Climate Tech Convening

2020

EDF ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

SYNTHESIS REPORT

From the Planning Committee

On January 29–30, 2020, in San Francisco, we brought investors and experts together with entrepreneurs who are building the climate solutions needed for a safe and healthy future. We were inspired by companies that are seeking to grow their market share today, as well as by those that are still developing their technologies. Although financial rewards typically take some patience, there are clearly high-impact options open to investors across the entire risk spectrum.

As we've reflected on the terrific conversations that took place, three key insights have emerged:

- Supporting entrepreneurs is critical to stabilizing the climate, and we need more of these kinds of community-building opportunities.
- Many promising solutions are technically advanced, which means investors need access to scientific and engineering expertise — often across a range of disciplines — to make informed decisions.
- Celebrating climate tech pioneers can inspire people's optimism and drive action on incentives that can help bring climate solutions to scale.

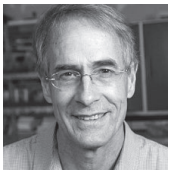
Join us in achieving the full promise of innovation in solving the climate crisis.

— Len Baker, Matt Cohler, Dani Lambert, Kathryn Murdoch and Matt Rogers

This report is organized around four sectors with great potential to use technology to reduce climate pollution *(see "Climate math," p. 6).* For more information, please contact **EDF Executive VP Amanda Leland, aleland@edf.org or 202-387-3500.** Speakers' viewpoints are their own and do not necessarily represent the views of EDF, nor does EDF endorse the companies or products listed in this report.

Agriculture

Briefing



Keith Paustian, University Distinguished Prof., Dept. of Soil and Crop Sciences, Colorado State Univ.; Coord. lead author, IPCC national GHG inventory

- More carbon can be stored in soil through greater use of proven practices (e.g., diversified crop rotations, no-till) as well as R&D for frontier technologies (e.g., perennial grains).
- Exciting co-benefits of soil carbon building include: better soil health, increased water storage, higher and more stable yields, reduced runoff and erosion. No change in land use needed.
- Reduce nitrous oxide emissions from cropland through better fertilizer management and improved technology.
- Reduce methane and nitrous oxide from livestock by using feed additives, improved manure management, genetics and production efficiency.
- To address permanence of carbon storage, design systems to be more profitable than old practices.

Barriers and strategies

What three barriers, if removed, would lead to the most impact *(as ranked by Climate Tech Convening participants)* on emissions reduction and avoidance? What strategies could help remove those barriers?

1. **Lack of verification tools and tracing.**

   Strategies: Collect complete data from farm to table. Provide incentivization. Much today is clipboards and paper; need to modernize. Blockchain has promise.

2. **Farmers' resistance to change in behavior/practice.**

   Strategies: Farmers need to see the impact on the ground, so conduct independent field trials in each area. Replicate U.S. government-backed agricultural extension services in other countries.

3. **Market pricing does not favor better products and sequestered carbon.**

   Strategies: Partnerships with food distributors for low-carbon products. Development finance institutions could set best practices. Provide incentives (e.g., favorable lending rates, shelf space). Adopt a marketing word akin to "Organic."

Agriculture entrepreneurs

Charm Industrial
Peter Reinhardt | Co-Founder and CEO
peter@charmindustrial.com

Charm Industrial is working to produce reliable, cost-competitive green hydrogen from biomass. Raised $3.5M to date.

DSM Nutritional Products
Mark van Nieuwland | VP and Program Director Clean Cow
Mark.Nieuwland-van@dsm.com

DSM's Bovaer feed additive for cows and other ruminants consistently reduces enteric methane by 30%. In scaling and commercialization stage. Open to funding for scaling.

Full Harvest
Christine Moseley | Founder and CEO
Christine@fullharvest.com

Full Harvest is addressing the massive food waste problem as the first business-to-business online marketplace for 'ugly' and surplus produce. Raised $11.5M including Series A.

Hazel Technologies, Inc.
Aidan Mouat | CEO
Aidan@hazeltechnologies.com

Hazel Technologies' products reduce waste in the food supply chain by preventing the spoilage of produce and other perishables. Finished Series B funding round.

KETOS Inc.
Meena Sankaran | Founder and CEO
meena@ketos.co

KETOS offers real-time water monitoring and actionable data analysis to boost yield and manage runoffs and groundwater contamination for agriculture. Autonomously detects and analyzes 23+ water quality parameters within a single modular system with no capital expense. Raised $13M in Series A.

Pivot Bio
Karsten Temme | CEO and Co-Founder
karsten@pivotbio.com

To provide farmers with a way to fertilize without the pollution caused by synthetic nitrogen fertilizers, Pivot Bio developed a nitrogen-producing microbe for cereal crops. These naturally occurring microbes adhere to the plants' roots and supply nitrogen. Completed Series B.

Trace Genomics, Inc.
Poornima Parameswaran | Co-Founder
poornima@tracegenomics.com

Trace Genomics performs biological analysis of the soil to create actionable insights that help optimize production, utilize integrated nutrient management and mitigate soil degradation. It maps DNA of soil microbial constituents to track pathogens and results of actions. Post Series A; $22.5M raised.

Carbon removal

Briefing

Jen Wilcox, James H. Manning Chaired Prof. of Chemical Engineering, Worcester Polytechnic Inst.; former Stanford Univ. prof. in energy resources engineering

- Removing CO_2 won't substitute for avoiding emissions, which is cheaper and easier; we'll need to do both. The permanence of removal (e.g., underground) is critical.
- The more dilute the CO_2, the costlier to capture. For example, it takes only 1/3 the energy to remove CO_2 from coal-plant flue gas exhaust as from ambient air.
- Direct air capture (removing CO_2 from ambient air) now costs about $600/ton CO_2. Assume innovations will bring that down to $100/ton. Then, $20B per year could buy capture of 200M tons of CO_2 annually, about 5% of U.S. emissions (aviation plus long-haul trucking). Land use implications of such a project could be sizable, depending on the energy source.
- If natural gas is used as the energy source for direct air capture — even with carbon capture at the exhaust — methane emissions associated with the production and transportation of the gas must be eliminated or minimized. Failing to address such emissions would significantly undercut the climate benefits associated with CO_2 removal.

Barriers and strategies

1. **No national price to store carbon.**

   Strategies: Increase the transparency of current data, including from tipping fees, 45Q income tax credits and enhanced oil recovery. Need tracking mechanism for verification.

2. **Cost for direct air capture is currently too high per ton.**

   Strategies: Fund more research in direct air capture breakthroughs. Give each company a subsidy until costs come down, as with electric vehicles.

3. **Market for captured CO_2 is too limited.**

   Strategies: Finance and build more CO_2 pipelines and injection sites to eliminate bottlenecks. Create a trading platform connecting CO_2 suppliers and users.

Carbon removal entrepreneurs

8 Rivers (NET Power)
Bill Brown | CEO
bill.brown@8Rivers.com

8 Rivers developed the Allam-Fetvedt Cycle licensed to NET Power to produce zero-emission power from natural gas while providing industrial-grade CO_2. It can be built in the desert (needs no water) or underground (needs no smokestack). 8 Rivers is considering additional investors.

Blue Planet, Ltd.
Ken Hines | VP Business Development and Licensing
khines@blueplanet-ltd.com

Blue Planet's patented technology captures CO_2 directly from the atmosphere and/or flue stack and, without any purification step, uses it to form limestone aggregates to be sold at a profit for use in concrete, permanently sequestering the CO_2. Doing Series C funding.

LanzaTech
Benjamin Blackburn | VP of Corporate Development
ben.blackburn@lanzatech.com

LanzaTech uses gas fermentation technology and proprietary microbes to convert carbon-rich gas streams to ethanol, jet fuel and high value chemicals such as plastics and synthetic fibers. It has raised $400M over five rounds and is considering additional growth capital.

Mosaic Materials
Thomas McDonald | Co-Founder and CEO
tmcdonald@mosaicmaterials.com

Materials are 80% of direct air capture costs today. Mosaic is developing a materials technology for direct air capture that will enable capture costs below $100/ton by providing superior CO_2 capacity and process flexibility. Fundraising in Q2 2020.

Opus 12
Etosha Cave | Chief Science Officer
cave@opus-12.com

Opus 12 has developed a device that bolts onto industrial sources of CO_2 emissions and, with only water and electricity as inputs, transforms that CO_2 into cost-competitive chemicals and fuels. Starting a Series A.

Verdox
Sahag Voskian, Ph.D. | Co-Founder and CTO
svoskian@verdox.com

Verdox's proprietary 'electroswing adsorption' tech, invented at MIT, uses shifts in voltage rather than temperature or pressure to capture atmospheric CO_2 and release it at pressure, with 80% lower energy input than current technology. Closed first round of financing.

Advanced nuclear

Briefing

Rachel Slaybaugh, Asst. Prof., UC Berkeley Nuclear Engineering Dept.; Program Director, Advanced Research Projects Agency–Energy

- 450 reactors in 30 countries produce 10% of electricity (20% in U.S.). The market for new reactors is likely to remain primarily outside the U.S. through 2030.
- Gen III+ reactors use more passive safety (e.g., gravity); 67 being built, 165 planned.
- Gen IV reactors aim to have no offsite accident consequences and maintain proliferation resistance. The types vary by fuel choice (form and enrichment level), generation size (from 1 to 1000 MW, allowing new deployment models) and coolant type. A few designs may be on the market by 2025, more by 2030.
- Some Gen IV operate at higher temperatures, up to 1000°C, suitable for certain industrial processes. Some can vary their output to integrate well with renewables on the grid.
- Fusion is making progress, but it's unclear when a commercial plant will be available.

Barriers and strategies

1. **Fear of nuclear (safety, security, proliferation, waste).**

   Strategies: Ensure that Gen IV designs fully address concerns, including fuel cycles that can't lead to weapons manufacture. Engage the public on how the designs could be used in their communities, and have an open discussion about public fears. Consider rebranding new designs as new technologies.

2. **U.S. environmental and energy policies biased against valuing nuclear as carbon-free energy.**

   Strategies: Support federal, state and local policies targeted at achieving 100% carbon-free electricity by 2050. Recraft renewable portfolio standards to be 'clean energy standards,' enabling nuclear to qualify. Price carbon. Qualify nuclear for green bonds.

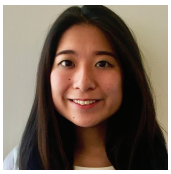
3. **U.S. limitations on the export of nuclear technology.**

   Strategies: Build official consensus that Gen IV development and export is in the U.S. interest. Remove export funding barriers at the U.S. International Development Finance Corporation and the World Bank.

Advanced nuclear entrepreneurs

Commonwealth Fusion Systems
Tyler Ellis, Ph.D. | Advisor
tyler@cfs.energy

CFS sees a path to an operating fusion power plant in 15 years, leveraging a collaboration with MIT. Developing a new class of high-field superconducting magnets to demonstrate net energy from fusion for the first time in 2025. $115M in Series A funding.



Elysium Industries
Carl Perez | Co-Founder and CEO
c.perez@elysium-v.com
Seira Mori | Co-Founder and COO
s.mori@elysium-v.com

Using declassified U.S. DOE technologies, Elysium's 200-1200 MW reactor concept can decarbonize all energy end uses while addressing the industry's impediments (high costs) with 'hands-free' safety, the reuse of nuclear waste (more than 1000 years of power) and enhanced proliferation resistance. Prototype to be operational by 2027; raising its Series A round.

NuScale Power
Lenka Kollar | Director, Strategy and External Relations
lkollar@nuscalepower.com

NuScale has developed a modular light water reactor for electrical generation, district heating, desalination and other process heat applications. It uses a factory-fabricated 60 MW module with a safer, smaller, scalable version of pressurized water reactor technology. Majority investor Fluor Corporation.

Oklo Inc.
Jake DeWitte | Co-Founder and CEO
J@oklo.com
Caroline Cochran | Co-Founder and COO
C@oklo.com

Oklo's first advanced fission power plant, the Aurora, can produce 1.5 MW of reliable, affordable, distributed clean energy for 20 years without refueling. The plant can use waste from today's reactors as fuel and has the potential to save more than 1 million tons of carbon, compared with fossil alternatives. Three rounds of funding, most recently Series A.

TerraPower
Jeff Navin | Director of External Affairs
c-jnavin@terrapower.com

TerraPower was founded in 2006 to develop advanced nuclear energy projects including molten salt reactors, which have a high degree of passive safety, and traveling wave reactors, which have the potential to operate more efficiently for long periods with less waste. Funding from Bill Gates, DOE and others.

Transportation

Briefing

Dan Sperling, Prof. at UC Davis; Founding Director, Institute of Transportation Studies; Member of California Air Resources Board

- As the largest emitting sector, transportation accounts for 30% of U.S. greenhouse gas emissions, and it is the most difficult sector to decarbonize.
- Emissions are going up (because people are driving more), and despite the gains in electric vehicle technologies, we still rely overwhelmingly on internal combustion engines.
- Vehicle electrification is by far the most important strategy. Automakers are committed to electric vehicles. Cars and SUVs represent close to 60% of U.S. transportation emissions. Trucks 20%. Aviation 10%.
- Biofuels will be needed for long-haul trucking and long-haul aviation. Shift the focus of biofuels from ethanol (which we don't need, because electrification will replace gasoline) to diesel and aviation fuels.
- Policies such as California's Low Carbon Fuel Standard can help stimulate innovation in electric vehicles, low-carbon aviation fuels and even direct air capture of CO_2.
- Over time, the widespread availability of automated vehicles and ride-sharing could reduce emissions, since automation will reduce travel costs when carrying multiple passengers.

Barriers and strategies

1. **The role of electric utilities in accommodating electric vehicles on the electric grid.**

   Strategies: New regulatory approaches could foster steps by electric utilities to promote vehicle electrification. Show how this benefits consumers directly. Fund it without raising electricity prices.

2. **Cities are built around cars and legacy transit.**

   Strategies: Don't take current infrastructure for granted; new generations have different preferences. Create a culture of good incentives. Show subway operating schedules in real time. Build weather-shielded electric mobile travel pods that fit in bike lanes.

3. **Consumer habits.**

   Strategies: Model transportation as a service, with integrated payment systems. Make electric vehicle test drives and trials easy. Speed recharging. Make pooled services faster, cheaper, nicer.

Transportation entrepreneurs

Electriphi
Sanjay Dayal | Co-Founder and CTO
Sanjay.Dayal@electriphi.ai

The Electriphi platform leverages machine learning algorithms to provide comprehensive fleet and energy management solutions. These reduce operational costs significantly, while accelerating deployment of infrastructure and electric vehicles. Finished seed round.

Sila Nanotechnologies
Gene Berdichevsky | Co-Founder and CEO
gene@silanano.com

Sila Nanotechnologies designs and manufactures advanced battery materials to dramatically improve energy storage and accelerate the electric car revolution. Its new battery materials chemistry enables lighter, safer, higher energy density batteries. Raised over $340M to date.

Streetlight Data
Laura Schewel | CEO
laura.schewel@streetlightdata.com

Without the need for sensors or surveys, Streetlight Data uses trillions of mobile location data points to measure mobility of vehicles and people, providing on-demand analytics for transportation planning, policy and operations. This reduces vehicle miles traveled through better decision-making and optimization of vehicular infrastructure. Three rounds of capital totaling $27M.

Perspectives on the climate tech playing field

Systems thinking

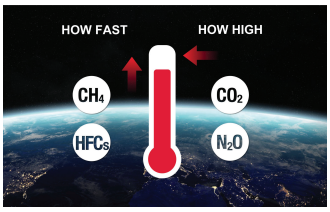
Matt Rogers | Co-Founder of Incite and Nest Labs

I started my career at Apple, and Apple is all about end-to-end thinking. How can we apply that systems thinking to the kind of change we want to see in the world?

I hope philanthropists are looking for the highest risk things no one else could fund that could eventually have impact. Those are the kind of shots on goal I think philanthropy should take.

For investors, finding the right entrepreneurs and giving them that early capital can have monumental impact — even looking at what's frowned upon, as taking CO_2 out of the air was until recently. And then the third piece of systems thinking for climate tech is to help stimulate government policy and funding.

Climate math: Pathways to reach net zero

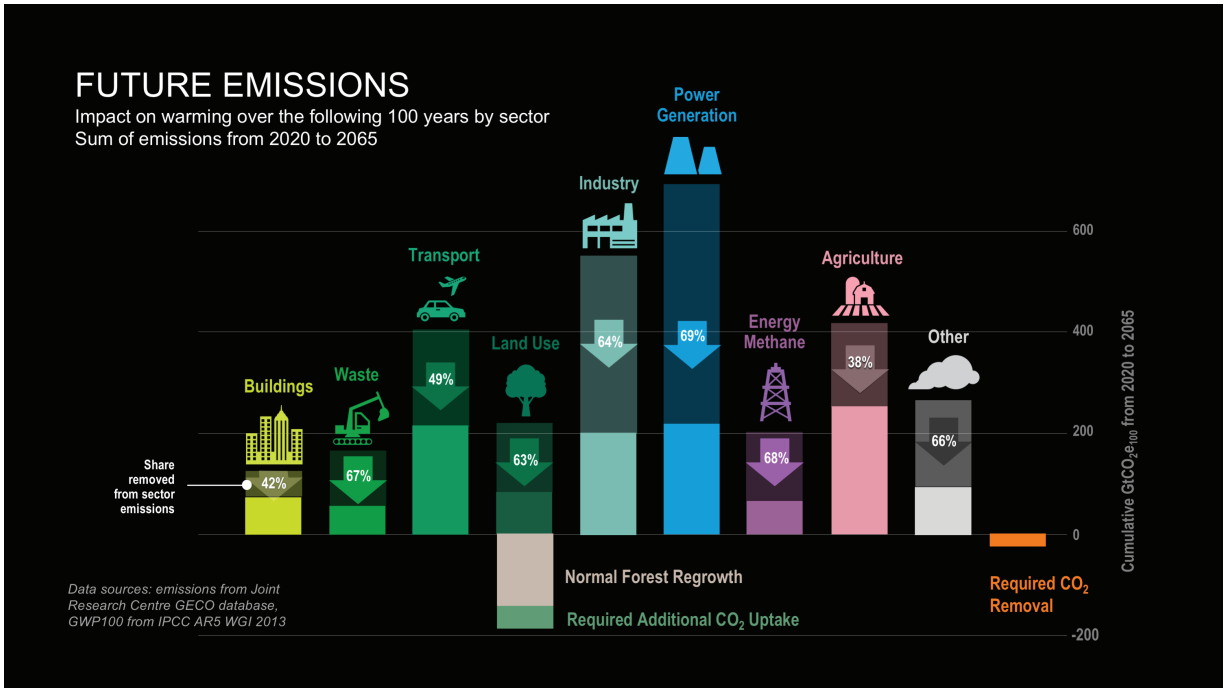


Nat Keohane, EDF Senior Vice President for Climate
Ilissa Ocko, EDF Senior Climate Scientist

Prior to the Tech Convening, Nat Keohane and Ilissa Ocko conducted a live 20-minute webinar on the sources of greenhouse gas emissions and the reductions that will be needed by midcentury to stabilize the climate. A complete recording of the webinar and Q&A is at *edf.org/climatemath.*

Key points include:

- Emissions are concentrated in a relatively small number of countries, with more than half the impact on warming in this century expected to come from China, India, the U.S. and the EU.
- Emissions of methane (CH_4, mainly from oil and gas operations and agriculture) and hydrofluorocarbons (HFCs, which are common refrigerants) determine **how fast** the Earth will warm. They play an outsized role in near-term warming.
- Carbon dioxide (CO_2, primarily from fossil fuel combustion) and nitrous oxide (N_2O, primarily from agriculture) control **how high** the global average temperature will ultimately go.
- Technology can help achieve the types of reductions in emissions needed by midcentury to stabilize the climate. In the figure below, each column's height is proportional to projected total emissions for that sector through 2065. The percentage reductions shown represent one possible path to stabilize the climate.
- For a stable climate, we must achieve **net-zero emissions** by midcentury, that is, to be adding no more to the air than we remove. This will require new CO_2 removal technologies *(see p. 3)*.



The essential series of events

Chris Costello | Prof. of Resource Economics, UC Santa Barbara
EDF Trustee

For climate tech to put a major dent in the climate problem, a series of events must occur that will draw on our collective expertise:

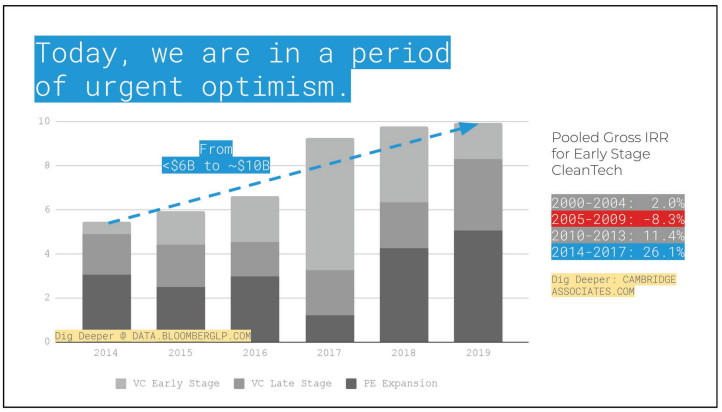
- Innovations must be targeted toward the right sectors — the ones that contribute the most emissions and have the potential to reduce the most. Insights from climate scientists can help ensure this.
- The innovations must find a market and be able to scale. This requires astute entrepreneurs and skilled investors.
- Smart climate policy can stimulate investment. That's where economists and policy experts come in.

A period of urgent optimism

Ryan Panchadsaram | Advisor to the Chair, Kleiner Perkins
Former U.S. Deputy Chief Technology Officer

With all the troubling news on the climate crisis, we are in a period of urgent optimism for climate tech investment. The amount of venture capital flowing into clean tech companies has steadily increased over the past six years. When you look at the private markets and see internal valuations, the companies started in 2014 and beyond have a healthy internal rate of return.

- We need more early stage capital and ways to support audacious founders reaching for the North Star of zero emissions at scale.
- The bar is higher for all of our products. No one pays more for a lesser product with an eco-friendly badge. They expect superior products with equivalent or better performance. Tesla, Beyond Meat and Nest are wonderful examples.



The innovation supply chain

Matt Price | President and Chief Operating Officer, Activate

For the climate tech innovation supply chain — from discovery to prototyping, manufacturing, permitting and customer adoption — the key question is: How do we speed up the commercial deployment of new technologies? The answer to that is hard and always changing.

- Venture capital, late-stage capital, philanthropy and government each have their own business models for investment. Make sure that the business model of your technology overlaps with the model of the money that's going to bring it forward.
- It's not sufficient to have a manufacturable technology and customers that want to buy it. For solutions targeting climate change, there are often major issues with permitting, regulations and other policies that can have a very significant impact on deployment.
- The human behavior element doesn't get enough attention. We have a very conservative customer base, because of concerns about jobs, safety, longevity and reliability that take time to answer. Often, entrepreneurs focus on the economic reasons why customers would buy a solution and fail to address the vast behavioral reasons why they would not — at least not quickly.

Next steps

Hope for the future

Amanda Leland | EDF Executive Vice President

The Climate Tech Convening gave me a tremendous sense of hope for the future. The energy and vision of the entrepreneurs spread throughout the venue, and we achieved our goal of connecting them with investors, academics and climate policy experts under one roof.

Already, I've heard many calls to build on this event, to continue creating new bridges and to help ensure a strong and collaborative climate tech community of practice and action.

Based on what we heard, we're also looking for ways to connect investors with expert advisers to help them gauge the validity of proposed technologies.

Climate heroes are not only those in today's media spotlight, but all of the inventors, data experts, engineers and entrepreneurs — and those who provide the resources to bring their ideas to scale. EDF is proud to join with you all on this critical mission.

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