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The Case for Federal Support to Advance Direct Air Capture

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A White Paper by the Bipartisan Policy Center's Direct Air Capture Advisory Council

Bipartisan Policy Center

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Director of the Energy Project

Danny Broberg
Senior Policy Analyst

Xan Fishman
Consultant

Kim Dean
Senior Advisor for BPC Action

Emma Waters
Research Analyst

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DISCLAIMER

The findings and conclusions expressed herein do not necessarily reflect the views or opinions of BPC, its founders, its funders, or its board of directors.

THE SPIRIT OF CONSENSUS

The BPC's DAC Advisory Council endorses the ideas outlined in the report as a package. As with all principled compromise, no member should be assumed to be satisfied with every individual proposal or to support a particular recommendation in isolation.

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BPC's Direct Air Capture Advisory Council was launched in 2019 to explore the role of direct air capture in achieving a net-zero carbon economy and to address related policy and technology challenges. The council's 15 members include leaders from academia, the private sector, labor, and the NGO community.

INTRODUCTION

Addressing the impacts and challenges posed by climate change will take coordinated action from companies and governments around the world on an unprecedented scale. The United Nations' Intergovernmental Panel on Climate Change (IPCC) estimates that more than 2,200 gigatons of carbon dioxide (CO_2) have been emitted to the atmosphere as a result of human activities since the pre-industrial period, and that avoiding the worst impacts of climate change requires limiting future CO_2 emissions to a "budget" of 420–770 gigatons.[i] Given current global emissions on the order of 42 gigatons per year, the expert consensus, as reflected in recent reports by the IPCC, America's National Academies of Science, and other scientific bodies, is that carbon removal—through both natural and engineered solutions (including direct air capture)—will be a key complement to emissions mitigation strategies in achieving international climate goals.[ii] This white paper makes the case for a robust federal effort to accelerate the further development and deployment of direct air capture (DAC) technology. It follows two previous Advisory Council white papers that made the environmental, and economic case for investing in DAC as a critical tool for addressing the climate crisis.

The first Advisory Council paper, presenting the environmental case, focuses on the need to leverage every tool available for addressing the climate crisis.[iii] Given the difficulty of zeroing out all sources of emissions over the course of a few decades, it discusses the critical importance of carbon dioxide removal (CDR) options, both natural and engineered, as a complement to emissions mitigation strategies, and as a form of insurance against the possibility that global emissions will "overshoot" the limited carbon budget that remains before highly damaging climate consequences become unavoidable.[iv] This paper also discusses the specific benefits of DAC relative to other CDR options in terms of land and water requirements, siting flexibility, scalability, and the ability to verify permanent removal from the atmosphere when paired with geological storage.

The second paper in this series, which presents the commercial case for DAC, focuses on emerging market opportunities, and recent commitments from private companies to invest in DAC.[v,vi] Noting that cost

estimates for DAC have declined from as much as $1,000 per ton of CO_2 captured a decade ago, to within a range of $100–$250 per ton for future large-scale facilities according to more recent cost analyses, the paper emphasizes the importance of further efforts to support a diverse array of technologies and business models for DAC deployment.[vii] Expanding beyond current small-scale demonstration efforts is critical to enable the further cost reductions that can come from learning by doing and to develop the supply chains, and financing mechanisms needed to support a robust domestic industry. Recent developments, notably the planning that is currently underway for a 1-million-ton-per-year DAC facility in the Permian Basin, are promising in this regard, and should be bolstered by the additional federal investments recommended in this white paper.[viii]

In sum, while carbon removal is a long-term strategy for addressing climate change, near-term actions are required to enable CDR deployment at the scale needed to help achieve net-zero by 2050. According to a recent article in Nature Communications, even a scenario for the "emergency crash deployment of DAC" requires substantial investments and supportive policies this decade, to develop requisite supply chains and industrial manufacturing capacity.[ix] The next sections of this paper underscore this message, and advocate for a targeted set of near-term policies and investments to leverage the full potential of DAC technology for addressing the climate crisis.

Sustained Federal Commitment to Carbon Removal, Starting Today

The Energy Act of 2020, which passed Congress with broad bipartisan support at the end of the year, and was subsequently incorporated into the Fiscal Year 2021 Omnibus Spending Bill, contains provisions authorizing over $400 million for CDR research, development, and deployment efforts at the U.S. Department of Energy (DOE). Other provisions aim to promote new commercialization opportunities for DAC.[x] Robust follow-through on these provisions, in the form of sustained annual appropriations and effective program implementation, is needed to ensure they have a meaningful impact.

Meanwhile, additional climate commitments announced by the Biden administration in the early months of 2021 promise continued federal support for a range of climate-friendly technologies.[xi,xii] In the case of DAC, additional investments are needed across the entire innovation lifecycle, from basic research to commercial demonstration and early deployment,[xiii] together with creative mechanisms to leverage both near-term markets for commercial uses of captured CO_2, such as in concrete production, synthetic fuels production, or enhanced oil recovery,[xiv] and quickly forming markets for voluntary CO_2 removal certificates.

To provide clear policy direction and maintain momentum, we recommend that Congress and the administration **set a goal of having at least 7 million tons per year of DAC capacity operational or under construction by 2030**. This target could be met with several large projects (> 1 million tons of capture capacity), and many smaller-scale facilities representing a diverse array of designs and business models. This level of deployment activity will position the United States as a global leader in DAC technology.

Reaching this deployment goal will require policy efforts on multiple fronts, including to scale up innovation investments, expand existing tax credits, and develop additional financing tools. Further support for early deployment can be provided by leveraging government procurement, building the requisite infrastructure for a carbon managed economy, and implementing carbon accounting frameworks that reward long-term CO_2 removal. Specific recommendations in these areas are discussed in the sections that follow.

RECOMMENDATIONS FOR RDD&D INVESTMENT

Historically, federal funding for DAC research, development, demonstration, and deployment (RDD&D) has been sporadic and minimal. Between 1993 and 2019, DOE funding for DAC totaled just $10.9 million (by comparison, overall funding for DOE's Office of Energy Efficiency and Renewable Energy totaled $2.8 billion in 2020 alone).[xv] Funding for DAC innovation has recently increased substantially—appropriations for 2020 and 2021 reached $35 million and $32.5 million, respectively—but remains lower than it needs to be to provide a foundation for achieving our proposed deployment target of 7 million tons removal capacity by 2030. Other groups, including the National Academies of Sciences, Engineering, and Medicine (NASEM), the Energy Future Initiative, and the World Resources Institute, have likewise called for a large increase in federal funding for DAC RDD&D—their specific recommendations vary, but proposed spending levels are on the order of $1.5 billion over the next decade.[xvi,xvii] This proposed spending level should serve as a lower bound on federal DAC investment in the coming decade, while $7.5 billion should serve as a more ambitious target that reflects the scale of climate impact that DAC can provide. Figure 1 shows how the support directed to basic R&D vs. demonstration vs. deployment can be expected to shift over time.[xviii,xix] To maximize the probability of success and the economic benefits of these investments, federal funding should prioritize diversity in DAC system designs, project locations, and business models.[xx] As a positive sign of progress, Senate Energy and Natural Resources Committee Chair Joe Manchin (D-WV) recently unveiled a proposal to invest $3.5 billion over five years to establish four regional DAC hubs as part of the Senate bipartisan infrastructure compromise legislation. [xxi]

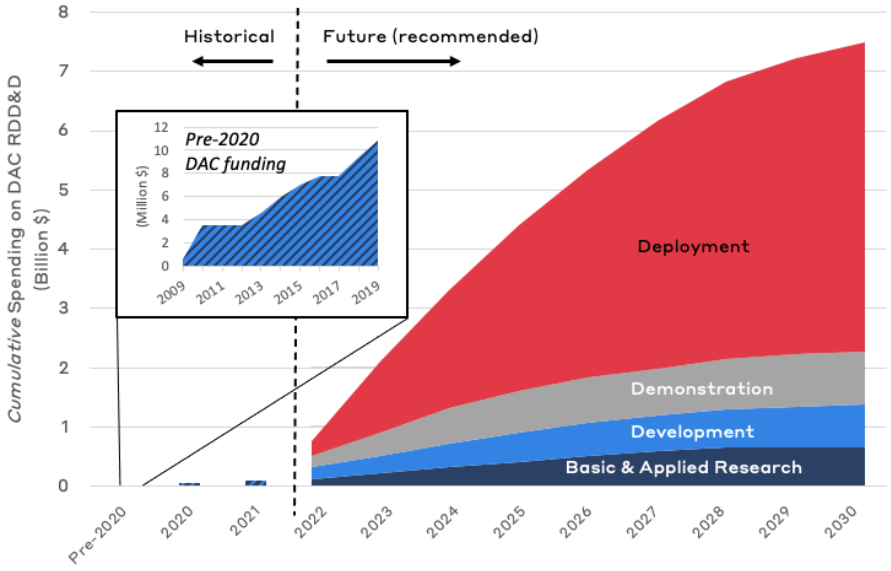

Figure 1: Cumulative funding for DAC research, development, demonstration, and deployment across the federal government (actual historical and recommended future). To unlock the full potential of DAC for addressing climate change, policymakers should continue to scale funding to between $1.5 and $7.5 billion in cumulative spending by 2030, with a focus on supporting deployment using a diverse array of DAC designs, business models, and geographic locations.

As already noted, the Fiscal Year 2021 Omnibus Spending Bill authorized more than $400 million in funding for CDR research at DOE through 2025, including funding for both pilot projects (10–100 tons capture capacity per year), and demonstration projects (>1,000 tons per year). The bill also included grant funding for a DAC Test Center and a one-time authorization of $115 million to fund a prize competition for both pre-commercial, and commercial DAC technology applications. It will be critical for Congress to fully fund these authorizations in the years ahead.

For maximum impact, collaboration within DOE—including between the Office of Fossil Energy and Carbon Management, the Advanced Manufacturing Office, the Office of Science, and the National Energy Technology Laboratory—and with external organizations, such as the National Science Foundation (NSF), universities, and industry groups, will also be critical. Collaborative agreements, competitive grant solicitations, and the expansion of NSF engineering research centers can boost the impact of federal spending on DAC innovation.[xxii]

DOE has also been authorized to establish an interagency CDR taskforce to evaluate practical pathways for CDR technology development, and deployment, and to evaluate progress toward carbon removal goals. This taskforce could be very helpful in promoting the coordination of DAC efforts across the federal government.

Recommendation 1: Increase federal RDD&D spending for DAC to between $1.5 and $7.5 billion (cumulative) by 2030

- Adjust RDD&D funding to the evolving requirements of the DAC innovation cycle, with an immediate emphasis on rapidly increasing demonstration and deployment.
- Support collaboration within relevant offices at DOE, along with interagency collaboration with DOD, Commerce, and EPA.

Existing legislation supported by the DAC Advisory Council:

- *CREATE Act* S. 843

In fact, other federal agencies could also play a significant role in exploring DAC opportunities and applications. The Department of Defense (DoD) has already begun investigating CO_2 capture and utilization for liquid fuel production—an application that could provide both climate, and national security benefits.[xxiii] Since 2019, DoD has also had its own Direct Air Capture, and Blue Carbon Removal Technology Program.

Within the Department of Commerce, the National Institute of Standards and Technology (NIST) will play an important role in developing common standards and protocols as DAC technologies scale up.[xxiv] NIST already supports standardization, and common protocols for the deployment of new water management, energy efficiency, and telecommunications technologies. These efforts aim to ease commercial adoption by ensuring that new technologies can be readily integrated with existing systems and market frameworks.[xxv]

While DOE offices, such as the Office of Fossil Energy and Carbon Management, are best suited to lead early development work, such as front-end engineering design and techno-economic analyses, the Office of Research and Development at the U.S. Environmental Protection Agency (EPA) can play a complementary role, particularly with regard to lifecycle and environmental assessments.[xxvi] Fine tuning DAC operations based on research in these areas will allow for better cost estimates, and help identify technical issues over time.

As these efforts intensify, further coordination of the government's CDR activities, beyond the new DOE-led task force, may be needed. Bipartisan legislation recently introduced in Congress, the *Carbon Removal, Efficient Agencies, Technology Expertise (CREATE) Act (S. 843)*, would create a committee on large-scale carbon management within the President's National Science and Technology Council. The proposed bill is co-sponsored by Sens. Kyrsten Sinema (D-AZ), Lisa Murkowski (R-AK), Sheldon Whitehouse (D-RI), and Shelley Capito (R-WV).[xxvii]

RECOMMENDATIONS FOR FINANCING DAC DEPLOYMENT

Creating viable business models for DAC facilities and additional certainty around revenue generation will be critical for scaling deployment in the coming decade. This means supporting the broader economy of carbon management, including other forms of CO_2 capture, CO_2 transportation via pipelines, and hubs for safely storing CO_2 in underground reservoirs or putting it to use in other value-added applications. Put simply, it won't be possible to develop successful business models for DAC deployment without the requisite infrastructure for transporting, sequestering, or using captured CO_2. Some of this infrastructure exists in certain parts of the country, but existing networks are insufficient to support large-scale DAC deployment.[xxviii] Expanded financing options and expedited permitting of CO_2 pipelines, DAC facilities, and climate-friendly infrastructure more generally, will increase investor certainty, reduce cost barriers, and increase revenue-generating potential—all essential elements for the successful commercialization of DAC technology.[xxix]

Support the Build-Out of Enabling Infrastructure

The lack of enabling infrastructure creates an unintended penalty for early movers in the broader carbon management ecosystem. If a DAC facility requires access to a CO_2 pipeline to generate revenue, then the cost of building a pipeline, if none already exists, needs to be factored into project costs. Likewise, access to geologic storage can create a barrier to entry for new facilities. For this reason, other countries, including Australia, Canada, the Netherlands, and Norway, have taken steps to directly incentivize and finance carbon management infrastructure. The European Union designates carbon management infrastructure projects as "projects of common interest," which means developers can access funding through the Connecting Europe Facility (since 2014, the Facility has awarded €4.6 billion to energy projects).[xxx] Similar policies should be implemented in the United States.

Fortunately, bipartisan interest in this topic is growing. The *Storing CO_2 and Lowering Emissions (SCALE) Act (S. 799/H.R. 1992)*, introduced by Sens. Chris Coons (D-DE) and Bill Cassidy (R-LA), and Reps. Marc Veasey (D-TX), David McKinley (R-WV), Cheri Bustos (D-IL), and Pete Stauber (R-MN), expands resources for permitting and implementing CO_2 storage in saline formations.[xxxi] This bill would also establish a new program, modeled after the U.S. Department of Transportation's popular Transportation Infrastructure Finance and Innovation Act (TIFIA) program for financing highway projects, to administer low-interest loans and grants for CO_2 pipeline projects.[xxxii] A recent analysis by the Decarb America initiative finds that a similar program to support carbon infrastructure finance and innovation ("CIFIA") could generate more than 13,000 jobs in the first year alone.[xxxiii] Aspects of the *SCALE Act* are also reflected in the American Jobs Plan unveiled by Pres-

ident Biden on March 31, 2021.[xxxiv] Given the bipartisan support that exists for this legislation and the benefits it could deliver, Congress should pass the *SCALE Act* this year.

Expand the Toolkit of Financing Options

Innovative financing methods that have been used to support other energy systems can add to the set of financing options for DAC facilities.

One proposal is to extend eligibility for master limited partnerships (MLPs). These tax structures, which the oil and gas industry has used for decades, allow a company to receive favorable tax treatment as a partnership, but be traded as corporate stock. Traditionally, eligibility for MLPs has been mostly limited to fossil-fuel-related businesses, but legislation sponsored by Sens. Chris Coons (D-DE), Jerry Moran (R-KS), and Reps. Mike Thompson (D-CA) and Ron Estes (R-KS), called the *Financing our Energy Future Act*, would extend MLP eligibility to a broader set of clean energy technologies, including carbon capture facilities.[xxxv] This bill has been included in the House Ways and Means Committee energy tax credit bill, the *GREEN Act*.

Existing legislation to expand eligibility for tax-exempt private activities bonds (PABs)[xxxvi] could also be helpful. PABs are issued by local or state governments and have tax-exempt status with favorable pay-back periods. The *Carbon Capture Improvement Act*, sponsored by Sens. Michael Bennett (D-CO) and Rob Portman (R-OH), and Rep. Tim Burchett (R-TN), would extend eligibility for PABs to carbon capture facilities, including DAC.

The Energy Act of 2020 included provisions for the DOE Loan Programs Office (LPO) to enhance credit subsidies and expand eligibility to new forms of carbon capture. Sufficient funding for LPO to implement these provisions could create substantial new financing opportunities for DAC projects. In general, the ability to stack multiple financing options would be very valuable in supporting DAC deployment. Congress should continue to explore options that build on existing financing mechanisms, and that credit the unique value provided by a negative emissions technology like DAC, such as technology-neutral, or DAC-specific investment tax credits.[xxxvii]

Recommendation 2: Expand the toolkit of financing options for DAC and enabling infrastructure

- Support the buildout of CO2 pipelines, storage hubs, and a broader network of carbon capture facilities.
- Make DAC projects eligible for favorable tax structures, such as master limited partnerships.
- Make DAC facilities eligible for tax-exempt bonds, such as private activity bonds.
- Support DAC financing through DOE's Loan Programs Office.

Existing legislation supported by the DAC Advisory Council:

- *SCALE Act* S. 799/ H.R. 1992
- *Financing Our Energy Future Act* S. 1034/ H.R. 3249
- *Carbon Capture Improvement Act* S. 1829

RECOMMENDATIONS TO ENABLE SHORT- AND LONG-TERM DAC REVENUE STREAMS

As discussed in a previous BPC DAC Advisory Council white paper, CO_2 utilization opportunities and markets for voluntary CO_2 removal continue to expand, but remain too small at present to support DAC deployment at the scale needed to help meet climate targets.[xxxviii] For this reason, additional government support—through tax credits, guaranteed procurement, and other financing mechanisms—is crucial to accelerate near-term deployment.

Enhancing Existing Tax Incentives

The 45Q tax credit provides a performance-based incentive to capture CO_2 and put it to use or permanently store it in geologic formations.[xxxix] It is available to the owners or operators of power plants, DAC facilities, and industrial facilities. While critical updates were made in 2018 and 2020,[xl] including increasing the credit to $50 per ton for CO_2 capture, and permanent geological storage (a lower credit of $35 per ton applies if captured CO_2 is used in products, or for enhanced oil recovery), the Internal Revenue Service (IRS) did not release final guidance on the 45Q credit until 2021, during the COVID-19 pandemic.[xli] The IRS delay, combined with the effects of the pandemic, have amounted to critical time lost for DAC deployment. In addition, the value of the credit does not create sufficient incentives that reflect the potential long-term advantages of commercializing DAC technology as a carbon removal option, particularly with regard to scalability and verifiability.

Four important modifications would significantly enhance the effectiveness of the 45Q tax credit in supporting DAC deployment: (1) allowing for direct payments to facility owners in lieu of the credit, (2) extending the deadline for construction to commence on eligible projects, (3) increasing the credit for DAC projects, and (4) eliminating minimum capture thresholds.

To date, access to the 45Q tax credit has been severely constrained, in part because the saturation and stagnation of tax equity markets during the pandemic removed the only practical means for monetizing the credit. Rather than requiring developers to navigate a complex, and costly process for turning the credit into usable capital, Congress should enact a "direct pay" mechanism that directly monetizes the credit to finance new projects. A similar approach was applied to renewable energy tax credits as part of the *American Recovery and Reinvestment Act of 2009*.[xlii]

Recommendation 3: Reform and expand the existing 45Q tax credit for carbon capture

- Allow for direct payments to be made in lieu of the credit.
- Extend the deadline for construction commencement for eligible projects.
- Raise the credit for DAC to $180/ton for geologic storage ($130/ton for use in products or enhanced oil recovery).
- Eliminate minimum capture thresholds for DAC facilities.

Existing legislation supported by the DAC Advisory Council:

- *ACCESS 45Q Act* H.R. 1062
- *CCUS Tax Credit Amendments Act* S. 986

A further problem is that projects need to be planned, permitted, and in the beginning stages of construction by January 1, 2026 to qualify for the credit. Even the early stages of planning and permitting can take multiple years and if there is no assurance that the credit will be available as a revenue stream, many DAC projects may never be considered in the first place. Bipartisan legislation—the *ACCESS 45Q Act* (H.R. 1062) introduced by Representatives McKinley (R-WV) and Veasey (D-TX)—addresses this problem by extending the commenced construction deadline another ten years (to 2036), and by allowing for direct payments to be made to developers in lieu of the credit. Elements of this proposal were included in President Biden's American Jobs Plan.[xliii]

Finally, the 45Q tax credit should be increased to reflect DAC's unique value as a CO_2 removal technology (as opposed to carbon capture technologies that only avoid the release of new emissions). According to an analysis by the Rhodium Group, a modified credit of $180/ton for DAC with geologic CO_2 storage would be adequate to incentivize early demonstration efforts for DAC projects this decade.[xliv] Similarly, the credit value should be increased to $130/ton when the CO_2 produced by DAC is reused in products such as cement, steel, carbon nanotubes, or in EOR, rather than saline storage. Legislation introduced by Sens. Tina Smith (D-MN) and Shelley Capito (R-WV)—the *CCUS Tax Credit Amendments Act* (S. 986)—would extend the commenced construction deadline, allow for direct payments in lieu of the tax credit, and increase the credit to $120/ton for DAC with geologic CO_2 storage ($75/ton for CO_2 used in products and for enhanced oil recovery). Senate Finance Committee Chair Ron Wyden (D-OR)'s *Clean Energy for America Act* which passed out of committee, would reform clean energy tax credits more broadly; this bill likewise increases the 45Q tax credit for DAC with specific forms of geologic storage to $175/ton.

As discussed in the Advisory Council's white paper on the economic case for DAC,[xlv] some DAC developers are having success with business models that target smaller-scale industrial applications for captured CO_2. Unfortunately, only projects that capture at least 100,000 metric tons CO_2 per year are eligible for the 45Q tax credit. Eliminating minimum capture thresholds or allowing similar facilities to aggregate their capture capacity would allow a greater number of projects to qualify.

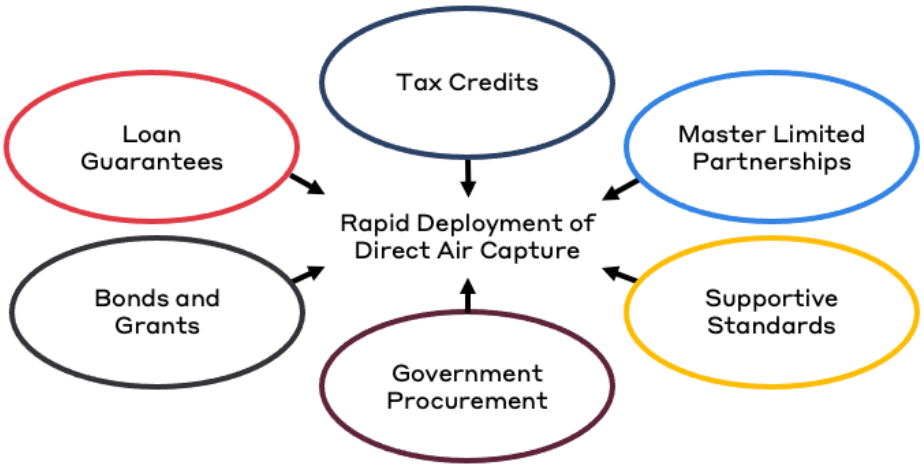

Figure 2: A diverse set of government financing options will be needed for deploying DAC at scale in the coming decade.

Leveraging Federal Procurement

Federal commitments to expedite the siting and permitting of climate-friendly infrastructure on federal lands, or to procure carbon credits or products that make use of captured CO_2 can also help improve the economics for future DAC projects. Approximately 28% of U.S. land is federally owned and the U.S. government is the single largest purchaser of goods, and services in the world.[xlvi] This means the federal government has considerable leverage to incentivize DAC deployment through procurement and siting policies.[xlvii]

Similar approaches have been used previously to support renewable energy deployment. The *Energy Policy Act of 2005* directed the Department of Interior to permit 10 gigawatts (GW) of renewable energy on federal land by 2015; this target was met three years early, in 2012.[xlviii] The more recent *Energy Act of 2020* expanded this target to 25 GW of wind, solar, and geothermal energy permitted on federal land by 2025. Similar targets should be established for permitting CDR projects, including DAC, as well as CO_2 pipelines and geologic CO_2 storage sites on federal land.

The federal government can also support DAC deployment by committing to buy carbon credits attributed to DAC.[xlix] As we have already noted, DAC with geologic CO_2 storage offers distinct advantages in terms of the verifiability and permanence of carbon reductions relative to other sources of carbon credits or offsets (this topic is also discussed in more detail in the Council's previous white papers). Recognizing these benefits, several prominent corporations, including Microsoft, Stripe, Shopify, and United Airlines, have

either directly financed DAC projects, or committed to purchasing a certain amount of DAC-generated carbon credits.[l]

The government can also commit to purchase products, such as synthetic fuels that use captured CO_2 as a feedstock. (The U.S. military is currently conducting research in this area, as mentioned in a previous section of this paper; it also has experience in using procurement as a tool for supporting innovation, with DoD acting as the initial, guaranteed purchaser of many technologies that were first developed by the Defense Advanced Research Projects Agency (DARPA) and later widely commercialized.[li,lii])

For example, sustainable aviation fuels (SAFs) produced using captured CO_2 as a feedstock have been proposed as an option for decarbonizing long-haul aviation.[liii] To overcome the current cost differential between SAFs and traditional jet fuel, countries around the world are considering SAF blending mandates to help drive further development and commercial adoption.[liv] There is precedent for this approach in the United States, which has adopted a federal Renewable Fuel Standard (RFS) for domestically sold transportation fuels. As currently structured, the RFS primarily supports biomass-based fuels—it does not recognize fuels produced using carbon feedstocks of non-biogenic origin. However, changes to the RFS or a new version of this program that accommodates a wider range of SAFs are important options for incentivizing DAC and driving progress toward decarbonization more broadly.

California's "Buy Clean" program offers another model for a procurement-based approach. This program requires reductions in direct and embodied carbon emissions from state-funded construction projects over time.[lv] Reductions can come from innovative manufacturing processes, including processes that capture CO_2, or directly use captured CO_2, for example to strengthen concrete.[lvi,lvii] A similar federal program would indirectly support not only DAC deployment, but also domestic production of steel and cement. Even without congressional action, the General Services Administration can choose to prioritize carbon management and transparency about carbon impacts when procuring goods and services. This basic idea is reflected in both the Biden Administration's Executive Order 1400 and the American Jobs Plan.[lviii]

For low-carbon procurement policies to be effective, further progress is needed on data collection, transparency, and assessment to document "cradle-to-grave" lifecycle emissions, and to establish robust carbon accounting frameworks for different products and services. Sen. Amy Klobuchar (D-MN) has introduced legislation, the *Buy Clean Transparency Act* (S. 1864), that would direct federal agencies to catalog and critically assess emissions and environmental costs associated with products used in public projects.[lix]

Recommendation 4: Leverage government procurement to support a carbon-managed economy

- Use government procurement to support the build-out of carbon management infrastructure (including DAC facilities). This can include commitments to purchase carbon removal credits from DAC facilities, setting aside federal land for expedited permitting of DAC projects, or commitments to purchase construction materials and other products that use captured carbon as a feedstock.
- Include fuels that use captured CO_2 as a feedstock in clean fuel standards. Support the quantification of emissions and environmental impacts associated with products and services procured by government agencies.

Existing legislation supported by the DAC Advisory Council:

- *Buy Clean Transparency Act* S. 1864

RECOMMENDATIONS FOR CREATING ROBUST CARBON ACCOUNTING FRAMEWORKS

High-quality, rigorous carbon accounting practices are essential to document and track progress toward climate goals, and to preserve the integrity of both voluntary and compliance credit markets. This issue has received more attention in recent years as concerns have been raised about the verifiability, additionality, and permanence of the carbon benefits claimed for some CDR projects.[lx,lxi]

In the near term, revenue opportunities for DAC projects are more likely to come from voluntary carbon credit markets, which some advocates predict will grow strongly over the coming decade. The Taskforce on Scaling Voluntary Carbon Markets, for example, has estimated that voluntary carbon markets will have to expand 15-fold by 2030 to achieve net-zero goals.[lxii]

In this context, there has been ongoing discussion about the appropriate balance of private and public sector involvement in developing verification protocols, assessing cradle-to-grave lifecycle emissions, establishing credit registries, and accounting for the nuances of natural versus technology-based carbon removal approaches. Oxford University, for example, has developed a set of principles for "net zero aligned offsetting."[lxiii] The Oxford principles urge companies, organizations, cities, and other institutions to:

- Cut emissions, use high quality offsets, and regularly revise offsetting strategy as best practice evolves.
- Shift to carbon removal offsetting (as opposed to offsets for emissions reductions).
- Shift to long-lived storage (of captured CO_2).
- Support the development of net zero aligned offsetting.

Developing a supportive policy environment requires a strategic vision for the future of carbon accounting that emphasizes the appropriate quantification and crediting of different CDR approaches. To that end, DOE, EPA, and the Department of Commerce should work together to develop robust environmental, and techno-economic analyses and standardize carbon accounting protocols. Similar collaboration will be needed to support robust carbon accounting practices more generally.[lxiv] As noted previously, the *Energy Policy Act of 2020*, which was included in omnibus budget legislation for 2021, contains provisions directing DOE to form an interagency CDR task force that could be very helpful in addressing these issues.[lxv]

Recommendation 5: Support the creation of robust carbon accounting frameworks

- **Strengthen carbon accounting frameworks in ways that enhance accountability and address concerns regarding the verifiability, permanence, and additionality of carbon benefits claimed for different CO_2 capture or mitigation efforts.**

CONCLUSION

Recognition of the importance of options for removing CO_2 from the atmosphere, and of the specific advantages of DAC relative to other forms of CDR, has grown in recent years. But additional policies and incentives are needed this decade to support DAC deployment on the scale, and in the timeframe needed to reach current climate goals. Prompt action on the recommendations offered in this white paper would help ensure that the United States emerges as a leader in the development, commercialization, and eventual export of DAC technology to the rest of the world. The alternative is to risk falling behind countries in Europe and elsewhere that have already started to invest in DAC, and other critical infrastructure for carbon management. A set of targeted federal policies, in tandem with growing commitments, and investments from the private sector, will position America for success—both in advancing DAC and in achieving a net-zero economy.

Endnotes

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iv In addition to the Environmental Case report (Ibid), see Chapter 1 of the recently released "CDR Primer" by Jennifer Wilcox and co-authors for a longer discussion of moral hazard and carbon overshoot. Available at: https://cdrprimer.org/

v "The Commercial Case for Direct Air Capture of Carbon Dioxide," Bipartisan Policy Center, February 2021. Available at: https://bipartisanpolicy.org/report/the-commercial-case-for-dac/

vi See press releases surrounding recent CDR interests from Elon Musk and Bill Gates, for example: https://www.bloomberg.com/news/articles/2021-03-05/bill-gates-investment-in-carbon-removal-tech

vii Noah McQueen et al, A review of direct air capture (DAC): scaling up commercial technologies and innovating for the future", Prog. Energy, 3 032001 (2021). Available at: https://doi.org/10.1088/2516-1083/abf1ce

viii For more on the Permian Basin project, see: https://carbonengineering.com/news-updates/new-development-company-1pointfive-formed/

ix Ryan Hanna et al., "Emergency deployment of direct air capture as a response to the climate crisis," Nature Communications, 12, 368 (2021). Available at: https://doi.org/10.1038/s41467-020-20437-0

x The Energy Act of 2020 was passed as Division Z of the Consolidated Appropriations Act of 2021, signed into law on December 27, 2020. The Act authorized research and deployment programs on topics spanning energy efficiency, nuclear energy, renewables and storage, carbon capture, and technology commercialization. It directs the Secretary of Energy to coordinate an interagency CDR RD&D program (including a $115 million authorization for a DAC prize competition), and to convene an interagency taskforce to evaluate the benefits and disadvantages of different CDR approaches. The taskforce will also issue a biannual report with recommendations for legislation and financing assistance needed to enable CDR for net-zero emissions. For more details, see: https://www.energy.senate.gov/2020/12/murkowski-manchin-house-colleagues-reach-agreement-on-energy-package-for-year-end-appropriations-bill

xi On January 27, 2021, President Biden signed Executive Order 1400- Tackling the Climate Crisis at Home and Abroad, which calls for a carbon-free electricity sector by 2035, net-zero economy-wide emissions by 2050, and a "whole-of-government approach"

to achieving these targets. The full text of the order is available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

xii On March 31, 2021, President Biden outlined his American Jobs Plan, which includes building out "next generation industries" with support for hard-to-decarbonize industrial applications and direct air capture. See: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

xiii For more on the need for federal investments in later-stage energy innovation, see the American Energy Innovation Council's Scaling Innovation Project: Technology Demonstration Case Study Series. Available at: http://americanenergyinnovation.org/aeic-scaling-innovation-project/

xiv Climeworks, a member of BPC's DAC Advisory Council, has stated that it will not pursue enhanced oil recovery as a business model.

xv Historical funding levels from before 2020 were compiled as part of "Carbon Removal: Comparing Historical Federal Research Investments with the National Academies' Recommended Future Funding Levels," Bipartisan Policy Center and the Energy Futures Initiative, April 2019. Available at: https://bipartisanpolicy.org/wp-content/uploads/2019/06/Carbon-Removal-Comparing-Historical-Investments-with-the-National-Academies-Recommendations.pdf

xvi "Clearing the Air: A Federal RD&D Initiative and Management Plan for Carbon Dioxide Removal Technologies," Energy Futures Initiative, 2019. Available at: https://energyfuturesinitiative.org/efi-reports

xvii Katie Lebling, "To Unlock the Potential of Direct Air Capture, We Must Invest Now," World Resources Institute, 2020. Available at: https://www.wri.org/blog/2020/03/to-unlock-the-potential-of-direct-air-capture-we-must-invest-now

xviii For an overview of DAC innovation pathways with associated impacts on cost, see Chapter 5 of the National Academy of Sciences report, "Negative Emissions Technologies and Reliable Sequestration: A Research Agenda," 2019. For earlier stage research, NASEM recommends a focus on advanced process designs (shallow contractor to minimize pressure drop, improved packing material properties and contactor designs) for liquid-solvent air capture, or improved materials for solvents and sorbents (improvements to diffusion kinetics and solvent capacity) to help drive down costs. Report available at: https://www.nap.edu/catalog/25259/negative-emissions-technologies-and-reliable-sequestration-a-research-agenda

xix Beyond basic materials and engineering research, environmental and techno-economic assessments are important in advancing new technologies such as DAC. For an overview of existing research and development activities at DOE, along with recommendations for improved deployment and demonstration, see: "Clearing the Air: A Federal RD&D Initiative and Management Plan for Carbon Dioxide Removal Technologies," Energy Futures Initiative, 2019. Available at: https://energyfuturesinitiative.org/efi-reports

xx "Chairman Manchins legislative proposal is a part of active infrastructure negotiations and details may have changed since publication of this report. For details on Chairman Manchins legislative proposal at the time of this reports publication see: https://www.energy.senate.gov/hearings/2021/6/full-committee-hearing-to-examine-infrastructure-needs "

xxi A recent report by Resources for the Future finds that rapidly increasing RD&D funding for DAC over the next decade creates $26.70 in economy-wide benefits for every dollar spent, when combined with other climate policies. See: Daniel Shawhan et al, "The Value of Advanced Energy Funding: Projected Effects of Proposed US Funding for Advanced Energy Technologies," Resource for the Future, 2021. Available at: https://www.rff.org/publications/working-papers/projected-effects-proposed-us-funding-advanced-energy-technologies/

xxii Sydney Bopp and Lindsay Steves, "Recommendations for DAC Research, Development, and Demonstration," Bipartisan Policy Center, August 2020. Available at: https://bipartisanpolicy.org/blog/recommendations-for-dac-research-development-and-demonstration/

xxiii The Direct Air Capture and Blue Carbon Removal Technology Program at the Departments of Defense and Homeland Security has a budget of around $10 million per year and supports two categories of technology for CO2 removal and utilization in the production of liquid fuels for military applications: Small-scale air-to-diesel systems appropriate for use at forward operating bases (led by the Army Research Laboratory) and shipboard seawater-to-fuels systems (led by the Naval Research Laboratory). See: https://news.bloomberglaw.com/environment-and-energy/military-researching-ways-to-suck-carbon-from-air-to-make-fuel

xxiv For more on relevant NIST activities, see: https://www.nist.gov/infrastructure

xxv The Rhodium Group has suggested that NIST or another independent standard-setting organization should work to establish standards for products, such as concrete and aggregate, that use CO2 as a feedstock and could provide valuable financing opportunities for DAC in the future. See John Larsen et al., "Capturing Leadership: Policies for the US to Advance Direct Air Capture Technology," Rhodium Group, 2019. Available at: https://rhg.com/research/capturing-leadership-policies-for-the-us-to-advance-direct-air-capture-technology/

xxvi The Energy Futures Initiative has suggested that EPA should exercise its authority to perform research and development under Section 103 of the Clean Air Act to assist with DAC development. See: "Clearing the Air: A Federal RD&D Initiative and Management Plan for Carbon Dioxide Removal Technologies," Energy Futures Initiative, 2019. Available at: https://energyfuturesinitiative.org/efi-reports

xxvii The 2019 Energy Futures Initiative report (see endnote xxiv) offers detailed recommendations on federal funding and coordination to deploy CDR. These recommendations include establishing a federal committee on Large Scale Carbon Management within the President's National Science and Technology Council (NSTC), as designated within the CREATE Act. The proposed committee would include four working groups that cover different forms of CDR (oceans, terrestrial, geological, and technological). The recently authorized interagency CDR taskforce led by DOE is similar in design and will help coordinate the budgeting, planning, and implementation of CDR activities. Future efforts to coordinate federal activities on CDR deployment should build on the activities of the CDR taskforce.

xxviii This white paper focuses on targeted legislative priorities to enable DAC technologies. For another resource on legislative priorities to enable a broader carbon managed economy, see the Carbon Capture Coalition's 2021 Federal Policy Blueprint: https://carboncapturecoalition.org/national-coalition-releases-federal-policy-blueprint-for-carbon-capture-for-the-117th-session-of-congress/

xxix The infrastructure requirements for a net-zero economy are significant in scope and underappreciated in difficulty. This is not unique to carbon management, as significant challenges in terms of unlocking public financing and improving permitting will need to be overcome in the coming decade to achieve the net-zero goal. For a longer discussion on infrastructure with suggested policy reforms, see: "Six Big Ideas for Infrastructure—Updated for the 117th Congress," Bipartisan Policy Center, 2021. Available at: https://bipartisanpolicy.org/blog/six-big-ideas-for-infrastructure/; and "Bridging the Gap Together: A New Model to Modernize U.S. Infrastructure," Bipartisan Policy Center, 2016. Available at: https://bipartisanpolicy.org/report/modernize-infrastructure/

xxx For more on the Connecting Europe Facility program, see: https://ec.europa.eu/inea/en/connecting-europe-facility

xxxi EPA has historically lacked adequate resources for granting primacy to states for permitting Class VI wells, which cover saline geologic storage sites. See: https://carboncapturecoalition.org/coalition-weighs-in-on-federal-budget-areas-key-to-commercializing-carbon-capture/

xxxii For more on the SCALE Act, see: https://www.coons.senate.gov/news/press-releases/bipartisan-group-introduces-nations-first-comprehensive-co2-infrastructure-bill

xxxiii "Employment Effects of Investments in CO2 Transport Infrastructure and Geologic Storage—the 2021 SCALE Act," February, 2021. Available at: https://www.catf.us/wp-content/uploads/2021/03/2021-SCALE-Act-Jobs-Report.pdf

xxxiv Details on President Biden's American Jobs Plan available at: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

xxxv For more on master limited partnerships and the Financing Our Energy Future Act, see: https://www.coons.senate.gov/issues/master-limited-partnerships-parity-act

xxxvi For more on private activity bonds and The Carbon Capture Improvement Act, see: https://www.bennet.senate.gov/public/index.cfm/2019/6/bennet-portman-reintroduce-bill-to-reduce-overall-carbon-emissions-and-boost-domestic-energy-production

xxxvii Rhodium has suggested that either a 30% DAC-specific ITC or a price on carbon could go a long way in spurring DAC deployment. See: https://rhg.com/research/capturing-leadership-policies-for-the-us-to-advance-direct-air-capture-technology/

xxxviii "The Commercial Case for Direct Air Capture of Carbon Dioxide," Bipartisan Policy Center, February 2021. Available at: https://bipartisanpolicy.org/report/the-commercial-case-for-dac/

xxxix Kurt Waltzer, "The Role of 45Q Carbon Capture Incentives in Reducing Carbon Dioxide Emissions," Clean Air Task Force, 2017. Available at: https://www.catf.us/wp-content/uploads/2017/12/CATF_FactSheet_45QCarbonCaptureIncentives.pdf

xl The 45Q tax credit was originally introduced in 2008 and was updated in both the Bipartisan Budget Act of 2018 and the Consolidated Appropriations Act of 2021. The update in 2018 modified the value of the tax credit to increase incrementally over ten years from $10 to $35 per metric ton of captured CO2 used (and permanently stored

underground) in EOR applications and from $20 to $50 per ton for captured CO2 that is directly stored in saline and other types of geologic formations. The modifications made in December 2020 allow the credit to be made available to carbon capture projects that commence construction before 2026 and allow the credit to be claimed up to 12 years after being placed into service.

xli "Carbon Capture Coalition Welcomes IRS Issuance of Proposed 45Q Rule and Requirements for Secure Geologic Storage," Carbon Capture Coalition, 2020. Available at: https://carboncapturecoalition.org/carbon-capture-coalition-welcome-irs-issuance-of-proposed-45q-rule-and-requirements-for-secure-geologic-storage/

xlii See "ARRA Section 1603 Grants in Lieu of Tax Credits for Renewable Energy: Overview, Analysis, and Policy Options," Congressional Research Service, 2011. Available at: https://www.everycrsreport.com/reports/R41635.html

xliii Press Release for The ACCESS 45Q Act in the 117th Congress available at: https://mckinley.house.gov/news/documentsingle.aspx?DocumentID=2993 ; Initial details on President Biden's American Jobs Plan were unveiled on March 31st. See more at: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

xliv John Larsen et al., "Capturing Leadership: Policies for the US to Advance Direct Air Capture Technology," Rhodium Group, 2019. Available at: https://rhg.com/research/capturing-leadership-policies-for-the-us-to-advance-direct-air-capture-technology/

xlv "The Commercial Case for Direct Air Capture of Carbon Dioxide," Bipartisan Policy Center, February 2021. Available at: https://bipartisanpolicy.org/report/the-commercial-case-for-dac/

xlvi The U.S. federal government spends more than $550 billion on products and services each year. For more details, see: https://www.epa.gov/greenerproducts/selling-greener-products-and-services-federal-government#:~:text=The%20U.S.%20federal%20government%20is,%E2%80%9Cgreener%E2%80%9D%20products%20and%20services

xlvii While "government procurement" has been used to categorize specific policy proposals, this report uses the term broadly for any government commitments that either (1) directly support DAC projects through offsets or by setting aside federal land for DAC construction, or (2) directly support a carbon managed economy (e.g., setting aside federal land for geologic storage or committing to purchasing construction products that use CO2 as a feedstock).

xlviii "Renewable Energy on the Nation's Public Lands," Natural Resources Defense Council, 2013. Available at: https://www.nrdc.org/sites/default/files/policy-basics-renewables-FS.pdf

xlix An advance commitment to purchase carbon credits for DAC would play an analogous role to power purchase agreements for renewable energy procurement.

l "The Commercial Case for Direct Air Capture of Carbon Dioxide," Bipartisan Policy Center, February 2021. Available at: https://bipartisanpolicy.org/report/the-commercial-case-for-dac/

li Regina E. Dugan and Kaigham J. Gabriel, "`Special Forces' Innovation: How DARPA Attacks Problems," Harvard Business Review, 2013. Available at: https://hbr.

org/2013/10/special-forces-innovation-how-darpa-attacks-problems

lii Climeworks, a member of BPC's DAC Advisory Council, has stated that it will not engage in research partnerships with the DoD and the arms industry more generally and will not sell DAC products or CDR certificates to military organizations.

liii "The Commercial Case for Direct Air Capture of Carbon Dioxide," Bipartisan Policy Center, February 2021. Available at: https://bipartisanpolicy.org/report/the-commercial-case-for-dac/

liv As one example, the U.K. government is considering SAF mandates as part of its "Ten Point Plan for a Green Industrial Revolution." For more, see: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title

lv Rebecca Dell, "Build Clean: Industrial Policy for Climate and Justice," Climateworks Foundation, 2020. Available at: https://www.climateworks.org/report/build-clean-industrial-policy-for-climate-and-justice/

lvi There is an interesting business case to be made for combining carbon removal financing with the revenue streams from industrial manufacturing. For example, CarbonCure uses captured carbon to strengthen concrete aggregate. Its approach to capturing and using carbon has attracted investment from Mistubishi and others. For more, see: https://www.carboncure.com/news/carbon-direct-and-mitsubishi-corporation-invest-in-cleantech-company-carboncure/

lvii It is worth noting that New York and New Jersey have likewise initiated discussions about low-carbon concrete procurement policies at the state level. For more, see: https://www.greenbiz.com/article/smart-procurement-policies-can-help-decarbonize-concrete

lviii See: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/ and https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

lix For more, see: https://www.klobuchar.senate.gov/public/index.cfm/2019/6/klobuchar-introduces-legislation-to-incentivize-green-manufacturing-practices

lx Lisa Song and Paula Moura, "An Even More Inconvenient Truth: Why Carbon Credits for Forest Preservation May Be Worse Than Nothing," ProPublica, 2019. Available at: https://features.propublica.org/brazil-carbon-offsets/inconvenient-truth-carbon-credits-dont-work-deforestation-redd-acre-cambodia/

lxi There is growing recognition of the challenges associated with carbon accounting practices and historical observations suggest the need to reprioritize credit quality over cost. For a discussion of this topic, see David Roberts, "Carbon offsets aren't working, and probably can't: A conversation with Cullenward & Victor, part two," Volts, 2020. Available at: https://www.volts.wtf/p/carbon-offsets-arent-working-and

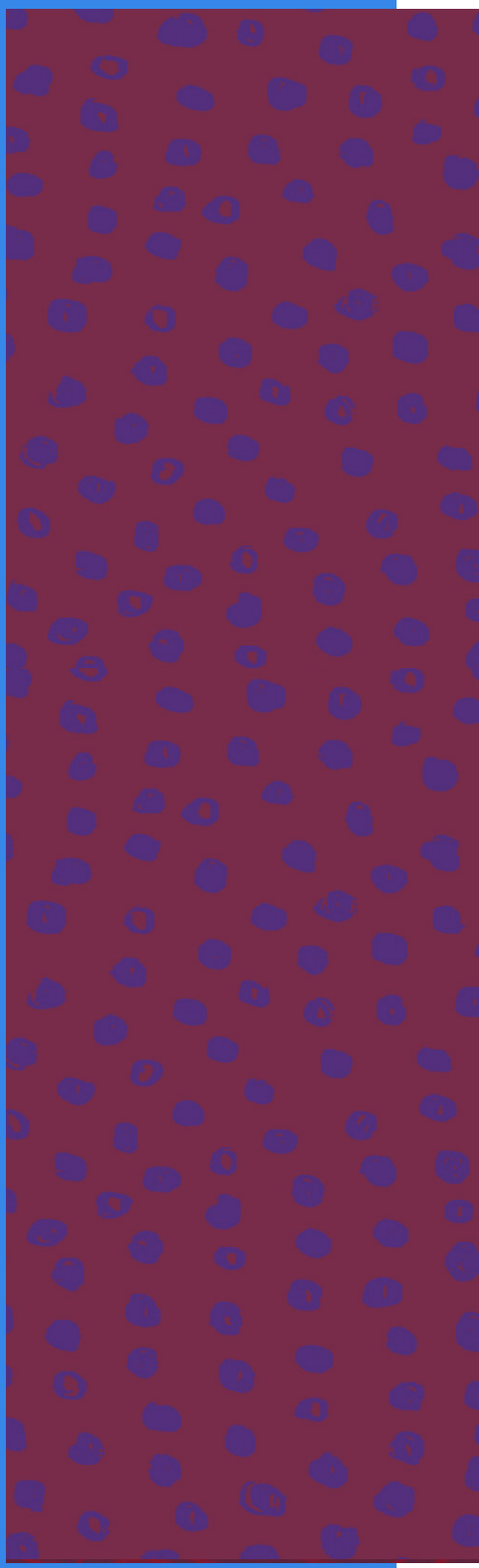
lxii "Taskforce on Scaling Voluntary Carbon Markets—Final Report," January, 2021. Available at: https://www.iif.com/tsvcm

lxiii Myles Allen et al., "The Oxford Principles for Net Zero Aligned Carbon Offsetting," University of Oxford, 2020. Available at: https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf

lxiv There is already interest in Congress in supporting carbon accounting practices for farmers. For example, the Growing Climate Solutions Act, sponsored by Senators Braun

(R-IN), Stabenow (D-MI), Graham (R-SC), and Whitehouse (D-RI), would establish a program at the U.S. Department of Agriculture to help certify third-party verifiers and technical service providers for services that produce credits from a variety of agriculture- and forestry-related carbon management activities. See: https://www.braun.senate.gov/growing-climate-solutions-act-set-be-introduced-us-senate

lxv Supporting interagency collaboration on CDR strategies is essential. Another supportive bill - The CREATE Act, sponsored by Senators Sinema (D-AZ), Murkowski (R-AK), Whitehouse (D-RI), and Capito (R-WV) - would create a CDR working group within the National Science and Technology Council with the aim of elevating critical planning and strategizing to the White House and ensuring coordination among the many agencies involved with large-scale carbon management. See: https://www.sinema.senate.gov/sinema-continues-bipartisan-effort-growing-arizonas-economy-boosting-innovative-energy-technologies



Bipartisan Policy Center

1225 Eye St NW, Suite 1000
Washington, DC 20005

bipartisanpolicy.org

202 - 204 - 2400

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