feedback from the VC community and our own experience, we applied a filter on investment time frame and minimum size of funding for startups[26] to produce a shortlist of startups we think will be of most interest to the VC community. Through this, we excluded startups who are still relatively small (those that have raised less than $1 million in VC funding), as well as those who are staying private for longer, and who have more in common with many corporates than with startups still raising early rounds of capital.

PwC developed a **machine learning approach** to further filter and prioritise this shortlist by likelihood of being climate tech relevant. Our analysis was underpinned by extensive human verification of our results, and each of our climate tech startups was tagged to relevant challenge areas and levers.

Quantitative analysis was conducted on deal data provided by Dealroom.co, which allowed for analysis on areas such as amount of funding raised, geographic split, investors involved, and several other important fields – see the results section for more details. Additional detail on our methodology can also be found in the Appendix.

25 IPCC Fifth Assessment Report, Chapter 10 (IPCC, 2014

26 More details on the boundaries of our analysis is available in the Appendix

Key findings: Investment

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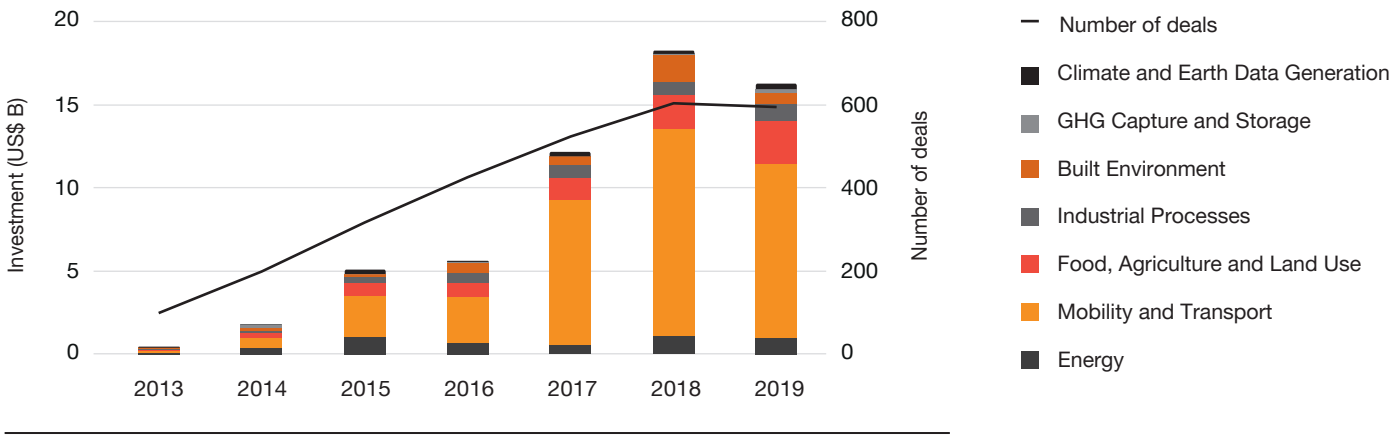
Overall Funding Levels: 2013-19

Investment in climate tech has grown at almost five times the rate of the overall global venture capital market, with similar growth seen in numbers of deals. There was ten-fold growth in investment between just 2013 and 2018 – though 2019 experienced a small drop-off, concomitant with wider VC investment trends.[27]

VC investment in Climate Tech and number of deals



Source: PwC analysis on Dealroom data

Key highlights from our dataset include:

- PwC identified around **2,700 unique investors** from venture capitalists, corporate VCs, angel investors, philanthropists, and government funds who have participated in funding over **1,200 climate tech startups** between 2013 and 2019, covering **over 2,700 funding rounds**.
- Investment levels are growing rapidly from a low base. Of the firms that met our criteria of having raised venture capital (or the equivalent) between 2013 and 2019, we see an **84% compounded annual growth rate (CAGR) in total capital deployed. This represents almost five times the growth rate of the wider VC industry**, where investment grew at just 18% annually. It also is on the order of 3 times the growth rate of VC investment into AI, during a time period renowned for its uptick in AI investment.
- Over this seven year period, **$59.5 billion of venture capital** flowed into startups contributing to tackling the net zero challenge.
- In 2013, climate tech attracted only $418 million in venture capital. By 2018, nearly fifty times as much capital was deployed, before levels cooled off to $16.3 billion in 2019. The venture industry as a whole deployed approximately $264.4 billion last year, implying **climate tech investment represented 6% of global venture capital activity in 2019**.
- We also see a rapid acceleration in the number of deals being done. The **number of funding rounds grew at a 35% CAGR over the seven year period**. As this was a lower growth rate than funds deployed, it implies an increase in the typical deal size, suggesting a maturing of the climate tech market. This was particularly noticeable for investments in the Mobility and Transport challenge area.
- The Mobility and Transport challenge area represents 63% of all climate tech funding over the past seven years, as investments in electric vehicles, micro-mobility and other transit models have attracted significant investor attention – of the ten firms which attracted the most capital in the period, nine were in the Mobility and Transport challenge area. VC investment in this challenge area alone grew at a CAGR of 151% over the period; whilst the remaining climate tech challenge areas grew at a more temperate, but still pacy, gait of 57% per annum.

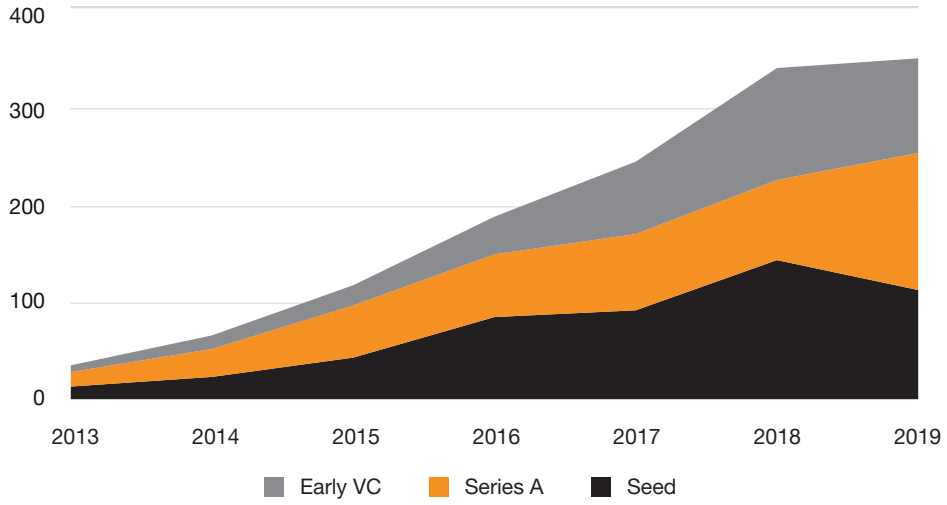
27 We note that there is often a time lag between when funding is raised and when it is reported. Our report makes use of data from Q2 of 2020, and as such, figures for 2019 may be underestimated. Based on the level of additional 2019 funding identified by Dealroom since the data for this report was extracted, we estimate this 'reporting gap' represents approximately 3% of 2019 funds

How does investment vary by stage?

Early stage company formation

PwC analysis also shows a vibrant and growing ecosystem of early stage firms and investors. In 2013, we identified 35 early stage, seed or series A rounds in excess of $1 million. By 2019, this had increased by an order of magnitude to 353. This implies a healthy pipeline of younger firms in the market, ready to approach more mature funding milestones in the coming years.

Number of early stage rounds worth >$1m



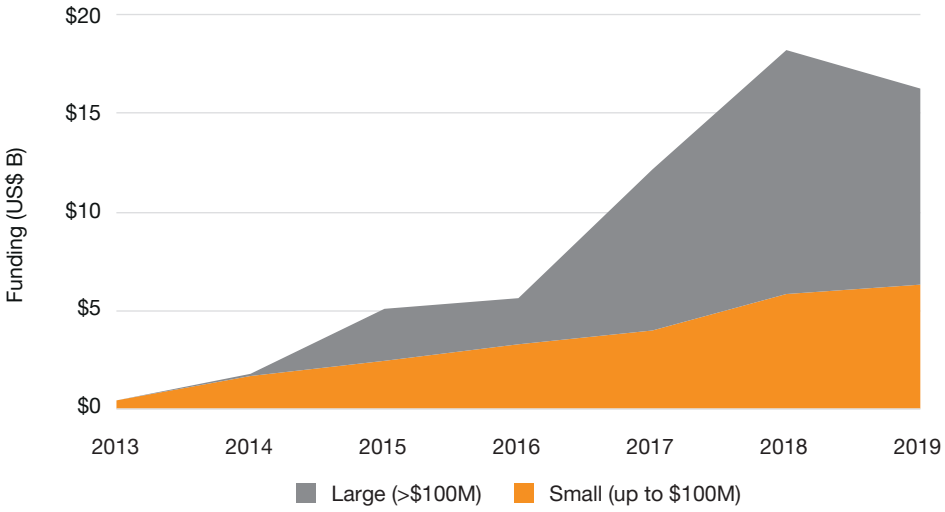
'Early VC' is the default label for rounds of $1-10m with no self-reported label

Source: PwC analysis on Dealroom data

Large deals

We see that a large part of the top line growth in VC funding is driven by large deals (that is, those in excess of $100 million). In 2013, negligible venture dollars went into large deals in climate tech, but by 2019 sixty one cents of every venture dollar invested came from a large deal. This reflects a maturation of the climate tech market, characterised most strongly in the Mobility and Transport challenge area, where an increasing number of successful late-stage startups are disrupting traditional urban mobility, through offerings such as electric vehicles and micro-mobility options.

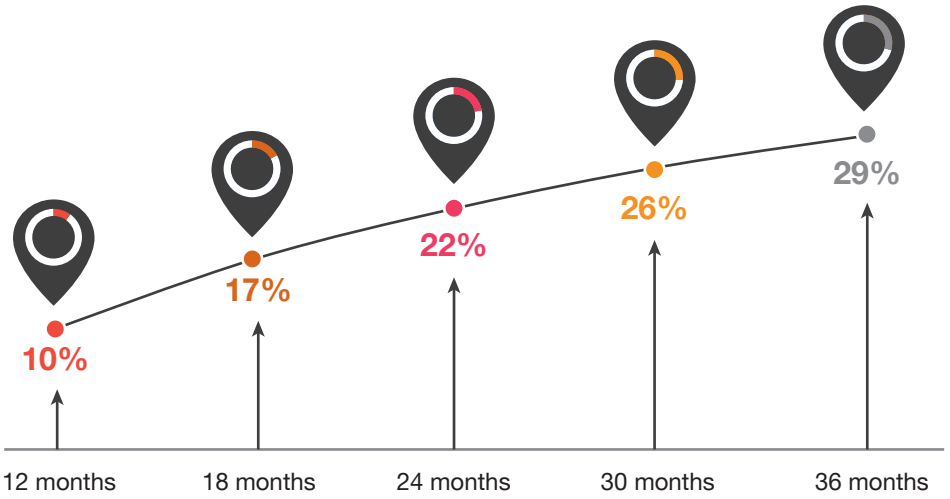
Funding split by deal size



Graduation time

Of climate tech startups that raised a seed round, approximately 29% had raised an A round within 36 months.[28] This compares favourably against the wider VC market. Previous analysis by Dealroom suggests that, for typical startups which have managed to raise seed funding, only 19% graduate to Series A funding within 36 months.[29]

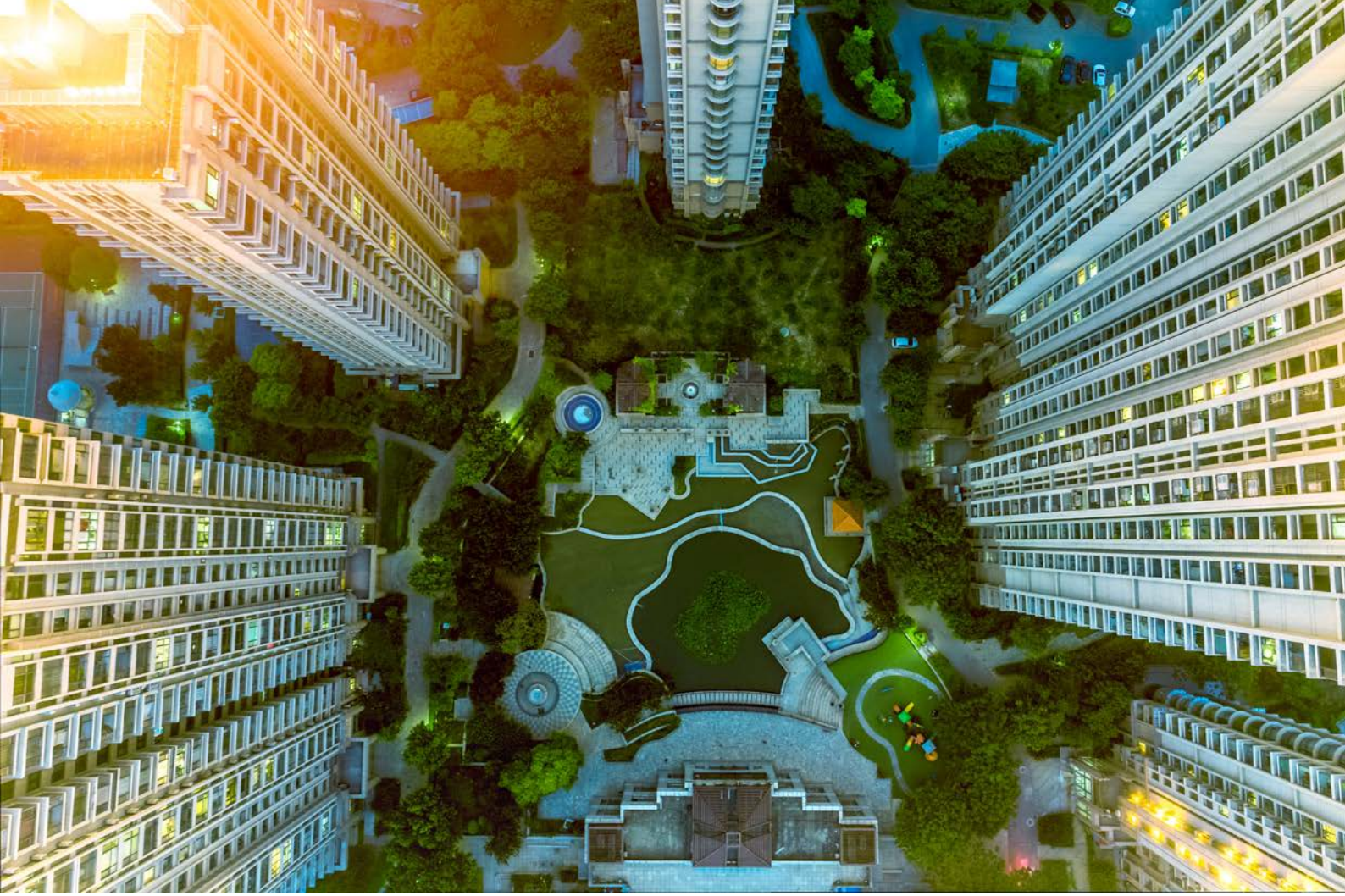
Conversion to Series A by time elapsed since Seed round



Source: PwC analysis on Dealroom data

28 There may be a lag between when a round is reported to have happened and when it has actually happened. There is potential for bias – perhaps investors are more active to announce investments in climate tech startups compared to other types of startups – but this is inevitably impossible to assess externally

29 Approximately 90% of series A rounds have happened within 36 months of the seed round, making it a useful cutoff for measuring conversion rates



Investment by challenge area

Overall findings

Each challenge area attracts very different amounts of capital, as indeed does each lever within the challenge areas, reflecting the maturity of the underlying technology. For example, solar and wind power generation has well-tested, established technologies and a proven, mature business model. Accordingly, this lever attracts substantial overall finance, but comparatively limited amounts of venture capital.

We see a similar scenario in the Mobility and Transport challenge area: overall, the challenge area is nearing maturity, but this top-level view obscures the underlying detail within each lever. In practice, electric car startups are attracting large amounts of venture capital, particularly in China, and micro-mobility has also been the recipient of substantial investment. Yet venture investment into essential low-emissions solutions for international transport challenges such as shipping are almost non-existent.

> The Mobility and Transport; Food, Agriculture, and Land Use; and the Built Environment challenge areas have been the major recipients of climate tech investment.

Energy

Challenge area overview and climate challenge

Generating electricity and heat energy accounts for around one-third of global greenhouse gases emissions each year.[30] Finding net zero sources of energy – which are also reliable and affordable – is vital to limiting the effects of climate change. Some solutions are already a mainstay: falling costs and rising efficiency means that renewables such as wind and solar are increasingly competitive with their fossil fuel counterparts.[31] However, there is a need to develop new tools that are more consistent, reliable, and available to all. Battery storage will be crucial to help with intermittency of many renewables. Society also needs smarter, more efficient grids that can store and transmit clean energy when and where it's needed. Emerging technologies, such as AI and blockchain, can enable and optimise decentralised grids which are well suited to renewable sources. Finally, a clean transition from carbon-based fuels must include tools which abate the emissions of our current energy system.

Headlines from PwC analysis

Investment level: Energy is the third largest challenge area by level of investment, accounting for $4.9 billion of investment between 2013 and 2019, or 8.2% of total climate tech investment.

Growth rate: Investment in Energy startups has grown at a moderate pace, recording a CAGR of 41%, which is substantially lower than the overall growth rate of climate tech investment (though still double that of the wider VC ecosystem). This reflects the relative maturity of two of the major sources of renewable energy – wind and solar – which are now being deployed globally at scale, and are increasingly financed through traditional project, debt and other finance rather than venture capital.

Number of deals: The deal flow has increased steadily from 14 in 2013 to 101 in 2019 in this area. The majority of this growth in deals, however, has taken place in renewable energy generation, energy storage, and grid management. These are clearly at greater levels of maturity than the remaining levers, such as nuclear and alternative fuels, which are early in their investment development path.

Investors: Volkswagen Group, Kleiner Perkins, and Schneider Electric are the biggest investors in the challenge area by total dollars invested, while in terms of the number of deals, Total Energy Ventures, GE Ventures, and InnoEnergy lead.

Unicorns: SolarCity, specialising in solar energy services, gained a valuation of $2.6 billion during its acquisition by Tesla, Inc. and is the only $1 billion plus investment identified in Energy during the period analysed.

Other notes: An apparent dip in investment takes place in 2017. The number of deals year on year shows a more even trend and indicates this is predominantly due to large deals landing in 2015 and 2018, particularly in renewable energy generation and energy storage.

Sector definition:

- Production, development and distribution of alternative fuels
- Measures which support proliferation of renewable energy, including load-balancing (storage) and supply-demand balancing mechanisms
- Measures which increase efficiency of the energy sector or of energy intensive electronics (such as data centres)
- **Excludes** measures which create efficiencies specifically for fossil fuel energy generation, such as improvements to venting/flaring mechanisms on oil and gas refineries

30 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors (WRI, 6th Feb 2020)

31 Renewables Increasingly Beat Even Cheapest Coal Competitors on Cost (IRENA, 2nd Jun 2020)

Key levers

Renewable energy generation

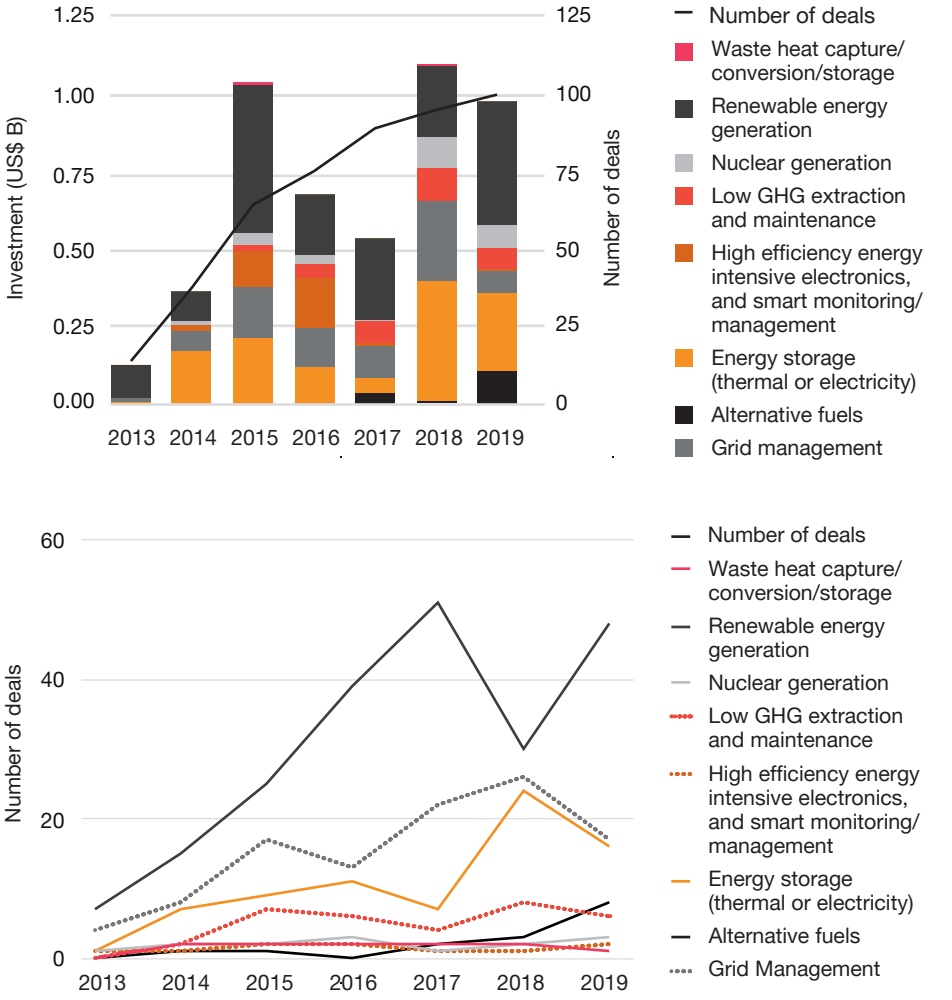
- **Major investment themes:** Thirty-six percent (36%) of investment (215 deals) is from this important lever, which is relatively mature given the high levels of funding and regulatory support since the clean tech boom. Startups have predominantly focussed on renewable energy (mainly solar), encompassing technology development as well as innovative funding/distribution models for solar and wind, but also including exploration of other technologies, such as wave and geothermal energy.

- **Noteworthy startups:** Oxford Photovoltaics raised $120 million and is making breakthrough perovskite-on-silicon tandem solar cells which demonstrates much higher efficiency than traditional cells. Fenix International raised $130 million, and is building affordable solar home systems to deliver electricity to remote, off-grid households. Similarly, Bboxx have raised $90 million to deliver clean energy using solar home systems, and tackle energy poverty.

Energy storage:

- **Major investment themes:** Twenty-five percent (25%) of investment is focused on energy storage: predominantly development of batteries, but also some more fringe chemical/kinetic storage startups. Increasing penetration of intermittent renewables goes hand in hand with rising investment in this lever, as increased dependence on wind and solar require deployment of storage to balance their variability.

- **Noteworthy startups:** Just five companies account for more than 50% of storage investments: Quantumscape, Sonnen GmbH, Aquion Energy, Energy Vault SA, and Vionx Energy. Of these five, only Energy Vault SA is a non-chemical battery system, using a novel form of gravity storage.



Source: PwC analysis on Dealroom data

Nuclear generation:

Major investment themes: Nuclear generation on the whole has not been invested in heavily during the period, with only six startups identified with a combined total of $262 million VC funding. Two-thirds of this funding came in 2018 and 2019, focussed primarily around fusion power, suggesting this may be an area to watch.

Noteworthy startups: Energy General Fusion has raised $136 million, while Commonwealth Fusion Systems closed an $84 million funding round in May 2020 (just outside of our analysis time frame).

Mobility and Transport

Challenge area overview and climate challenge

Transport has been one of the fastest growing sources of emissions, having increased by 71% since 1990,[32] and now accounts for approximately one-quarter of global GHG emissions.[33] The transition to electric vehicles has been a favoured tool for abating GHG emissions, perhaps unsurprising given that 72% of global transport emissions arise from road vehicles.

Reducing global transport GHG emissions will still be challenging, however, as the continuing growth in passenger and freight activity could outweigh all mitigation efforts unless transport emissions can be strongly decoupled from GDP growth (and carbon-intensive energy systems). Though electrifying transport systems remains a vital part of the net zero transition, other changes need to occur too. An increased focus on increasing the attractiveness of different mobility options (leading to modal shifts, shared transport, or avoided journeys), improved vehicle performance technologies, alternative fuels, investments in related infrastructure, and changes in the built environment, will all be necessary to mitigate the impacts of climate change.

Headlines from PwC analysis

Investment level: This is by far the largest area of investment at $37.4 billion, or 63% of the funding analysed between 2013 and 2019. Much of this is attributable to heavy EV investment in China (nearly half of all investment here takes place in Chinese startups) and investment into micro-mobility (e.g. e-scooter rental platforms).

Growth rate: Investment has grown dramatically, recording a CAGR of 151%, which is substantially above the overall growth rate of climate tech of 84%. CAGR by number of deals sits below this at 47%, but above the climate tech average (35%). The difference between these indicates a disproportionate growth in large deals.

Number of deals: Deal flow has increased steadily from 18 in 2013 to 182 in 2019, with efficient transport systems as the lever with the most deals. Growth in the number of deals has shown early signs of slowing since 2017 as some of the main levers – efficient transport systems (31% of deals), and low GHG road transport (22% of deals) – reach maturity. Low GHG shipping, low GHG air transport, and batteries/fuel cells recorded significantly less deals than the other levers, indicating the relative immaturity of these levers.

Investors: Evergrande Health Industry Group, SoftBank, China Cinda Asset Management, and Zhongji Holding are the biggest investors by total dollars invested – all of whom, excluding SoftBank, are Chinese investors. Sequoia Capital and DST Global are the only other non-Chinese investors in the top 10. In terms of the number of deals, Y Combinator, Sequoia Capital and Tencent lead.

Unicorns: Mobility and Transport contains the largest number of unicorns for any challenge area, with 30 from a total of 43. The majority of these are EV-related (15) or electric micro-mobility related (7). Of the 30, nearly half are Chinese startups, again predominantly EV-related (9) and electric micro-mobility related (3).

Sector definition:

- Developments which increase efficiency (of engines, design, or materials) associated with movement of goods or people by land, air or sea
- Development of electric vehicles and micro-mobility vehicles, and the infrastructure used to propagate these technologies, including ride sharing apps and charging points
- Development of battery technologies for mobility applications and the associated infrastructure
- Improvements to the efficiency of transport systems, including use of autonomous & sensor technologies, improvements to maintenance and repair, and urban planning and design

32 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors (WRI, 6th Feb 2020)

33 Everything You Need to Know About the Fastest-Growing Source of Global Emissions: Transport (WRI, 16th Oct 2019)

Key levers

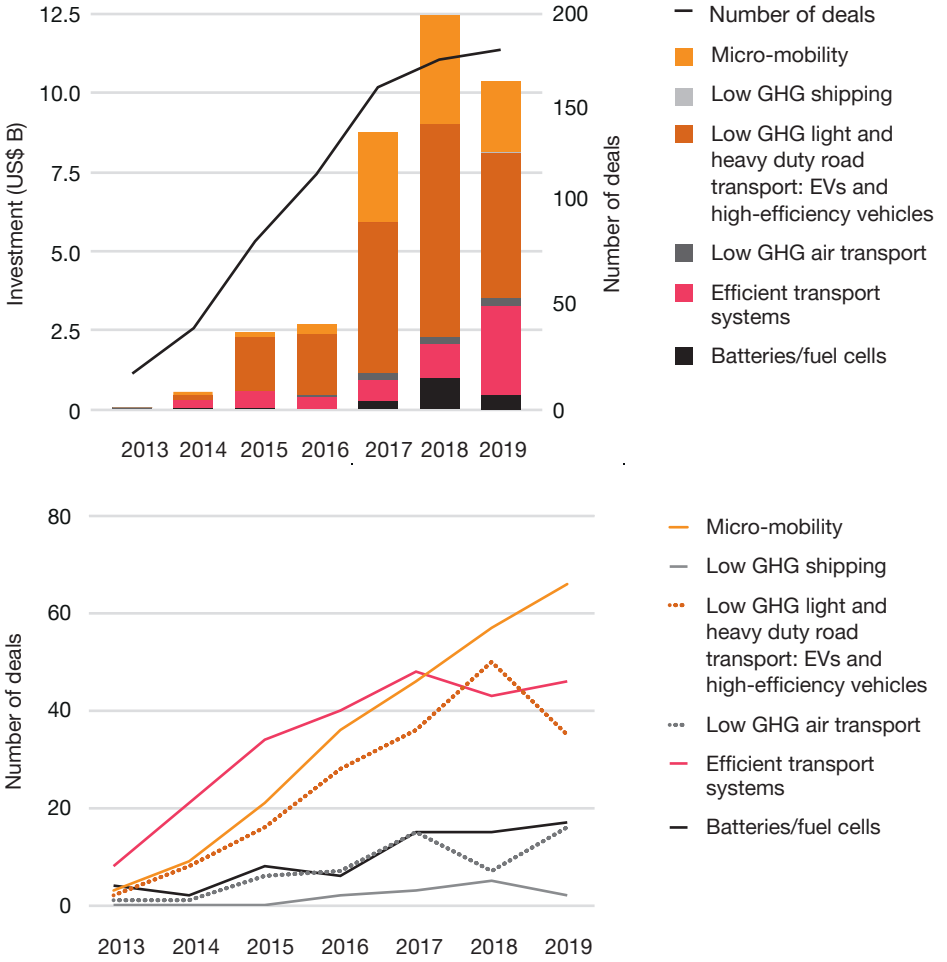
Micro-mobility

- **Major investment themes:** Micro-mobility is the second most heavily invested lever in this challenge area, with $9.1 billion raised between 2013 and 2019 (approximately one quarter of all investment in the challenge area, and larger than any other challenge area). The level of investment in this space is unsurprising as major cities around the world have seen a surge in the number of providers of dockless bikes and scooters. There are also some examples of other modes of transport, including e-skateboards and self-driving robots.

- **Noteworthy startups:** Ofo, the most heavily funded startup during our analysis period, had – at its peak – 10 million bicycles in 250 cities, and 20 countries, with 63 million monthly active users. Hellobike and Mobike have also raised significant funds to provide bicycle sharing systems, headquartered in China. This area has seen some bumpy times in recent years, however, particularly outside of China.

Low GHG light and heavy duty road transport: EVs and high-efficiency vehicles

- **Major investment themes:** Low GHG road transport is the most heavily funded lever in this challenge area, with $19.4 billion raised between 2013 and 2019. This represents over half of all investment in this challenge area, and nearly as much as all investments in the other challenge areas combined. Nearly 85% of this investment is directed towards electric vehicle (EV)/hydrogen-EV development in Chinese startups. Other focus areas include development of heavy duty vehicles such as buses and trucks, smart infrastructure for EVs, and sharing platforms/rental services targeted at emissions reduction.



Source: PwC analysis on Dealroom data

- **Noteworthy startups:** NIO is a Chinese startup which designs and develops electric autonomous vehicles. They are the most heavily funded startup in this analysis, having raised $3.1 billion, and went public on the New York Stock Exchange in 2018.

Notes:

- The onset of COVID-19 points to further growth in the micro-mobility sector, as governments, such as the UK, have fast tracked micro-mobility trials in response.
- EV startups identified in our analysis are predominantly China-based because venture capital is a big stream for Chinese EV investments. In Europe and North America, by contrast, EV investment is taking place through incumbent auto-manufacturing companies, a funding mechanism which is excluded from this analysis.
- Growth rate in this challenge area may be surprising given the major levers – electric vehicles, micro-mobility, and efficient transport systems – have been relatively mature for a while. However, our analysis indicates how much investment can grow significantly once scientific and product risks are overcome and investors become more certain of tangible value in an investment space.

Food, Agriculture, and Land Use (FALU)

Challenge area overview and climate challenge

The food systems that feed the world's population account for 19-29% of global GHG emissions.[34] By 2050, global population is expected to grow by 25%,[35] leading to an acute increase in GHG emissions if we do not transform the way we grow food. There is a need to find more efficient and productive ways to feed the planet's growing population whilst lowering the environmental load of food production.

Current approaches to mitigation often focus on improving efficiency in farming processes. However, with $44 trillion of economic value generation moderately or highly dependent on nature and its services, society will need to also find innovative approaches which are less land-intensive. These include whole new forms of nutrition, ways to manage natural environments more effectively, mitigate and capture carbon during agricultural processes, and disrupt the current food supply chain.

Headlines from PwC analysis

Investment level: FALU is the second largest challenge area by level of investment at $8.1 billion, or 13.6% of the funding analysed between 2013 and 2019. A major portion of this can be attributed to growth in alternative foods (such as plant-based burgers and meat alternatives) and precision agriculture.

Growth rate: Investment in FALU has seen strong growth at 75% CAGR, slightly below the overall growth rate of climate tech at 84% (though the overall average is 57% when discounting Mobility and Transport, which heavily distorts this figure). At 41%, CAGR by number of deals is significantly lower than investment CAGR, indicating disproportionate growth in large deals.

Number of deals: The annual number of funding rounds has risen from 21 in 2013 to 162 in 2019. The majority of this growth has taken place in alternative foods and precision agriculture: together they form 64% of deals in 2019.

Other more nascent levers showing early signs of accelerating, include urban farming and value chain GHG reduction; while land use management, energy efficient agricultural equipment, and earth and marine protection are still embryonic, with only one deal each in 2019.

Investors: Temasek, Kleiner Perkins, and Insight Partners are the biggest investors in terms of total dollars, while in terms of the number of deals, SOSV, New Crop Capital, and S2G Ventures lead.

Unicorns: This challenge area records the second highest number of unicorns after Mobility and Transport, (7 from a total of 43). The majority of these are in alternative foods (4), while precision agriculture (2) and value chain GHG reduction (1) form the remainder.

Sector definition:

- Food production methods, commonly using biotech, that often replace carbon intensive animal-based products, such as synthetic proteins or insect proteins
- Low-GHG farming practices which improve efficiencies or reduce carbon from farming, such as precision farming, vertical farming or aeroponics
- Management and modification of natural environments, in particular through reforestation, afforestation, or (avoided) deforestation
- Managing land resources in a way which reduces carbon emissions (e.g. reducing soil CO_2 emissions)
- Any activity associated with reduced GHG emissions in food supply chains (e.g. eliminating spoilage)
- Development of new fertilisers with lower carbon footprints and processes which reduce the level of GHG emitted in production and use of current fertilisers

34 Vermeulen et al., 2012

35 World Population Prospects 2019 (UN, 2019)

Key levers

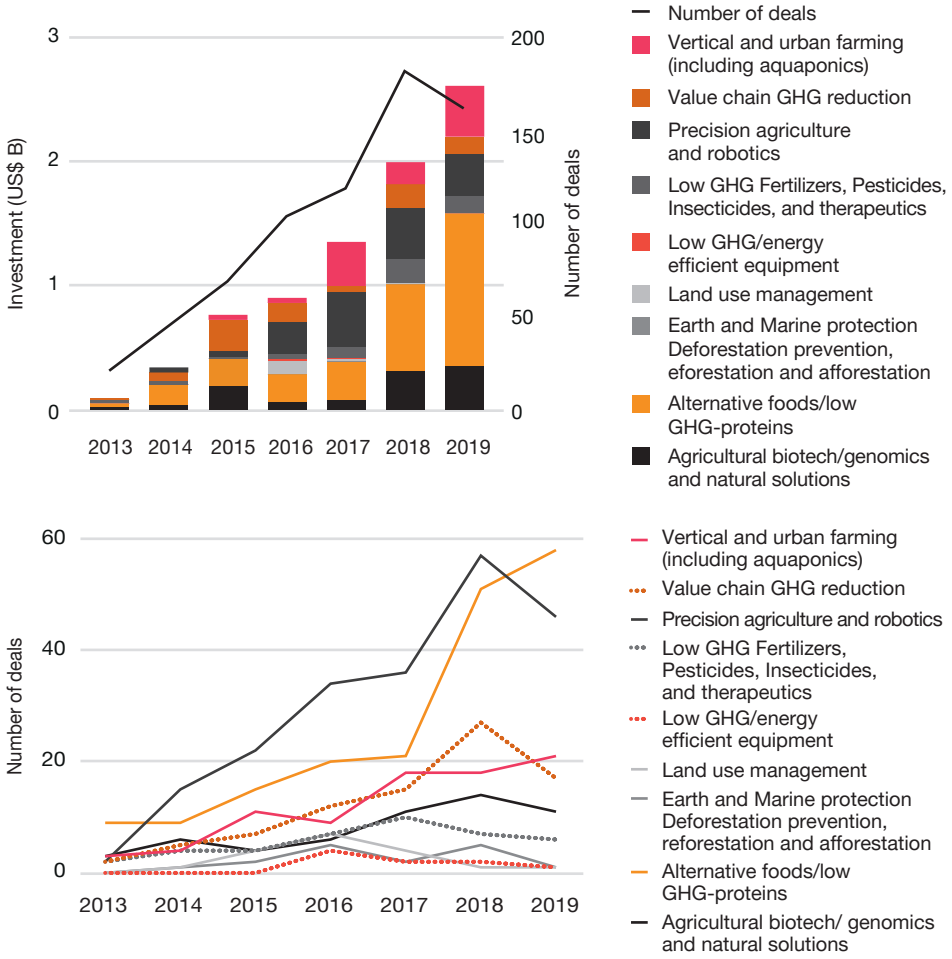
Alternative foods/low-GHG proteins

- **Major investment themes:** This is the most heavily invested challenge area in FALU with over one-third of the overall investment. Deal size is higher than the sector average, reflecting more momentum for startups reaching scale. Alternative foods and low-GHG proteins is typified by food technology companies exploring plant-based and lab-based alternatives to animal-based products. This lever has seen a dramatic increase since 2017 in both the number of deals and the level of investment, reflecting improved investor confidence following the success of recent unicorns (such as Beyond Meat and Impossible Foods).

- **Noteworthy startups:** Impossible Foods is an American startup founded in 2011 that develops plant-based substitutes for meat products. It is the most heavily invested startup in this challenge area during the analysis period and had a valuation of $2 billion in 2019. The company researches animal products at the molecular level, then selects proteins and nutrients from plants to recreate the experience and nutrition of meat products. Their signature product, the Impossible Burger, was launched in July 2016, after years of research and development.

Precision agriculture and robotics

- **Major investment themes:** Precision agriculture and robotics is the second most invested lever in FALU. It is the lever with the highest number of deals, but conversely one of the lowest average deal sizes, illustrating the early stage many of the startups find themselves at. They typically use established technologies, which therefore do not need as much capital investment: e.g. AI, sensors, drones, and robotics to either gather data or distribute resources more efficiently and productively.



Source: PwC analysis on Dealroom data

- **Noteworthy startups:** Indigo Agriculture is an American agricultural technology company founded in 2014 and is the most highly valued agritech startup, with a post money valuation of $3.5 billion after raising $500 million in Series F funding in 2020. Indigo started with a microbe-based seed treatment that improves yields of products such as cotton, wheat, and rice.
They have since evolved into an online grain marketplace, an online transport matchmaking service for that grain, a carbon market to give farmers a financial incentive for sequestering carbon with regenerative agriculture, and a data platform, underscored by its acquisition of the satellite imagery business TellusLabs.

‘VCs are especially interested in Land Use as a sector because of it being relatively outdated, it is prone to tech as a disruptor’

Hampus Jakobsson
General Partner, Pale Blue Dot

Heavy Industry

Challenge area overview and climate challenge

Heavy industry is accountable for around one-fifth of GHG emissions,[36] and has been the fastest growing and most difficult to abate challenge area.

The materials which drive the need for industrial processes underpin our everyday lives: chemicals form our plastics, fertilisers, and synthetic fibres; concrete and metals are the basis of much of our infrastructure. Furthermore, GHG emissions in industry come from both energy used in industrial processes, as well as emissions generated by industrial processes themselves (such as CO_2 emitted during a chemical reaction). Therefore, an absolute reduction in emissions from the industry sector will require deployment of a broad set of mitigation options beyond simply energy efficiency measures. Society will need to explore other innovations such as material use efficiencies, transformative recycling, product efficiencies, and demand reduction.

Headlines from PwC analysis

Investment level: Heavy industry attracted $3.8 billion of venture capital between 2013 and 2019, or 6.4% of overall investment, making it one of the smaller challenge areas. The investment into each lever varied significantly year on year, attributable to the challenge area's relative immaturity: as new technological breakthroughs appear, they are flooded with VC capital. The steadiest investment has funnelled into other low-GHG materials (such as BOLT Threads, which use bio-engineered yeast to produce silk; Modern Meadow, which produces bio-leather; and Allbirds, which produces wool shoes) and energy/resource efficient manufacturing processes – over three-quarters of the total invested in this challenge area went to these levers.

Growth rate: Investment in heavy industry startups has grown consistently, with the challenge area recording a CAGR of 75%, slightly below the overall growth rate of climate tech investment of 84%.

Number of deals: The deal flow has increased modestly from 22 in 2013 to 45 in 2019, reaching a peak in 2017, attributable to an abnormal influx of deals in the efficient manufacturing processes lever that year. Most of the deals have taken place in this same lever, while the lever with the highest growth rate is low GHG plastics and plastic alternatives.

Investors: Top investors by dollars invested include Viking Global Investors, Cascade Investment, and General Atlantic, while in terms of the number of deals, SOSV, Y Combinator, and O'Reilly AlphaTech Ventures lead.

Unicorns: Four unicorns were recorded in this challenge area: three in low GHG: other materials (Ginkgo Bioworks, Allbirds and Zymergen) and one in efficient manufacturing processes (Carbon).

Sector definition:

- Reduction of emissions from the manufacturing of large, heavy articles and materials in bulk
- Includes activities and actions to reduce, reuse, or manage waste in manufacturing
- The creation of low GHG alternatives to traditional inputs (e.g. chemicals, steel, plastics, etc.)

36 Global Greenhouse Gas Emissions Data (WRI, retrieved Aug 2020)

Key levers

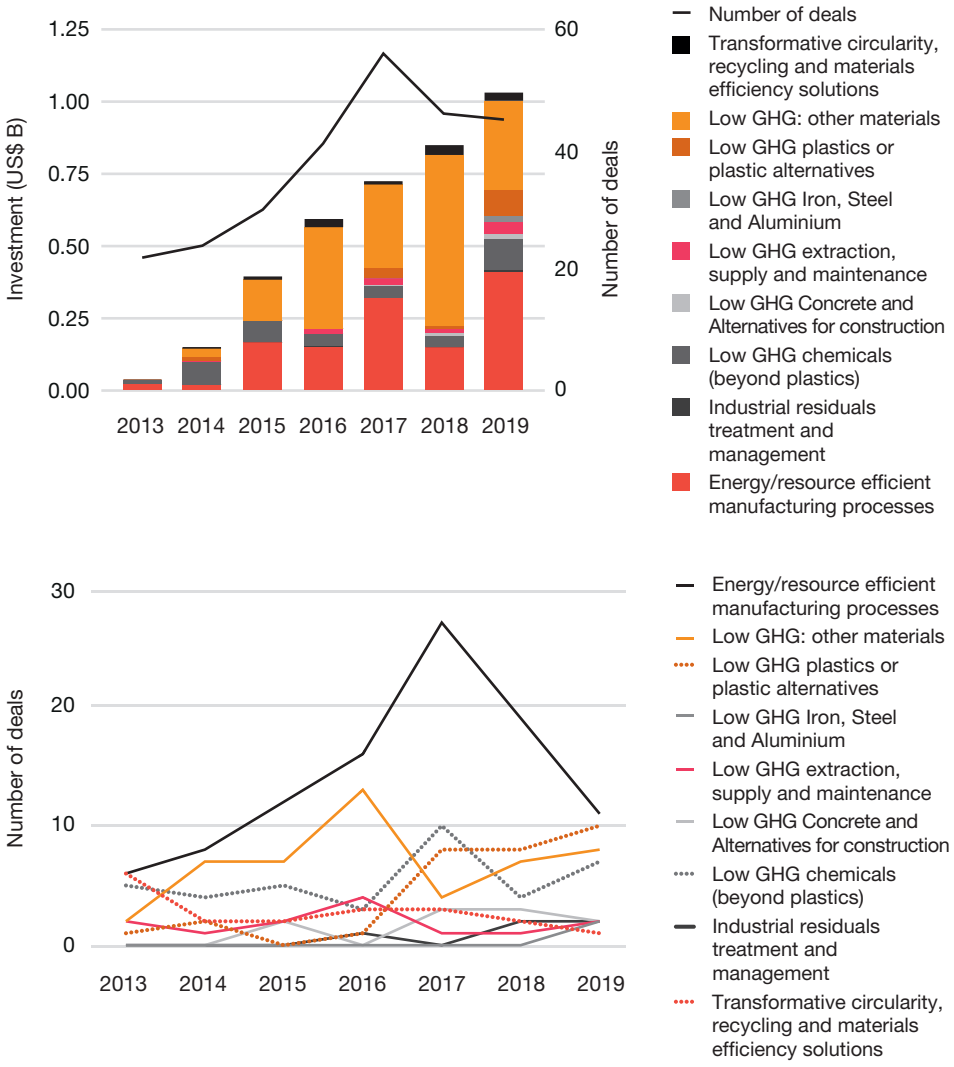
Energy/resource efficient manufacturing processes

- **Major investment themes:** The lever covers nearly a third of all the startups and total investment in heavy industry. This is due in part to this lever containing the least technically and financially challenging startup opportunities, in particular using software and hardware to increase efficiencies in production processes. The types of solutions found in this lever include: use of AI, Internet of Things (IoT), sensors, and drones, to increase efficiencies; 3-D printing of products; industrial robotics to reduce material waste; and automated maintenance using autonomous robots and drones.

- **Noteworthy startups:** Carbon is an American digital manufacturing company founded in 2013. Carbon develops and manufactures 3-D printing hardware, software, and its own printing materials.

Low GHG: Other materials

- **Major investment themes:** The lever includes 18 startups, which are predominantly focused on two applications: bio-based product alternatives for broad industrial purposes; and bio-based and plant alternatives for the fashion industry specifically. The largest startups in the challenge area are biotech companies; while the fashion focused startups, though greater in number, have garnered significantly less investment.



Source: PwC analysis on Dealroom data

- **Noteworthy startups:** Two startups alone form 75% of the investment in this lever: Ginkgo Bioworks and Zymergen. Both are American biotech companies which specialize in using genetic engineering to produce bacteria with broad industrial applications, and are two of the world's largest privately held biotech companies.

Built Environment

Challenge area overview and climate challenge

Buildings and construction are responsible for 39% of global greenhouse gas emissions.[37] Operational emissions (generated from energy used to heat, cool and light buildings) account for nearly two-thirds of this, while the remainder comes from embodied carbon emissions, or the 'upfront' carbon that is associated with materials and construction processes. To eliminate the carbon footprint of the built environment, both buildings and the materials they are made from must therefore be more efficient, smarter, and cheaper than those used today. Small scale efficiencies such as improvements in heating, lighting or appliances will play a role. However, given the breadth of the built environment's impact, more pivotal solutions will also be needed: for example, building-level electricity and thermal storage, innovative construction methods and transformative circularity, or sensor-led smart building management.

Headlines from PwC analysis

Investment level: Built environment is the smallest of the vertical challenge areas, with $3.7 billion of VC invested between 2013 and 2019, or 6.2% of overall investment.

Growth rate: Investment in built environment startups has grown strongly, with the challenge area recording a CAGR of 57%, though this is substantially below the overall growth rate of climate tech investment of 84%.

Number of deals: The number of deals has increased steadily from 13 in 2013 to 65 in 2019. Nearly one-third of these deals have focused on sensortech and smart management of buildings/infrastructure, while a similar number of deals have been aimed at high efficiency appliances/lighting/cooling systems. This is reflective of the relatively low investment cost, relatability for investors to typical tech investments, and consumer demand signalling (see more in key levers section). Other areas have seen fewer deals and are relatively more nascent, including low GHG construction processes (35 total) and transformative circularity and recycling (32 total).

Investors: Khosla Ventures, Obvious Ventures, and DFJ Growth are the biggest investors in the challenge area by total invested, while in terms of number of deals Amazon Alexa Fund, Demeter, New Enterprise Associates, and Prelude Ventures lead.

Unicorns: There is only one startup with a $1 billion plus valuation in this challenge area for the time period analysed: Katerra, an American technology-driven offsite construction company.

Other notes: We see 'bumpy' investment in high efficiency space water heating/cooling (in 2016), high efficiency urban spaces and communities (in 2017), and low GHG construction processes (in 2018), reflecting the relatively nascent level of investment in all of these levers. As startups in these sectors develop, we would expect to see more evenly distributed investments rather than funding allocated to a small handful of startups.

Sector definition:

- High efficiency fittings, fixtures, lighting, and heating and cooling for commercial and residential buildings, including district-level solutions
- Smart management of building energy consumption using sensors, smart devices, AI analysis of the ensuing data, and app control for consumers
- Efficient construction methods, with an emphasis on ease to construct and reduced waste on site (in particular modular construction, 3-D printing, imagery/computing)

37 New report: the building and construction sector can reach net zero carbon emissions by 2050 (World Green Building Council, 23rd Sep 2019)

Key levers

Low GHG Construction Processes

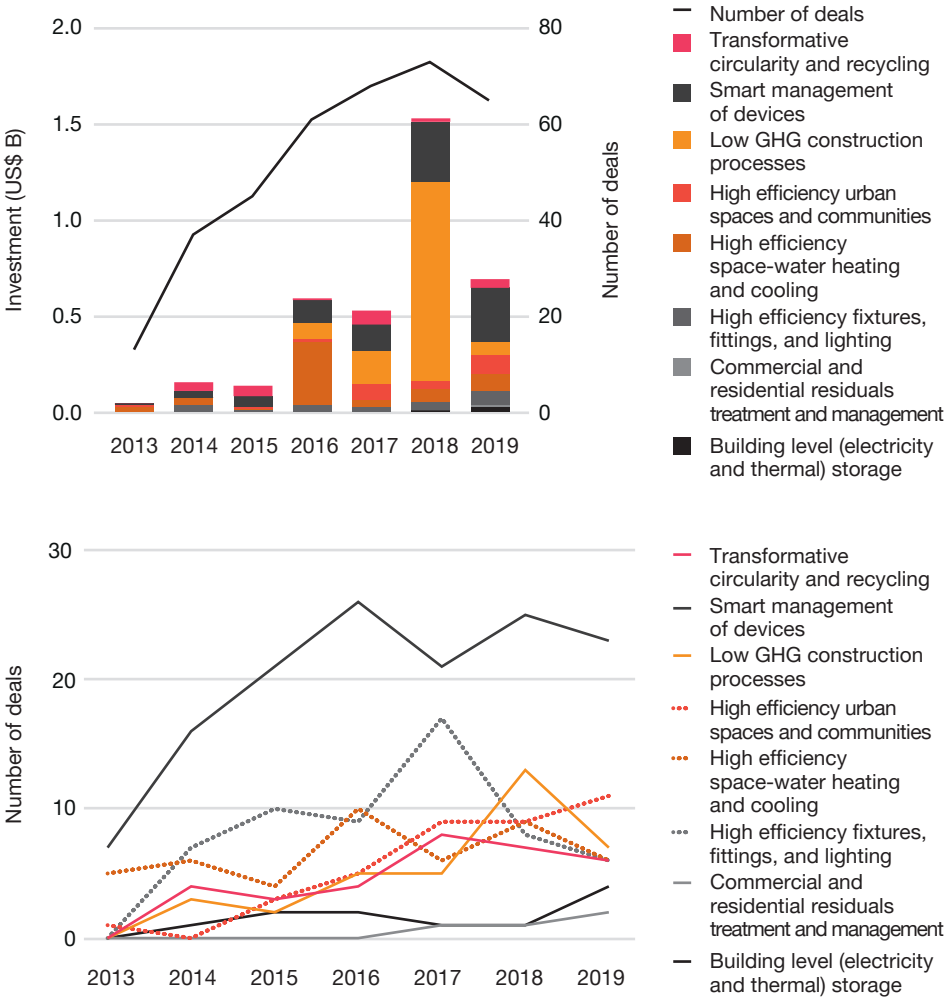
- **Major investment themes:** This lever accounts for 37% of funding, though 90% of this is attributable to just one startup, Katerra. Only 13 startups fall under this lever, all of which address waste reduction during construction or controlled construction environments: typically off-site construction, modular construction, 3-D printing, or 3-D imagery enabled construction planning.

- **Noteworthy startups:** Katerra raised the most funding in this lever in our data set, at $1.2 billion since 2016. Other startups include NODE and Biokable. This lever has seen some challenges also, with some startups reducing the size of their workforce in recent years.

Smart management of devices

- **Major investment themes:** Twenty-six (26%) of investments for the challenge area and 139 deals fall into this lever. Startups are focused on cost saving measures relating to energy consumption for residential/commercial consumers, and address this typically via data gathering sensors, analysis of energy consumption, and remote control of energy devices.

- **Noteworthy startups:** Ecobee is a Canadian home automation company that makes smart thermostats, temperature and occupancy sensors, smart light switches, smart cameras, and contact sensors. The thermostats are controlled by using the built-in touchscreen, web portal, or app. Their products and services are typical of much of the startups in this lever.



Source: PwC analysis on Dealroom data

Notes:

Smart management of devices is a significant proportion of the challenge area's deals (approx. one-third), with several possible explanations. Firstly, founders could be vectoring into areas they understand and are able to tackle. Of the levers, this is the most clearly tangible to founders with technology backgrounds. Secondly, the investments in this lever are also more reflective of the type of deals which tech investors are affiliated – smart sensors, consumer apps to manage devices remotely, and artificial intelligence of underlying data, are all much more comparable to a typical tech company than a 3-D device printing homes, as an example (i.e. lower capital investment and quicker potential return on investment). Finally, consumer demand for cheap and cheerful home energy improvements could also be leading to larger growth in this area.

GHG Capture and Storage

Challenge area overview and climate challenge

Though some major economies are transitioning their energy systems from coal to cleaner fuels, fossil fuels will likely remain a primary contributor to energy production for some time. The availability and dependence on these fuels to provide affordable energy means significant mitigating measures must be taken if society is to reach net zero. Capturing, storing and reusing greenhouses could play an important role in stabilising and reducing greenhouse gas emissions while our energy and industrial systems transition. Carbon sequestration technologies must be developed rapidly and deployed at scale if the world is to continue using fossil fuels as a key energy source.

Headlines from PwC analysis

Investment level: GHG capture and storage is one of two horizontal challenge areas (i.e. those which are sector agnostic), and is both the smallest of the horizontals and smallest absolute challenge area by level of investment: overall it has raised less than 1% of the total venture capital identified, at just $506 million. Of the three levers featured in this challenge area, over 80% of the investment has been raised by carbon, capture, utilisation, and storage (CCUS) startups.

Growth rate: This is a particularly nascent challenge area and accordingly the investments in this space record a CAGR of 102% between 2013 and 2019.

Number of deals: Low deal flow highlights the immaturity of this challenge area, with only 2 deals recorded in 2013. This has risen moderately, but still to a small absolute figure, of 15 deals in 2019, in comparison with nearly 600 deals across all challenge areas for the same year.

Investors: Novo Holdings and Zurich Cantonal Bank are the biggest investors in the challenge area by total venture capital invested, while in terms of number of deals, Chevron Technology Ventures and Husky Energy lead, both with less than five deals: illustrating that this sector is yet to attract a large number of active investors.

Unicorns: This the only challenge area with no unicorns raising VC investment during the analysis period. However, as of June 2020, LanzaTech reached a valuation of over $1 billion.

Sector definition:

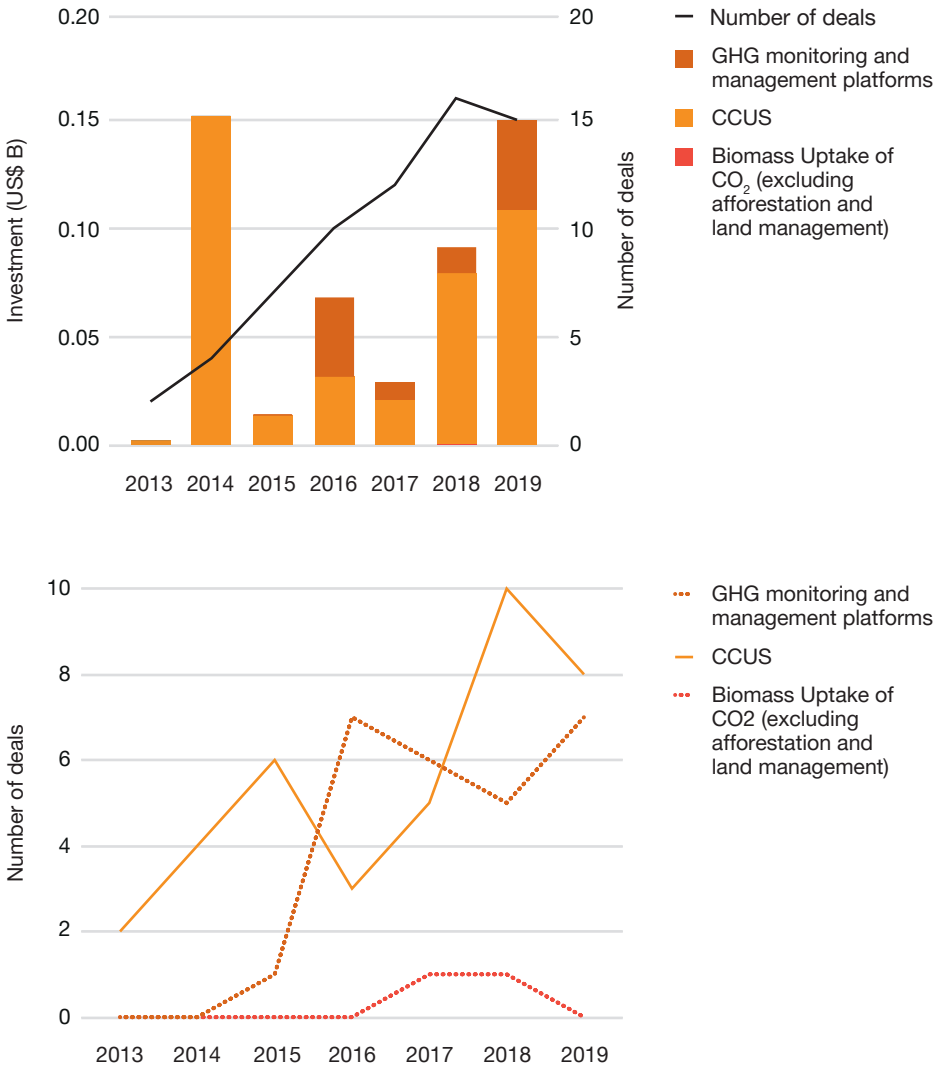
- The removal of greenhouse gases from the atmosphere and their storage for long periods, primarily from energy and industrial processes but also including natural climate solutions developed specifically to sequester greenhouse gases
- Systems for monitoring and managing the carbon footprint of organisations or governments

Key levers

Carbon capture, utilisation, and storage (CCUS)

- **Major investment themes:** This is by far the most mature lever within GHG capture and storage, having raised over 80% of the overall investment for the challenge area. It is however by no means mature itself, comprising 18 startups which have raised $406 million collectively. The startups fall into two key categories: carbon capture technologies deployed at emissions source used for various industry purposes; and production of useful by-products to sell on for further industrial purposes (e.g. thermoplastics). Investment in this challenge area is showing some signs of growth, most likely driven by the regulatory environment around carbon for industry.

- **Noteworthy startups:** LanzaTech is an American carbon capture startup founded in 2005. They are developing a technology that can turn waste carbon streams into ethanol, which can be used for fuel or chemical processes. They are also attempting to branch into processes which produce useful products other than ethanol. Similar to many of the types of startups we would expect to see in this entire challenge area, solutions made by LanzaTech could be heavily utilised by those working other challenge areas, primarily Mobility and Transport, Energy, or Heavy Industry.



Source: PwC analysis on Dealroom data

Notes:

The economics of carbon capture and storage are challenging, and require the right enabling environment to tackle. Startups in our analysis highlight the level of capital investment and time horizons which some will take to make meaningful carbon emissions reductions, while also indicating some of the limitations in this sector around funding, as technologies often take longer to develop and return investment than typical venture capitalists are willing to bear.

Climate and Earth Data Generation

Challenge area overview and climate challenge

Environmental policymaking, one of the largest drivers for the business case around climate tech, depends on timely, accurate information about the state of our planet and predictions about its future. Deregulation of the space industry in the US – typified by the rise of SpaceX and Planet – has led to the development of this challenge area, as open source satellite units have driven down the cost of nano-satellites and therefore data generation. Climate and earth observation is beginning to provide a wealth of data relating to the land, oceans and atmosphere: data which is crucial to enhancing protecting the environment and achieving broader sustainable development aims. The resulting information offers greater detail than we have ever had access to before, which will be pivotal in both supporting the environmental regulation which climate tech needs to prosper while also creating unique business opportunities for climate tech startups.

Headlines from PwC analysis

Investment level: Climate and Earth data generation is one of two horizontal challenge areas (i.e. those which are sector agnostic). It is the larger of the two horizontal challenge areas, with $1.1 billion of venture capital deployed between 2013 and 2019, though still smaller than any of the vertical challenge areas, at approximately 2% of the total funding analysed.

Growth rate: Investment in this space has recorded a CAGR of 18% between 2013 and 2019. This is likely under-reporting growth in the challenge area though, as this figure is skewed by Planet's 2013 funding round, the largest of any individual startup in 2013. Nearly all of the growth for the challenge areas is recorded in startups explicitly focused on climate/earth data generation: less than 0.5% of the challenge area's funding was raised by startups within our low-GHG satellites and sensors lever.

Number of deals: Low deal flow reflects the relative immaturity of this challenge area, with only 8 deals recorded in 2013. This has risen moderately, but still to a small absolute figure, of 23 deals in 2019, in comparison with nearly 600 deals across all challenge areas for the same year. Nearly all of these deals were related to climate/earth data generation, while only 8 deals were recorded in total for low-GHG satellites, all taking place from 2017 onwards.

Investors: Pitanga Fund and Lux Capital are the biggest investors in this challenge area by total venture capital invested, while in terms of number of deals, Dylan Taylor and GV lead. This is the only challenge area where an angel investor features in the top 5 investors by number of deals or investment value.

Unicorns: There is only one startup with a $1 billion plus valuation in this challenge area for the time period analysed: Planet Labs, an American aerospace and analytics company.

Sector definition:

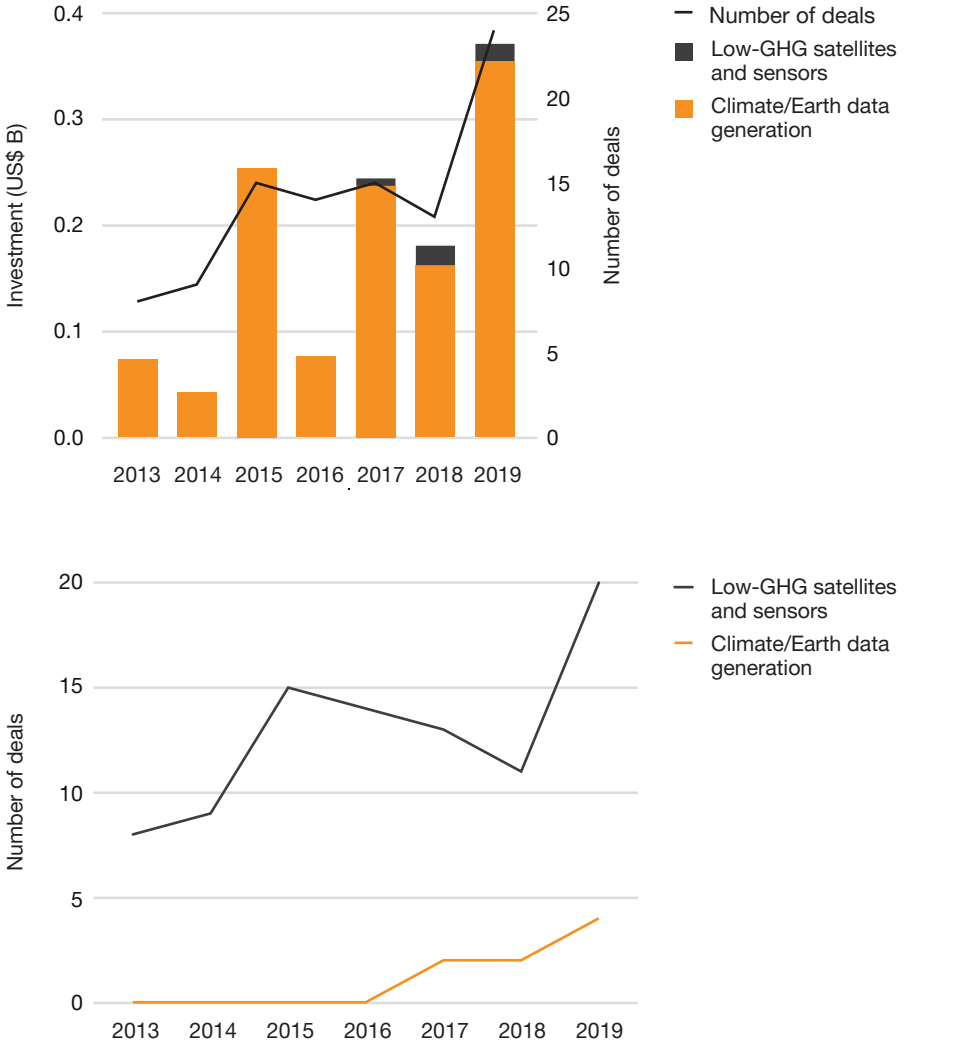
- Recording or analysis of earth and climate related data which will be useful specifically for reducing emissions or by climate tech companies. Typically collected via satellites, sensors or weather machines and analysed using machine learning algorithms
- Development of technologies which reduce emissions associated with satellites, such as mini-satellites, electrified launch equipment, improved energy efficiency of satellites, or biodegradable satellites

Key levers

Climate/Earth data generation

- **Major investment themes:** This lever constitutes over 99.5% of the funding in this challenge area: a testament both to cost reductions seen in space ventures, and the ability for low cost hardware/ software (sensors, machine learning algorithms) to disrupt this area and provide insightful data for companies and governments. Startups which gather and or process climate and earth data for broad applications are typical of this lever. Beyond the startups captured in this challenge area, there are even more startups performing similar functions but focusing their efforts on one industry (typically agriculture). Those startups are categorised under the specific challenge areas they address. However, it is fair to assume that these startups may attempt to reach into other markets in the future, given the breadth of data they are collecting, and so the investments recorded in this lever can be viewed as a conservative estimate.

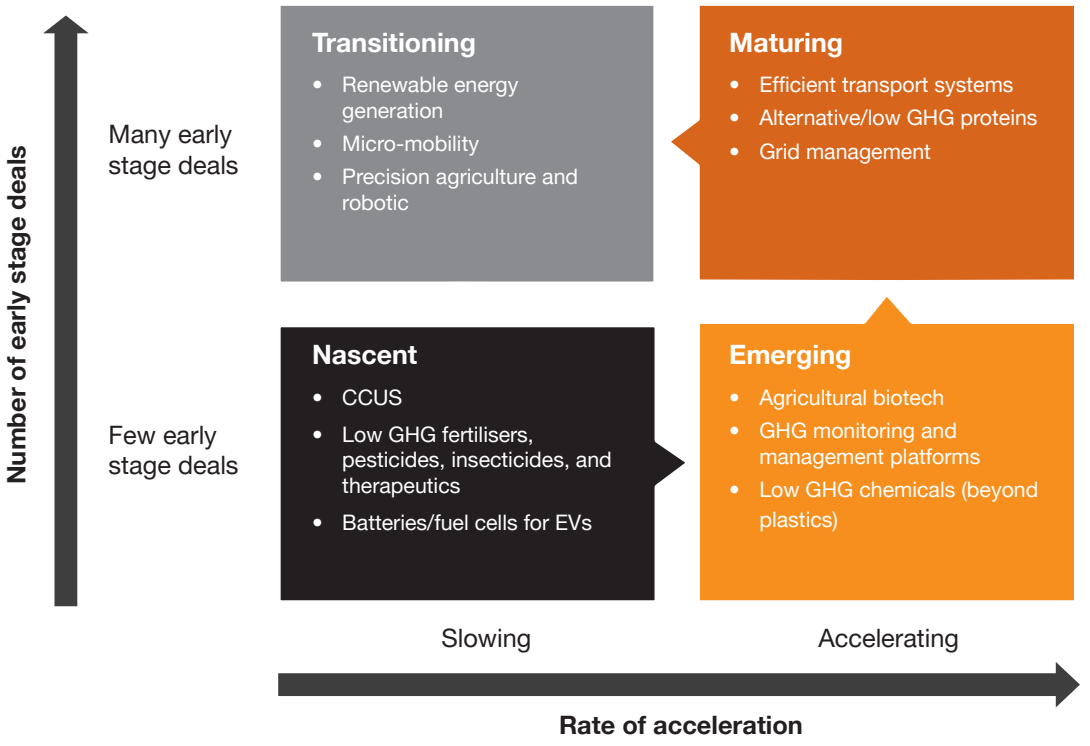
- **Noteworthy startups:** Planet Labs, founded in 2010, has a post-money valuation of $2.2 billion from their latest investment round in 2019. They build small satellites which are delivered into orbit as secondary payloads on other rocket launch missions. Their satellites provide frequently updated information and insights relevant to climate monitoring, crop yield prediction, urban planning, and disaster response.



Source: PwC analysis on Dealroom data

Maturity

A more granular analysis on a lever by lever basis helps us understand where each lever is in its maturity curve. By plotting the **acceleration** of a lever (a measure of whether the growth rate in venture capital invested is increasing or decreasing) against the **number of early stage deals**, we're able to categorise our levers into four distinct phases of their lifecycle:



Example levers within each of the four phases of the lever lifecycle
Source: PwC analysis

Nascent levers demonstrate limited new venture activity, and slowing (or in some cases, shrinking) venture capital investment. These levers are often associated with excess R&D risk or lack of an enabling environment – with CCUS an archetypal example. Some of these may move onto the next stage of maturity in the coming years, though it is hard to predict which and when.

Emerging levers are the next stage in the lifecycle of a lever. These show a speeding up in the growth of VC capital deployed, though still few early stage deals – suggesting areas where VCs are just starting to see the first signs of success from some of their big bets.

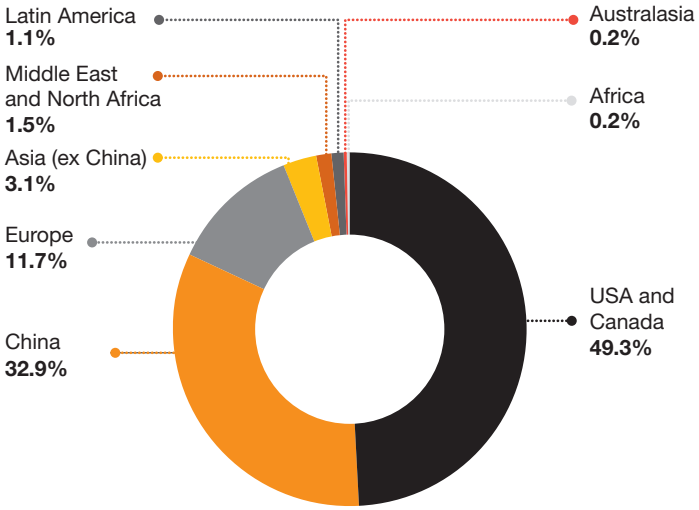
Maturing levers show high acceleration and growing early stage activity. Take, for example, **alternative proteins**, where there has been a raft of recent Seed and Series A activity, buoyed by the success of unicorns such as Beyond Meat demonstrating the commercial viability of the lever.

Transitioning levers are those which are beginning the phase out of the VC ecosystem. Though there are still many new startups exploring innovative ideas, the business models have overall proven mature enough for traditional sources of financing to take over. For example, **renewable energy** businesses are increasingly being funded by debt or project finance, rather than VC.

Regional investment distribution

Overall breakdown of investment by startup region

The geographical split shows that nearly half of all venture dollars in climate tech startups, $29 billion, went to startups in the USA and Canada. China is the second most significant region at $20 billion. The European market is approximately a third of China's at $7 billion invested.



Source: PwC analysis on Dealroom data

Top 10 climate tech investment hubs

China and the USA and Canada dominate investment in Mobility and Transport, the most heavily invested challenge area, and so it's no surprise they feature heavily in our list of top 10 investment hubs. India and Germany are the only countries to feature cities in the top 10 outside of the US and China.

Startup HQ	Funding raised
San Francisco Bay Area, United States	$11.7B
Shanghai, China	$7.5B
Beijing, China	$6.6B
Los Angeles, United States	$3.5B
Boston, United States	$2.1B
Guangzhou, China	$1.7B
Nanjing, China	$1.2B
Hangzhou, China	$1.0B
Berlin, Germany	$930M
Bengaluru, India	$870M

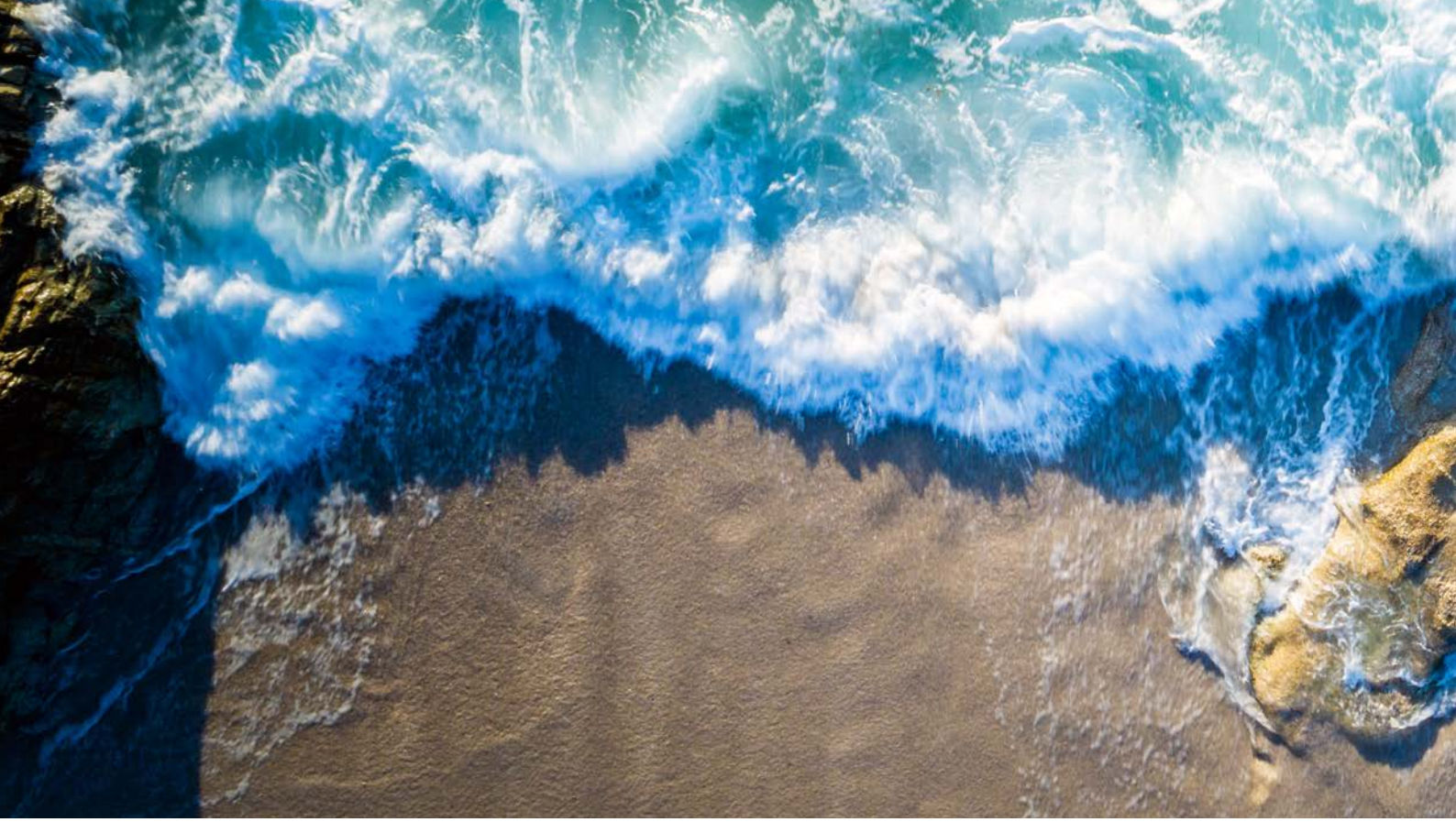
Top 10 climate tech investment hubs (excluding Mobility and Transport)

Given the dominance of the electric vehicle and micro-mobility levers in our data set – which are no doubt important, but perhaps not reflective of overall trends – it is useful to examine funding outside the Mobility and Transport challenge area.

Here we see notably different results for top climate tech investment hubs. No Chinese cities feature, and the US dominates. However, three of the top 10 cities only have one startup in their jurisdiction, indicating the nascency of investment outside of established hubs.

The disproportionate investment in the San Francisco Bay area suggests that investor hubs can create a positive feedback loop of investment as startups and investors congregate, even for new areas such as climate tech.

Startup HQ	Funding raised
San Francisco Bay Area, United States	$6.9B
Boston, United States	$2.1B
Berlin, Germany	$650M
New York, United States	$650M
Sioux Falls, United States	$370M
London, United Kingdom	$350M
Labège, France	$300M
Boulder, United States	$300M
Chicago, United States	$240M
Pittsburgh, United States	$220M



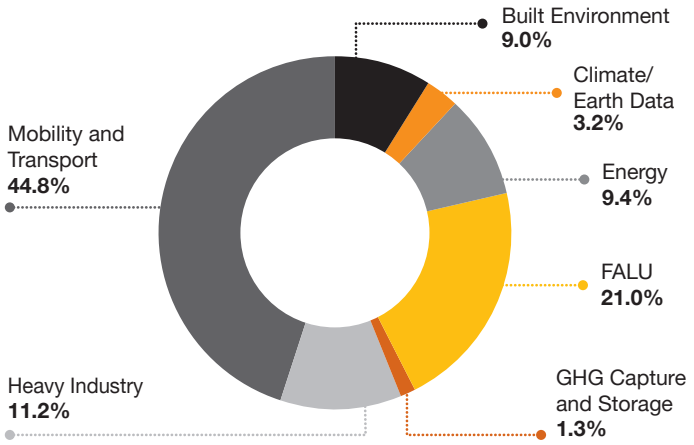
A closer look at the top three regions

USA and Canada

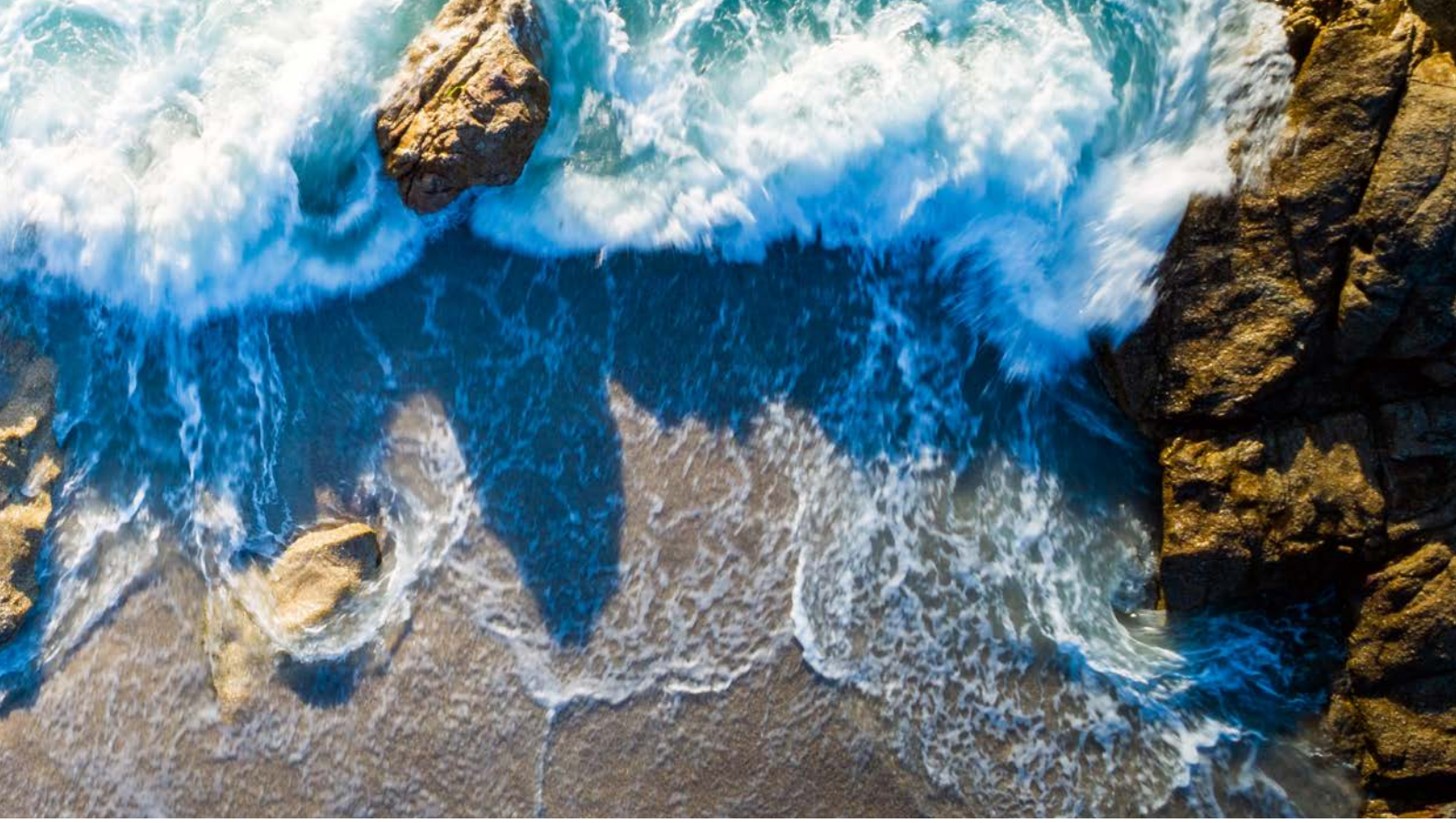
The US has the most mature venture capital market in the world, and this is reflected in North America leading in climate tech venture capital investment. Investment is concentrated in two challenge areas, representing two-thirds of investment dollars – Mobility & Transport and FALU – though this is somewhat reflective of overall trends in climate tech.

Where this region varies from the norm is in its higher than average investments in four challenge areas: FALU, Heavy Industry, Climate/Earth Data Generation and GHG Capture and Storage. Coupled with disproportionately high investment R&D-heavy levers such as nuclear fusion and CCUS, this points to a greater appetite for risk in US founders and investors, and greater interest in challenge areas that are still at relatively nascent stages of development.

We see some of the fruits of this risk taking in the region's success stories. Looking at even relatively 'mature' challenge areas such as FALU, the North American startups that have raised the most funding in our database have tackled arguably more novel lab-based challenges than their European counterparts (e.g. Impossible Foods and Indigo in North America, vs. HelloFresh in Europe), and have been rewarded for it with unicorn status. Similarly, the highest funded Heavy Industry startup in Europe (Avantium Technologies) raised just a tenth of the highest funded US startup (Ginkgo Bioworks) – with another 9 US startups exceeding funding raised by Avantium.



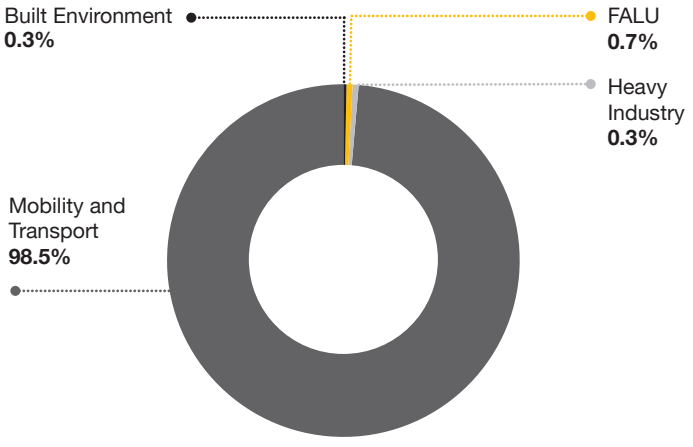
Source: PwC analysis on Dealroom data



China[38]

Chinese investment is highly skewed towards one challenge area, with Mobility and Transport encompassing 98.5% of climate tech related venture investment. This is reflected in China tending to dominate the Mobility and Transport challenge area, providing 53% of overall investment in the area.

One reason for the significant imbalance here is the Chinese automotive sector is relatively young, so much of the investment is made in entrepreneurial firms. By contrast, much investment in electric vehicles and the supporting battery technologies in Europe and the US is dominated by incumbent auto manufacturers, the majority of whose investment does not feature in this venture capital-focused analysis.



Source: PwC analysis on Dealroom data

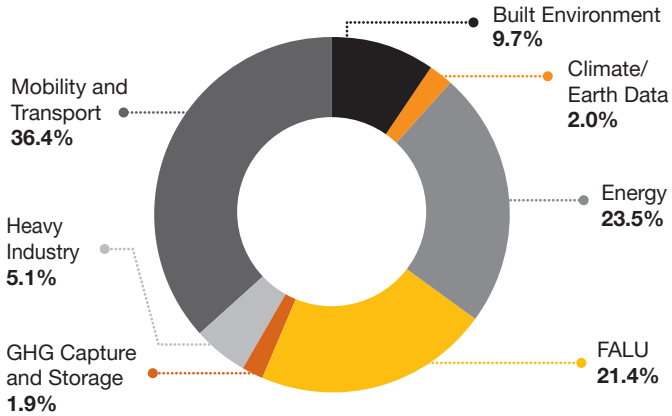
38 Our data coverage is stronger in European and North American markets, and this analysis may therefore underestimate the relative levels of Chinese investment

Europe

As with the other two regions, Mobility and Transport again dominates European investment, though most of this investment is being directed towards new sharing business models in micro-mobility (predominantly e-scooters and e-bikes) and efficient transport systems (such as ride sharing apps).

Compared to the other regions however, Europe is disproportionately invested in Energy. Most investment is taking place in developing the core technologies for renewable energy generation (predominantly PV cells) and the energy storage (batteries) to support their proliferation.

FALU is the third most heavily funded challenge area in Europe, owing to heavy investments in alternative foods/low GHG-proteins. Nearly 75% of funding in this lever is targeted at insect proteins for animal rearing and aquaculture, in stark contrast with American investments which predominantly target synthetic proteins for human consumption.

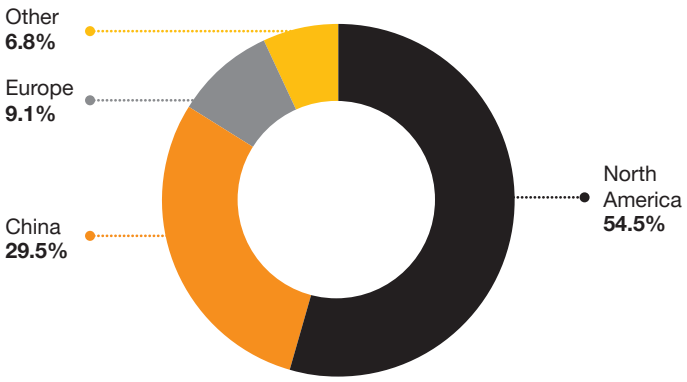


Source: PwC analysis on Dealroom data

Climate tech unicorns

Firms like Tesla, Nikola, Beyond Meat and Nest have demonstrated it is possible for climate tech startups to reach unicorn level (that is, valuations at or exceeding $1 billion). Our research estimates that there are currently 43 privately held, venture-backed climate tech startups with valuations in excess of $1 billion. These unicorns are concentrated in the Mobility and Transport challenge area and, unsurprisingly, represent firms founded relatively earlier in our research period – though this suggests room for a stream of additional climate tech unicorns in the coming years.

The US has the most unicorns and the most diverse set of unicorns, with billion-dollar firms in Mobility and Transport, FALU, Heavy Industry, Built Environment and Climate and Earth Data Generation.



Source: PwC analysis on Dealroom data

Gender diversity in founders

It is well understood that the tech startup ecosystem faces diversity challenges across several different axes. Our analysis backs this up, at least for gender.[39] Of the approximately 28,000 climate tech startup founders whose gender was identified in our dataset, just 10% identified as female (slightly lower than comparable non-climate tech startups, which came in at 11%). In terms of challenge areas, FALU was a leader in proportion of female founders at 15%, whilst Built Environment and Energy both lagged at 7% each.

What about startups with multiple founders? We found that 16% of climate tech startups had at least one female founder, suggesting a small number of mixed gender teams. Just 15% of venture funding went towards startups with at least one female founder. For comparison, 19% of comparable non-climate tech startups had at least one female founder, and this group received 20% of funding.

Clearly there is still much work to be done to address even just gender diversity. Beyond the social equality argument, it's also critical to have a diversity of thinkers and founders working on net zero, to maximise the chances of success. In addition, there's an economic argument to be made, with an estimated $8tn boost to GDP up for grabs for Organisation for Economic Co-operation and Development (OECD) countries if we can close the gender gap on employment and pay.[40] Some venture capitalists are starting to take notice, with an increasing number of firms with a mandate to invest in female founders.[41]

15%

of climate tech VC funding went to startups with **at least one female founder**

39 Not all of our gender data is self-reported. Though self-identification of gender would be preferred, our results broadly match with comparable recent survey-based studies. We acknowledge however that this analysis does not give a complete picture of the involvement of gender minorities in climate tech, and we encourage further research in this area

40 Women in Work Index 2020 (PwC, 2020). See more on Women in Technology on our website

41 14 Venture Firms That Are Helping to Close the Massive Gender Funding Gap (Inc., Oct 2018

Key findings: Investors

Key findings: Investors

Clean tech to climate tech: what has changed?

The clean tech boom and bust, discussed in greater detail in our introduction, saw VC investors learn critical lessons after losing around half of their investment.[42] Clean tech investment was dominated by energy startups, and investors did not have sufficient experience in navigating the capital intensity or regulatory complexity of that ecosystem.

Much has changed with the growth of climate tech. Firstly, investors are coming into this with the hard-earned lessons of their clean tech days, and are better equipped to handle those complexities where they emerge. Secondly, the very concept of climate tech is deliberately much broader than clean tech, choosing to focus on decarbonisation across all sectors of the economy, not solely the energy sector. This diversification is in response to demand signals from the market, who have clearly indicated the need for net zero transformation across all sectors of the economy.

Thirdly, and most importantly, is the change in the enabling environment. Between the above mentioned corporate and consumer demand; the increasing ubiquity of advanced tech; and an increasingly supportive regulatory environment, climate tech is happening at a very different 'moment in time' than the clean tech movement.

Who are the climate tech investors?

We identified around 2,700 unique investors from venture capitalists, corporate VC, angel investors, philanthropists, and government funds, who collectively have participated in funding over 1,200 climate tech startups between 2013 and 2019.

Our analysis suggests the climate tech investor ecosystem is still nascent. The top 10 investors averaged about 28 climate tech deals each in the time period, or about 4 per year. However, the vast majority of investors (over 75%) have made only one or two investments in climate tech. This suggests that only a handful of investors have established the deeper familiarity that comes with frequent investing activity, with most investors just dipping their toes in climate tech so far.

Top investors by amount of venture capital deployed

Investor	Investor type
Sequoia Capital	VC
Tencent	Corporate VC
Temasek	Government
Kleiner Perkins	VC
Founders Fund	VC
GV	Corporate VC
Khosla Ventures	VC
Horizons Ventures	VC
Tao Capital Partners	VC
Y Combinator	Accelerator
Total Energy Ventures	Corporate VC
Engie	Corporate VC
GE Ventures	Corporate VC
Prelude Ventures	VC
Bpifrance	Government
S2G Ventures	VC
Demeter	VC
SOSV	Accelerator
InnoEnergy	Government
New Crop Capital	VC
500 Startups	VC
Techstars	Accelerator

Top investors by number of deals

Investor	Investor type
Y Combinator	Accelerator
SOSV	Accelerator
Sequoia Capital	VC
Bpifrance	Government
GV	Corporate VC
Khosla Ventures	VC
Demeter	VC
Kleiner Perkins	VC
Techstars	Accelerator
Temasek	Government
Total Energy Ventures	Corporate VC
Engie	Corporate VC
500 Startups	VC
Founders Fund	VC
GE Ventures	Corporate VC
Horizons Ventures	VC
Prelude Ventures	VC
Tao Capital Partners	VC
S2G Ventures	VC
InnoEnergy	Government
New Crop Capital	VC
Tencent	Corporate VC

42 3 hard-won lessons from a decade of negative cleantech returns (World Economic Forum, Mar 2020)

Investors by type

Venture capital firms

The most active VCs in the climate tech space, both in number of deals as well as amount invested, include:

500 Startups	Matrix Partners
Accel	New Crop Capital
Breakthrough Energy Ventures	New Enterprise Associates
Data Collective	Obvious Ventures
Demeter	Partech
Founders Fund	Prelude Ventures
GGV Capital	S2G Ventures
Horizons Ventures	Sequoia Capital
Khosla Ventures	Tao Capital Partners
Kleiner Perkins	UpHonest Capital

In our discussions with investors, we heard how the mix of Limited Partners (LPs) has changed over time, transitioning to become more aligned with mainstream VC investing.

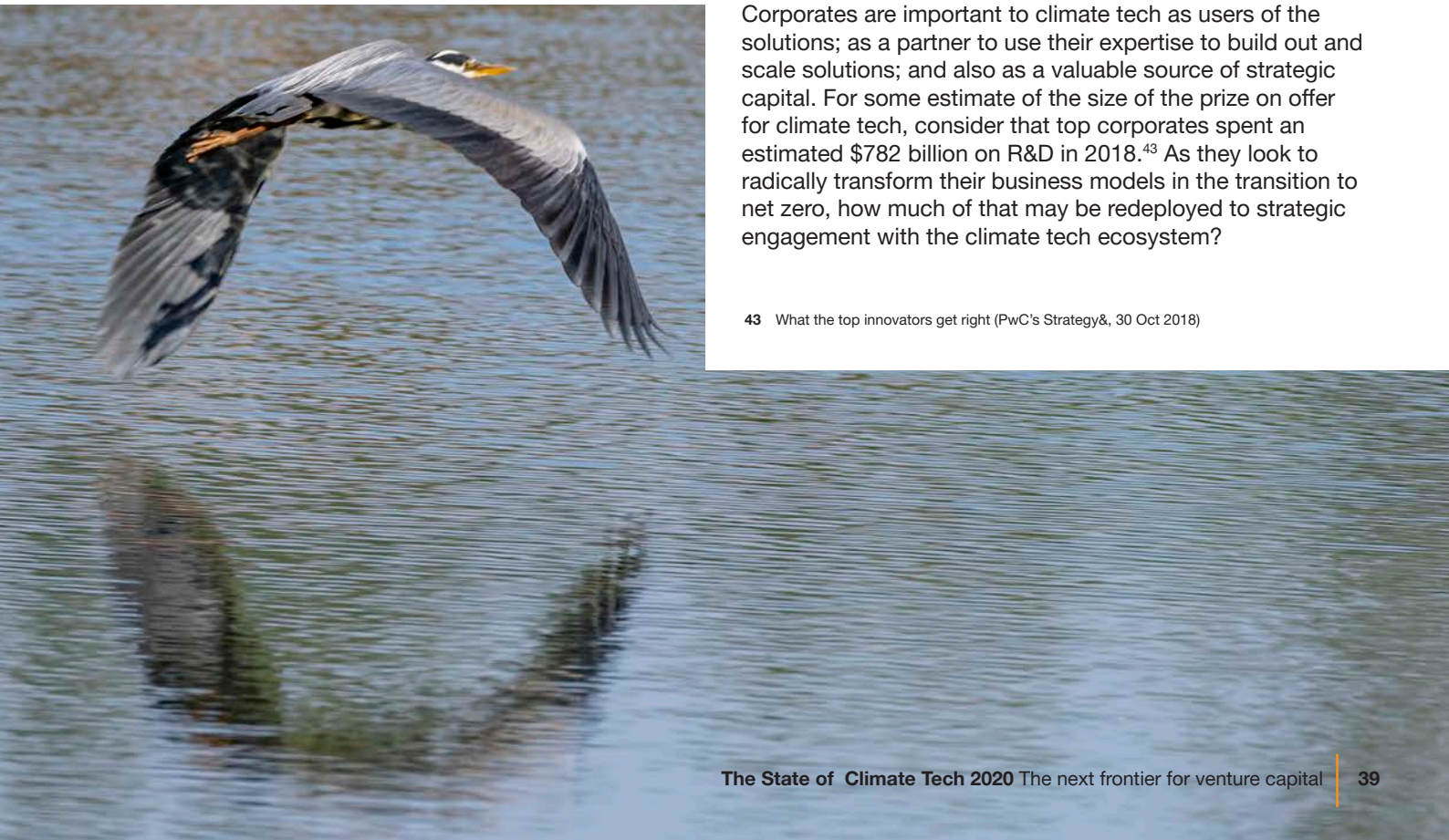
Corporate venture capital (CVC

The involvement of corporates will be key to the continued success of climate tech. CVCs are seeing the importance of strategic investing and partnerships with key industry players, particularly in Mobility & Transport, where 30% of deals include a CVC firm, and Energy, where 32% of capital deployed came from CVCs. Overall, nearly a quarter of climate tech deals (24%) included a corporate investor (approximately 670). The most common CVCs include:

Acre Venture Partners	GE Ventures
Airbus Ventures	GV
BMW i Ventures	InMotion ventures
BP Ventures	Intel Capital
Chevron Technology Ventures	Next47
Constellation Technology Ventures	Qualcomm
Daimler	Shell
e.on	Tencent
Engie	Total Energy Ventures
Foxconn Technology Group	Verizon Ventures

Corporates are important to climate tech as users of the solutions; as a partner to use their expertise to build out and scale solutions; and also as a valuable source of strategic capital. For some estimate of the size of the prize on offer for climate tech, consider that top corporates spent an estimated $782 billion on R&D in 2018.[43] As they look to radically transform their business models in the transition to net zero, how much of that may be redeployed to strategic engagement with the climate tech ecosystem?

43 What the top innovators get right (PwC's Strategy&, 30 Oct 2018)



Accelerators and incubators

Alongside providing early funding, perhaps the most important role of accelerators and incubators is working closely with founders to de-risk the business and technical aspects of their startups, and in the process get them ready for Series A and B funding.

Our analysis finds investors in this class with potentially varying motivations for investing in climate tech. Some funds, such as SOSV, structure their programs around climate tech related challenge areas. In our list of top investors in this class (by number of deals), however, we find accelerators such as Y Combinator and Techstars, alongside SOSV, who bring a broader focus on a variety of tech themes.

Breed Reply	SOSV
EIT Digital	Techstars
Indie Bio	The Yield Lab
Oxford Sciences Innovation	Venture Kick
Plug and Play	Y Combinator

PE/growth stage investment managers

Investors in this class historically invest in companies later in their life cycle than VC firms, but we've found that they are beginning to enter earlier deals. There is a growing focus on climate tech in both impact funds as well as mainstream investing. Top investors by estimated investment include:

China Fortune Ocean	Primavera Capital Group
Greenoaks Capital Management	Silver Lake Partners
Hillhouse Capital	Summit Partners
HPS Investment Partners	TPG Capital
LL Funds	Warburg Pincus

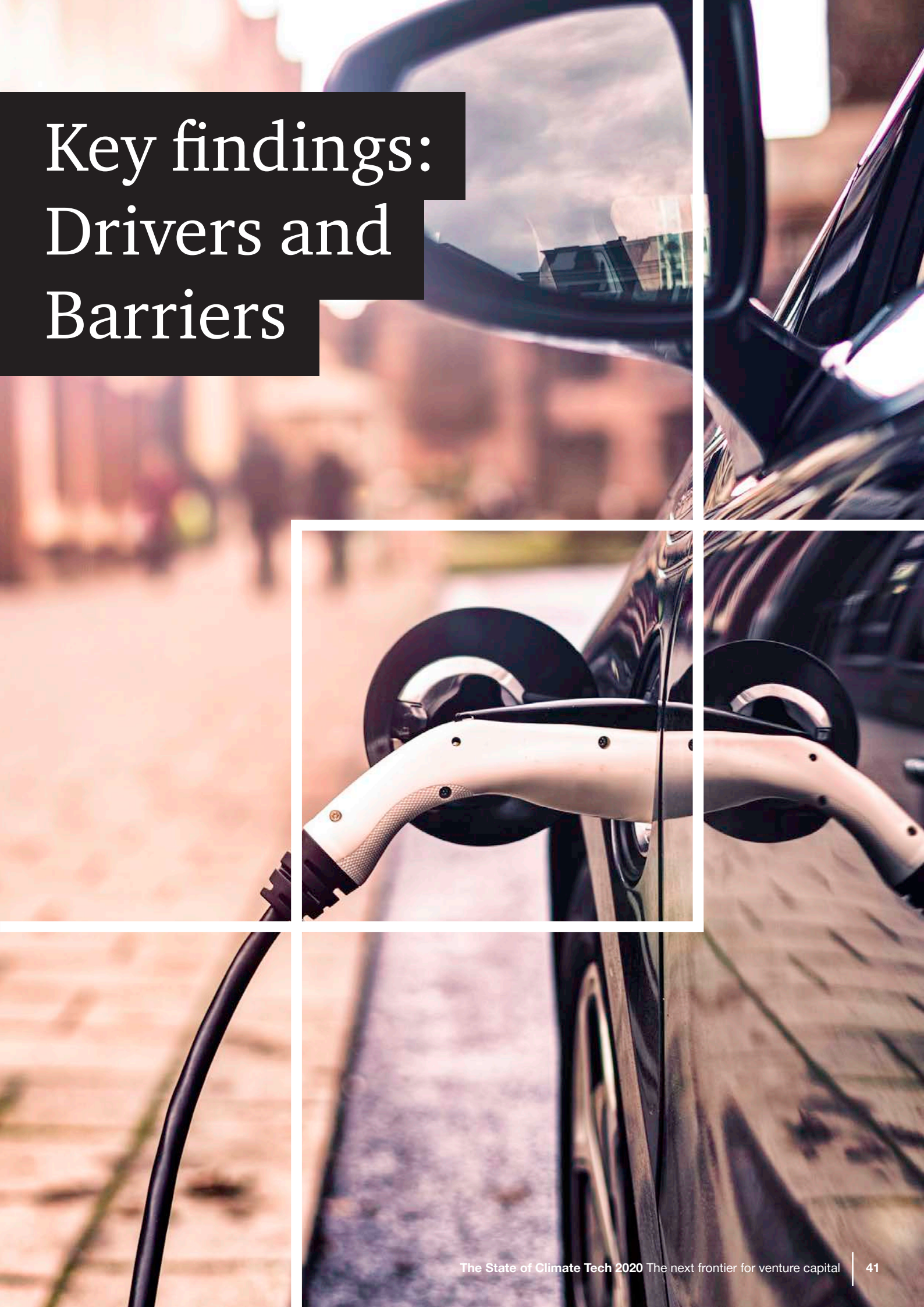
Government and Universities

We've only looked at venture capital as part of this analysis, but of course government funding and grants each have big parts to play in helping jumpstart the climate tech response in R&D-heavy challenge areas. Indeed, we would see this were we to expand the scope of our analysis – for example, the European Innovation Council has provided over 200 grants to climate tech startups, while government-owned Temasek have invested over $2 billion in climate tech startups over the time period.

‘Our original investors started largely as foundations and banks, but the 2008 financial crisis removed banks from the mix, with family offices, ultra high-net-worth (UHNW) individuals, and public pension funds filling the gap along with continuing participation from foundations. These days, LPs in climate VC funds mirror those of typical Sand Hill Road fund investors, and climate tech investment enjoys a broad level of support, across all asset classes.’

Nancy Pfund
Founder and Managing Partner, DBL Partners

Key findings: Drivers and Barriers



Key findings: Drivers and Barriers

Factors driving recent successes

Climate tech is expected to play an increasingly significant role in the transformation required to reach net zero, with the rapidly-growing market already demonstrating an impressive ability to scale. If climate tech is to have a more central role in the net zero transformation, it makes sense to ask what have been the key factors behind this impressive growth to date, and how can those be amplified? Through our research and analysis we have identified seven key drivers that have acted to help develop and grow the climate tech ecosystem over the past several years:

- **Technology and infrastructure:** low-carbon technology, in particular as regards renewable electricity generation and battery manufacturing, has become much cheaper and more widely available.
- **Finance and investor demand:** much more investment capital is being made available, both by institutional VC funds and from alternative sources, as set out above.
- **Policy and process:** the policy and regulatory environment is increasingly more supportive, with 120 national governments[44] having made commitments to decarbonise their economies – with commensurate spending and policy action across both regulatory standards e.g. bans and phase-outs to market-based measures, including carbon pricing.
- **People:** increasingly high-quality founders, and top talent, have been drawn to different parts of this important and increasingly urgent challenge, across multiple sectors and geographies.
- **Corporate demand:** corporate ambition, and in turn action, is accelerating, with nearly 300 global companies having made net zero commitments, alongside an increasing number of broader and more concrete Environmental, Social, and Governance (ESG) goals.
- **Consumer demand:** high-quality low-carbon products and services have created a range of high-profile 'winners', including Beyond Meat, Tesla, and Nest, for others to see and mimic.
- **Inspired founders:** the success of a growing number of individual startups is motivating an increasing number of founders to tackle the climate challenge.

> ‘There’s been an increase in interest in working on the climate challenge. We’ve been able to attract a high level of quality talent in our company, even if the tech giants are more competitive on salary.’
>
> **Tony Pan**
> Co-founder and CEO, Modern Electron

> ‘The ecosystem has become more developed over the past decade. There’s now a big clean energy and clean transportation sector, which can start to nourish itself. The fact there are now tens of thousands of wind turbines, for example, means you can now be a venture-funded company that uses machine learning to optimise wind turbines. That business model just couldn’t exist in 2005.’
>
> **Michael Liebreich**
> Chairman and CEO, Liebreich Associates

44 What Does ‘Net-Zero Emissions’ Mean? 6 Common Questions, Answered (World Resources Institute, Sep 2019)

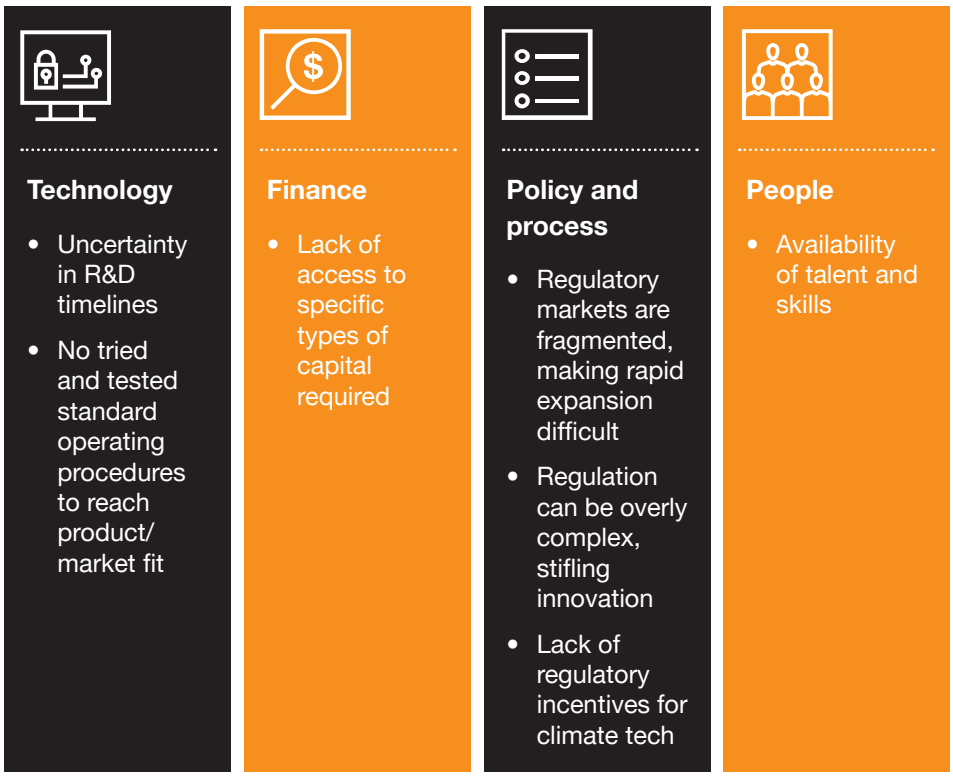
Barriers

Despite this significant growth, and strong set of driving forces, we must be clear – the levels of funding and innovation into climate tech have simply been insufficient to drive the pace and scale required for net zero transformation. Moreover, economies and societies are now also faced with the rapid decarbonisation challenge while trying to build back better from COVID-19.[45]

As a result, there is an urgent need for faster, bolder, innovation in climate tech. Achieving this step-change will require significant additional VC dollars, of course, but for climate tech to reach its full potential, the full range of the market's key challenges, beyond funding, must be proactively identified and overcome.

Through our interviews with leading players in the market, we have identified some of the fundamental barriers that still remain:

Overview of barriers



We detail these below, and in the subsequent section discuss recommendations for addressing these barriers.

> ‘Reduced cost is actually not the driver of change here, but is the effect of the four forces actually driving action (and which are in turn driven by climate change). These are consumer preference combined with mistrust of institutions; corporate investors responding to employees and consumers; governments spending and regulating; and founders with strong values.’
>
> **Hampus Jakobsson**
> General Partner, Pale Blue Dot

45 Building back better: A sustainable, resilient recovery after COVID-19 (OECD, Jun 2020)

Technology

Uncertainty in R&D timelines

The climate tech ecosystem has the potential to create novel and high-impact solutions to the net zero transition; but R&D is inherently uncertain, and early-stage startups in this market often face unpredictable timelines for product development.

This uncertainty can dissuade capital – and thus company formation – given that venture funds are typically structured to return capital to their limited partners within a fixed 10-to-12 year time span. This has been evident in climate tech, where sectors such as novel nuclear power or carbon capture and storage (CCS) have attracted only modest amounts of venture funding (less than $700 million over the 2013-2019 period), in part because the technologies are not yet proven to work cost-effectively, or at all.

Challenges with reaching product/market fit

Prominent entrepreneur and investor Marc Andreessen defines product/market fit as 'being in a good market with a product that can satisfy that market',[46] and has argued that reaching product/market fit is key to startup success.

In other markets such as the web and software, there are tried and tested operating procedures for reaching product/market fit, such as lean startup, blitz scaling and agile methodologies. These established approaches provide roadmaps to success, allow teams to stand on the shoulders of the many giants before them, and serve to communicate their progress to later-stage investors and other stakeholders more clearly – a lingua franca for their market.

In contrast, many early stage climate tech startups find the journey to product/market fit difficult. Without a long line of historic climate tech startups to learn from, they find themselves needing to invent the playbook at the same time as executing it.

46 Product/Market Fit (Marc Andreesen, 25 Jun 2007)

Finance

Financing risk remains a key, and ongoing, challenge with climate tech. Founders and investors must ask themselves how they can create a funding model for capital and labour to go on the difficult journey to create and get a product to market.

The capital requirements over the life-cycle of a sustainability play are nuanced. Climate tech startups may face three different classes of capital challenge that differ from a traditional venture capital-backed startup. The question is not merely about the amount of capital required at each point, but the participatory structure of that capital that works for climate tech:

- R&D may take a long time and thus requires patient capital
- Proof-of-concepts or pilot programmes may require significant amounts of capital, meaning large investments may be required before products have been proven
- Large scale deployments may have long pay-back periods, running into decades. These might typically have involved project finance rather than venture capital structures

As Joshua Posamentier (Co-founder and Managing Partner, Congruent) has put it, 'The climate tech market is nowhere near mature as traditional tech markets, especially in terms of expected milestones. Some investors are worried that if they are funding seed rounds, no one will fund the 'A' round. One consequence is that companies with the slightest bit of traction get lots of money piled on to it.' This is reflected in our analysis, which found that the top 5% of startups captured two-thirds of climate tech VC funding.

Access to patient capital will be important, with Vinod Khosla (Founder, Khosla Ventures) saying that 'matching the time horizons of ClimateTech startups with investors is a key challenge. Patient capital is needed, which is why Breakthrough Energy Ventures was set up a 20-year fund, rather than demanding returns within the traditional 10 years'.

Hampus Jakobsson (General Partner, Pale Blue Dot) also noted that 'there is a potential gap of later stage capital. Some pension funds are making noises about investing but we assume at this point that family funds may have to step in if the gap is going to be filled', though in recent months had seen an increase in interest from pension funds. Michael Liebreich (Chairman and CEO, Liebreich Associates) also states that 'the big opportunity is in creating blended finance structures, cleverly mixing government guarantees and private funding. Low-carbon solutions are almost always capital intensive, they require low-cost debt to work, but debt providers need to be remunerated for the risk they're taking. If we can solve two problems – credit risk in the aftermath of COVID-19, and sovereign wealth risk for developing countries – that would unleash a wall of money'.

It may yet take more time and more success to increase the number of investors with experience of supporting founders through their scaling journey. Mike Zelkind (Co-Founder and CEO of 80 Acres Farms), who avoided traditional venture capital, argues that 'there isn't yet an understanding of what will be an accelerator to growth. So, we felt it was more helpful to have [corporate] partners with value add and a balance sheet.'

Our data and analysis shows that corporate investors are increasingly active in climate tech investments. Corporate investors seem to be active in direct investments across the different stages of a startups life, as well as participating as limited partners in investment funds and accelerators. Some professional investors are more sanguine about the role of this capital. 'Corporate venture capital has a role to play if it doesn't come with strings attached', says Albert Wenger (Managing Partner, Union Square Ventures).

Michael Liebreich (Chairman and CEO, Liebreich Associates) expanded on the role of corporates in climate tech further, saying that 'the heavy lifting on tackling climate change will come from hundreds of billions or trillions of dollars spent by businesses. Many of these investments will be made by risk-averse players, who don't just swap out their business models overnight – the world doesn't work that way – but who nevertheless have committed themselves to a net zero pathway. Every 5 years or so, at the start of a decision cycle, these companies evaluate what is in the 'hopper' of technologies to support their net zero commitments. The role of technology and venture capital is not so much to destroy these businesses, but to make sure those hoppers are full of technologies ready to scale. We only have a couple of those cycles to take a big bite out of emissions'.

On the positive front, the broader 'capital markets' deep engagement in climate change has structurally changed financing, with rising cost of capital for carbon-intensive projects and falling cost of capital for low carbon initiatives. This is likely to foster improving capital access for clean tech start-ups, provided the regulatory framework is attractive, as we lay out in our Carbonomics research', points out Michele DellaVigna (Head of European Natural Resources Research, Goldman Sachs).

Policy and Process

Fragmented regulatory markets and scaling complexity

Market and scaling represent a unique set of challenges for startups in climate tech. Markets are often fragmented at a regulatory level and also differ across geographies i.e. city, state, and national levels. Delivering a proof-of-concept at scale, therefore, can be capital intensive. Even signing a first pilot agreement with an incumbent can be hazardous. Bilal Zuberi of Lux Capital of pilots illustrates: 'If you make a mistake in negotiations, it could be the end of you. You could be stuck in contract for two years or more.'

Dawn Lippert, CEO of Elemental Excelerator sums it up: 'The road to commercial realization is actually quite long and bumpy. In this sector you also have the market expansion valley of death: can you sell successfully into many specific markets?'

Accelerators such as Powerhouse and Elemental Excelerator actively help founders break through this 'market expansion valley of death'. Elemental is partnered with governmental bodies as well as utilities from around the world, such as Korea's SK Gas, the UK's National Grid and Japan's Tepco, to help startups build proof-points for commercial expansion.

Scaling to many customers may involve navigating a fragmented regulatory landscape. For example, in the United States, 'there's no national energy policy really. You do have to go to states and even local governments. If you don't understand that, it can be very daunting', says Nancy Pfund (Founder and Managing Partner, DBL Partners).

Of course, the flip side of regulatory complexity is that it creates meaningful rewards for the founders who are able to navigate the patchwork of regulations. To achieve success, some founders have 'gone after early adopter markets that have progressive regulatory and political infrastructures and built their companies from there', says Nancy Pfund. Many startups also find themselves in a complex network of suppliers, regulators, partners and incumbents, which can also be a challenge to navigate successfully.

Tightly regulated markets

Regulation of key industries can help reduce information asymmetry, protect consumers, and increase market confidence.[47] Overly stringent regulation can also hinder innovation, however. One of our interviewees highlighted the US electricity market as an example of this, where regulation makes decentralisation – a key innovation critical for clean distributed grids – overly burdensome.

To encourage climate tech, governments should look not only at regulation, but also deregulation. An example of this working well in a different area is the UK Financial Conduct Authority's 'regulatory sandbox', which has made the UK one of the leading hubs for Fintech firms, as well as the UK energy regulator's innovation sandbox, which is supporting the UK's net zero targets.[48]

Lack of regulatory incentives for climate tech

Incentives are a key part of the regulatory toolkit and currently the climate tech market lacks a globally consistent and meaningful carbon price to drive decarbonisation. The current reality is a carbon price set on narrow economic segments, in specific regions, at different levels (including in some places prices too low to provoke change). An internationally agreed carbon price covering all sectors is the ideal market signal to foster innovation in low-carbon technologies, as inadequate regimes effectively subsidize incumbent high-carbon offerings. Carbon pricing is particularly important for capital-intensive solutions that are key to many of the harder to abate sectors (e.g. shipping, aviation, carbon capture and storage). Several of our interviewees believe funding in this segment is unlikely to improve without stronger policy and regulation. In the absence of a global carbon price, pragmatic solutions include downstream taxes on product based emissions, and differentiated carbon prices including higher carbon prices for harder to abate sectors.

47 3 ways that regulation benefits economies (World Economic Forum, 18 Jul 2018)

48 Innovation Sandbox Service Overview (OFGEM, 27 Feb 2020)

People

Founder quality and the talent of the teams they can attract is critical for these firms to succeed. In established startup sectors, such as software, Internet or biotech, the mature ecosystem attracts, grows and supplies this talent. Serial founders are commonplace, and they have access to large pools of execs with deep experience at the different stages of a company's development. With fewer successes, the climate tech sector has a smaller pool to draw from. The sector is also complex in needing deep technical expertise from different domains, as well as commercial leaders who know how to get to market.

But as Vinod Khosla (Founder, Khosla Ventures) puts it: 'A dozen entrepreneurs is what we need to change the planet on sustainability. One guy, Elon Musk, changed the assumptions for electric vehicles. One guy, Pat Brown [of Impossible Foods], did it for plant-based burgers. We only need ten more.'

Aaref Hilaly (Partner, Bain Capital Ventures) concurs. 'The calibre of teams tackling climate issues has increased and improved.' For those high calibre teams, the 'entrepreneurs can be choosy and demand the highest quality investors', says Lila Preston (Co-Head of Growth Equity Strategy, Generation IM).

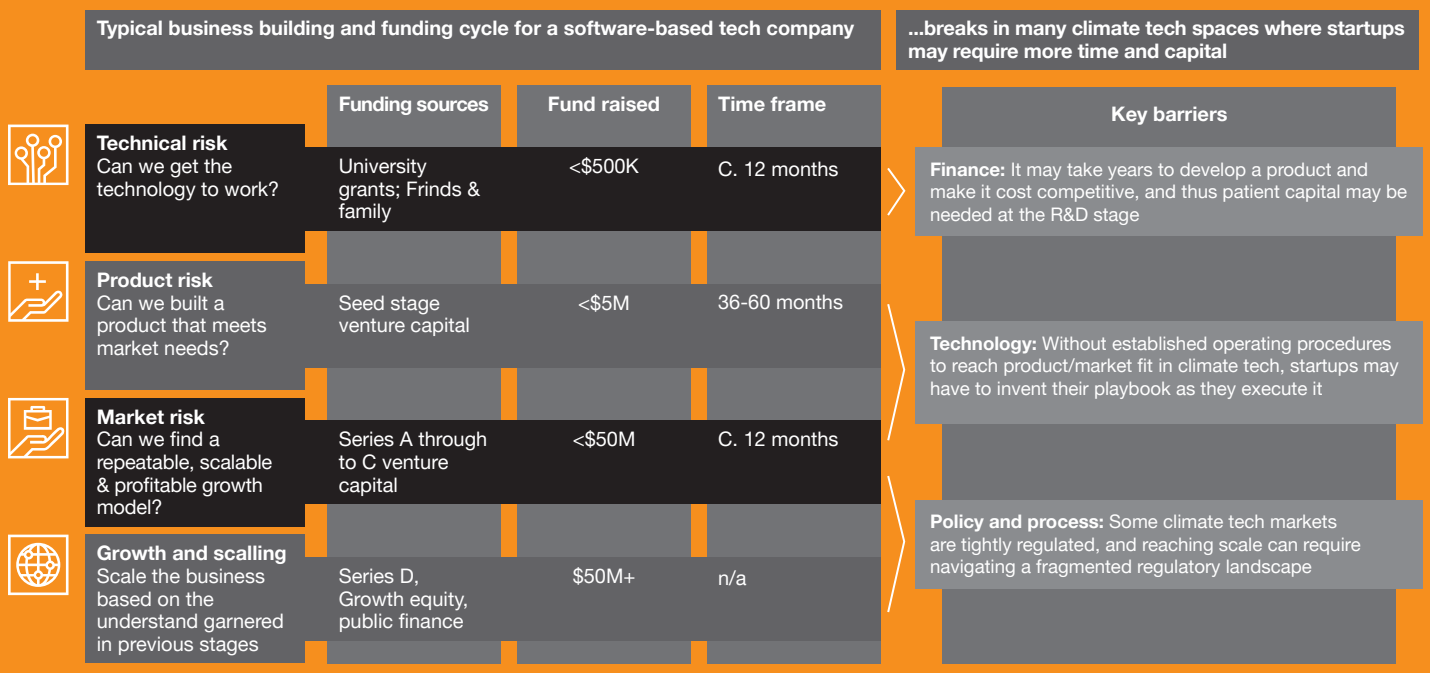
Whether it is singular individuals or the teams around them that matters, talent is critical. This includes talent that can help startups interact with large and significant customers, who may not operate at the same pace as a startup. For startups aiming to develop repeatable sales with such customers, 'founders may need to bring in talent from large, incumbent firms', argues Bilal Zuberi (Partner, Lux Capital).

The underlying mission of climate tech may increasingly help firms in this sector. 'Purpose driven companies have better access to talent', argues Hampus Jakobsson (General Partner, Pale Blue Dot). This is a view echoed by Albert Wenger (Managing Partner, Union Square Ventures). 'There is a huge amount of talent that wants to work on these problems. They don't want to be stuck in the old world.'

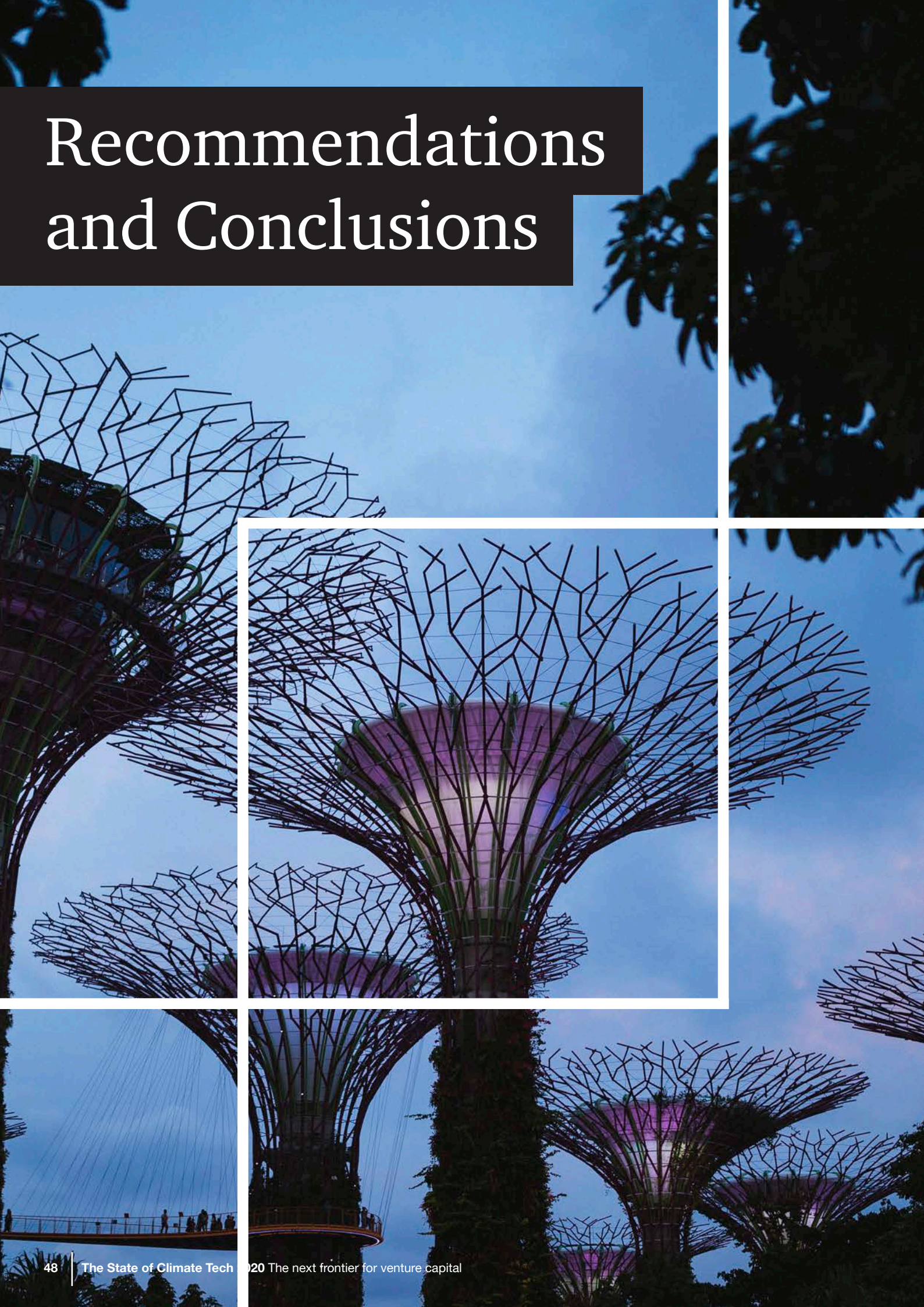
How these barriers impact startups throughout their VC lifecycle

Startups face a different set of challenges at each stage of growth. Though many startups will experience most or all of the above barriers, some will be more relevant to early-stage startups focused on developing their tech; while others will be more relevant to mature startups looking to reach scale and preparing to go public. Founders and investors should be aware of these differences, and make sure they have access to the right expertise to overcome these speed bumps on the journey. Failure to do so can arrest development, decrease the pace and ability to scale, or simply attenuate the startup's likelihood of success.

In the diagram below we map these barriers to key lifecycle stages:



Recommendations and Conclusions



Recommendations and Conclusions

Recommendations

Our research and analysis has uncovered a range of drivers, and barriers, to scaling climate tech startups. Issues arise at different stages of development, but one fundamental point is clear: addressing the barriers and amplifying the drivers is crucial if society is to harness climate tech to make a net zero emissions economy before 2050 possible. At the same time, doing so will likely free up high return, impact-driven investments which stakeholders are increasingly seeking, and often mandating, from their investors.

We have identified three key overarching recommendations, drawn from the longer list of barriers and enablers, which will enable further scaling of the climate tech startup ecosystem. These can be broadly categorised as funding needs, talent, and the role of government:

1. **Funding the early-stage investing life cycle of climate tech**

   Investors across the early stage life cycle of climate tech companies need to work harder to recognise the time-critical and strategic opportunity climate tech offers and to free up more capital to address the large financing and funding gap:

   a. **Venture Capital firms and funds:** a subset of VC firms are focused on climate tech, or a sub-set of climate tech, and that number is growing including both traditional VCs and dedicated or specialist climate tech venture funds. The onus is growing on venture firms to respond to the implications of the net zero transition, with an increasing number of institutional investor LPs making portfolio decarbonisation commitments[49], asking for climate risk disclosure, and interested in the climate tech investment opportunity. Likewise net zero offers a strategic positioning for VCs looking to build an LP base for a fund, given the growing interest of LPs from sovereign funds to corporate investors, pension funds, and universities and family offices.

   b. **Corporate:** The strategic role of a corporate venture partner is critical to many climate tech startups, particularly those typified by heavy capital costs targeted at disrupting asset-heavy incumbent industries with high barriers to entry such as in the energy, heavy industry and transport sectors. These established corporates have the financial means, commercial know-how, and market knowledge to rapidly deploy and scale new innovations into the market. Corporates need to develop new and more proactive models of engaging with start-ups critical to providing transformative solutions to meet their own corporate net zero pledge. Being involved as an investor in earlier stages will both enable partnership to deploy and scale new solutions, In order to do so, they must:

      i. integrate net zero into their corporate innovation strategy, M&A strategy, and corporate venture/accelerator arm to help identify and fund the climate tech solutions that are not yet mature or commercially deployable.

      ii. be willing to pilot and proof-of-concept at earlier stage;

      iii. explore partnerships with climate tech startups to help them scale while helping to meet their own climate targets (examples include innovation grants, business alliances, or investment)

      iv. explore partnerships which include funding to help bridge the gap for climate tech startups

   c. **Later stage investors (PE firms, investment firms):** PE and other growth stage investment firms are also increasingly showing interest in the climate tech investing opportunity, from investing in VC firms active in this space to getting exposure directly as the lead or key investor in venture capital rounds. This is particularly the case for more well established startups that have already raised

49 See Climate Action 100+ and the United Nations-convened Net-Zero Asset Owner Alliance, for example

substantial capital from VCs. At the average climate tech growth rates observed in this research, there will be a considerable pool of large enough valuations within only a few years. PE firms can capitalise on the investment opportunity presented by climate tech by:

i. Filling the funding gap in order to accelerate the climate tech startup lifecycle by funding VC firms and related investment intermediaries that are targeting early-stage climate tech ventures;

ii. Developing in-house technical and commercial capability to support successful direct investment in climate tech deals, including more established startups;

iii. Investing earlier in the life cycle of startups, building exposure, relationships and understanding of the climate tech ecosystem which will aid their future later round investments, including decisions around restructuring and value creation.

2. Foster and attract more talent to climate tech

With fewer success stories, the climate tech sector has a smaller pool of founders to draw from. Bringing in, and fostering, the right blend of founder talent would develop more fundable climate tech companies and consequently attract even more successful and experienced founders. In order to build the climate tech talent pool, the following needs to be recognised:

a. Incubators, accelerators and platform VC firms play an important role in being able to help founders build and nurture early stage teams that blend the deep technical expertise which distinguishes many domains of climate tech with commercial expertise from C-suite (including second time successful founders) to operational (e.g. growth marketing, customer experience).

b. Young engineers will also be critical to climate tech and are the most sought after talent globally, but big tech and high growth software startups tend to win out on recruitment. A new approach on university campuses and by talent/recruitment agencies is needed to help steer passion-driven top talent into climate tech ventures.

c. Governments, at a national, regional and city level, can support entrepreneurial and investor expertise by developing climate tech innovation hubs. There are existing hubs of innovation, e.g. fintech, but no region has yet strongly established itself as a world-leading climate tech hub. For a heterogenous field, hubs may be sector-specific and meet specific gaps or needs. Such hubs will lead to a positive feedback loop as investors and founders begin to congregate and establish expertise.

3. Increase Government funding and policy incentives for climate tech

Government interventions that create the right enabling environment can, and will, play a critical role in nurturing the climate tech startup ecosystem. In particular, some sectors may never receive venture funding as they do not fit the funding requirements of venture capital (capital investment heavy and long payback periods). Government should urgently focus on developing these sectors by:

a. Ensuring that public R&D funding is channeled towards priority climate tech/net zero challenge areas.

b. Bridging public R&D with the venture ecosystem through funding joint public-private R&D efforts, and creating startup spaces in research centres.

c. Financing startups in the early stage for these sectors with mechanisms such as R&D grants, innovation prizes, and through government-backed incubators and accelerators.

d. Deploying public finance mechanisms to facilitate scaling of climate tech solutions – in particular those with higher technology costs – and build investor confidence, including the use of commitments on public procurement for price guarantees or advanced purchase agreements (e.g. buying the first one million units), loan guarantees, or concessional green loans, or green subsidies.

e. Improving climate policies including stable (long-term), efficient and pragmatic carbon pricing mechanisms and removing artificial support (e.g. direct and indirect fossil fuel subsidies and tax breaks) which compete with and suppress the climate tech ecosystem. Sector specific examples include carbon taxes on high emissions aviation, cement, vehicles, or plastics incineration; energy efficiency standards and green fuels standards; or construction standards.

f. Channelling and targeting significant portions of COVID-19 recovery packages including infrastructure investment to accelerate the net zero transformation through green stimulus – the EU Green Deal is an early example – as economies and societies slowly start to rebuild from the crisis in the early-2020s. Examples include EV recharging or hydrogen refuelling infrastructure, CCS storage and pipelines infrastructure, scale-up of renewable power production.

Conclusions

Climate tech has experienced rapid growth in investment over the past seven years (2013-2019), rising more than 3750% in only seven years. This impressive growth has been driven by a confluence of factors, which include but are not limited to: growing consumer and corporate demand, an increasing number of founders entering the space, rising investment levels and investor attention, falling infrastructure and technology costs (increasing cost-competitiveness), and a stronger policy environment, including carbon pricing and other incentive mechanisms. Despite this impressive growth, however, the climate tech landscape across geographies and sectors displays different levels of maturity and, overall, is far from the scale society needs to make the overarching goal of a net zero emissions economy before 2050 a reality.

Across geographies, there is significant variance in regional funding, partly due to an uneven policy and regulatory landscape across regions. The breadth and depth of policy differs significantly between the EU, US and China, for example. There are also big differences in investment culture – US venture capital levels are substantially higher than in Europe in general. And levels of corporate involvement also differ: for example, investment in batteries and EVs is driven by incumbents in the EU, while it is startup-driven in China.

Across sectors, some areas – most notably energy – are much more mature than others. And even within areas, including energy and mobility, several solutions are much more developed. Many of the developed and deployed climate tech solutions thus far display similar characteristics. They are minimally capital intensive, for example, which can include applying increasingly established mainstream technologies to the climate space (e.g. AI, sensors, drones), or are solutions that have been explicitly targeted or supported by government regulation (e.g. renewable energy).

From an investment perspective, varying maturity can also be ascribed to the level of sector risk, including both the amount of capital and time it would take to generate returns, and the financial support available from governments and elsewhere, to support the startup business case. There are also a number of scientific and product risks that have led to different levels of engagement and investment thus far.

In terms of the macro picture, it is clear that climate tech has a hugely important role to play as the world grapples with transforming all sectors of the economy towards net zero emissions. We hope that the substantial rates of growth we have seen in climate tech in the late 2010s, which to a large extent mirror the exciting growth in VC funding of AI startups in the early 2010s, augurs for an explosion of climate tech into the mainstream investment and corporate landscape of the 2020s, as is widely-recognised to have happened with AI over the past few years.

That said, many of the climate tech startups that have been founded, and reached scale (i.e. achieved ‘unicorn’ status), during the late-2010s are the ones already most likely to have a significant impact on sizable emissions reduction in the 2020s. Large-scale investment in climate tech is urgently needed now to have a meaningful impact on rapid emissions reductions in the late 2020s to support society’s 2030 goals, and global net zero commitments beyond.

As more strong founders enter climate tech, the scientific, product, and sector-specific risks will increasingly be overcome. Investors are cautiously becoming more certain of climate tech as an investment space. Institutional investors are asking more of their asset managers around climate performance; corporate investors are needing to identify solutions to transform their own industries; and a clearer product to market fit is emerging as customer and consumer demand grows for sustainable solutions.

Investment will increasingly flow into these spaces if the right support is provided, and nurtured, from across founders, research, investors, corporations, and governments. Key stakeholders will need to work collaboratively, and often in partnerships, to unlock barriers and achieve desired outcomes.

Finally, as countries and regions around the world cautiously develop COVID-19 recovery packages in the coming months and years, these stimuli provide an important opportunity for governments to support, and accelerate, climate tech as a high-impact area which has the potential to support the overarching goal of net zero emissions growth.

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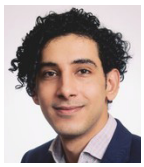

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https://dealroom.co/

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Michele DellaVigna (Head of European Natural Resources Research, Goldman Sachs)
Bill Gross (Chairman & CEO, Idealab)
Aaref Hilaly (Partner, Bain Capital Ventures)
Jason Jacobs (Host, My Climate Journey)
Hampus Jakobsson (General Partner, Pale Blue Dot)
Shayle Kann (Managing Director, Energy Impact Partners)
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Albert Wenger (Managing Partner, Union Square Ventures)
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Appendix

Methodology

This section explains key features in the methodology that we have followed in our exercise to assess venture capital investment in climate tech. Our approach follows three broad steps:

Step 1 was to establish boundaries for the analysis.

These boundaries guide our analysis by defining what is and isn't a startup, and what should be considered venture capital (for the purposes of this analysis). Our boundary conditions included:

- **Time boundaries:** We included startups formed at any date, but only examined funding which was raised from 2013 onwards. This time boundary was chosen based on qualitative discussions with interviewees and our own experience of the increased interest in climate tech investment since 2013.
- **Funding boundaries:** We included only startups which had raised at least $1 million. Startups smaller than this are not unimportant to climate tech, but are less able to be robustly assessed against our climate tech criteria, as many are still pivoting their strategies in order to reach product/market fit.
- **Funding type boundaries:** We filtered by round type to only include early stage VC/PE funding. IPOs, ICOs, and debt offerings, for example, were excluded from our analysis

Step 2 was to assess whether individual startups should be considered climate tech startups.

This is not a black and white issue, and so we applied a set of guiding questions to assess whether startups were sufficiently climate tech focused:

a. **Does the startup have an emissions/net zero focussed strategy?**
   Startups publicly indicating that reducing emissions was a clear objective for them were included in our analysis.

b. **Does the startup address a challenge area or lever of critical importance to net zero?**
   Startups tackling certain levers seen as pivotal to emissions reduction, or with use cases almost exclusively focused on resource efficiency and emissions reduction, were marked as climate tech irrespective of meeting our first criteria. For example, satellite operators gathering Earth observation data which will be critical in informing effective climate action and optimising resource use.

c. **Will the startup have a first order impact on emissions?**
   Startups which reduce emissions directly through their actions were included in the analysis, while those which had second order impacts were not included (unless they met our first criteria). For an example of the latter, consider a manufacturer of AI-focused processors – these will potentially be useful for startups using AI to address the net zero transition, but they do not themselves directly contribute to emissions reduction (and depending on how they are applied, may indeed lead to greater emissions).

d. **Does the startup show a level of innovation and/or use of technology?**
   Startups were expected to demonstrate that they were developing or using innovative tools or techniques. For example, within alternative proteins, a company developing lab grown meat would be considered sufficiently innovative, whilst a company selling plant-based food supplements (in the absence of any other form of major innovation) would not be included.

Step 3 was to allocate startups to challenge areas and levers.

We assigned each startup a 'primary' challenge area and lever, based on the targeting of their products or services. We continually reviewed our taxonomy, making adjustments where we found startups were not naturally aligning with our initially hypothesised framework.

In some cases, startups provided solutions applicable to more than one challenge area: for example, development of electric vehicle battery technology, which also supports grid management when connected to the grid. In these cases, we adopted a pragmatic approach to classification by choosing the companies' primary industry of focus (Mobility & Transport in the prior example).

Noteworthy startups:
Our report discusses noteworthy startups within certain levers. These have been selected based primarily on funding raised in the relevant period or those having the highest valuation, as well as to display the diversity of offerings produced under each lever.

Taxonomy

Challenge area

Energy

- Renewable energy generation
- Nuclear generation
- Grid management
- Waste heat capture/conversion/ storage
- Alternative fuels
- Energy storage (thermal or electricity)
- Low GHG extraction and maintenance
- High efficiency energy intensive electronics, and smart monitoring/ management

Challenge area

Mobility and Transport

- Low GHG Air Transport
- Low GHG Shipping
- Micro-mobility
- Low GHG Light and Heavy Duty Road transport: EVs & High-Efficiency vehicles
- Efficient transport systems
- Batteries/Fuel Cells

Challenge area

Food, Agriculture and Land Use

- Alternative foods/low GHG-proteins
- Vertical and urban farming (including aquaponics)
- Agricultural biotech/genomics and natural solutions
- Precision agriculture and robotics
- Low GHG/energy efficient equipment
- Earth and Marine protection Deforestation prevention, reforestation and afforestation
- Land use management
- Value chain GHG reduction
- Low GHG Fertilizers, Pesticides, Insecticides, and therapeutics

Challenge area

Heavy Industry

- Low GHG chemicals (beyond plastics)
- Low GHG Iron, Steel and Aluminium
- Low GHG plastics or plastic alternatives
- Low GHG Concrete and Alternatives for construction
- Energy/resource efficient manufacturing processes
- Extreme durability for energy intensive materials
- Low GHG extraction and supply
- Transformative circularity, recycling and materials efficiency solutions
- Industrial residuals treatment and management
- Low GHG: other materials

Challenge area

Built Environment

- High efficiency fixtures and fittings
- High efficiency lighting
- High efficiency space-water heating and cooling
- Building level (electricity and thermal) storage
- Low GHG construction processes
- High efficiency urban spaces and communities
- Transformative circularity and recycling
- Commercial and residential residuals treatment and management

Challenge area

GHG capture and storage

- CCUS
- Biomass Uptake of CO2 (excluding afforestation and land management)
- Geo-engineering based direct air capture and storage
- GHG monitoring and management platforms

Challenge area

Climate/Earth data generation

- Climate/earth data generation
- Low-GHG satellites and sensors

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