Autodesk Foundation
Impact Brief Series:

Low Carbon Innovation

AUTODESK. FOUNDATION

What we've learned

An Autodesk Foundation Impact Perspective

This impact brief is the second in a three-part series that examines Autodesk Foundation's work in three key issue areas over the course of our five-year history: future of work, low carbon innovation, and resilient communities. In each brief, we define the problem we are tackling and articulate our approach to supporting solutions and evaluating impact.

This second brief seeks to clarify the challenges and opportunities posed by climate change and defines Autodesk Foundation's strategy for investing in actionable solutions that mitigate greenhouse gas emissions. It also provides insights from our preliminary research and early investments in low carbon innovations.

This brief is written with a diverse audience in mind. By openly sharing how we see the challenges and opportunities climate change presents and by communicating our investment thesis and commitment to action, we hope to drive more collaboration to solve critical issues facing the world today.

Autodesk Foundation supports the design and creation of innovative solutions to the world's most pressing social and environmental challenges. We believe in the power of technology to transform society in positive ways.

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Why low carbon innovation?

Introduction

Autodesk Foundation's mission is to support the design and creation of innovative solutions to the world's most pressing social and environmental challenges. We believe in the power of technology to transform society in positive ways, and currently there is no more meaningful challenge than the threat posed by climate change. We believe that scalable technology innovation has a pivotal role to play if we're to achieve a low carbon future. Our work has several defining features:

- We invest in entrepreneurship and innovation, particularly at the early stages of a company or organization's development, where our resources can have the greatest effect;
- We help bring transformative technologies to scale with a thesis-driven approach and value beyond dollars;
- We drive flexible, risk-tolerant philanthropy by embracing both nonprofit and for-profit models, utilizing grants and impact investment structures to align incentives for scale.

Access to capital remains the overriding challenge facing "tough tech" startups in energy, infrastructure, and utility industries—the very sectors that most need technology innovation to drastically reduce the global carbon footprint. Startups need risk capital and entrepreneurial support to help them get to scale. Because of our unique blend of impact-oriented funding and in-kind resources, Autodesk Foundation is well positioned to help bring early stage breakthrough technologies to market. Here's the impact we have had since 2016:

$2.5M
committed in 7 low carbon innovation startups and ecosystem partners

$100.5M
yielded in follow-on funding from our and our partners capital commitment

$100M
worth Autodesk software donated to more than 1800 clean tech organizations

11 giga tons
carbon dioxide emission reduction potential

67,500 metric tons
carbon dioxide emission reduction realized till date

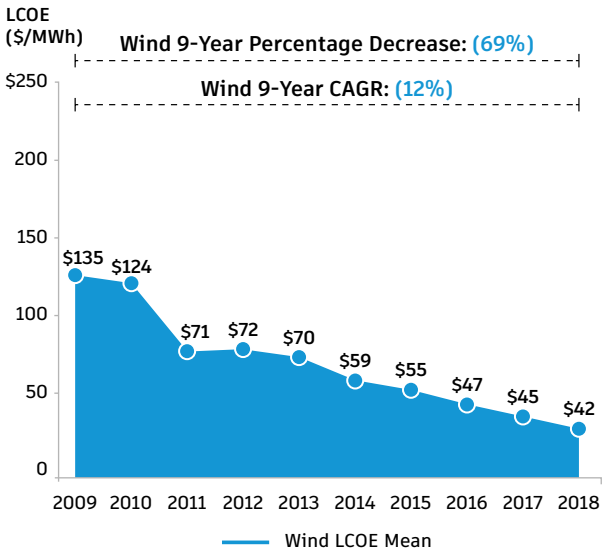
What is the problem?

According to the Intergovernmental Panel on Climate Change (IPCC) 2018 special report on Global Warming of 1.5° C, human-induced warming reached approximately 1° C above pre-industrial levels in 2017—the impacts of which are witnessed by each of us daily. That single degree has resulted in profound alterations to human and natural systems, including increases in extreme weather events, droughts, floods, sea level rise, and biodiversity loss. These changes, again according to IPCC, are "causing unprecedented risks to vulnerable persons and populations."

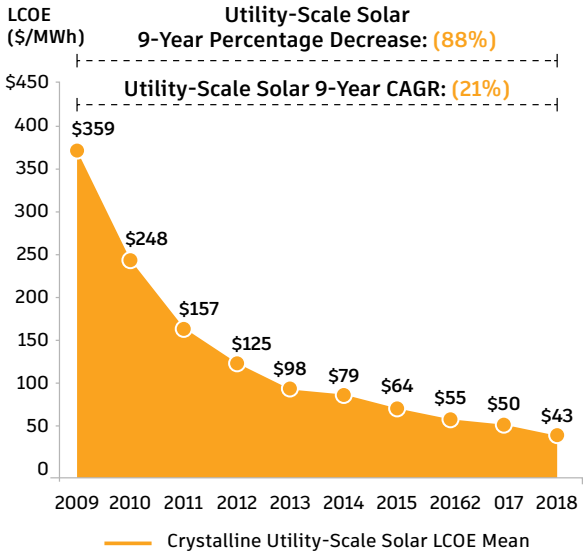
There is resounding consensus from the scientific community—and unified commitment from international government actors as shown by the Paris Agreement—that we collectively need to mitigate greenhouse gas emissions if we're going to avoid the most catastrophic effects of climate change. It has been shown that maintaining warming to 1.5° C, while difficult, is in the realm of possibility. At Autodesk Foundation we argue that it's imperative—and that technology and automation, while not the only solutions, can help.

There have been significant strides in the advancement of new low carbon and clean energy technologies over the last 30 years. The levelized cost of electricity (LCOE) from solar and onsite wind generation has dropped 49 percent and 84 percent, respectively, in just the last eight years alone. In many markets, alternative energy costs have decreased to the point that they are now at or below the marginal cost of conventional generation. As a result, renewables accounted for almost one-quarter of global energy demand growth in 2018. The traction is impressive – however it isn't enough to avoid the worst effects of climate change. New solutions are needed.

Unsubsidized Wind LCOE



Unsubsidized Solar PV LCOE



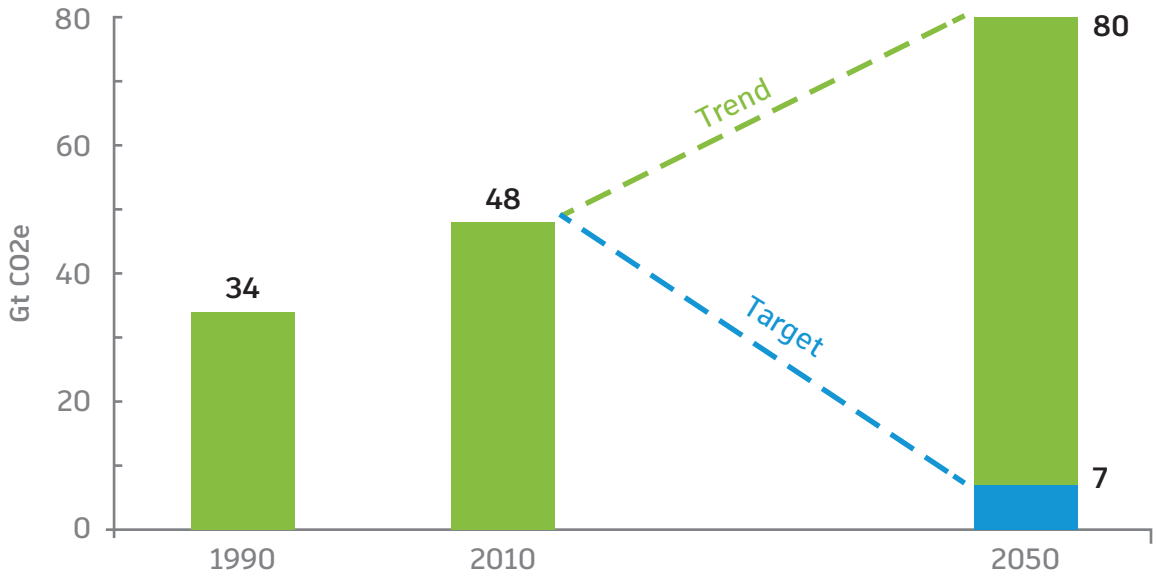
The need for technology innovation

Beyond increasing adoption of existing cleantech solutions, new innovations are still critically needed to decarbonize high emission industries such as transportation, energy generation, manufacturing, agriculture, and the built environment. Roughly 70 gigatons of CO2e annually needs to be abated from today's 2050 trendlines to achieve the 1.5° C warming goal.[1] To put that in perspective, all onshore and offshore wind deployed globally equates to only roughly 1 gigaton CO2e abatement. Even if all commercially available technologies reach their maximum potential, we'd still fall far short of our mitigation need.

Fortunately, researchers and innovators within the public and private sector continue to do what they do best—design and build new solutions. Potentially transformative low carbon innovations and new business delivery models exist in universities, accelerators, incubators, and public research labs all around the globe. If adopted at scale, these ideas will transform how the world accesses reliable and affordable energy, food, goods, and services without emitting greenhouse gasses. Unfortunately, many of these new innovations languish within research institutes and simply never make it out into the world.

New technologies are vitally needed to avoid the worst effects of climate change

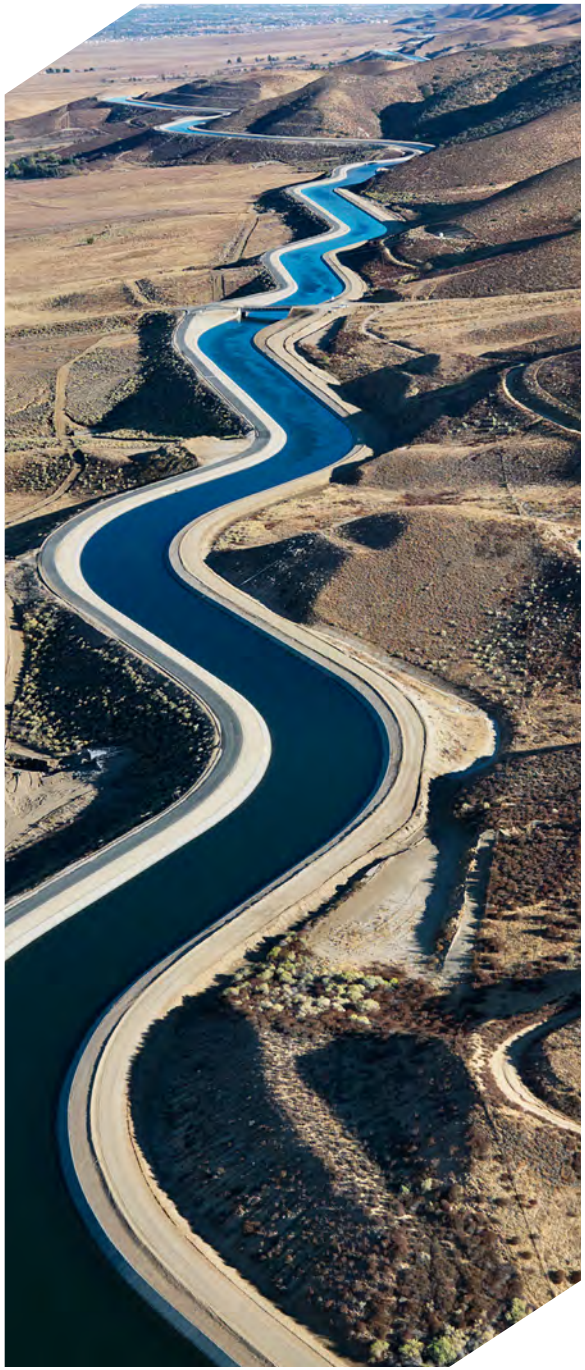
We must emit massively less greenhouse gases alongside growing global energy consumption to avoid the worst effects of climate change



Source: IPCC, PRIME Coalition

1. Scientists have modeled several scenarios based on today's existing climate pledges, known as "nationally determined contributions (NDCs)." If all NDC pledges are met by 2030, it is estimated we face a gap of 16-19 GtCO2e to maintain a trajectory under 1.5°C. To prevent 1.5°C of temperature rise by 2100, our total emissions will have to stay below 24 GtCO2e. Today we emit greater than ~55 GtCo2e. Source: The Emissions Gap Report 2018, UNEP.

Our investment thesis



The role of risk-tolerant capital and resources

Low carbon innovations are often deprived of early stage risk capital to help establish product-market fit and effectively scale beyond research. They are underfunded by both traditional and impact-focused investors alike. Traditional venture capitalists, many reticent because of the cleantech boom and bust of the 2000s, are incentivized to invest in capex-light, later stage technologies with proven product-market fit.

Research from MIT Energy Initiative has shown that from 2010 onward, venture capitalists have sharply reduced Series A funding for new companies and transitioned remaining clean tech investments to software. Between 2010 and 2017, the ratio of investment dollars between early stage versus late stage clean tech venture deals skyrocketed nearly 400 percent, leaving a dearth of capital at the earliest stages.[2]

Philanthropic capital providers, on the other hand, have focused more on grantmaking to policy and advocacy instead of investing directly in new technologies. Today less than 0.5 percent of all philanthropic assets are invested annually in private technology innovation.[3] Even less goes to actionable climate solutions.

Low carbon technologies hold tremendous commercial potential if they can cross the valley of death of early stage funding. In fact, with the right business models and scale, these technologies can fundamentally revolutionize markets. Tesla revolutionized electric vehicles; Nest revolutionized home IoT; Impossible Foods and Beyond Meat are revolutionizing the food industry. What these entrepreneurs are missing isn't a market opportunity, but adequate access to risk-tolerant capital and technology resources at the earliest stages when risk is at its highest. If deployed thoughtfully, corporate philanthropy can shift incentives toward scaling impact-driven startups by reducing perceived technology, product-market fit, and/or financing risk for the commercial market.

2. B. Gaddy, V. Sivaram, F. O'Sullivan, Venture Capital and Cleantech: The wrong model for clean energy innovation, MIT Energy Initiative, 2016. http://energy.mit.edu/wp-content/uploads/2016/07/MITEI-WP-2016-06.pdf
3. An impact investment case study by CAPROCK Group. https://www.caprock.com/wp-content/uploads/2019/05/EMEF_Case%E2%80%93Study.pdf

Catalyzing low carbon innovation

We support low carbon innovation in two ways:

- Direct investments: We invest directly in climate tech startups at the early stages of commercialization. We believe direct investments in startups will yield viable technologies that ultimately reduce greenhouse gas emissions.
- Ecosystem partners: We fund the climate startup ecosystem, which includes accelerators, incubators, and funds to bolster the growth of the entire field. We believe funding the ecosystem will create an enabling environment, allowing a larger number of climate technologies to develop and become investible than the current status quo.

For all organizations in our portfolio, we provide grants or investments through Autodesk Foundation and in-kind support through Autodesk, Inc. This in-kind support could be in the form of donated software, training, or employee pro bono expertise.

In order to decarbonize high emissions industries, many technology breakthroughs are needed. We have begun to prioritize certain technology subsectors where Autodesk's design and make expertise, in addition to our capital, can be particularly relevant: 1) renewable energy generation, storage, and distribution; 2) electrification of transportation; and 3) building/industrial energy efficiency.

In terms of geography, we invest in the United States, where emissions per capita dwarf those of other developed nations, but we recognize the importance of enabling sustainable growth in both emerging and developing markets. Looking ahead, we aim to target mitigation technologies and low carbon adaptation measures across the Global South.

	Total Emissions (MT CO2e)	% of Global	Emissions Per Capita (MT CO2e/p)
USA	5,254	15%	16.5
China	10,292	28%	7.5
India	2,238	6%	1.7
SSA	823	2%	0.8
Rest of World	17,531	49%	4.97

Investing in solutions

Our approach

The roots of Autodesk's commitment to low carbon innovation started in 2007, long before the creation of the Foundation, with the establishment of the company's sustainability goals. The Cleantech Partner Program[4] launched in 2009 and became a cornerstone initiative of the Autodesk sustainability strategy by providing clean tech companies with software grants to help in the design and manufacture of products that improve environmental performance and mitigate future emissions.

The Cleantech Partner Program provided Autodesk exposure to hundreds of technology startups using design and engineering in the energy and environmental sector. In the early years of the Foundation, this served as an initial pipeline for the types of promising early stage technologies we would consider funding. However, given the volume and diversity of the technologies we encountered, we lacked the ability to evaluate the viability of these technologies in a structured format.

Partnering with ecosystem organizations such as Prime Coalition, Cyclotron Road, Village Capital, and Venture Well helped us to understand early stage technologies from a market and investment perspective. Their networks also helped expand our pipeline of opportunities.

In short, these partnerships gave us a nuanced view of the funding landscape and the role of incubation and acceleration for unproven, novel technologies. Over time, we built internal capacity for technical and investment diligence and fine-tuned our investment thesis and post-investment in-kind services, allowing us to launch an investing function supporting low carbon entrepreneurs directly.

4. The Cleantech Partner program granted Autodesk software and technology to hundreds of early stage social impact startups and entrepreneurs before merging with Autodesk's nonprofit donation program in 2018 and re-branding as the Technology Impact Program. Since 2015, Autodesk has donated $98M USD in software to thousands of organizations across the globe.

Investment timeline

	Pre-2015 Exposure	2016 Exploration	2017 Commitment	2018 to today Continued investment
Stage	We garnered exposure to the clean tech innovation landscape via the successful growth of Autodesk's Cleantech Partner Program.	We sought out intermediaries in the climate ecosystem as partners and began to articulate a thesis around supporting early stage technologies to address climate change.	We publicly committed to a thematic focus for our portfolio, centered on climate change mitigation and adaptation. We made our first program-related impact investment.	We crystalized our focus on climate change, developing investment rationale for each subsector. We deepened formal and informal relationships with pipeline partners and co-investors and began to build out a direct investment portfolio.
Rationale	We used our exposure to the clean tech community to better define potential features for Autodesk's own product suite.	We explored the startup landscape around climate mitigation via ecosystem investments without needing to fundamentally restructure our team and processes.	We demonstrated a commitment to a critical global challenge and used a thesis-driven approach to address it.	We deepened direct investment relationships to maximize value creation and growth with a portfolio of investments.
Investment output	We granted software to a myriad of cleantech startups, prior to the Foundation's formation.	We utilized Prime Coalition as a financing intermediary to support early stage for-profit technologies. Our grant was deployed as investment capital into two startups.	We made our first equity-based impact investment in Closed Loop Ventures.	We made our first direct impact investment using a SAFE note into a low carbon startup–Treau. We invested in Prime Impact Fund through a $1M recoverable grant.

How we think about impact

We define impact in low carbon innovation simply as greenhouse gas emissions abatement, i.e., mitigating the amount of carbon dioxide and other global warming–inducing elements in the atmosphere. As investors at the earliest stages where risk is greatest, we target opportunities where potential impact outcomes are commensurate with the underwritten risk. We therefore target moonshot opportunities–those that at scale could mitigate greater than 500 million metric tons (MMT) carbon dioxide equivalent (CO2e) annually.

Although there is complexity in any attempt to model potential future CO2 mitigation, it is a quantitative metric that can be used to compare potential impact across a diverse set of investment opportunities. The impact we are attempting to catalyze within the climate startup ecosystem is both qualitative and quantitative. We consider the number of entrepreneurs and startups supported, follow-on capital raised, milestones met, growth rates achieved, mentorship networks strengthened, and the benefits of increased visibility through thought leadership.

In the table below, we explore some of the metrics we are asking our partners to track and how they connect to the ultimate outcomes we want to see in the ecosystem. This drives our definition of success.

	Opportunity area	Action	#Metric	Why this is important
	Low Carbon Innovation	Ecosystem Investments: Funds, Incubators, Accelerators	# of companies supported	Grow the innovation pipeline so that we maximize the number of new approaches and technologies
			# Follow-on funding # Funders	Expand the capital base and funder/investor profiles so that more funding flows into this space
			# % of companies active	Indicative of maturity of technologies and companies
	Low Carbon Innovation	Direct investments in startups	# CO2e mitigated	Show the impact of the technology on the planet
			# CO2e reduction potential	Indicative of the promise of impact of the technology on the planet

Our impact since 2016

- We've built and supported a portfolio of seven[5] low carbon innovation startups and ecosystem partners.
- We've invested in two companies, two impact-oriented funds, and three incubators/accelerators, yielding $100.5M in follow-on funding from an Autodesk initial capital commitment of $2.5M and a total investment from our ecosystem partners of $30.4M (as of July 2019).
- These efforts have resulted in a portfolio capable of potentially mitigating upwards of 11 GtCO2e. Of this emissions reduction potential, 67,500 metric tons CO2e of abatement has been realized to date. We provide more detail on three partnerships in the case study section of this brief.
- Beyond financial capital, we've engaged 13 companies with in-kind technology, training support, and pro-bono expertise.
- We have also donated more than $100M worth of software to approximately 1800 clean tech organizations.

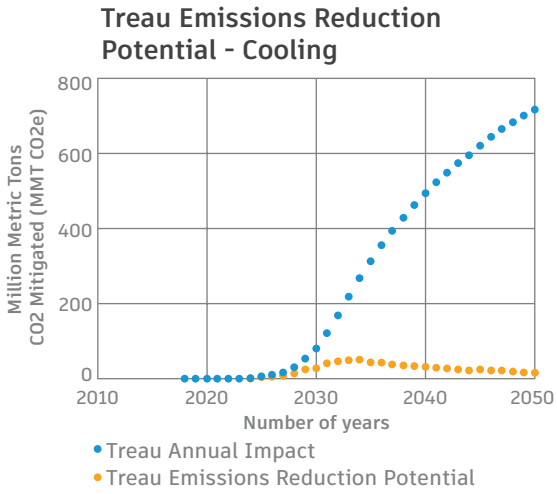
Case study: Treau

Impact objective

Mitigate space heating and cooling emissions with residential HVAC products.

Space heating and cooling presents a massive climate challenge. Nearly 10 percent of total US primary energy goes to conditioning (heating or cooling) spaces, and this demand is skyrocketing globally. It is estimated that two times as many people will have access to conditioned spaces in the next 10 years due primarily to economic growth in emerging markets, leading to two-thirds of the world's households conditioned by 2050. Treau meets this increasing demand for conditioned spaces without sacrificing the integrity of the planet through a well-designed and better-performing product for consumers.

Treau is developing heat exchangers and compressors based on soft polymer membranes with the potential to make heating, ventilation, and air conditioning (HVAC) applications twice as efficient without the need for harmful greenhouse gas-emitting refrigerants. Treau's first product, a cost-competitive room air conditioner and space heater with performance more than twice that of best-in-class window units, is capable of mitigating over 700 MMT CO2e by 2050[6] in cooling alone.



5. Closed Loop Ventures, Prime Coalition, Rebound, Treau Inc., Venture Well, Village Capital, Cyclotron Road
6. International Energy Association (IEA), The Future of Cooling: Opportunities for energy-efficient air conditioning, 2018. https://webstore.iea.org/the-future-of-cooling

"Treau's mission is to make people's homes more comfortable without compromising the environment. We began with a strong conviction that great product design of environmentally friendly technologies was the key to having a big impact on one of the biggest challenges we face, mitigating climate change. Autodesk was an ideal partner as they understand why design is important for adoption of low-carbon technologies."

– Vince Romanin, Treau CEO

Investment rationale

Autodesk Foundation participated in Treau's seed round because of our conviction that low-emission HVAC solutions will be vital to mitigating emissions in the built environment, the unique role design plays in unlocking a potentially high-growth direct-to-consumer distribution model, and our ability to be catalytic beyond capital with a founder that has unwavering commitment to delivering climate impact at scale.

Since investment, Treau has developed and tested a series of beta units with consumers and secured $5.8M in follow-on grant funding. This has positioned the company for initial commercial sales in 2021.

"Mitigating climate change is the challenge of our lifetime, and we need to pull every lever to answer the call. This includes not only public policy interventions, behavior change, and deployment of proven technological solutions in the places that matter most. It also must include developing the unproven solutions of tomorrow and making sure they have a path to commercial scale, as fast as possible."

– Sarah Kearney, Prime Coalition Founder & Executive Director

Case study: Prime Coalition

Impact objective

Unlock philanthropic capital to invest in breakthrough climate solutions.

Prime Coalition is a 501c3 public charity that partners with philanthropists to invest in market-based solutions to climate change. Through a first-of-its-kind Impact Fund, Prime Coalition supports startups working on extraordinary technologies that promise significant reduction of greenhouse gas emissions, are attractive to follow-on investors, and would otherwise have a difficult time raising commercial capital. Since its inception, Prime Coalition has mobilized $11.1M into 13 ventures promising upwards of seven annual gigatons in greenhouse gas emissions reduction potential.[7]

Investment rationale

Prime Coalition is at the forefront of climate impact and philanthropy, having been built to unlock philanthropic capital to invest in actionable solutions to climate change. Autodesk Foundation invested in Prime Coalition and the Prime Impact Fund to support investments in actionable low carbon innovation breakthroughs, to further unlock more risk tolerant capital into the sector, and to help build a movement that reshapes philanthropy and technology investing.

7. C.Motive, Lilac Solutions, MicroByre, Via Separations, Quidnet Energy, RedWave Energy, ConnectDER, Anfiro, Rebound, Wright Electric, Opus 12, Mallinda, Treau Inc.

"Our ability to mitigate and adapt to a changing climate directly relates to how we obtain, generate, and manage resources, including food, water, energy, waste, and the material building blocks of society. The premise of Closed Loop Ventures is that these resource-efficiency technologies and new business models are better for the environment, society, and for the bottom line of companies and individuals who buy these products and services."

– Danielle Joseph, Closed Loop Ventures Investment Officer

Case study: Closed Loop Ventures

Impact objective

Invest in and scale startups delivering a circular economy future.

Closed Loop Ventures (CLV) catalyzes solutions for the circular economy through early stage equity investments across the entire circular value chain, from collection, sortation, and processing to the design, manufacturing, and distribution of consumer goods. CLV's portfolio consists of sustainable consumer goods companies, advanced recycling technologies, and services related to the circular economy—in service to reducing waste or closing the loop on various materials.

Since inception, CLV has mobilized over $14M into 16 ventures.[8] These ventures, by closing the energy and material loop, promise upwards of four gigatons in greenhouse gas emissions reduction potential by 2050.

Investment rationale

Closed Loop Ventures and its parent organization, Closed Loop Partners, have been leaders in shaping the circular economy innovation landscape across all stages of company growth. Closing the loop on energy and materials—across all sectors—will be vital to mitigating emissions when a world of 10 billion people in 2050 demands ever more goods and services. CLV supports actionable solutions and aims to further the collective understanding of circularity and climate mitigation.

8. AMP Robotics, HomeBiogas, Cambridge Crops, Rebound Technologies, Atlas Organics, CurbMyClutter, Evrnu, For Days, The Renewal Workshop, Thrilling, Loliware, Linhaus, Natural Machines, TradeLanes, CoLoadX, EasyAerial

Way forward

In conclusion

We know that a problem as important as climate change will not be solved by technology innovation alone. Coordinated action that brings forward a greater set of holistic solutions will be required—from regulations and policies to incentivize and enforce corrective action in industry, to community advocacy and awareness, to individual and household behavior change. People are still at the center of this work to drive large scale systemic change in a just and equitable manner.

Our identity as a tech corporate philanthropy positions us to be most effective in supporting early stage technology innovation that we know is needed. In the last five years we have learned several key lessons that continue to guide our work:

Lessons learned

Impact is a direct result of commercial success

We target opportunities where commercial success yields positive impact outcomes. We're impartial on go-to-market and marketing, but impact must be fundamentally embedded in the business model, not a staple on.

Founders-centric

Achieving transformative impact in climate technologies requires moving mountains. Many low carbon innovations compete in heavily regulated industries with large incumbents. Disruptions come more from founders and their persistent drive, and technology innovation is a by-product of that drive.

Patience is a necessity

We aren't beholden to a closed end fund cycle and thus take this flexibility as a responsibility. We aim to align incentives to long-term impact outcomes through our deal structures and relationships.

Next steps

In the last five years, we have evolved our thinking on how to evaluate the impact of our portfolio. Rather than only considering impact at the end, we define the problem we are trying to solve at the outset of a partnership. This is essential to identifying right types of solutions and outcomes we want to catalyze in the world. Only when we have a clear understanding of the solutions and outcomes can we then measure the impact that matters.

Looking ahead, our low carbon innovation work will be to drive the creation of new technologies that can drastically reduce CO2 emissions, this is our impact north star. We invite fellow philanthropists, investors, and corporates to join us on this journey, through syndicating capital together and working with our portfolio of low carbon innovations.

We will strive for cross-sector collaboration to push forward systemic change to drive toward a shared vision of impact.

We invite you to join us.
Contact us at info@autodesk.org

Appendix

Additional resources

There is a well-established body of scientific knowledge on the causes and effects of climate change, as well as the new financing mechanisms needed to support climate innovation. We have included a selection of resources undertaken by reputable public sector research bodies and portfolio partners below.

- Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report
- IPCC's Special Report on Global Warming of 1.5° C
- Climate Policy Initiative's Global Landscape of Climate Finance 2017
- US Energy Information Administration's International Energy Outlook 2018
- Stanford Social Innovation Review's The Investment Gap that Threatens the Planet

A note of thanks

Thank you to the following organizations who helped us review and provided insights into the information in this impact brief: Prime Coalition, Closed Loop Ventures, and Treau.