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CARBON180

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This work is preliminary, and subject to change. Questions and comments are welcome at givinggreen@idinsight.org. ***Last updated November 12, 2021.***

Executive Summary

In this document, we provide a descriptive overview of Carbon180's activities and describe a quantitative cost-effectiveness analysis (CEA) model that assesses the organization's marginal impact. Based on our assessment, we believe that Carbon180's work on supporting carbon removal technologies and practices will lead to reductions in greenhouse gases in the atmosphere. We focused our assessment on Carbon180's federal policy workstream, which included advocating for carbon removal and carbon management solutions in the Infrastructure Investment and Jobs Act and Build Back Better Act. Carbon180's other work, which was not incorporated into our CEA model, includes its programs on improving soil carbon practices and bringing carbon removal research to market. It is also starting some initial work on developing a federal procurement program to expand the carbon removal market.

We estimated that Carbon180's work on federal policy can remove CO_2 from the atmosphere at a cost of $0.66 per metric ton (in expectation), which compares favorably to other high-performing organizations that we have analyzed. Because our CEA model only includes Carbon180's work on federal legislation and does not include Carbon180's full portfolio of work, it seems likely that we may even have underestimated Carbon180's impact and cost-effectiveness.

Notably, a large part of Carbon180's potential impact relies on how quickly the cost of negative emission technologies drops over time. Although this aspect of Carbon180's work is inherently uncertain, Carbon180 is directly driving down costs by advocating for increased funding for carbon removal research and development. We are cautiously optimistic that Carbon180 will remain cost-effective in the future because it has proven itself to be nimble and has also maintained a portfolio of solutions instead of honing in on any one type of carbon removal technology or practice. It therefore seems likely to us that Carbon180 would be able to pivot if one of its projects turned out to be less impactful than expected.

We recommend Carbon180 as one of our top charities to donate to based on its strategy of supporting neglected technologies and practices, organizational strengths, and cost-effectiveness. However, we are somewhat uncertain about Carbon180's need for more funding in the near future and its ability to scale. Nonetheless, we still believe that it is worthy of a recommendation given its past performance and current funding gap. We may change our recommendation in the future if Carbon180 raises more money than it can spend effectively.

Overview

Carbon180 is an insider policy advocacy organization that focuses on accelerating the development of carbon removal solutions. Its four initiatives include (1) building and enacting federal policy to scale up carbon removal solutions, (2) accelerating the adoption of soil carbon sequestration practices, (3) encouraging community engagement between carbon removal researchers, and (4) stimulating innovation. In terms of federal policy, Carbon180 both develops and lobbies for policies that support carbon removal technologies and practices. For example, it has developed policy playbooks for both the Biden administration and Congress. In 2021, its federal policy work included advocating for carbon removal research, development, and deployment (RD&D) and increasing the 45Q tax credit for carbon sequestration and direct air capture (DAC). Outside of the US, Carbon180 has worked on expanding carbon removal internationally such as through its partnership with Carbon Gap.

Giving Green's Research

We researched Carbon180 by reviewing publicly available information about the organization, speaking with its representatives, speaking with multiple experts on carbon removal and climate policy, and conducting a CEA based on data that we found. Publicly available information on Carbon180 included its website and various policy reports as well as media coverage of the organization. Founders Pledge, an organization that recommends impactful donation opportunities to entrepreneurs, also has a report on Carbon180's work that covers its benefits and general cost-effectiveness.

History of Carbon180

Carbon180 was founded in 2015 as the Center for Carbon Removal by Giana Amador and Noah Deich. It was incubated at the University of California, Berkeley, where both Amador and Deich were students at the time. The organization's initial goals included conducting research and analysis on opportunities and challenges related to carbon removal systems; hosting events on carbon removal research needs; and curating an online hub of information on carbon removal. Carbon180's policy emphasis grew over time as it became clearer to the organization that federal policy is highly important for catalyzing innovation and unlocking capital for carbon removal. In 2020, Carbon180 moved its operations to Washington, DC in order to enhance its impact via policy.

Carbon180 in Historical Perspective

What are carbon capture and carbon removal?

Carbon capture and carbon removal refer to a broad set of technologies that concentrate CO_2 at higher-than-atmospheric levels, usually to remove or prevent emissions into the atmosphere.

Carbon capture usually refers to the removal of CO_2 molecules directly from a point source of carbon emissions. Often, it takes the form of "scrubbers" that sit at the top of coal-burning power plants and absorb the carbon dioxide directly from the exhaust. When the CO_2 is converted into other useful products, this is referred to as carbon capture and utilization (CCU); when it is sequestered, it is referred to as carbon capture and sequestration (CCS). Carbon capture, utilization and sequestration (CCUS) is an umbrella term sometimes used to refer to both processes.

Carbon dioxide removal (CDR) removes carbon directly from the atmosphere where it is far more dilute. This can happen through biological ecosystem processes or through negative emissions technologies. While a CCUS project reduces emissions after its installation and at the specific facility at which it is installed, at best resulting in a net zero facility, CDR projects do not need to be tied to an emitting facility and, if scaled widely, can result in net negative emissions.

Why do we need negative emissions technologies?

According to the Intergovernmental Panel on Climate Change (IPCC), we need both emissions reductions *and* carbon removal in order to keep global warming below the Paris Agreement's climate target of less than a 2°C rise in average global temperature. In fact, the IPCC's 2021 Sixth Assessment Report estimates that we will need to remove somewhere between 100 billion to a trillion tons of carbon by 2100 to prevent the worst effects of climate change. Delays in driving down emissions will increase the risk of warming exceeding 1.5°C and also increase our need for negative emissions.

What are some technologies and practices that remove carbon from the atmosphere?

Types of carbon removal include but are not limited to following:

- **Bioenergy with carbon capture and storage (BECCS)** – BECCS refers to the process of burning trees or other biomass to produce energy; the carbon released as CO_2 gas during burning is recaptured from the source. BECCS can also be used to produce chemically stable and carbon-rich biochar, which sequesters carbon.
- **Direct air capture** – DAC uses large fans to direct air over a chemical reactant, which can be a solid sorbent filter or liquid system, to remove CO_2 from the air. (For more information, please see our report on DAC.)
- **Accelerated rock weathering or mineralization** – Carbon dioxide can be reacted with minerals to form a stable compound.
- **Soil carbon sequestration** – Techniques such as regenerative agriculture or managed croplands can enhance soil carbon uptake with co-benefits on crop yield.
- **Encouraging the growth of carbon-negative organisms** – The growth of carbon-negative organisms (e.g. trees, crops, plankton) can be encouraged through wide-ranging techniques such as afforestation or reforestation, genetically modified crops, ocean fertilization, and desert flooding.

What is standing in the way of scaling up negative emissions technologies?

Numerous engineering, economic, and political challenges stand in the way of scaling up negative emissions.

Engineering challenges

Carbon dioxide is much more dilute in the atmosphere than it is in a smokestack, making it difficult and often expensive to capture. For instance, forestry requires large amounts of land while DAC requires large amounts of energy. Additionally, some technologies for removing CO_2 from the atmosphere are still under development and remain unproven.

Economic challenges

Negative emission technologies are currently in their early stages of development and are too expensive to scale widely. Additionally, there has been limited demand for carbon removal technologies other than from corporate social responsibility efforts by companies such as Microsoft, Stripe, and Shopify. Stripe and Shopify have invested $8 million and $5 million in carbon removal thus far in order to help accelerate R&D. Microsoft has pledged to remove 1.3 million metric tons of carbon and has invested in companies such as Climeworks as well as projects focused on soil regeneration and afforestation.

Political challenges

Some carbon removal technologies and practices have been divisive among environmentalists because of carbon capture and removal's history of material and rhetorical use primarily by the fossil fuel industry. Materially, it can offer a way for fossil fuel extractors to cut costs. Captured CO_2, for example, can be injected into oil wells to extract more oil through a process known as enhanced oil recovery; as a side benefit, that carbon is sequestered in the ground. Carbon removal also serves a rhetorical purpose by suggesting that we do not need to stop emissions now, because we have the technology to "undo the damage." This has led to environmental justice concerns over carbon removal because fossil-fuel-producing companies

disproportionately harm the health of Black, Indigenous, and other communities of color and low-income communities relative to other communities. Given these concerns, which typically come from the left, carbon removal requires a balancing act from its advocates in order to maintain bipartisan support. At the moment, advocacy for carbon removal tends to come from either center-right organizations (e.g. ClearPath) or policy think tanks, which can increase the risk of polarizing support for carbon removal.

How does Carbon180 fit into the carbon removal landscape?

Funding for carbon removal

Carbon180's priorities have been shaped by carbon removal's political environment. For example, when Carbon180 was founded in 2015, there had been limited awareness of carbon removal let alone funding for the technology. Carbon180's early work therefore emphasized the importance of philanthropy in catalyzing carbon removal technologies, which venture capitalists and traditional research and development funders likely saw as too risky and expensive at the time. Now that more government funding is available for carbon removal, thanks in part to Carbon180's policy advocacy, Carbon180 has more room to push the field forward. For example, the US government's appropriations for carbon removal increased from $68 million in FY2020 to $447 million in the following year. Increased investment in carbon removal opens up future opportunities for Carbon180 to work on deployment and scale-up.

Gathering support for carbon removal from the left

Carbon180 plays a crucial role in advocating for carbon removal from a center-left perspective. By shoring up support for carbon removal from those on the left, Carbon180 helps to increase support for carbon removal overall and lowers the risk of polarizing support for carbon removal policies.

Carbon180 has addressed some concerns from the left by publishing its *Removing Forward* report, which centers environmental justice in carbon removal. The report defines types of justice relevant to carbon removal; provides case studies of previous environmental failings in carbon management; and presents principles for integrating environmental justice into carbon removal policy development, advocacy, and implementation. The report also contains federal policy recommendations for carbon removal that would enhance labor and economic opportunities and promote transparency and inclusion. Carbon180 has also helped inform the environmental justice requirements of XPRIZE Carbon Removal, a competition for carbon removal innovation and scale-up. Finally, Carbon180 is also launching a multi-year regranting effort that would help environmental justice organizations build sustained capacity for work on CDR.

Carbon180's Organization and Operations

Staff and leadership

Carbon180 had about six employees in March 2020 and has 21 employees as of November 2021. It plans on having about 25 employees by the end of 2021. Although rapid growth often leads to organizational growing pains (e.g., unclear roles), we do not have enough evidence to believe that Carbon180 has been negatively impacted by its growth.

Carbon180's organization can be roughly divided into its policy team, which focuses on policy research, design, and coalition building; its support team, which includes people working on government affairs;

communications; and science and innovation, which involves working with researchers and businesses to inform policy.

Carbon180's leadership team maintains close ties to policy insiders, which helps improve the organization's chances of success. Importantly, its president Noah Deich was recently appointed to the Secretary of Energy Advisory Board, which works to improve the US Department of Energy's (DOE) research and development portfolio and program activities. Additionally, Carbon180's former Deputy Director of Policy at Carbon180 is now the Chief of Staff of DOE's Office of Fossil Energy and Carbon Management.

Advisory board members

Carbon180's board of directors has five members including two Carbon180 employees, founders of investment firms, and a policy expert. Carbon180's science advisory board has 11 members, including various academics and scientists with expertise in clean energy policy and technology.

Organizational strengths

In general, Carbon180 is willing to use an approach that is both strategic and adaptable. Notably, Carbon180's move to Washington, DC to better support its work on policy suggests that it is willing to make substantial changes to its organization to have a larger impact. According to a carbon removal expert we spoke to, Carbon180 has a low ego and is willing to learn and collaborate with others. In particular, this expert said that as a young organization, Carbon180 had relatively little experience in carbon removal when it first began; it has since compensated for this as it matured and has been skilled in bringing in experts and working in coalitions to fill gaps in its knowledge.

Room for more funding

Carbon180 has been successful in raising funds and garnering publicity. In addition to being part of the Founders Pledge Climate Change Fund, numerous celebrities named Carbon180 as the beneficiary of their sales of nonfungible tokens, or NFTs. The musical artist Grimes, for example, raised about $6 million in NFT sales in February 2021 with an undisclosed percentage going towards Carbon180.

Carbon180 spent roughly $3 million between January and August 2021, which is an increase from its 2020 budget of $2.7 million. Carbon180 has said that it has limited room for more funding through the end of 2021 but anticipates a gap in funding of around $2.5 million for its 2022 budget, which is estimated to reach $6 million total. It has $3.5 million of committed funding thus far and plans on regranting about $2 million of its funds for programs related to federal procurement and environmental justice. Carbon180's general operations has the biggest gap in funding.

The largest points of uncertainty in our recommendation of Carbon180 are related to its need for more funding and ability to scale. For example, an expert in the donor community said that it is likely that Carbon180 will be able to meet its funding goals in 2022 through grants from large foundations. However, given Carbon180's past performance and current funding gap, we believe at this point it can still benefit from individual donations. Nonetheless, this may change in the future if Carbon180 can indeed raise more money than it can spend effectively.

Carbon180's Tactics

Carbon180's tactics can be roughly categorized into research, policy advocacy, and ecosystem building.

Research and policy advocacy

Carbon180 conducts research on carbon removal technologies and practices to inform its policy advocacy. For example, Carbon180 developed a white paper on low-carbon concrete, which also included recommendations for a federal procurement strategy. It has also developed a list of priorities for administrative action and developed a Congressional blueprint for scaling carbon removal. Carbon180 also engages in policy advocacy to support bills with carbon removal provisions. Specifically, it has brought on The Coefficient Group to lobby in favor of carbon removal. Carbon180's policy development and advocacy applies pressure on elected officials to pass bills that support carbon removal technologies and practices.

Ecosystem building

Carbon180 supports ecosystem building for carbon removal on numerous fronts. For example, it coordinates other organizations focused on carbon removal, supports RD&D through its Science and Innovation Team, and works with farmers to improve soil sequestration.

Collaboration with other organizations

New Carbon Economy Consortium

Carbon180 played a lead role in developing the New Carbon Economy (NCE) Consortium, which brings together fourteen different universities, national labs, and non-governmental organizations working on carbon removal. Founding contributors to the Consortium include Arizona State University, University of British Columbia, and Lawrence Livermore National Laboratory. Over the coming years, NCE plans to develop foundational knowledge for carbon removal by catalyzing innovation, mobilizing funding for research collaborations, building research infrastructure, and supporting carbon removal innovators and practitioners.

Carbon Gap

Carbon180 played a key role in establishing Carbon Gap alongside people at Climate Pathfinders, Net Zero Climate, and the University of Oxford. This effort aims to make Europe a global leader in CDR by improving its research funding, deployment incentives, and public acceptance. According to a carbon removal expert we spoke to, Carbon180 has played a critical role in building philanthropic support for carbon removal in Europe and has excelled at pulling people together to work on this project. The expert also said that this project leveraged Carbon180's infrastructure and is unlikely to exist without Carbon180. Because Carbon Gap is a new organization, we do not have enough information on its accomplishments thus far. We look forward to learning more about Carbon Gap in the future.

Science and Innovation Team

Carbon180's Science and Innovation team focuses on interacting with both academic researchers and large corporations to reach its carbon removal goals. An early version of Carbon180's work was its EIR Fellowship program, which was launched in late 2019 to create a startup ecosystem for carbon removal. It provided each of its seven fellows with a $100,000 grant to help them launch carbon removal businesses that could scale to a highly ambitious goal of a billion tons of CO_2 removed per year by 2030. Carbon180 also provided

the fellows with training on carbon removal technologies, connected them with leaders in the field, and helped them navigate the carbon removal space.

Carbon180's work on the EIR Fellowship program has been foundational for its co-development of the Activate Fellowship program alongside Activate and Stripe Climate; this new fellowship program is intended to support "scientists and engineers in [taking] their innovations from lab to market." This program has led to $500,000 in procurement contracts through its partnership with Stripe Climate and currently includes eight Activate Fellows who are focused on developing and deploying new CDR technology. Carbon180 hopes to replicate its technology incubation model with other organizations that have a focus on innovation. For example, it has helped inform the development of XPRIZE Carbon Removal.

Soil sequestration program

Carbon180 works with partners in Wyoming, Montana, Colorado, and New Mexico to accelerate the adoption of practices that would increase the amount of carbon stored in soils (soil carbon). Its on-the-ground work includes organizing and hosting soil health workshops. Carbon180 has also connected local researchers with farmers who are interested in measuring their soil health. Carbon180 has used its collaborative work with farmers and scientists to develop a report on recommended federal policies. This report includes recommendations in education, science, and incentives such as funding demonstration projects, developing a cost-effective soil carbon assessment methodology, and subsidizing infrastructure to scale soil carbon storage.

Carbon180's Activities and Outcomes

Policy advocacy

Energy Act

Carbon180 successfully advocated for carbon removal in the Energy Act of 2020, which was passed as part of the Consolidated Appropriations Act of 2021. Alongside this, Carbon180 helped secure funding appropriations for carbon removal in line with the National Academies of Sciences' recommendations (about $100 million per year); Carbon180 submitted about 500 appropriations recommendations to ensure that this funding would be approved.

Carbon removal provisions in the Energy Act of 2020 included policies that support carbon capture RD&D, including incentives and the authorization of a comprehensive carbon capture R&D program. The Section 45Q tax incentive for carbon sequestration and DAC was also extended a further two years. Finally, the Energy Act of 2020 revamped the DOE's Office of Fossil Energy to explicitly include carbon capture technologies; this included a name change to the Office of Fossil Energy and Carbon Management.

Infrastructure Investment and Jobs Act

For the Infrastructure Investment and Jobs Act, the major federal infrastructure spending bill of 2021, Carbon180 advocated for numerous policy proposals that would support carbon removal technologies and practices. Ultimately, the bill was passed in November 2021 with billions of dollars in funding allocated for carbon removal RD&D, CO_2 infrastructure, and forestry. Its technology-based carbon removal and carbon management provisions include funding for regional DAC hubs, representing the single largest federal

investment in DAC; US Environmental Protection Agency saline storage permitting; carbon capture demonstration plants; CO_2 transport and storage infrastructure; and a DAC prize program that would support commercial and pre-commercial applications. Its land-based provisions include the REPLANT Act, which would assist the US Forest Service in planting 1.2 billion trees over the next decade; $200 million for improving tree nursery capacity; $200 million for tribal reforestation demonstrations; a Healthy Streets program that involves urban tree planting; and other forest management provisions.

Build Back Better Act

For the Build Back Better Act, a Democrat-supported spending bill that is being pushed through budget reconciliation, Carbon180 advocated for funding for a "soil carbon moonshot" research program to better understand CO_2 storage and for extending and increasing the Section 45Q tax credit for carbon removal. The Section 45Q tax credit extension and increase are both in the current [November 9, 2021] iteration of the Build Back Better Act. The Build Back Better Act also has $27 billion in funding for conservation programs, $8 billion for agriculture and climate research, and $38.6 billion for forestry; some of the funding in these areas could potentially support carbon removal projects. The Build Back Better Act is currently waiting on a vote in Congress.

Ecosystem building

At the end of the EIR Fellowship in 2020, fellows raised more than $5 million from top climate investors for their carbon removal projects. CarbonPlan, an organization that analyzes climate solutions, and Heirloom, an organization that focuses on low-cost DAC, were both participants in the EIR Fellowship.

Future work

Currently, carbon removal technologies face limited corporate interest because of high cost and relative newness. To address these concerns, catalyze carbon removal scale-up, and set a model for the corporate world, Carbon180 plans on working with other organizations to drive federal procurement of carbon removal technologies and products. Carbon180's goals for federal procurement include getting the US government to procure 1 gigaton of carbon removal by 2050 and getting CDR to reach an average cost of $100 per ton. It plans on driving federal procurement by advising the Biden Administration on policy implementation, educating policymakers on the role of procurement in scaling CDR, convening stakeholders, and advocating for legislation that would support procurement. Carbon180 also plans on addressing non-economic barriers to scaling up carbon removal such as permitting, access to CO_2 storage networks, and financing the carbon removal network.

Carbon180's Theory of Change – In Depth

We illustrate Carbon180's theory of change in the figure below (Figure 1).

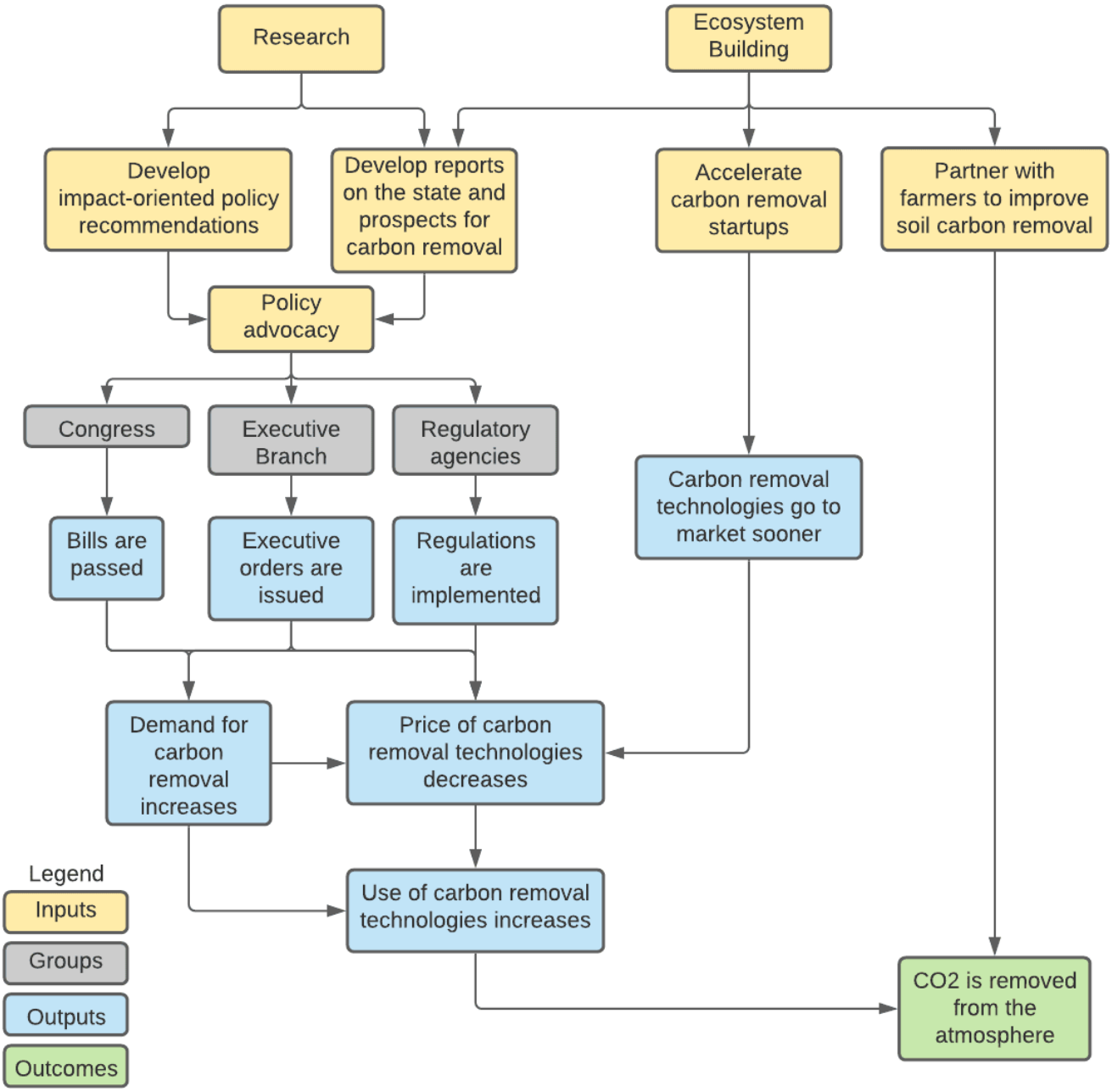

Figure 1: Theory of change of Carbon180's work. Yellow, gray, blue, and green boxes represent inputs, groups, outputs, and outcomes, respectively.

Examining the Assumptions behind Carbon180's Theory of Change

Below, we discuss and evaluate each of the assumptions related to Carbon180's theory of change. For each of the assumptions identified, we rank whether the assumption most likely holds, may hold, or is unlikely to

hold. Importantly, a number of the stages of Carbon180's theory of change are not amenable to easy measurement or quantification or are expected to occur in the future but have not occurred as of yet. For each assumption, we assess whether the best available evidence, primary or secondary, suggests whether the assumption will plausibly hold or not.

1. *Policies that Carbon180 introduces enter the public discourse and are debated as parts of potential bills, regulations, and executive actions (most likely holds).*

Numerous policies that Carbon180 has advocated for have entered recent bills, including the Energy Act, which was passed via the Consolidated Appropriations Act; the Infrastructure Investment and Jobs Act; and the Build Back Better Act. We are less familiar with Carbon180's work on regulations and executive actions because we prioritized research into Carbon180's work on federal legislation given its timeliness. We look forward to learning more about Carbon180's other work in the future.

2. *The policies that Carbon180 has developed and advocates for will pass in the House and Senate (most likely holds).*

The Consolidated Appropriations Act was passed during the Trump administration with numerous carbon removal proposals intact and with major bipartisan support in both chambers of Congress. The Infrastructure Investment and Jobs Act was passed in November 2021 with bipartisan support; thirteen House Republicans, for example, broke against party lines to vote in favor of the act.

As of early November 2021, it is unclear whether the Build Back Better Act will pass in Congress. Although Democrats hold a government trifecta and can pass the Build Back Better Act along party lines, its future rests in the hands of Democratic Senators Joe Manchin and Kyrsten Sinema who have expressed concerns with the scope of the bill.

3. *Carbon180 is still able to enact policy change when the political environment is less amenable to climate action (most likely holds).*

We believe that because carbon removal has bipartisan support, bills that contain carbon removal provisions are likely to be passed even when Democrats do not hold a government trifecta. Indeed, the Consolidated Appropriations Act was passed with carbon removal provisions while President Donald Trump of the Republican Party was still in office. However, there is some risk that carbon removal may lose support from the left given concerns that progressive have expressed over carbon capture's connections to the fossil fuel industry and its potential issues related to environmental justice. Carbon180 plays a critical role in maintaining trust with those on the left, which includes centering environmental justice in its work, acting on input from critics, and communicating carbon capture's benefits.

4. *Carbon capture and removal technologies will become cost-competitive within a meaningfully short period of time (may hold).*

It is not yet clear how quickly permanent carbon capture and removal technologies and practices will become cost-competitive, which will influence the degree to which they can scale. Their cost will rely in part on early R&D investments and heavily depend on the technologies' energy and equipment requirements.

Overview

We developed a simple cost-effectiveness analysis (CEA) model that estimated Carbon180's cost-effectiveness in reducing GHG emissions. Our model centered on various carbon removal provisions that Carbon180 has advocated for in the Energy Act, which were passed via the Consolidated Appropriations Act; the Infrastructure Investment and Jobs Act; and the Build Back Better Act. To calculate Carbon180's expected value, we estimated the amount of CO_2 each provision would remove from the atmosphere if passed and the change in likelihood of a bill passing due to Carbon180. We used this expected value along with Carbon180's 2019 to 2021 policy budget to estimate cost-effectiveness. Because we are unable to estimate the effects of policies that will take a long time to bear fruit, such as R&D, we may have underestimated Carbon180's cost-effectiveness.

We developed three scenarios (i.e. Pessimistic, Realistic, Optimistic) that varied in terms of the number of years that we estimated Carbon180 would advance policy and by how much Carbon180 would change the likelihood of a bill passing. Under our Realistic scenario, in which Carbon180 advances policy by four years and changes the probability of a bill passing by 3%, Carbon180 is predicted (in expectation) to reduce emissions at a cost of about $0.66 per metric ton of CO_2 under our Realistic scenario. In other words, our Realistic scenario predicts that Carbon180 can reduce CO_2 by 1.5 metric tons per dollar. These results should be viewed as rough, indicative estimates given the uncertainty in our different model inputs. Overall, however, our results suggest that Carbon180 could be highly cost-effective in reducing GHG emissions.

Methods

Overview

We illustrate our CEA's steps in the flowchart below (Figure 2).

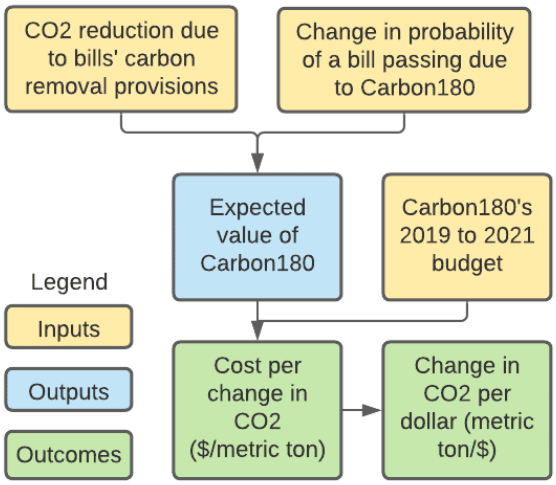

Figure 2: Flow chart of the Carbon180 cost-effectiveness model. Yellow, blue, and green rectangles represent inputs, outputs, and outcomes, respectively.

Our model inputs included Carbon180's 2019 to 2021 budget, reductions in emissions due to carbon removal provisions in various bills, and the change in probability of a bill passing with said carbon removal provisions due to Carbon180. We computed Carbon180's expected value by multiplying the bills' CO_2

reduction relative to business-as-usual by the change in probability of a bill passing with the provision due to Carbon180. We then used Carbon180's expected value and its budget to determine its cost per change in metric ton of CO_2. We used the reciprocal of this outcome to estimate the change in CO_2 per dollar.

We also input our CEA into a Guesstimate model, which allows us to set ranges for each input and uses a Monte Carlo simulation to estimate cost-effectiveness. Each metric included 5,000 samples. This simulation enabled us to account for uncertainty in each parameter by predicting many thousands of potential futures.

Detailed overview

Number of years that Carbon180 moves policy forward

We assume that progressive federal legislation will only be introduced once a decade, which is how frequently Democrats have held a government trifecta over the past 40 years. Because carbon capture and removal has bipartisan support, we assume that bills containing carbon capture and/or removal will be introduced more frequently than progressive bills, e.g. more than once a decade. We therefore assumed that under the Pessimistic, Realistic, and Optimistic scenarios, Carbon180 will move policy forward by 2, 4, and 6 years, respectively.

CO_2 reduction due to bills' carbon removal provisions

Although Carbon180 has a broad portfolio of work that includes its EIR Fellowship and soil sequestration programs, we hone in on federal legislation in our analysis because of its especially high potential for impact in 2021. We estimated CO_2 reductions from the following provisions that Carbon180 has advocated for:

- **Two-year extension of 45Q** – The US government provides tax credits for carbon capture and sequestration and DAC under Section 45Q, which previously required facilities to begin construction by 2023 to qualify for the tax credit. Under the Energy Act, the deadline to begin construction was extended until the end of 2025. We estimated CO_2 reductions due to this extension by multiplying the estimated annual reduction in CO_2 due to the Section 45Q tax credit by two.
- **Increased and extended Section 45Q tax credits** – The Build Back Better Act includes a proposal to raise the Section 45Q tax credit and extend the date by which carbon removal projects must begin construction. We estimated CO_2 reductions due to this increased payout by using a model projection of greenhouse gas reductions developed by Energy Innovation.
- **DAC Hubs** – The Infrastructure Investment and Jobs Act included a proposal for four regional DAC hubs. Although each hub is only expected to reach a million metric tons in capacity (four million metric tons total), we assume that this initial investment could open up further investment opportunities and lead to Carbon180's goal of nine million metric tons by 2030.
- **Carbon capture and removal RD&D** – Although the Infrastructure Investment and Jobs Act includes funding for carbon capture and removal RD&D, we do not believe that this investment will lead to significant removal of CO_2 by the end of the decade. Although future improvements in carbon capture and removal due to RD&D could be an important part of Carbon180's impact, we leave this out of the model since we do not have a reasonable way to incorporate these highly uncertain impacts into our model.

For more detail on how we calculated CO_2 reductions for each of the policy proposals, please refer to our CEA model.

Change in probability of a bill passing due to Carbon180

To determine the change in probability of a bill passing due to Carbon180, we first assumed that Carbon180's influence on each of the bills is likely the same. We further assumed that Carbon180 only has a small effect on whether a bill passes with carbon capture- or removal-related provisions. For the Pessimistic, Realistic, and Optimistic scenarios, we assumed that Carbon180 would change the probability of a bill passing by 1%, 3%, and 5% respectively. Our estimates are informed by conversations that we had with experts in carbon removal who are knowledgeable about Carbon180's work. Our estimates are highly subjective and were the most challenging part of this CEA to estimate.

Carbon180's 2019 to 2021 budget

We calculated Carbon180's 2019 to 2021 budget based on its annual expenditures. We used Carbon180's annual reports to calculate our estimates and verified its spending by reviewing the organization's publicly available 990 tax forms.

Results

Under the Realistic scenario, Carbon180 is estimated to remove CO_2 from the atmosphere at a cost of $0.66 per metric ton of CO_2. In other words, it can remove about 1.5 metric tons of CO_2 per dollar. The Pessimistic and Optimistic cases predict a cost of $3.47 and $0.24 per metric ton, respectively (e.g. about 0.29 and 4.1 metric tons of CO_2 per dollar).

An example run using the Guesstimate model predicts that the median cost per change in CO_2 is about $0.70 per metric ton (about 1.4 metric tons of CO_2 per dollar) across the thousands of simulated futures. The 5th and 95th percentiles were estimated as $0.32 and $2.14 per metric ton, respectively (about 0.45 and 3.0 metric tons of CO_2 per dollar). The distribution for the cost per change in CO_2 is skewed right (Figure 3).

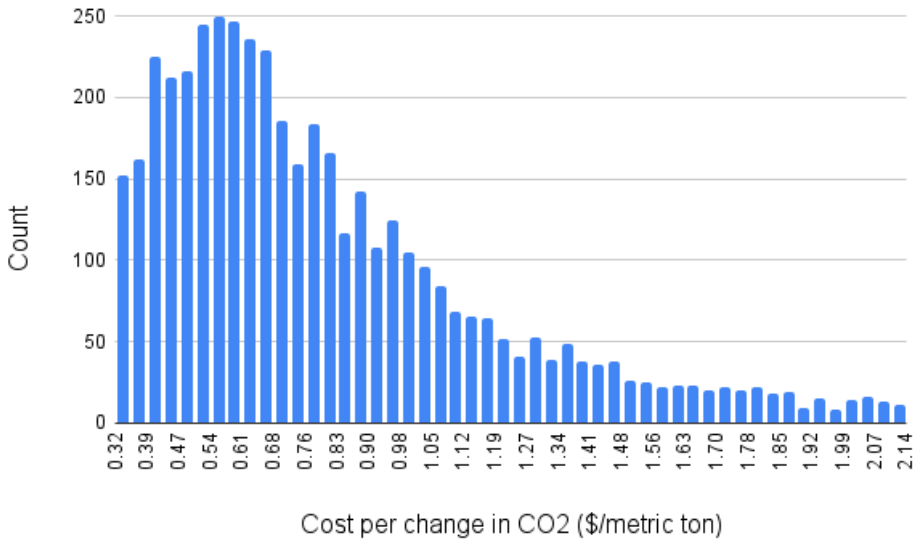

Figure 3: Histogram of cost per change in CO_2. Values along the horizontal axis indicate the cost to remove one ton of CO_2. The horizontal axis is truncated to values between the 5th and 95th percentiles.

Discussion

Overview

According to our CEA model, Carbon180 is cost-effective at removing CO_2 from the atmosphere and has a cost-effectiveness similar to our other top charities. Major sources of uncertainty in our model include the number of years that Carbon180 advances policy and Carbon180's influence on getting a bill passed with its climate provisions. Notably, our CEA model results are only a snapshot in time and do not guarantee Carbon180's cost-effectiveness far into the future. It is possible that Carbon180's influence may change over time (e.g., a shift in political climate and support for carbon removal). Additionally, we do not include the potential impact of innovation spillover where RD&D investments in the US could improve carbon removal technologies elsewhere in the world.

A large part of Carbon180's potential effectiveness is its ability to drive down the price of carbon removal in the future, which is an aspect of Carbon180's work that is not captured in our model. By not including the effects of RD&D in our calculations, we are likely underestimating Carbon180's impact. There is some risk that unexpected technical or economic barriers will prevent large scale deployment of carbon removal programs in the future. However, because Carbon180 supports a wide portfolio of carbon removal technologies and practices, we are optimistic that it would be able to pivot if it became clear that one or more of its programs does not meet expectations.

Focusing on federal legislation

Our model underestimates Carbon180's overall cost-effectiveness because we focused only on its federal policy workstream and did not include the rest of its portfolio. For example, we did not include Carbon180's impact from influencing the Executive Branch nor its EIR and soil sequestration programs; we still included these programs' cost in our analysis because we could not partition out their individual costs from Carbon180's total spending.

Conclusion

Carbon180 can remove CO_2 from the atmosphere if the carbon capture and removal provisions it advocates for are passed, made into law, and implemented effectively. According to our CEA model results, Carbon180 is predicted to be highly cost-effective in removing CO_2 from the atmosphere and is comparable to other top charities we have analyzed. However, its cost-effectiveness is not guaranteed because the likelihood of its provisions passing depend on political support for carbon capture, which may change over time. Our model is currently limited in that it solely focuses on Carbon180's work on federal legislation and does not include its full portfolio of work.