Carbon Direct

Boulder County | Sustainability, Climate Action & Resilience

4 CORNERS CARBON COALITION

BEST PRACTICES PLAYBOOK

Local Carbon Removal & Resilience Strategies

Tactical guidance for governments, decision makers, and implementers

Table of contents

Executive summary

Best practices for place-based projects

CASE STUDY

Boulder County Climate Innovation Fund

CASE STUDY

4 Corners Carbon Coalition

Conclusions and future outlooks

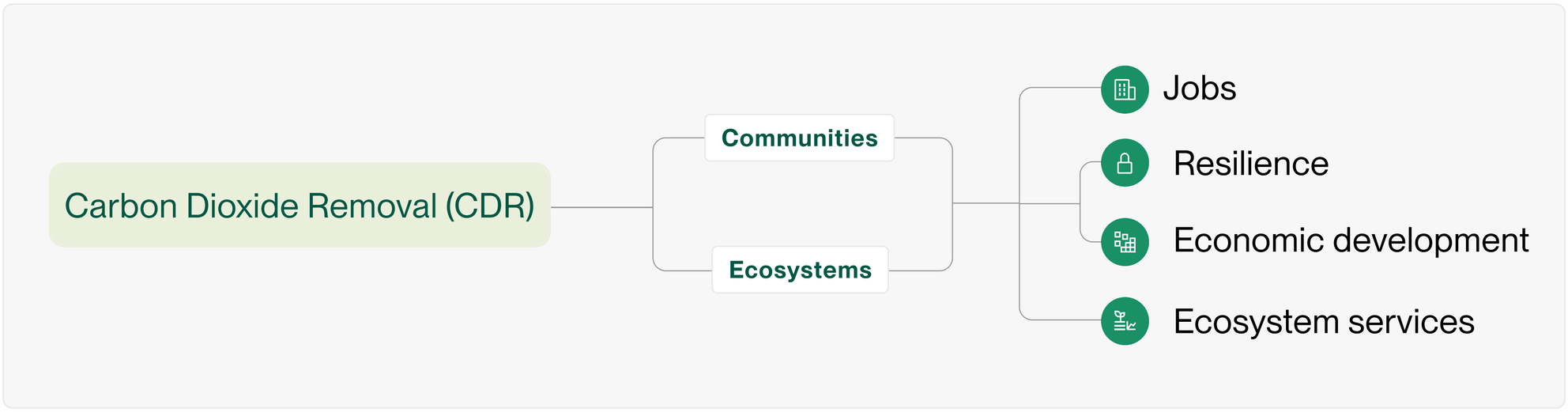
Appendix

Executive summary

This brief is a public resource for sustainability practitioners and decision makers focused on local impact. It outlines how carbon dioxide removal (CDR) can be incorporated into local climate action plans to support livelihoods, innovation, and ecosystem and landscape resilience. It is a roadmap for decision-makers to adopt CDR policy in local jurisdictions, for government and civil society members who wish to drive the creation of local CDR programs, and for any individuals supporting local carbon removal.

It is increasingly clear that active carbon dioxide (CO_2) removal from the atmosphere is an essential component of any holistic climate strategy in addition to greenhouse gas emissions reduction and avoidance. The IPCC estimates that CDR will need to scale to between 100 and 10,000 billion metric tonnes by 2100 to meet 1.5°C warming goals.[1] Although these numbers seem daunting, local action can make a meaningful impact.

Carbon removal action can be incorporated into local climate action plans with an eye to emphasizing a place-based approach. This involves collaborating with local communities and stakeholders to identify climate action priorities that carbon removal projects can support, such as landscapes that are resilient to disruptions, or scaling nascent technologies and industries.[2] Considering the unique priorities of every community for climate action, this brief outlines four phases that local governments should adopt as best practices to support CDR initiatives:



PHASE 1 **Assess community needs & resources**	▪ Community needs ▪ Local resources ▪ Programmatic goals & principles ▪ Programmatic design ▪ Engagement & partnerships ▪ Impact potential ▪ Barriers to implementation ▪ Communication strategies
PHASE 2 **Evaluate & design a CDR program**	▪ Quality criteria ▪ Solicitation & evaluation ▪ Budget considerations ▪ Climate justice & co-benefits ▪ Feasibility ▪ Innovation, scalability & future impact ▪ Team, composition, expertise, & partnership
PHASE 3 **Select & implement CDR projects**	▪ Weighting percentage by review topic ▪ Quality criteria scoring rubric ▪ Internal capacity for implementation and operationalization
PHASE 4 **Monitor, report & verify outcomes**	▪ Data and reporting requirements ▪ Annual report ▪ Reflection & continuous improvement

PHASE 1

Assess community needs and resources

Before engaging in program design and goal setting, local governments are encouraged to conduct a holistic assessment of community needs and priorities in the context of climate change. For example, urban centers might prioritize climate-related job creation and industry building, while more rural counties might prioritize fire or drought mitigation. Local governments should also realistically assess internal resources, additional external funding sources such as philanthropies or U.S. Department of Energy grants, and capacity for operationalizing CDR programs.

Community engagement should be conducted via listening sessions, public comment, outreach, and strategic partnerships to help local government program developers identify target solutions and priorities for funding. Local environmental context, local resource assessment and climate risks will further inform programmatic objectives, guiding principles, and design elements.

Local governments with shared priorities can increase the impact potential of these initiatives by combining resources to develop regional programs and funding opportunities.

Ultimately, a programmatic framework should enable local governments to invest in projects that accelerate carbon removal, foster local innovation, and prioritize the needs and safety of communities, all with an eye towards scaling climate impact.

PHASE 2

Evaluate and design a CDR program

A place-based carbon removal and resiliency program should have a clear and transparent set of standards in place for applying best-in-class scientific and community impact metrics when assessing the quality and impact potential of projects. Impact potential is multifaceted and contingent on the measurability of intended outcomes and risk tolerance.

At the project level, best-practices consider budget, feasibility, innovation, scalability, and team capabilities to assess feasibility and geographic suitability. Local governments should solicit expert guidance for developing standards and a project assessment framework.

PHASE 3

Select and implement CDR projects

The priorities and standards identified in Phase 1 and defined in Phase 2 are used to evaluate project proposals. Implementers create scorecards for consistency and traceability. The project evaluation rubric and scoring mechanism provide guidelines for evaluating criteria for high-quality projects in a local context. These programs have clear processes in place for tracking funded project implementation, and communicating outcomes to local stakeholders.

Local governments should ensure operational capacity to execute the fund, engage with stakeholders, and ensure ongoing monitoring and reporting of climate impacts.

PHASE 4

Monitor, report and verify outcomes

Establish metrics that permit the on-going review of project activities and evaluation of their impact. Tailor measurement and reporting requirements to suit technology- and project-specific designs. Consider both the type of carbon dioxide removal project and its technological maturity when defining metrics and reporting requirements.

Based on these identified metrics, projects produce annual reports to enable local governments to qualitatively and quantitatively assess project activities and impact. These impact reports and associated metrics should be made publicly available. Local governments are encouraged to use the annual review as an opportunity for continuous improvement and community engagement by reflecting on lessons learned and outlining future considerations to enhance monitoring, reporting, and verification of carbon removal and community and ecosystem benefits.

This brief showcases the four phases as two case studies from local governments and regional coalitions that developed carbon removal and resiliency programs in 2022 and 2023: Boulder County's Climate Innovation Fund, and the 4 Corners Carbon Coalition (4 Corners).

Following the 2021 Marshall wildfires, the 2022 Boulder County Climate Innovation Fund prioritized nature-based carbon removal projects with an emphasis on landscape resiliency. The 4 Corners – Boulder County (CO), Flagstaff (AZ), Salt Lake City (UT), and Santa Fe (NM) – focused on engineered carbon removal in the built environment.

Actions for decision-makers to implement local carbon removal projects:

1. Assess the situation
   What are the unique conditions and opportunities of your community?
2. Evaluate and design the plan
   What are your community and stakeholder climate priorities and what are your available resources?
3. Select and implement projects
   What pilot projects do you want to start with? How will you choose them?
4. Monitor and report outcomes
   What metrics will you choose to track the impact of your efforts?

Executive summary

Best practices for place-based projects

CASE STUDY

Boulder County Climate Innovation Fund

CASE STUDY

4 Corners Carbon Coalition

Conclusions and future outlooks

Appendix

Best practices for place-based projects

Leadership by example

Before engaging in program design and goal setting, local governments are encouraged to conduct a holistic assessment of community needs and priorities in the context of climate change. For example, urban centers might prioritize climate-related job creation and industry building, while more rural counties might prioritize fire or drought mitigation. Local governments should also realistically assess internal resources, additional external funding sources such as philanthropies or U.S. Department of Energy grants, and capacity for operationalizing CDR programs.

Balancing leadership with technical rigor

A firm grounding in scientific theory and best-practices is a requirement for all projects. When implementing a CDR program, ensuring that funding goes to support projects that are technically rigorous reduces reputational risks and facilitates actual climate impact.

If local governments do not have the ability to conduct technical diligence in-house, they can bring in experts to sit on project review panels and collaborate on program development more broadly from submission criteria to identifying key metrics for monitoring and reporting. Technical experts in CDR can be sourced from advisory firms, as was the case with the relationship between Carbon Direct and Boulder County, non-profits, and academia.

A key consideration for local jurisdictions is the balance of impacts across government operations vs. the entire community's aggregate footprint when considering local carbon removal and climate resilience policies and projects. A local government may have significantly more authority to mitigate its own emissions through carbon removals than to mitigate its constituents' emissions. However, local policies, ordinances and permitting can be fast-acting and effective in service of bringing carbon removal projects to fruition. Ideally, local governments lead by example (by locally procuring appropriate high-quality removals and/or resilience services) to catalyze broader community activities in these areas.

Local governments may choose the scope of their emissions management if it does not conflict with state directives, or if no state rules or regulations exist. The state may respond to a municipality or county's order by adopting a statewide ordinance that conflicts with the local government's, potentially requiring an adjustment. There is precedent for municipal and county climate action plans to consider constituent emissions that occur within boundaries, such as transportation and residential building emissions. In San Francisco's climate action plan, for example, the city's emissions scope includes residential buildings and intra-city transportation, as well as emissions from the upstream and downstream supply chain of products consumed within the city.[3] However, the city does not cover all constituent emissions (e.g., energy consumption, fuels, and products consumed outside the city) because residents engage in emissions-generating activities outside of the city's boundary, such as when they travel.

Check point

A key step when considering program design is for local governments to determine their authority in defining the scope of emissions management - e.g., emissions from municipal operations, from constituent consumption, etc. There is no overarching formula for confirming authority beyond the recommendation to consult the appropriate legal teams.

A framework for action

This brief describes a four phase framework for municipalities and counties interested in investing in or implementing place-based solutions for CDR that should be tailored to on on the ground realities (Table 1): assess community needs and resources **(Phase 1)**; evaluate and design a CDR program **(Phase 2)**; and select and implement CDR projects **(Phase 3)**; monitor, report, and verify outcomes **(Phase 4)**.

We summarize these phases below and then describe them in the context of two case studies: the **Boulder County Climate Innovation Fund** (see page x) and the **4 Corners Carbon Coalition** (see page x).

Table 1. Phases of planning, design, practical implementation, and ongoing monitoring for local-based projects

Phase of work	Determinants
Phase 1: Assess community needs & resources	▪ Community needs ▪ Local resources ▪ Programmatic goals & principles ▪ Programmatic design ▪ Engagement & partnerships ▪ Impact potential ▪ Barriers to implementation ▪ Communication strategies
Phase 2: Evaluate & design a CDR program	▪ Quality criteria ▪ Solicitation & evaluation ▪ Budget considerations ▪ Climate justice & co-benefits ▪ Feasibility ▪ Innovation, scalability & future impact ▪ Team, composition, expertise, & partnership
Phase 3: Select & implement CDR projects	▪ Weighting percentage by review topic ▪ Quality criteria scoring rubric ▪ Internal capacity for implementation and operationalization
Phase 4: Monitor, report, & verify outcomes	▪ Data and reporting requirements ▪ Annual report ▪ Reflection & continuous improvement

PHASE 1

Assess community needs and resources

Local governments are encouraged to conduct a holistic assessment of community needs and priorities in the context of climate change. For example, urban centers might prioritize climate-related job creation and industry building, while more rural counties might prioritize fire or drought mitigation. Local governments should also realistically assess internal resources, additional external funding sources such as philanthropies or U.S. Department of Energy grants, and capacity for operationalizing CDR programs. Community engagement should be conducted via listening sessions, public comment, outreach, and strategic partnerships to help local government program developers identify target solutions and priorities for funding. Local environmental context, local resource assessment and climate risks will further inform programmatic objectives, guiding principles, and design elements. Local governments with shared priorities can increase the impact potential of these initiatives by combining resources to develop regional programs and funding opportunities.

> Ultimately, a programmatic framework should enable local governments to invest in projects that accelerate place-based carbon removal, foster local innovation, and prioritize the needs and safety of communities, all with an eye towards scaling climate impact.

PHASE 2

Evaluate and design a CDR program

A localized carbon removal and resiliency program should have a clear and transparent set of standards in place for applying best-in-class scientific and community impact metrics when assessing the quality and impact potential of projects. Impact potential is multifaceted and contingent on the measurability of intended outcomes and risk tolerance. At the project level, best-practices consider budget, feasibility, innovation, scalability, and team capabilities to assess feasibility and geographic suitability. Local governments should solicit expert guidance for developing standards and a project assessment framework.

Table 2. Phase 2 considerations and recommendations for local-based carbon removal & landscape resiliency projects.

Category	Carbon removal	Landscape resiliency
Quality criteria	Commit to quality criteria across industry-leading standards[4] that take into account: 1. Additionality & baselines 2. Carbon accounting method 3. Harms and benefits 4. Durability / permanence 5. Environmental, social, and economic justice 6. Leakage 7. Monitoring, reporting, and verification (MRV)	Consider community/ecosystem interfaces including (but no limited to): 1. Stormwater abatement; 2. Flood/inundation management 3. Erosion control; 4. Heat island amelioration; 5. Air quality; 6. Wildfire risk management; 7. Landscape connectivity; 8. Biodiversity; and 9. Soil Fertility
Solicitation & evaluation	▪ Consider various solicitation strategies including Request for Information (RFI), Request for Proposal (RFP), direct outreach to project developers and credit suppliers, and rolling procurement on a continual basis; ▪ Foster relationships with local organizations that express interest and who are new to the carbon removal and management space to increase the diversity of applications; ▪ If resources allow, make grant-writing and technical assistance available to all organizations who express interest; ▪ Perform quality control evaluations and due diligence at the project, developer, and protocol levels (where applicable); ▪ Account for all types of greenhouse gasses through a full cradle-to-grave life cycle assessment (LCA)[5]; ▪ Determine specific project type(s) of interest and possible interest in selecting a portfolio of projects (to promote diversification and mitigate risk); ▪ Avoid blindspots to unintended consequences by referencing Phase 1 findings and encouraging projects that meet multiple community needs.	
Budget considerations	Take into account the following factors: ▪ Cost-sharing opportunities ▪ Current vs. future project costs ▪ Local revenue creation & investment opportunities	

Category	Carbon removal
Climate justice & co-benefits	Prioritize projects with one or more of the following traits, focusing improvements on historically disadvantaged communities: ▪ Hazardous waste remediation ▪ Local air quality improvement ▪ Local health benefits / reduced health ailments ▪ Reduced chemical and fertilizer use ▪ Reduced urban heat island effect ▪ Reduced traffic and noise pollution ▪ Increased access to natural landscapes & recreation
Feasibility	Take into account the following factors: ▪ Capital (CAPEX) & operational (OPEX) expenditure requirements ▪ First-of-a-kind (FOAK) vs. Nth-of-a-kind (NOAK) ▪ Permitting / regulatory needs (incl. federal, state, county, local, tribal); ▪ Political considerations & vulnerabilities; ▪ Scientific certainty vs. uncertainty; ▪ Supply chain readiness (incl. local vs. non-local materials and feedstock sourcing); and ▪ Workforce barriers or considerations.
Innovation	Take into account the following factors: ▪ Demonstration of new technology innovations; ▪ Industry data generation & collection opportunities; ▪ Learning by doing and using (cost and performance breakthroughs); and ▪ New local market / sector development.
Scalability	Take into account the following factors: ▪ Energy & land use requirements; ▪ Geographic adaptability / flexibility; ▪ Manufacturing needs; ▪ Modularity; ▪ Siting considerations; and ▪ Vertically-integrated operation vs. need for external equipment / feedstocks / business partners.

Category	Carbon removal
Team composition, expertise, and partnerships	Take into account the following factors: ▪ Area(s) of expertise; ▪ Business partnership(s); ▪ Previous project(s); and ▪ Year(s) in operation Prioritize projects with developers that understand the local context and/or are willing to partner with local stakeholders to inform project design parameters.

PHASE 3

Select and implement CDR projects

The priorities and standards identified in Phase 1 and defined in Phase 2 are used to evaluate project proposals. Implementers create scorecards for consistency and traceability. The project evaluation rubric and scoring mechanism provide guidelines for evaluating criteria for high-quality projects in a local context. Ensure these programs have clear processes in place for tracking funded project implementation, and communicating outcomes to local stakeholders. Local governments should ensure operational capacity to execute the fund, engage with stakeholders, and maintain ongoing monitoring and reporting of climate impacts.

PHASE 4

Monitor, report and verify outcomes

Establish metrics that permit the on-going review of project activities and evaluation of their impact. Tailor measurement and reporting requirements to suit technology- and project-specific designs. Consider both the type of carbon dioxide removal project and its technological maturity when defining metrics and reporting requirements.

Based on these identified metrics, projects produce annual reports to enable local governments to qualitatively and quantitatively assess project activities and impact. These impact reports and associated metrics should be made publicly available. Local governments are encouraged to use the annual review as an opportunity for continuous improvement and community engagement by reflecting on lessons learned and outlining future considerations to enhance monitoring, reporting, and verification of carbon removal and community and ecosystem benefits.

Executive summary

Best practices for place-based projects

CASE STUDY

Boulder County Climate Innovation Fund

CASE STUDY

4 Corners Carbon Coalition

Conclusions and future outlooks

Appendix

Case study: Boulder County Climate Innovation Fund

Boulder County and other Colorado communities are living with worsening impacts of climate change, manifested in several alarming trends: more destructive wildfires, stronger heat waves and droughts, reduced snowpack, increased air pollution, and changing and unpredictable precipitation patterns, among other indicators. Boulder County saw the need to allocate resources to prepare for, respond to, and recover from the impacts of climate change. As identified by the IPCC and leading scientists, Boulder County recognized that climate change mitigation and adaptation must include carbon removal strategies.

Boulder County's Office of Sustainability, Climate Action & Resilience (OSCAR) wants its approach to CDR to address cross-sectoral benefits with climate adaptation and resilience imperatives that are regionally-specific and impactful. In 2022, OSCAR launched a $500,000+ Climate Innovation Fund to financially support local projects focused on CDR and landscape resilience and restoration. OSCAR aimed to fund innovative local projects that met carbon removal and landscape resilience goals pertinent to Boulder County, such as fire or drought resilience, and that prioritized community involvement and climate justice. Below is the step-by-step approach, outlined in three phases, taken by OSCAR and Carbon Direct to initiate and launch the Climate Innovation Fund.

PHASE 1 IN PRACTICE

Evaluating the needs and resources of Boulder County

The Climate Innovation Fund is a defining stage in Boulder County's long history of prioritizing sustainability and resilience while identifying community priorities and needs through stakeholder engagement in order to address them holistically. In 2010, the County received a $25 million grant from the U.S. Department of Energy (DOE) to launch their initial sustainability efforts and provide funding for county-level sustainability positions. In 2016, residents of Boulder County passed the Sustainability Tax Initiative, which allocates a portion of sales and tax revenues to sustainability infrastructure and programs.

Identifying sustainability priorities through stakeholder mapping

Boulder County leveraged stakeholder mapping to identify sustainability priorities through polling and roundtable discussions. This exercise is reflected in the Sustainability Tax Initiatives program, which allows constituents to determine how to disperse revenue across five key priority areas: (1) circular economy & waste; (2) transportation electrification; (3) clean energy and climate; (4) local food and agriculture; and (5) water resource protection. The program provides grants to local communities to fund high-impact environmental sustainability projects they deem most impactful.

With the Climate Innovation Fund, OSCAR sought to incorporate investments in CDR for the county in the context of the five climate adaptation and sustainability priorities identified by stakeholders. OSCAR focused on projects that avoided and minimized environmental and social harm while promoting racial and social equity, and sustainability (Table 3).

Table 3. Boulder County Climate Innovation Fund Phase 1 considerations for carbon removal & landscape resiliency projects

Category	Process
Community needs	▪ Apply holistic definition to include economic, social, and environmental factors ▪ Perform climate vulnerability and hazard risk assessment[6] that engages local insights (informed by current and future/ forecasted climate impacts)
Local resources	▪ Take stock of local innovation assets such as workforce capabilities, academic and research institutions, infrastructure availability, enabling policy and regulatory environment, potential business partnerships, land-use patterns and project siting opportunities, and ecosystem services that are already provided at the local level.
Programmatic goals and principles	▪ Establish clear programmatic goals and guiding principles (action-oriented measures to inform goal achievement) ▪ Align goals and guiding principles with community needs and local resources.

Category	Process
Programmatic goals and principles	▪ Establish clear programmatic goals and guiding principles (action-oriented measures to inform goal achievement) ▪ Align goals and guiding principles with community needs and local resources.
Programmatic design	▪ Conduct comprehensive research prior to any program commitments to learn from peer communities about best practices and lessons learned for similar efforts; ▪ Leverage the expertise and capabilities across local government departments for coordination, planning, and execution purposes (employ a 'whole-of-government' approach) ▪ Plan for the possibility of discontinuity between different administrations and priorities; seek durable programmatic design options ▪ Seek to harmonize target-setting and strategies across jurisdictions and stakeholder groups ▪ Define risk parameters for successful project outcomes (some degree or risk may be acceptable given scale of climate challenge) ▪ Promote equitable and inclusive program outcomes and incorporate climate and environmental justice in all aspects of the project[7] ▪ Commit to market transparency at the process and project levels
Barriers to implementation	▪ Align subnational government budgeting for climate-directed funds with established industry best practices such as those from the OECD;[8] ▪ Conduct a cost-benefit analysis at the community level and compare it to the 'cost of doing nothing ▪ Consider budgetary carve out for high-risk, high-reward projects through performance-based funding support ▪ Seek pooled purchasing power with local and regional entities across the public, private, non-profit, and philanthropic sectors ▪ Balance technical solution(s) with political solution (most viable option for passage and ability to be sustained over time) ▪ Weigh project siting options (and potential constraints) as informed by land ownership structures, permitting, and regulations

Category	Process
Impact potential	▪ Define positive impact through place-based solutions tailored to local contexts ▪ Develop measurable performance indicators/metrics for program outcomes; ▪ Consider the biosphere as an interconnected system (e.g., carbon cycle, water cycle, nutrient cycles, etc.) ▪ Explore opportunities to test new innovations and help answer fundamental scientific questions/uncertainties ▪ Help prove, demonstrate, and scale new technologies across the research, development, demonstration, and deployment (RDD&D) spectrum to promote learning by doing and using ▪ Seek to drive innovation in technologies, policies, and business models ▪ Determine potential to spur new local market formation for innovative climate solutions ▪ Encourage engagement with standards development processes and new protocol / methodology creation and maturation
Communication strategies	▪ Designate a central coordinating body to communicate across participating departments / agencies ▪ Hold public information session(s) to inform interested parties of intended goals and outcomes ▪ Convey measurable and demonstrable community impact and opportunities to promote social and economic mobility ▪ Promote cross-pollination of ideas across jurisdictions and interest groups ▪ Explain opportunities for outsized impact beyond local level (scaling potential) ▪ Emphasize importance of learning by doing and continuous improvement across subsequent program efforts ▪ Commit to ongoing dialogue and community outreach

Acknowledging that a broad portfolio of solutions are required to meet their carbon removal and broader climate goals, Boulder County also considered engineered carbon capture solutions that demonstrated a clear carbon management plan and focused on secure storage rather than the amount of carbon captured. Businesses that use or produce carbon in their operations and have the means to capture and/or utilize carbon were also encouraged to apply. Recognizing that no off-the-shelf solution was likely to exist, OSCAR used the Climate Innovation Fund as an opportunity to build local capacity and foster local innovation and stakeholder participation in carbon removal and resiliency projects. Phase 2 discusses this solicitation process.

Access to decision makers

It is important to note that in the case of Boulder County the success of the Climate Innovation Fund was made possible in part by the County's organizational reporting structure. The County Board of Commissioners interfaces with several departments across Boulder County (Parks and Open Spaces, Public Works, Land Use, etc.). The Office of Sustainability, Financial Planning and attorneys report directly to the Board, a rare configuration that provides direct access to decision makers. In this way, action is initiated through presentations to the Board of Commissioners, allowing for quick decision making.

PHASE 2 IN PRACTICE

Project solicitation and evaluation

To develop a rigorous solicitation and evaluation process for the Climate Innovation Fund, OSCAR partnered with Carbon Direct Inc., a leading carbon management advisory and technology firm backed by over 40 of the world's leading carbon scientists. The solicitation and evaluation process they developed followed a careful three-step process:

1. An announcement followed by a community stakeholder meeting and Q&A. OSCAR gave a brief presentation explaining priorities and then had an extensive Q&A session with attendees to explain what the County was looking for and aid project developers in their design.
2. A Request for Qualifications (RFQ).[9] This RFQ took the form of a short pre-proposal.
3. A Request for Proposals (RFP). The RFP was by invitation only and involved a more extensive project narrative and series of responses to specific questions and quality criteria.

All proposals passed a comprehensive independent review to assess the extent to which they met Boulder County's criteria. These included scientific merit, scalability, community and ecosystem benefits, and feasibility (Table 7). Projects that met the above prerequisites were invited to submit full proposals to the RFP.

The project assessment rubric, developed by OSCAR and Carbon Direct, included scoring guidelines for reviewers that considered criteria for high-quality carbon removal (Table 5).[10] The rubric included detailed rating criteria for each of five review topics: (1) carbon removal; (2) quality of carbon removals; (3) innovation, scalability & future impact; (4) co-benefits; and (5) team & resources. For each review topic, a project could receive a maximum score of five and a minimum score of zero (Appendix A contains detailed descriptions of each criteria and the associated scorecards).

PHASE 3 IN PRACTICE

Projects selected by Boulder County

The inaugural Climate Innovation fund received 17 RFQ applicants, seven of which were invited to submit full proposals through the RFP. Individual RFPs were reviewed by three subject matter experts. The zero to five "absolute" scores for each review topic were multiplied by coefficients, proportional to the percentages below, such that a perfect project (all "fives") would receive a total score of 100 (Table 4). The review coordinator compiled feedback from each project and calculated the average and standard deviation of the three "0-100" criteria-weighted total scores. All submissions were discussed and scored as an aggregate pool in the summary scoring rubric (Appendix B).

Table 4. Weighting percentage by review topic

Weighting percentage	Review category
20%	**Carbon removal.** The project's potential for carbon removal with any scientific and technical uncertainties resolved. For CDR projects, net negativity is a requirement.
10%	**Removal quality.** Assesses each project's compliance with Carbon Direct's quality carbon removal criteria:[11] Additionality and Baselines, Carbon Accounting Method, Durability, Leakage, Do No Harm, Monitoring, Reporting, and Verification (MRV).

Weighting percentage	Review category
25%	**Innovation, scalability & future impact.** How effectively the proposed activities advance the science of climate remediation and resilience, the introduction of new technologies or practices, the potential to support new businesses, and the availability of resources to replicate the project if successful.
25%	**Co-benefits.** Assessment of a project's non-carbon impact on landscape resilience, water resources, air quality, local employment, economic growth, and historically disadvantaged communities while minimizing negative effects.
20%	**Team & resources.** Measures the funding level's suitability for the tasks proposed and the lead applicants' and any other named team members' expertise.

Final awards were made in Fall 2022 to five projects, focused on biochar, soils, and landscape management, all of which support Boulder County's carbon dioxide removal, and landscape resilience and restoration goals. The selected projects are innovative, likely scalable and have the potential to remove carbon dioxide from the atmosphere while also providing co-benefits including, wildfire risk mitigation, increased agricultural productivity, waste reduction and diversion, improved soil quality, local job creation, and new potential revenue streams.

Kena and Mark Guttridge of Ollin Farms
Ollin Farms

Zach Hedstrom of Boulder Mushroom
Boulder Watershed Collective

After making awards, Boulder County developed a process for reporting, invoicing, and staying in communication with each grantee. The county will leverage the technical expertise at Carbon Direct to develop a template for annual reporting and ensure that key metrics for impact assessment are included. One primary consideration is to balance administrative and monitoring requirements; keeping them light enough to effectively spur innovation, but rigorous enough to accurately assess impact and ensure that the proposed scope of work is completed.

There are many logistics to be determined in the inaugural year of this grant program and lessons learned will be applied to future iterations.

Biochar product
Biochar Now

In the inaugural year of the Climate Innovation Fund, Boulder County ensured operational capacity to execute, engage with stakeholders, and conduct ongoing monitoring and reporting of climate impacts by:

- Creating a streamlined contractual process with a funding agreement that provides at least 50% upfront capital to support the innovative nature of the projects and to minimize risk for the awardee.
- Ensuring clear communication between in-house project manager to innovation awardees for close contact.
- Requiring quarterly reporting for awardees with requirements specific to the projects being completed.
- Requiring site visits where county staff could observe implementation and collect photos and video.
- Requiring a final annual report using a template provided by the county that documents key metrics and other project deliverables.

PHASE 4 IN PRACTICE

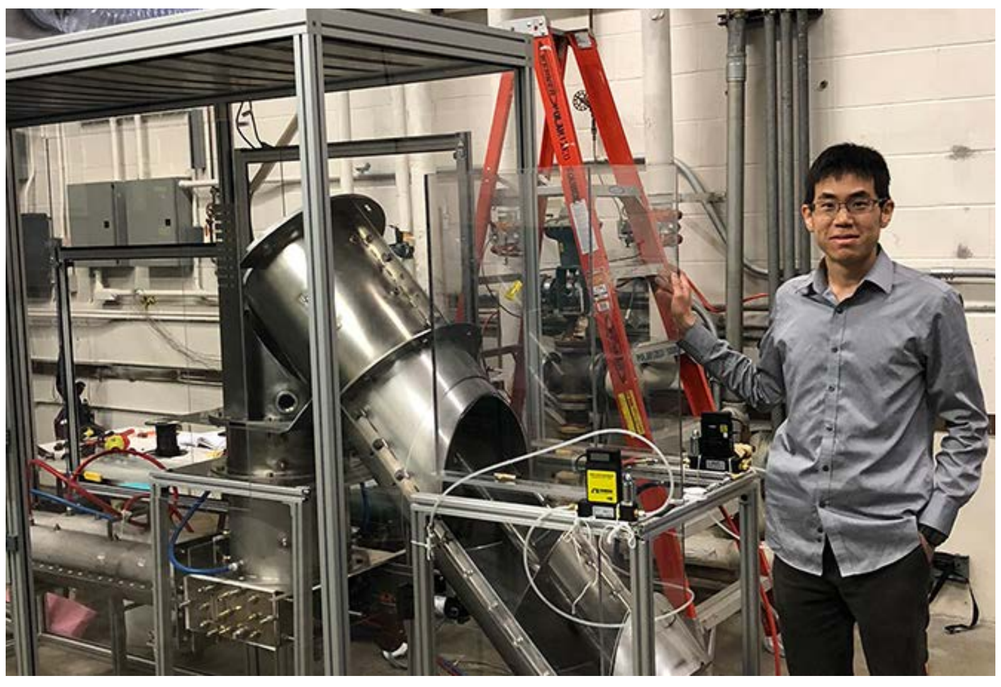
Defining monitoring, reporting and verification requirements in real time

Boulder County is developing strategies for effectively monitoring and reporting project activities and estimating impact. We outline Boulder County's planned approach below, with the caveat that these strategies remain under development during the time of this publication.

The projects selected for the Climate Innovation Fund's inaugural year are at various stages of technological readiness and represent two broad project categories: biochar and agriculture/soil carbon. Boulder County is partnering with Carbon Direct to create customized annual reporting guidelines according to technology type, readiness, and project design.

For each of these two project types, Carbon Direct will develop a data guidance document. Boulder County will share this guidance with project developers and request that the suggested metrics be included in each project's annual report. Carbon Direct will evaluate annual reports and assess project activities and potential impact. Where possible, these analyses will be quantitative. Boulder County and Carbon Direct will reflect on lessons learned from the inaugural annual review process and develop guidance on monitoring and reporting considerations for future Climate Innovation Fund rounds.

DAR's earthworks team. Left to right: Nick DiDomenico, Carlos Carrascal, Eric Knutsen, Josh Johnson, Amy Scanes-Wolfe, Anthony Levy
Drylands Agroecology Research



Takachar Chief Technology Officer Kevin Kung
Takachar

Executive summary

Best practices for place-based projects

CASE STUDY

Boulder County Climate Innovation Fund

CASE STUDY

4 Corners Carbon Coalition

Conclusions and future outlooks

Appendix

Case study: 4 Corners Carbon Coalition

The 4 Corners Carbon Coalition (4CCC) represents the collective CDR aspirations and actions of four local governments, Boulder County CO, Flagstaff AZ, Salt Lake City UT, and Santa Fe NM. The shared realities of mitigating the effects of climate change experienced by communities today led 4CCC members to be among the first city and county governments to adopt CDR as a formal component of their broader climate strategies. 4CCC, led by local governments and citizens, aims to aggregate local resources in coordinated campaigns to provide catalytic funding to accelerate CDR, creatively shape innovation, and spur local business development.

A novel priority at the core of 4CCC's mission is to accelerate the real-world implementation of innovative CDR projects by providing not only support for first of a kind projects through catalytic grants, but also secondary support that can help replicate projects at other sites in the 4 Corners region.

Opportunities for partnerships to drive impact

Local governments have limited resources and capabilities to initiate potentially complex and costly CDR projects on their own such as nascent engineered solutions. As a result, the engineered CDR projects invested in by local governments acting in isolation tend to be one-off projects, with limited scale and impact in terms of carbon drawdown.

As a supplement to jurisdictional efforts, local governments can work together to pool their resources and expertise to develop sustained funding opportunities for supporting otherwise cost-prohibitive projects and nascent technologies that have the potential to yield impact at scale.

PHASE 1 IN PRACTICE

Leveraging aggregated resources of 4CCC

Initiatives of 4CCC are co-funded directly by local governments and through crowdfunding campaigns supported by citizens. For the inaugural campaign described here, the four local government partners provided $389,000 in funds for catalytic project grants. Following the initial grant awards, 4CCC actively works with the grant recipients to assess how impact could be further enhanced or replicated through access to additional funds or other forms of support.[12]

During this second “multiplier” stage of the campaign 4CCC will work closely with grant recipients to seek and secure funds and/or other categories of support from other sources, including crowdfunding and engagement with philanthropies, public funders and/or private investors. To determine how to deploy funding to spur innovation, climate, and community impact, 4CCC was guided by the accumulation and synthesis of community feedback that had been gathered by the local governments in the preceding years, including stakeholder mapping and direct engagement, to understand how their local context would prioritize and define “socially acceptable" carbon removal.

Kicking off 4CCC with a focus on concrete

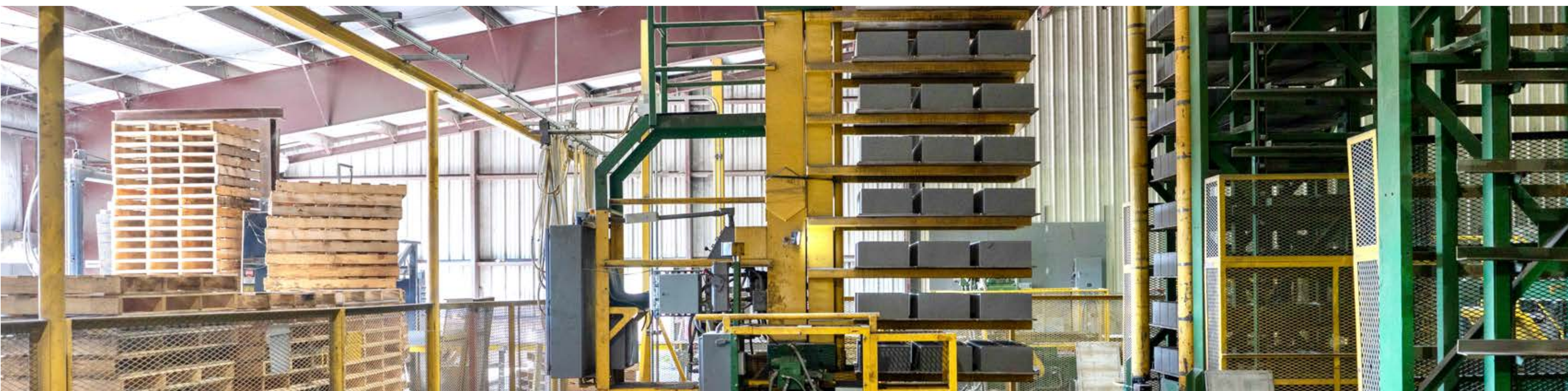
For its inaugural campaign, the 4CCC partners selected concrete as the focal point for CDR impact. Concrete provides a powerful platform for CDR innovation and early commercialization due to a number of factors. First is its ubiquity in the modern global built environment: it is the second most used material on earth after water.[13] And the Western States are home to many of the fastest growing construction and real estate markets in the U.S., which translates into high per capita use of concrete in its many different forms. Phoenix, Tucson, Flagstaff, Denver, Boulder, Salt Lake City, Provo and other large, medium and small metros have consistently ranked in the top 20 new construction markets over the past decade.

Second, concrete has a big CO_2 problem which will be complicated to solve without significant innovation, including products and methods that involve CDR and carbon utilization. Its main binding ingredient, Portland cement, represents a highly carbon-intensive and difficult to abate industry responsible for up to 8% of global CO_2 emissions.[14] Portland cement comprises 15% of concrete by volume but is responsible for 80% of concrete’s emissions. The urgency of this challenge has made the nascent concrete decarbonization field a promising and active area for both CDR-oriented solutions, and those focused on emissions avoidance and reduction.

Third, concrete production is inherently local. The structure of the industry is characterized by close proximity to end use, due to unique material and logistical factors. As a consequence concrete production plants are found in immediate proximity to virtually every town and city in the U.S., with over 2,064 ready-mix concrete plants in the country.[15] 200 of those plants are located within the Four Corners region.

Fourth, emerging CDR solutions intersect with concrete production and use across a wide range of materials and processes. As a result, CDR solutions involving concrete are diverse, but can be characterized within three major categories: (1) Supplementary Cementitious Material (SCM); (2) synthetic aggregate; and (3) CO_2 curing. Portland cement is a base material for concrete, mortar, stucco, and non-specialty grout, produced by burning and grinding a mixture of limestone and clay.[16] SCMs replace Portland cement with materials of similar chemical composition and lower production emissions, such as fly ash, slag, and silica fume.[17] Synthetic aggregates replace the rocks and gravel in concrete with solidified carbon dioxide produced through mineralization. Mineralization is a chemical reaction that converts carbon dioxide into a solid mineral, preventing it from escaping back into the atmosphere. CO_2 Curing uses flue gas chambers to capture atmospheric CO_2 and cure concrete.[18] Concrete curing is a process used to ensure adequate moisture and temperature conditions are maintained while concrete sets and hardens, enabling it to achieve its maximum strength and durability.[19] Instead of letting the concrete cure with humidity, a flue gas chamber pumps CO2 into the concrete, allowing it to cure in a CO_2-rich environment.[20] Of these three pathways, only SCM and CO_2 curing represent carbon removals, the focus of the 4 Corners catalytic funding opportunity.

Fifth, support for innovations in this industry at the local level creates opportunities to de-risk novel materials. Local governments are responsible for permitting construction projects. If a grant-making authority and the permitting office are “under one roof”, the commercial opportunity and any potential safety and/or durability concerns can be communicated to the relevant parties easily. Permit issues may get a chance to see a new process or material first-hand to increase their confidence that it can work. They can also advise the grant-makers on how to apply first-of-a-kind innovations to low risk projects, and what performance metrics to monitor to determine suitability for expanded use.



Defining 4CCC’s selection criteria

4CCC’s call for proposals was technology and pathway agnostic, beyond a focus on the general category of ‘innovation in concrete CDR.’ The quality and value of types of CDR solutions were measured by their effectiveness and potential co-benefits, as determined by community concerns and priorities. Ultimately, 4CCC wanted to support projects that: (1) provide permanent, long-term storage (at least 100 years); (2) can be measured and verified using rigorous and transparent best-in-class methods; (3) do not harm or burden communities anywhere; and (4) provide other economic, social, and environmental benefits.

4CCC's approach to project planning and design adheres to the Phase 1 guidelines outlined in the section titled Best Practices for Place-Based Projects while uniquely reflecting the guiding principles and process of 4CCC (Table 5).

Table 5. The 4 Corners Carbon Coalition’s Phase 1 considerations for planning and design

Category	Process
Local imagination	Leverage unique and comprehensive knowledge to take stock of local resources and brainstorm how these can be used as the basis for CDR business models.
Form partnership	Set up conditions to catalyze projects by forming partnerships with nearby municipalities to jointly support CDR.
Scope campaign’s CDR focus	Take stock of what CDR opportunities there are across collective jurisdictions and create a scope both financially and in terms of thematic CDR support.
Local accountability	Foster community-level collaboration to ensure project guardrails are in place to minimize or eliminate the possibility of harm and select for co-benefits that add value to a community.
Multiply impact	Establish programmatic structure which creates the conditions for a multiplier effect by channeling crowdfunding to provide secondary support that can help replicate burgeoning but highly innovative CDR solutions.

PHASE 2 IN PRACTICE

Practical implementation

4CCC established a process for applicants to submit proposals for catalytic grants. Catalytic grants allow financial support to be allocated to innovative projects with future large-scale potential in member regions. 4CCC partnered with Carbon Direct Inc. to leverage their expert insight during project solicitation and evaluation phases as well as the OpenAir Collective; a volunteer-led network dedicated to advancing, accelerating and co-inventing CDR. The solicitation and evaluation process took place over two months and followed a clearly defined four-step process:

1. **Announcement of Carbon Removal + Concrete campaign followed by community engagement meetings and Q&A.** 4CCC held a webinar to discuss eligibility criteria, explain what 4CCC was looking for, and aid project developers.
2. **Opportunity for Clarification.** Prospective applicants could submit questions regarding the grant application or the review and selection process. 4CCC posted responses to all questions on their website more than a month before the application deadline.
3. **Request for Proposals (RFP).** The RFP requested a comprehensive project summary, anticipated impacts and timeline, how projects would adhere to quality criteria, and responses to additional questions such as community awareness, engagement, and equity factors.
4. **Evaluation of project eligibility.** Eligibility review identified and excluded projects outside the scope of the campaign.

Following the technical review panel, representatives from each of the four partner jurisdictions reviewed the technical summaries, and considered proposals with added lens on social acceptance and economic benefits. Members of the OpenAir Collective participated as observers in the technical panel, and facilitated the partner panel, ensuring that contingencies and assumptions that influenced outcomes in the former were fully relayed in the latter.

Following the Best Practice Guidelines for Practical Implementation (Table 5), each project's supporting documents underwent a thorough review to determine how well they met 4CCC's criteria. In collaboration with Carbon Direct, 4CCC developed scoring guidelines for high-quality carbon removal criteria[21] for each of five review topics:

(1) carbon removal; (2) quality of carbon removals; (3) innovation, scalability & future impact; (4) co-benefits; and (5) team & resources. For each review topic, the project was ranked on a scale of zero to five, with five being the maximum score and zero being the minimum score a project could receive (Appendix B). Following individual reviews, the full review panel discussed all project reviews and scores and ranked as a shared pool.

PHASE 3 IN PRACTICE

Projects funded by 4CCC

In the inaugural catalytic funding round, 4CCC received six RFP applications. Of these six, one did not meet the project criteria and was therefore not considered. Three subject matter experts reviewed each submission. The absolute score for each review topic was weighted proportional to the percentages in Table 6, yielding a total score of 100 for a perfect project (all "fives"). The panel coordinator calculated the average and standard deviations of the scores for each individual project. All submissions were then discussed and scored as a group in the summary scoring rubric. Final scoring discussions accounted for variations across individual reviewers by discussing the standard deviation of scores for each project. (Table. 6).

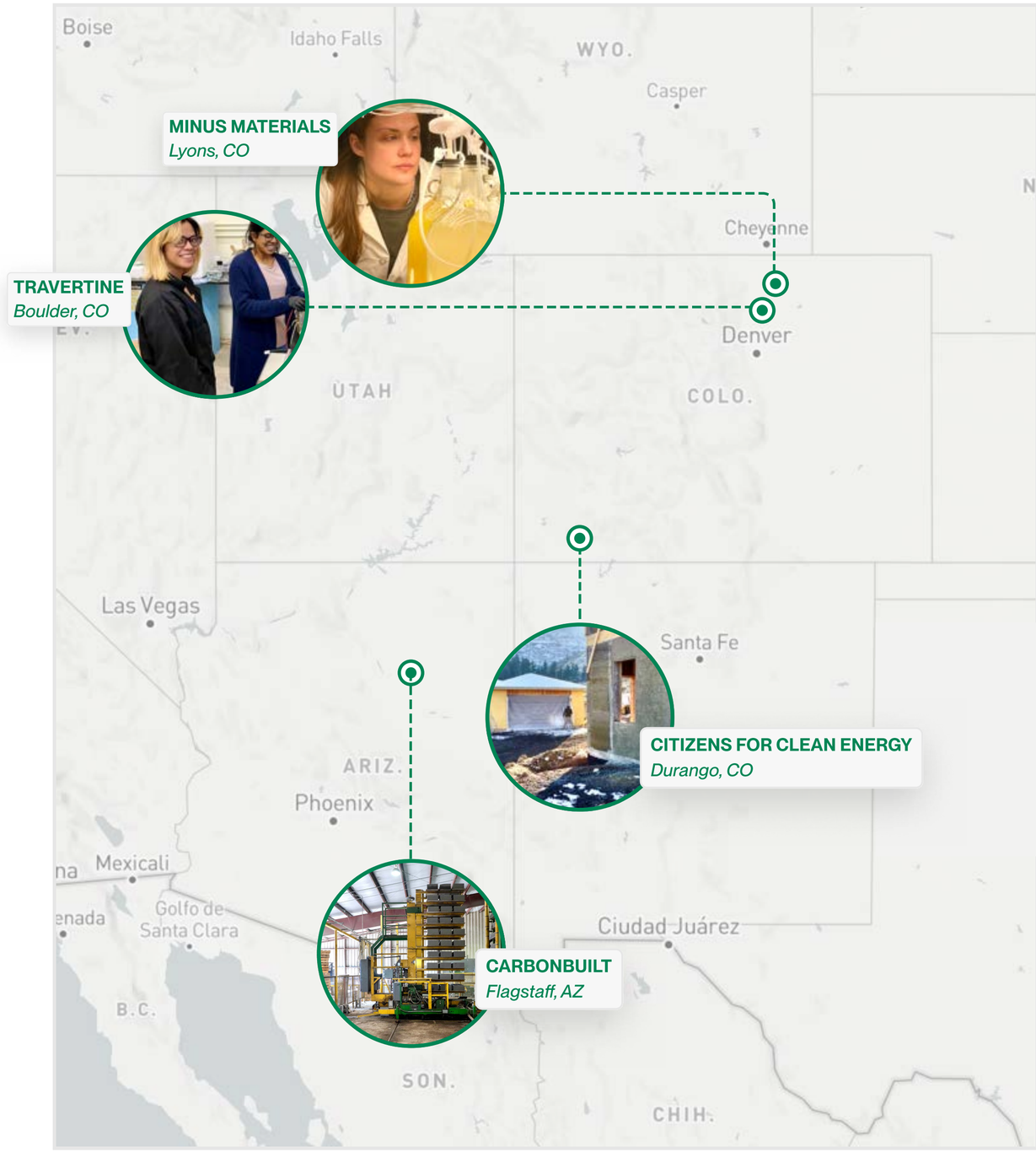
Table 6. Weighting percentage by review topic

Weighting percentage	Review category
15%	Carbon removal
15%	Removal quality
35%	Innovation, scalability & future impact
20%	Co-benefits
15%	Team & resources

In January of 2023 four projects were awarded funding. The selected projects demonstrated novel approaches to integrating concrete and CDR and offered numerous co-benefits such as waste diversion, reduced freshwater use, biodiversity protection, improved fire resilience, co-product creation, and job creation.

After distributing initial awards, 4CCC intends to create a multiplier effect by channeling crowdfunding resources and using donations from institutions and individual donors. The goal is to create a "second tier" of members within the four Corners region interested in replicating projects or providing gap funding for nascent but highly innovative local CDR solutions identified through the catalytic grant campaign.

For the inaugural funding round, 4CCC is primarily occupying a coordinating role and working closely with partners on these capacities. Funding Agreements for the distribution of public funds are being administered by staff at Boulder County.



Among other things, these funding agreements require quarterly progress updates from grantees to Boulder County and the other members; verification of self-reported progress and impact is expected to be done in collaboration with local government staff and with an experienced third party. Crowdfunding efforts will be executed in collaboration with the Windward Fund acting as fiscal sponsor and ensuring compliance. 4CCC may look to build internal capacity for these efforts in future funding years.

PHASE 4 IN PRACTICE

Defining monitoring, reporting and verification requirements in real time

4CCC is currently developing its approach to monitoring, reporting, and verifying funded projects' carbon removal and climate impact. They anticipate that their strategy will include a bespoke data questionnaire with annual reporting requirements, and a drive for continuous improvement.

Executive summary

Best practices for place-based projects

CASE STUDY

Boulder County Climate Innovation Fund

CASE STUDY

4 Corners Carbon Coalition

Conclusions and future outlooks

Appendix

Conclusions and future outlooks

Following the 2022 Climate Innovation Fund and 4CCC's inaugural campaign, Boulder County and the 4 Corners Carbon Coalition took the opportunity to pause and reflect on lessons learned from their inaugural CDR efforts and identify strategies for following up with funded projects. These learnings fell into three major categories:

1. Continued communication and iterative learning

Boulder County is committed to continued communication and iterative learning through knowledge sharing events, which could include panel discussions, webinars, or sessions at large conferences. Participants in funded projects will be able to showcase their successes (or failures), update the community, and share learnings and recommendations with future applicants.

4CCC is an incubator for CDR technologies and a steward for local climate action. It encourages project developers to share their knowledge and experience with the next class of funded projects to accelerate the innovation and implementation of CDR. Communities seeking similar partnerships should be willing, interested, and flexible. Approaching a partnership with the mindset of "we will grow and figure this out together" can be powerful and amplifying.

2. Interim milestones and metrics for success

Boulder County is committed to regular follow-ups with funded projects t o confirm project activities and facilitate the realization of intended impacts. The form of these regular check-ins will vary with the type of project but could include site visits, data, and document review, and regular interviews with project participants.

4CCC expects funded projects to be on the ground or in motion within one year. They will work with project developers to support these CDR technologies and ensure their successful implementation.

3. Scope

The Climate Innovation Fund welcomed a wide range of CDR projects in its first round, indicating a promising depth and breadth to existing projects and initiatives. This strategy allowed Boulder County to survey the community and get a sense of local capabilities, existing technologies and approaches, and community appetite. Future iterations of the Climate Innovation Fund can narrow in scope with alternating years of solicitations for nature-based and engineered projects.

Using the power of collective action, 4CCC will continue to advance CDR in the four Corners region, with new funding opportunities available semi-annually or annually. Future funding opportunities will focus on a diversity of CDR solutions and technologies.

Subnational governments will continue to play a key role in addressing climate change and championing solutions at the local level. To maximize impact potential, these initiatives can channel efforts through the lens of community needs and resource availability. The Boulder County Climate Innovation Fund and the 4 Corners Carbon Coalition efforts provide a blueprint for other subnational actors seeking to incorporate CDR into their climate action plans.

ABOUT THE REPORT PLAYBOOK SPONSORS

Boulder County, Colorado

Boulder County residents are experiencing the impacts of the climate crisis in the form of high heat days, extreme weather, drought, poor air quality, and devastating wildfires. As a global leader in climate action, Boulder County is committed to the radical transformation needed to meet this challenge. Through programs and policies that foster innovation, coalition-building, and equitable outcomes, Boulder County is cutting emissions, removing carbon dioxide from the atmosphere, and supporting systemic change to fight the climate crisis.

Follow Boulder County's Office of Sustainability, Climate Action & Resilience on Instagram, Facebook, and Twitter to learn more about our work.

The 4 Corners Carbon Coalition

The 4 Corners Carbon Coalition is a first-of-its-kind partnership of local governments pooling resources to envision and accelerate community-based carbon dioxide removal project deployment and business development. The Coalition was started in the Four Corners region of the Western United States; as of April 2023, members include Boulder County, CO, Flagstaff, AZ, Salt Lake City, UT, and Santa Fe, NM. Visit www.4cornerscarbon.org for more information about the Coalition and the status of ongoing and future campaigns.

Carbon Direct

Carbon Direct helps organizations go from climate goal to climate action. We combine technology with deep expertise in climate science, data, and policy to deliver carbon emission footprints, actionable reduction strategies, and high-quality carbon dioxide removal. With Carbon Direct, clients can set and equitably deliver on their climate commitments, streamline compliance, and manage risk through transparency and scientific credibility.

Our expertise is trusted by global climate leaders including Microsoft, American Express, and Alaska Airlines, as well as by the World Economic Forum, which selected Carbon Direct as an Implementation Partner for the First Movers Coalition. To learn more, visit carbon-direct.com.

Authorship & contributions

Carbon Direct

Tim Bushman, *Senior Science Analyst*

Sarah Federman, *Director of Landscape Decarbonization*

Lauren Gifford, *Science Advisor*

Shannon Keane, *Research Associate*

A.J. Simon, *Director of Industrial Decarbonization*

--

Chi Thorsen, *Design*

Britt Warthen, *Design*

Boulder County Office of Sustainability, Climate Action & Resilience

Tim Broderick, *Senior Sustainability Strategist*

Christian Herrmann, *Director of Climate Communication*

Kevin Peterson, *Boulder County Sustainability Specialist*

Susie Strife, *Director of Sustainability, Climate Action & Resilience & Co-Founder of the 4 Corners Carbon Coalition*

4 Corners Carbon Coalition

Ramón DC Alatorre, *Co-Founder and Director of the 4 Corners Carbon Coalition*

Christopher Neidl, *Co-Founder, The OpenAir Collective*

Executive summary

Best practices for place-based projects

CASE STUDY

Boulder County Climate Innovation Fund

CASE STUDY

4 Corners Carbon Coalition

Conclusions and future outlooks

Appendix

Appendix A:

Scoring criteria for the Boulder County Climate Innovation Fund and the 4 Corners Carbon Coalition

Carbon removal

The carbon removal evaluation criteria consider the amount of carbon removal the project could achieve if successfully implemented, with scientific and technical uncertainties positively resolved. The criteria provide a guide for evaluation based on a project's total potential carbon removal (Table A1). For CDR projects, net negativity was a requirement.

Table A1. Scoring rubric based on the amount of carbon removal the project could achieve

Score	Description
5	>1,000 tonnes of carbon can be removed by this project
4	100 - 1,000 tonnes of carbon can be removed by this project
3	10 - 100 of tonnes of carbon can be removed by this project
2	< 10 tonnes of carbon can be removed by this project
1	(see below)

Score	Boulder County	4 Corners Coalition
0	Zero potential to remove carbon to interim or durable surface or subsurface storage	The projects results in no carbon removals or clearly net-positive carbon emissions

Score	Description
-1	Project relies on other developments or actors to achieve above carbon removal quantity
+1	All of project's carbon impacts (removal & storage) occur within Boulder County or the 4 Corners region
-1	Project relies on significant capture or storage activity outside Boulder County or the 4 Corners region

Boulder County and the 4 Corners Coalition considered additional factors based on their unique needs and goals. To support the growth of a new local carbon economy, Boulder County not only sought projects with high carbon potential, but also projects that would provide regional economic development, job creation, and support for locally based organizations. Therefore, a project with the potential for all its carbon impacts (removal and storage) to occur in Boulder County received an additional point.

4CCC prioritized the innovation of projects which sequester carbon. The municipal and county government members had a strong focus on local innovation, regional economic development, and job creation, in parallel with their leadership in advancing carbon removal. Consequently, projects with the potential for all its carbon impacts (removal and storage) to occur within the 4 Corners region, preferably in the direct vicinity of the partner locations (Boulder County, Flagstaff, Salt Lake City, or Santa Fe), received an additional point.

One point was deducted from the above carbon removal score if the project was dependent on significant activities outside of Boulder County or the 4 Corners region for carbon capture or storage, and/or the project had the potential to achieve any of the above removal rates, but relied on other stakeholders or development to succeed. It's important to note that these score adjustments did not raise any project above the maximum score (5) or below the minimum score (0).

Carbon removal quality

Carbon Direct's multidisciplinary scientists developed the inaugural Criteria for High-Quality Carbon Dioxide Removal in 2021[22] to detail both overarching principles and tailored recommendations for a wide range of carbon dioxide removal methods that use natural and/or engineered systems. The scoring rubric evaluates how each project adhered to Carbon Direct's criteria for quality carbon removal: Additionality and Baselines, Carbon Accounting Method, Durability, Leakage, Do No Harm, and Monitoring, Reporting and Verification (MRV) (Table A2).

Table A2. Scoring rubric based on projects adherence to Carbon Direct's Criteria for High-Quality Carbon Dioxide Removal

Score	Description
5	Carbon removals address all of Carbon Direct's quality criteria, no major quality concerns
4	Some quality criteria addressed; project designed to resolve outstanding quality concerns
3	One major quality concern, or multiple moderate quality concerns that are not likely to be resolved
2	Multiple major quality concerns
1	No significant carbon removal quality strengths
0	Any project that crosses major harm red-lines (potential to cause serious harm to the environment or local communities)

Boulder County applicants purely focused on restoration and resilience, MRV in this context means that the project must have a clear data collection and maintenance plan, and that the project must be able to clearly demonstrate the benefits proposed.

A firm grounding in scientific theory and best-practices is a requirement for all projects. Projects must be scientifically credible with clearly referenced and up to date best practices, and verifiable with clear plans for monitoring, reporting, and verification (MRV) of project implementation and continuing impact. Quantification of carbon removal volumes must be transparent and follow peer-reviewed and generally accepted methodologies, subject to third party verification.

A firm grounding in scientific theory and best-practices is a requirement for all projects.

Budget considerations

Both Boulder County and the 4 Corners Carbon Coalition also considered a project's cost-sharing opportunities, current vs. future project costs, and local revenue creation & investment opportunities. Cost-sharing opportunities refer to a project's climate equity. Projects with high climate equity engage and empower diverse stakeholders who have otherwise faced systemic barriers to accessing carbon finance (e.g., small landholders, minority and women suppliers, new voices).

Boulder County prioritized projects that addressed the disproportionate impacts of climate change on low-income communities; vulnerable communities; and communities that bear the brunt of industrial pollution or are transitioning to low-carbon economies. As well as those that worked to include underrepresented and under-resourced communities in the transition to an environmentally just future. An ideal project had a path to being cost-competitive at scale in 5-10 years. Boulder County's target price range was $15-$25/tonne CO_2, but proposals at any unit cost that provided a future projected cost curve that exhibits a meaningful cost decline over time received consideration. Respondents were required to demonstrate how this early guarantee and advanced payment for future carbon removal delivery would support cost curve reduction and/or scaled resilience to climate change enabled through carbon removal.

4CCC sought to surface highly innovative projects that required additional funding to reach commercial scale and gain recognition in the market. Ideally, the project would have significant potential to scale regionally and/or globally within 10-20 years and become cost-competitive. Because of its focus on innovation and nascent technologies, they did not have a target price range. Rather, 4CCC prioritized any unit cost that indicated a significant cost decline over time. Respondents were required to detail how they planned to use funding to implement projects or facilities that use concrete to remove carbon dioxide from the atmosphere.

Both Boulder County and 4CCC prioritized projects that planned to enhance workforce and economic development and/or spur new market development.

Co-benefits

All projects must have sought to minimize harms and maximize co-benefits, and avoid or minimize environmental and social harm (e.g., continued reliance on fossil fuels, deforestation, environmental impacts due to mining of raw materials, water consumption, impacts to indigenous/local rights, violation of national sovereignty, etc.).

Projects should have also proactively promoted other measurable sustainability objectives especially in areas of high-risk in Boulder County and the 4 Corners region.

Table A3. Scoring rubric to quantify a project's co-benefits

Score	Description
5	More than one major co-benefit; few (if any) trade offs
4	Single major co-benefit, or multiple moderate co-benefits
3	1 - 2 moderate co-benefits, or multiple minor co-benefits
2	Single moderate or minor co-benefit
1	(see below)
0	Tradeoffs outweigh co-benefits

SPECIAL CONSIDERATIONS

Score	Description
-1	One or more minor/moderate unavoidable tradeoffs identified

Co-benefits considered the magnitude of a project's non-carbon benefits on landscape resilience, water resources, air quality, local employment, economic growth, and historically disadvantaged communities. Specifically, a project's impact on biodiversity, habitat creation or preservation, disease vectors, wildfire risk mitigation, drought resilience, erosion and/or flood control, soil quality, co-products (food, fiber, timber, energy, etc.), community education, job creation, poverty alleviation, waste reduction, reduced noise pollution, sustainable recreation and tourism opportunities, and urban beautification.

These considerations were used to determine a co-benefits quality score for each project (Table A3). Global, national, and regional (non-CO_2) benefits accrued from the project or adoption of practices advanced during project performance were considered, with a preference for co-benefits that occur within Boulder County or the 4 Corners region. 4CCC prioritized applicants whose co-benefits would specifically impact the partner locations (Boulder County, Flagstaff, Salt Lake City, or Santa Fe).

Innovation, scalability, & future impact

Innovation, Scalability, & Future Impact considers how effectively the proposed activities advance the science and practice of climate remediation and resilience, and if the project introduced new technologies or practices to create a stream of carbon removals in the future. The development or maturation of new businesses is possible through projects that result in commercial revenue if it were scaled-up and optimized. These considerations determined each project's subjective Innovation, Scalability, & Future Impact score (Table A4).

Table A4. Innovation, scalability, and future impact scoring rubric

Subjective Score	
If successful, will the project enable future carbon benefits? If so, what is the total carbon removal potential?	
Does the project support the development or maturation of new businesses (ideally in Boulder County or the 4 Corners region)?	
Will the project generate data that can be shared to replicate the demonstrated activities?	
Will the project achieve learning-by-doing?	
Boulder County	**4 Corners Carbon Coalition**
Are there ample resources (similar landscape, species, energy, water, manufacturing capability, skilled labor, etc.) to replicate the project if it is successful?	Are there ample resources (similar feedstocks, energy, water, manufacturing capability, skilled labor, etc.) to replicate the project if it is successful?
Does the project demonstrate new technologies or landscape management innovations?	Does the project demonstrate technological innovation in concrete manufacturing or construction?
Does the project introduce new technologies or practices that can create a stream of carbon credits?	

In determining a subjective score reviewers considered: (1) a project's ability to enable future carbon benefits (so long as the project is successful), (2) the project supports the development or maturation of new businesses within Boulder County or Colorado, and the 4 Corners Region, and (3) the availability of resources to replicate the project if successful.

Boulder County specifically considered a project's: (1) potential for replication outside the spatial/temporal extent of Boulder County, and (2) technological or practical innovation to produce carbon credits.

4CCC aims to leverage the power of local governments working together to identify and elevate cutting edge technologies developed within their region. By providing direct catalytic support to highly innovative projects their efforts have the potential to accelerate the market evolution of CDR. With this in mind, 4CCC specifically considered: (1) evidence of technological innovation in concrete manufacturing or construction to remove carbon dioxide from the atmosphere, and (2) the ease and viability of the project to be replicated both within and outside the 4 Corners Region, through follow-on philanthropy, crowdfunding and for-profit investment.

Team & resources

The scoring criteria for team and resources measures the quality of the proposing team and the appropriateness of the funding level to the tasks proposed. Reviewers also evaluated the expertise of the lead applicant and any other named team members listed for the tasks/ services proposed.

Reviewers consider whether the proposed budgets were sufficient to support the proposed activities, and whether the proposed activities are significant enough to justify the requested funds. If applicable, reviewers considered a team's performance on previous projects of related scope and similar technical readiness levels. These considerations determined each project's team and resources quality score (Table A5).

Table A5. Scoring rubric to measure the quality of the proposing team and appropriateness of funding

Score	Description
5	Highly likely to succeed based on the merits of the team and sufficient resources
4	Likely to achieve most stated objectives. Additional funding would improve chances of success; or requested funding modestly exceeds anticipated costs.
3	Single deficiency in team or appropriateness of budget identified.
2	Multiple deficiencies in team or budget identified
1	Team or budget are entirely inappropriate to the tasks described
0	Team and budget are entirely inappropriate to the tasks described

SPECIAL CONSIDERATIONS

Score	Boulder County	4 Corners Coalition
-1	Budget or team is >50% located outside of Boulder County	Budget or team is >30% located outside of the 4 Corners region
+1	Budget and team are >50% located inside of Boulder County	Budget and team are >80% located inside of the 4 Corners region

Based on the unique needs and goals of Boulder County and the 4 Corners Carbon Coalition, the location of a project's team and the percentage of a project's budget spent within the respective regions were also considered when determining a project's team and resources quality score.

A project whose team was entirely located entirely in Boulder County and planned to spend more than 80% of its budget within Boulder County received an additional point to its overall score. One point was subtracted from a project's overall score if less than 50% of the team is located within Boulder County, and/or the project planned to spend less than 50% of its budget within Boulder County.

4CCC added one point to a project's overall score if the team planned to spend more than 80% of its budget within the 4 Corners region. One point was subtracted from projects with more than 50% of their team and budget located outside the 4 Corners region.

Please note, these score adjustments did not raise any project above the maximum score (5) or below the minimum score (0).

Appendix B:

Scoring template

Proposal name	Carbon removal	Removal quality	Innovation & scalability	Co-benefits	Team and resouces	Average score	STDEV of score

Table B1. Quality criteria scoring rubric template

Appendix C:

Local government CDR and landscape resiliency efforts

Table A1. Scoring rubric based on the amount of carbon removal the project could achieve

Entity	Climate target	Carbon credit considerations	Carbon removal focus	Landscape resiliency focus
Boulder County, CO[23]	Emissions reductions 80 percent by 2030 over 2016 levels and achieving carbon neutrality by 2035.	Fund and support carbon removal projects and CDR credits to realize the 2035 goal of carbon neutrality.	Yes	Yes
Fairfax, VA[24]	Carbon neutral by 2040.	Aims to remove an equivalent amount of CO_2 from the atmosphere than is emitted from its operations.	Yes	No
Flagstaff, AZ[25]	Emissions reduction of 44% by 2030 and address residual emissions with CDR.	Procure carbon credits in the event an adequate amount of CDR cannot be realized to meet 2030 goal.	Yes	No
Oakland, CA[26]	Emissions reduction of 56% by 2030 (2005 baseline).	Not specified.	Yes	Yes
Shoreline, WA[27]	Net-zero emissions by 2030 (2009 baseline).	Not specified.	Yes	No
Austin, TX[28]	Carbon neutral by 2040.	Employ carbon credits or carbon dioxide removal to cancel out any remaining emissions. Carbon credits to be used as a last resort and not be used to achieve more than 10% of 2040 goal.	Yes	Yes
Dallas, TX[29]	Carbon neutral by 2050.	Achieve net zero GHG by reducing emissions as much as possible and then balancing remaining emissions with carbon removal or carbon credit programs.	Yes	Yes
Denver, CO[30]	Cut emissions 65% by 2030 and achieve carbon neutrality by 2040.	Denver will not purchase credits to achieve these goals.	Yes	Yes
Mesa, AZ[31]	Carbon neutral by 2050.	Remove carbon from the atmosphere to compensate for any remaining emissions.	No[32]	Yes

Entity	Climate target	Carbon credit considerations	Carbon removal focus	Landscape resiliency focus
Miami, FL[33]	Carbon neutral by 2050.	Purchase credits as a secondary and last resort measure, all efforts should be taken to eliminate sources of emissions.	Yes	Yes
Philadelphia, PA[34]	Carbon neutral by 2050.	Not specified.	No	Yes
New York City, NY[35]	Reduce emissions 40% by 2030 and 80% by 2050.	Use carbon sequestration and carbon credits to account for residual GHG emissions after all technically feasible reductions are achieved.	No	Yes
Raleigh, NC[36]	Achieve 80% GHG emissions reductions by 2050.	Not specified.	No	Yes
San Francisco, CA[37]	Carbon neutral by 2040.	By 2025, the San Francisco airport will expand its carbon mitigation and credit program to include soil carbon sequestration projects, where viable.	Yes	Yes
San Jose, CA[38]	Carbon neutral by 2030.	Not specified.	Yes	No
Montgomery County, MD[39]	Carbon neutral by 2035.	Purchase certified credits for some or all of the remaining emissions that cannot be reduced through available carbon mitigation and sequestration technologies.	Yes	Yes
Beverly & Salem, MA[40]	Reduce emissions 50% by 2030 and 80% by 2050.	Purchase carbon credits to mitigate approximately 10% of remaining emissions.	Yes	Yes
Boston, MA[41]	Reduce emissions 50% by 2030 and carbon neutral by 2050.	Support activities that remove carbon from the atmosphere (carbon credits) to compensate for any remaining emissions.	No	Yes
Salem, OR[42]	Reduce GHG emissions 50% by 2035 and achieve carbon neutrality by 2050.	Carbon credits may be considered as a strategy for Salem to reach net zero emissions.	Yes	Yes
Humboldt County, CA[43]	Reach net zero by 2045.	Continue to increase forests used as carbon reserves in the california cap-and-trade and voluntary carbon credit markets.	Yes	Yes
Kansas City, MO[44]	Net zero by 2050.	Implement a voluntary carbon credit pilot program to incentivize carbon sequestration on farms and ranches in our region.	Yes	Yes

Entity	Climate target	Carbon credit considerations	Carbon removal focus	Landscape resiliency focus
Cincinnati, OH[45]	Reduce emissions 40% by 2028 and 84% by 2050.	Develop a carbon credit program to fund tree planting efforts to allow individuals and businesses to calculate the carbon emissions generated by their daily activities, and voluntarily purchase trees to be planted to mitigate those emissions.	Yes	Yes
Orlando, FL[46]	Reduce emissions 90% by 2040.	Establish a Voluntary Carbon-credit for Visitors to Orlando to allow visitors to voluntarily contribute to mitigate the footprint they leave behind.	Yes	No
Bend, OR[47]	Reduce fossil fuel use 40% by 2030 and 70% by 2050.	Not specified.	Yes	No
Leon County, FL[48]	Reduce GHG emissions for county operations 30% by 2030.	Consider carbon credits for County employee travel.	Yes	No
Santa Barbara County, CA[49]	Reduce GHG emissions 50% by 2030.	Develop a County framework, budget, and procurement policy for investing in local carbon sequestration projects to mitigate the balance of community-wide emissions by 2030.	Yes	Yes
Ann Arbor, MI[50]	Carbon neutral by 2030.	Purchase carbon credits to reduce greenhouse gas emissions outside of the community.	Yes	No
Honolulu, HI[51]	Reduce emissions 45% by 2025 and carbon neutral by 2045.	Future updates will expand in scope to incorporate considerations for land use change and investment in carbon credit projects designed to capture carbon and reduce overall emissions in the atmosphere.	Yes	Yes
Torrance, CA[52]	Reduce emissions 49% by 2035 and 80% by 2050.	Purchase carbon credits to achieve municipal carbon neutrality.	Yes	No
Fort Collins, CO[53]	Reduce emissions 80% by 2030 and carbon neutral by 2050.	Invests in carbon credits to achieve net zero emissions.	Yes	Yes
Albenarle County, VA[54]	Reduce GHG emissions 45% by 2030 and carbon neutrality by 2050.	Not specified.	Yes	Yes
Lansing, MI[55]	58.5% reduction in emissions by 2030 and carbon neutral by 2050.	Use legitimate carbon credits to abate residual emissions.	Yes	Yes
Adams County, CO[56]	Reduce emissions 50% by 2030 and 90% by 2050.	Not specified.	Yes	No

Entity	Climate target	Carbon credit considerations	Carbon removal focus	Landscape resiliency focus
Alameda, CA[57]	Reduce emissions 80% by 2050.	Not specified.	Yes	No
Alexandria, VA[58]	50% reduction in GHG emissions by 2030 and 80-100% reduction by 2050.	Not specified.	Yes	No
Atlanta, GA[59]	Reduce GHG emissions 40% by 2030.	Not specified.	No	Yes
Bloomington, IN[60]	Reduce GHG emissions 25% by 2030 and achieve carbon neutrality by 2050.	Not specified.	Yes	No
Region of Southeast Florida[61]	Net zero by 2050.	Not specified.	Yes	Yes
Cambridge, MA[62]	Carbon neutral by 2050.	Not specified.	Yes	Yes
Charleston, SC[63]	Reduce emissions 56% by 2030 and net zero by 2050.	Not specified.	Yes	No
Concord, CA[65]	Reduce emissions 25% by 2020 and 80% by 2050.	Not specified.	Yes	Yes
Cupertino, CA[66]	Net zero by 2040.	Not specified.	Yes	No
Elk Grove, CA[67]	Reduce GHG emissions 40% by 2030.	Not specified.	Yes	Yes
Fremont, CA[68]	Reduce emissions by 25% by 2020. The city has not adopted a longer-term emissions reduction goal such as a 2050 target.	Not specified.	Yes	Yes
Lakewood, CO[69]	Reduce GHG emissions 20% by 2025 and 50% by 2050.	Not specified.	Yes	Yes
Longmont, CO[70]	Reduce emissions 20% by 2020 and 80% by 2050.	Not specified.	Yes	Yes
Los Angeles, CA[71]	Reduce emissions 50% by 2025, 73% by 2035, and carbon neutral by 2050.	Not specified.	Yes	No
Pittsburgh, PA[72]	Reduce emissions 20% by 2023, 50% by 2030, and 80% by 2050.	Not specified.	Yes	Yes

Entity	Climate target	Carbon credit considerations	Carbon removal focus	Landscape resiliency focus
Portland, OR[73]	Reduce emissions 40% by 2030 and 80% by 2050.	Not specified.	Yes	No
Providence, RI[74]	GHG reduction targets of 45% from 1990 levels by 2035 and 80% from 1990 levels by 2050.	Not specified.	Yes	Yes
St. Louis, MO[75]	Reduce GHG emissions 80% by 2050.	Not specified.	Yes	Yes
Sunnyvale, CA[76]	Reduce GHG emissions 80% by 2050.	Not specified.	Yes	Yes
Solano County, CA[77]	Reduce emissions 20% by 2020.	Not specified.	Yes	Yes
Richmond, CA[78]	50% reduction in emissions by 2030 and net zero by 2050.	Credits used to reach net zero.	Yes	Yes
Asheville, NC[79]	80% reduction in GHG emissions by 2047.	Will determine whether carbon credits may be generated by a project, and sold for profit, and if so, if it would be better to keep the credits as a hedge against rising carbon costs or future regulation.	Yes	No
Houston, TX[80]	Reduce emissions 40% by 2030, 75% by 2040, and 100% by 2050.	The City will evaluate mitigating remaining emissions, such as fuel used by City vehicles, with carbon credits generated from Texas based CO_2 sequestration projects.	Yes	Yes
Berkeley, CA[81]	Reduce GHG emissions by 80% by 2050.	Launch a "local carbon credit" project to track GHG emissions and contribute to local carbon reduction projects.	Yes	No
Bellingham, WA[82]	Reduce municipal emissions (city government operations) 70% by 2020, 85% by 2030, and 100% by 2050. Reduce community emissions (within city limits) 28% by 2020, 40% by 2030, and 85% by 2050.	Not specified.	Yes	Yes
Alameda, CA[83]	Reduce emissions by 50% by 2030.	May purchase carbon credits to achieve net zero GHG emissions.	Yes	Yes
Lancaster, CA[84]	Reduce emissions from municipal operations 79% by 2025, 80% by 2035, and 81% by 2050.	The City will use a carbon credit program to reduce emissions remaining emissions and reach climate targets.	Yes	No

Entity	Climate target	Carbon credit considerations	Carbon removal focus	Landscape resiliency focus
Sacramento County, CA[85]	Carbon neutrality by 2030.	The County will explore a carbon credit program, if needed, to account for any emissions that cannot be abated.	**Yes**	**Yes**
Fresno, CA[86]	Reduce emissions 80% by 2050.	The San Joaquin Valley Carbon Exchange was launched in November 2008 to quantify, verify, and track voluntary greenhouse gas emissions reductions. The District is participating in a new program designed by the California Air Pollution Control Officers to encourage banking and use of greenhouse gas reduction credits (GHGRx).	**Yes**	**Yes**
Skagit County, WA[87]	Reducing GHG emissions 80% by 2050.	Track progress and opportunities in the carbon trading and mitigation programs as well as markets to take advantage of new opportunities when they are more fully developed.	**Yes**	**Yes**
Yolo County, CA[88]	Reduce emissions 27% by 2030 and 80% by 2050.	Use verifiable carbon credits to achieve remaining GHG reductions.	**Yes**	**Yes**
Santa Monica, CA[89]	Reduce GHG emissions 80% by 2030 and carbon neutral by 2050 (or sooner).	Consider the use of carbon credits to mitigate remaining emissions or in cases where fuel switching is not viable.	**Yes**	**Yes**

Glossary of key terms

Additionality & baselines	Credited carbon removals are not mandated or a geographically common practice and would not have occurred without carbon removal payments. Baselines reflect a business-as-usual scenario of emissions without the influence of carbon finance and should be set conservatively to minimize the risk of over-crediting.
Carbon accounting method	Quantify and monitor net carbon removal using repeatable and verifiable methods and estimate project-specific uncertainty in removal estimates in a conservative manner.
Carbon reduction	Reducing the amount of carbon dioxide emitted into the atmosphere. The various methods of decarbonization can include renewable energy, energy efficiency, and waste reduction and diversion.
Carbon Dioxide Removal (CDR)	Removing carbon dioxide from the atmosphere, usually accompanied by short-, medium-, or long-duration storage.
Do no harm & pursue co-benefits	Low risk of any material negative impacts on the surrounding ecosystems and local communities. Potential for improving local communities, environmental quality, and climate resilience beyond carbon removals.

Durability or permanence	Low risk of stored carbon being re-released into the atmosphere through voluntary or involuntary reversal events. Projects should have measures in place to minimize risk and account for it in carbon estimates.
Environmental justice	All individuals should be equitably protected from environmental risk and empowered to participate in environmental decision-making processes that affect them. It begins with acknowledging past and present harms to communities of color, low-income communities, and others on the front lines of the climate crisis and racial and economic injustice. Environmental and climate justice work redirects leadership, resources, and decision-making to the communities who are most affected and previously excluded.
Landscape resiliency	The ability of ecosystems and the social, cultural, and economic systems that support communities within a landscape to withstand and recover from disturbances, such as climate change, natural disasters, and human activities. More resilient landscapes can absorb significant disturbances, while less resilient landscapes cannot adapt to change and are more vulnerable to damaging impacts.
Leakage	Minimal risk of activities that cause displacement of emissions from the project site to another site. Projects should account for any displacement.
Place-based strategies	Here, climate action strategies tailored to a location's specific needs and context. The locality should benefit from the carbon accounting of the carbon removal and/or resiliency effort. These in-situ approaches should account for unique characteristics such as geography, culture, and history, to develop solutions that meet the needs of local communities and stakeholders.

Sequestration	The process of capturing and storing carbon dioxide from the atmosphere through natural processes or human-made technologies.
Supplementary Cementitious Materials	Materials added to concrete mixtures to improve the performance of the concrete and reduce the amount of cement needed in a concrete mixture, which can reduce the cost and environmental impacts of concrete production. SCMs include fly ash, slag, silica fume, and other materials.
Voluntary carbon market (VCM)	A market for purchasing and selling carbon credits generated through activities that reduce or avoid greenhouse gas emissions. The VCM allows companies, organizations, and individuals to voluntarily mitigate their emissions by purchasing carbon credits from projects that reduce emissions.

Endnotes

1 Masson-Delmotte, V., et al. “Summary for Policymakers.” Global Warming of 1.5°C, Cambridge University Press, 2018, pp. 3-24, doi:10.1017/9781009157940.001.

---

2 Kruger, L and Williams, D. (2007). “Place and place-based planning.” United States Department of Agriculture Forest Service General Technical Report PNW, vol. 698. Available at: https://www.fs.usda.gov/rm/pubs_other/rmrs_2007_kruger_l001.pdf

---

3 “San Francisco’s Climate Action Plan”. City & County of San Francisco, 2021 https://sfenvironment.org/sites/default/files/events/cap_fulldocument_wappendix_web_220124.pdf

---

4 See additional information here: Carbon Direct & Microsoft. (2022). Criteria for high-quality carbon dioxide removal. Available at: https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f?utm_source=blog&utm_campaign=msft_criteria_2022

---

5 Potential tools for performing these assessments and informing strategy development include: Global CO_2 Initiative at the University of Michigan (https://www.globalco2initiative.org/research/techno-economic-assessment-and-life-cycle-assessment-toolkit/), National Energy Technology Laboratory at the U.S. Department of Energy (https://netl.doe.gov/LCA), and open LCA (https://www.openlca.org)

---

6 Potential tools for performing these assessments and informing strategy development include: U.S. Climate Resilience Toolkit (https://toolkit.climate.gov), Adaptation Planning Workbook from the U.S. Environmental Protection Agency (https://www.epa.gov/cre/risk-based-adaptation), Climate Change Vulnerability and Risk from UN Habitat (https://unhabitat.org/climate-change-vulnerability-and-risk-––-a-guide-for-community-assessments-action-planning-and), Climate Risk and Vulnerability Assessment from CDP (https://www.cdp.net/en/cities/climate-risk-vulnerability-assessment-training-guide-for-cities), and Vulnerability and Adaptation Assessments from the World Health Organziation (https://www.who.int/teams/environment-climate-change-and-health/climate-change-and-health/capacity-building/toolkit-on-climate-change-and-health/vulnerability)

7 Potential tools for performing these assessments and informing strategy development include: EJScreen by the U.S. Environmental Protection Agency (https://www.epa.gov/ejscreen), Climate and Economic Justice Screening Tool (https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5), and MiEJscreen (https://www.michigan.gov/egle/maps-data/miejscreen)

8 Organization for Economic Co-operation and Development (OECD). “Subnational Green Budgeting.” https://www.oecd.org/regional/snggreenbudgeting.htm. Accessed 1 Dec. 2022.

9 “Request for Qualifications Cover Page.” Boulder County, 2022, https://assets.bouldercounty.gov/wp-content/uploads/2022/04/RFQ-7339-22.pdf

10 Microsoft and Carbon Direct. “Criteria for High-Quality Carbon Dioxide Removal.” 2022, https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f?utm_source=blog&utm_campaign=msft_criteria_2022

11 ibid.

12 Note that this question of multiplier phase potential was included in the Application and considered as part of the evaluation process. Beyond project specific grant funding, catalytic resources available from engaged local governments and communities could include activities such as: support with permitting; relationship building with both private sector investors and local government decision makers with relevant authority; support with citing and leasing of property.

13 Gagg, C. “Cement and concrete as an engineering material: A historic appraisal and case study analysis.” Engineering Failure Analysis, 40, 114-140, 2014, https://doi.org/10.1016/j.engfailanal.2014.02.004

14 Fennel, P., et al. “Decarbonizing cement production.” Joule, 5, 1305-1311, 2014, https://doi.org/10.1016/j.joule.2021.04.011

15 Potential tools for performing these assessments and informing strategy development include: EJScreen by the U.S. Environmental Protection Agency (https://www.epa.gov/ejscreen), Climate and Economic Justice Screening Tool (https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5), and MiEJscreen (https://www.michigan.gov/egle/maps-data/miejscreen)

16 "Mineral commodity summaries 2020." U.S. Geological Survey, 2020, https://doi.org/10.3133/mcs2020.

17 "Supplementary cementitious materials." U.S. Department of Transportation, 2016, https://www.fhwa.dot.gov/pavement/concrete/pubs/hif16001.pdf

18 Neil, C., and Woodall, C. M. "A design guide to state and local low-carbon concrete procurement." Natural Resources Defense Council (NRDC), 2022, https://www.nrdc.org/sites/default/files/low-carbon-concrete-procurement-guide.pdf

19 "Curing of Concrete". American Concrete Institute (ACI), https://www.concrete.org/topicsinconcrete/topicdetail/Curing%20of%20Concrete?search=Curing%20of%20Concrete. Accessed 18 Feb. 2023.

20 Khan, M. T, et al. "Curing of Concrete by Carbon Dioxide." International Research Journal of Engineering and Technology, vol. 5, no. 4., 2018, https://www.irjet.net/archives/V5/i4/IRJET-V5I4980.pdf

21 Microsoft and Carbon Direct. "Criteria for High-Quality Carbon Dioxide Removal." 2022, https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f?utm_source=blog&utm_campaign=msft_criteria_2022

22 Microsoft and Carbon Direct. "Criteria for High-Quality Carbon Dioxide Removal." 2022, https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f?utm_source=blog&utm_campaign=msft_criteria_2022

23 Boulder County. "Boulder County Colorado Environmental Sustainability Plan." 2018, https://assets.bouldercounty.gov/wp-content/uploads/2018/08/2018-sustainability-plan.pdf

24 “Fairfax County Commits to Carbon Neutral Energy Use by 2040.” Fairfax County Virginia, 2021, https://www.fairfaxcounty.gov/news/fairfax-county-commits-carbon-neutral-energy-use-2040

25 “Carbon Neutrality Plan: Carbon Dioxide Removal.” Flagstaff Sustainability Program, https://gis.flagstaffaz.gov/portal/apps/sites/#/carbon-neutrality-plan/pages/carbon-dioxide-removal, Accessed 1 Dec. 2022.

26 City of Oakland. “Oakland 2030: Equitable Climate Action Plan.” 2020, https://cao-94612.s3.amazonaws.com/documents/Oakland-ECAP-07-24.pdf

27 Shoreline, WA. “Shoreline Climate Action Plan.” 2013, https://www.shorelinewa.gov/home/showdocument?id=14091

28 City of Austin, TX. “Austin Climate Equity Plan.” 2021, https://www.austintexas.gov/page/austin-climate-equity-plan

29 City of Dallas, TX. “Dallas Comprehensive Environmental and Climate Action Plan.” 2020, https://www.dallasclimateaction.com/_files/ugd/349b65_e4f9a262cebf41258fd4343d9af0504f.pdf

30 City of Denver, CO. “Denver 80 X 50 Climate Action Plan.” 2018, https://www.denvergov.org/files/assets/public/climate-action/documents/ddphe_80x50_climateactionplan.pdf

31 City of Mesa, AZ. “Climate Action Plan For a Sustainable Community.” 2022, https://www.mesaaz.gov/home/showdocument?id=43420&t=637589370357479436

32 The city does have a plan to plant shade trees that, among other benefits, will promote sequestration

33 City of Miami, FL. “Miami Forever Carbon Neutral.” 2021, https://www.miamigov.com/files/4e5f26f7-2622-4c90-834a-eaaa6aa3321e/Miami-Forever-Carbon-Neutral-FULL.pdf

34 City of Philadelphia, PA. “Philadelphia Climate Action Playbook.” 2021, https://www.phila.gov/media/20210113125627/Philadelphia-Climate-Action-Playbook.pdf

35 City of New York, NY. “Aligning New York City with the Paris Climate Agreement.” 2017, https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/1point5-AligningNYCwithParisAgrmt-02282018_web.pdf

36 City of Raleigh, NC. “Raleigh Community Climate Action Plan.” 2021, https://cityofraleigh0drupal.blob.core.usgovcloudapi.net/drupal-prod/COR27/RaleighCCAP.pdf

37 City of San Francisco, CA. “San Francisco's Climate Action Plan 2021.” 2021, https://sfenvironment.org/sites/default/files/cap_fulldocument_wappendix_web_220124.pdf

38 City of San Jose, CA. “Climate Smart San Jose: A People-Centered Plan for a Low-Carbon City.” 2021, https://www.sanjoseca.gov/home/showpublisheddocument/32171/637670572069040000 0

39 Montgomery County, MD. “Montgomery County Climate Action Plan.” 2021, https://www.montgomerycountymd.gov/climate/Resources/Files/climate/climate-action-plan.pdf

40 Beverly & Salem, MA. “Resilient Together Climate Action & Resilience Plan.” 2021, https://kladashboard-clientsourcefiles.s3.amazonaws.com/Beverly-Salem/Resilient+Together+Climate+Action+Plan+Final.pdf

41 City of Boston, MA. “Climate Action Plan.” 2019, https://www.boston.gov/sites/default/files/imce-uploads/2019-10/city_of_boston_2019_climate_action_plan_update_4.pdf

42 City of Salem, OR. “Salem Climate Action Plan.” 2021, https://www.cityofsalem.net/home/showpublisheddocument/5348/637801058544930000

43 Humboldt County, CA. “Humboldt Regional Climate Action Plan.” 2022, https://humboldtgov.org/DocumentCenter/View/106404/Humboldt-Regional-CAP----Public-Review-Draft-4-7-22-PDF

44 Kansas City, MO. “Climate Protection & Resiliency Plan.” 2022, https://www.kcmo.gov/home/showpublisheddocument/9912/638112897582470000

45 Cincinnati, OH. “2018 Green Cincinnati Plan.” 2018, https://www.cincinnati-oh.gov/sites/oes/assets/File/2018%20Green%20Cincinnati%20Plan(1).pdf

46 Orlando, FL. “2018 Community Action Plan.” 2018, https://www.orlando.gov/files/sharedassets/public/departments/sustainability/2018_orlando_communityactionplan.pdf

47 Bend, OR. “Bend Community Climate Action Plan.” 2020, https://www.bendoregon.gov/home/showpublisheddocument/52799/637856320279630000

48 Leon County, FL. “Integrated Sustainability Action Plan.” 2019, https://cms.leoncountyfl.gov/Portals/7/docs/isap.pdf?ver=gvPVtJqxelcxALV0gq0meA%3D%3D

49 County of Santa Barbara, CA. “County of Santa Barbara 2030 Climate Action Plan.” 2023, https://sbcountycap.konveio.com/draft-2030-climate-action-plan

50 Ann Arbor, MI. “Living Carbon Neutrality Plan.” 2020, https://www.a2gov.org/departments/sustainability/documents/a2zero%20climate%20action%20plan%20_3.0.pdf

51 City & County of Honolulu, HI. “One Climate One O’ahu.” 2020, https://static1.squarespace.com/static/5e3885654a153a6ef84e6c9c/t/6080c33e91bbf23a20b74159/1619051381131/2020-2025+Climate+Action+Plan.pdf

52 City of Torrance, CA. “Energy Efficiency Climate Action Plan.” 2015, http://southbaycities.org/sites/default/files/EECAP_Torrance_Final_20151218.pdf

53 City of Fort Collins, CO. “Fort Collins 2015 Climate Action Plan Framework.” 2015, https://www.fcgov.com/environmentalservices/pdf/cap-framework-2015.pdf

54 County of Albemarle, VA. “Climate Action Plan.” 2020, https://www.albemarle.org/home/showpublisheddocument/5432/637382865947300000

55 Lansing, MI. “City of Lansing Sustainability Action Plan.” 2022, https://content.civicplus.com/api/assets/3252692a-8fda-4a37-bf8d-ce9482e4f263

56 Adams County, CO. “Sustainable Adams County 2030 Plan.” 2021, https://www.adcogov.org/sites/default/files/Adams-County-Sustainability-Plan_v2022.02.08.pdf

57 Alameda, CA. “Climate Action and Resiliency Plan (CARP).” 2019, https://www.alamedaca.gov/files/sharedassets/public/public-works/climate-action-page/new-folder/final-carp-9-2019/alameda_carp_final_091119noappendices.pdf

58 Alexandria, VA. “Environmental Action Plan 2040.” 2019, https://media.alexandriava.gov/docs-archives/tes/eap2040v25.pdf

59 Atlanta, GA. “Local Actions and Policies for Reducing City of Atlanta’s Greenhouse Gas Emissions.” 2015, https://atlantaclimateactionplan.files.wordpress.com/2016/02/atlanta-climate-action-plan-07-23-2015.pdf

60 Bloomington, ID. “Sustainability Action Plan.” 2018, https://bloomington.in.gov/sites/default/files/2018-10/FINAL-SAP-draft-title-intro.pdf

61 Region of Southeast Florida. “Regional Climate Action Plan 3.0.” 2022, https://southeastfloridaclimatecompact.org/wp-content/uploads/2023/01/SEFL_RCAP3_Final.1.pdf

62 City of Cambridge. “Climate Protection Plan.” 2003, https://www.cambridgema.gov/~/media/Files/CDD/Climate/climateplans/climate_plan.pdf?la=en

63 Charleston, SC. “Charleston Green Plan.” 2009, https://www.charleston-sc.gov/DocumentCenter/View/1458/Charleston-Green-Plan?bidId=

64 Columbia, MO. “Climate Action & Adaptation Plan.” 2019, https://www.como.gov/sustainability/areas-of-focus/climate-action/

65 Concord, MA. “Climate Action and Resilience Plan.” 2020, https://concordma.gov/DocumentCenter/View/25318/Sustainable-Concord-Climate-Action-and-Resilience-Plan-2020?bidId=

66 Cupertino, CA. “Climate Action Plan.” 2014, https://www.cupertino.org/home/showdocument?id=9605

67 Elk Grove, CA. “Climate Action Plan.” 2019, https://www.elkgrovecity.org/sites/default/files/city-files/Departments/Planning/Projects/General%20Plan/GPU/Adopted_2019-02/ElkGrove_CAP_Adopted_Clean.pdf

68 Fremont, CA. “Climate Action Plan.” 2012, https://www.fremont.gov/home/showpublisheddocument/1631/637752865273481077

69 Lakewood, CO. “Sustainability Plan.” 2015, https://www.lakewood.org/files/assets/public/planning/sustainability/planning-for-sustainability/lakewoodco-sustainability-plan-2015.pdf

70 Longmont, CO. “Thrive Today and Tomorrow Creating a Sustainable Longmont.” 2018, https://www.longmontcolorado.gov/home/showdocument?id=23600

71 Los Angeles, CA. “L.A.’s Green New Deal.” 2019, https://plan.lamayor.org/sites/default/files/pLAn_2019_final.pdf

72 Pittsburg, PA. “Climate Action Plan.” 2020, https://apps.pittsburghpa.gov/redtail/images/7101_Pittsburgh_Climate_Action_Plan_3.0.pdf

73 Portland, OR. “Climate Action Plan.” 2015, https://www.portland.gov/bps/climate-action/documents/2015-climate-action-plan/download

74 Providence, RI. “Climate Justice Plan.” 2019, https://www.providenceri.gov/wp-content/uploads/2019/10/Climate-Justice-Plan-Report-FINAL-English-1.pdf

75 St. Louis, MI. “Climate Action & Adaptation Plan.” 2017, https://www.cakex.org/sites/default/files/documents/v1-1-CAP_FINAL.pdf

76 Sunnyvale, CA. “Climate Action Plan.” 2014, https://www.sunnyvale.ca.gov/home/showpublisheddocument/1318/637820055384170000

77 Solano County, CA. “Climate Action Plan.” 2011, https://www.solanocounty.com/civicax/filebank/blobdload.aspx?BlobID=10080

78 Richmond, CA. “Climate Action Plan.” 2016, https://www.ci.richmond.ca.us/DocumentCenter/View/40636/CAP-combined

79 Asheville, NC. “Sustainability Management Plan.” 2009, https://drive.google.com/file/d/1GzyhapFEMXfcHJ5BBaGEy3V_GJkY1hVo/view

80 Houston, TX. “Houston Climate Action Plan.” 2019, http://greenhoustontx.gov/climateactionplan/CAP-April2020.pdf

81 Berkeley, CA. “Climate Action Plan.” 2009, https://berkeleyca.gov/sites/default/files/2022-01/Berkeley-Climate-Action-Plan.pdf

82 Bellingham, WA. “Climate Protection Action Plan.” 2018, https://www.cob.org/wp-content/uploads/Climate-Protection-Action-Plan-2018-Update.pdf

83 Alameda, CA. “Climate Action and Resiliency Plan (CARP).” 2019, https://www.alamedaca.gov/files/sharedassets/public/public-works/climate-action-page/new-folder/final-carp-9-2019/alameda_carp_final_091119noappendices.pdf

84 Lancaster, CA. “Municipal Climate Action Plan.” 2019, https://www.cityoflancasterpa.gov/wp-content/uploads/2019/09/City-of-Lancasters-Municipal-Operations-Climate-Action-Plan-hi-res.pdf

85 Sacramento County, CA. “Climate Action Plan.” 2022, https://planning.saccounty.gov/PlansandProjectsIn-Progress/Documents/Climate%20Action%20Plan/Final%20Climate%20Action%20Plan.pdf

86 City of Fresno, CA. ”Greenhouse Gas Reduction Plan.” 2014, https://www.fresno.gov/darm/wp-content/uploads/sites/10/2016/11/F-2-Greenhouse-Gas-Reduction-Plan.pdf

87 Skagit County, WA. “Climate Action Plan.” 2010, https://www.skagitcounty.net/Sustainability/Documents/CAP%202010%20Adopted.pdf

88 Yolo County, CA. “Yolo County Climate Action Plan.” 2011, https://www.yolocounty.org/home/showpublisheddocument/18005/635289380535200000

89 Santa Monica, CA. “City of Santa Monica Climate Action & Adaptation Plan.” 2019, https://www.smgov.net/uploadedFiles/Departments/OSE/Climate/CAAP_SantaMonica.PDF