Carbon Direct

Boulder County | Sustainability, Climate Action & Resilience

4 CORNERS CARBON COALITION

LOCAL STRATEGIES PLAYBOOK

Carbon Removal Strategies for Local Communities

Tactical guidance for local ecosystems, communities, and economies

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Executive summary

How local governments can leverage carbon removal to reduce climate impacts & improve community resilience

Local governments must confront the impacts of climate change today while simultaneously safeguarding local communities for the future. For many communities, climate change first manifests in local ecosystems and environments. This is why it is important to build meaningful regional mitigation strategies that are grounded in local knowledge and priorities. Local carbon removal initiatives can play a role in both delivering climate mitigation and improving local resilience to its impacts.

This brief is a tool for positioning the strategic importance of local government investment in local carbon dioxide removal to benefit communities, economies and ecosystem services. Implementation provides an opportunity for local governments to expand their roles as:

As local experts

- Assessing local climate vulnerabilities and adaptation needs (70% of cities have already experienced harmful climate impacts to people and infrastructure, and 3.3 billion urban residents could be exposed to severe climate impacts by midcentury);
- Possessing knowledge and direct observation of local climate impacts;
- Facilitating collection of (& access to) climate data, can also help inform national inventories;
- Ensuring best-in-class science and a spirit for continuous improvement and knowledge sharing underpins strategies and solutions

As stewards

- Conducting community outreach and engagement;
- Promoting education and public awareness;
- Crafting climate risk reduction strategies;
- Driving development and implementation of laws, policies, strategies, programs, permitting/regulation, and fiscal measures that address climate change;
- Serving as a testbed for climate innovations through new technology demonstration and deployment projects;
- Building coalitions and forging partnerships (e.g., City of Flagstaff and Boulder County); and
- Sharing best practices and coordinating across subnational government actors.
- Fostering innovation and local capacity for climate mitigation action

As providers

- Enacting demand-pull procurement policies to drive consumption of low-carbon goods/materials and support innovative climate projects;
- Making funding and investment decisions on preferred local climate actions;
- Mobilizing climate finance across across various stakeholders and financing instruments (e.g., grants, subsidies, user charges and fees, tax revenues, loans, loan guarantees, bonds);
- Dispensing disaster relief, economic recovery, and green stimulus funds;
- Exercising taxation authorities to raise funds for climate projects;
- Raising revenues through carbon pricing mechanisms at the local level

Introduction

The science is clear. In concert with rapid efforts to dramatically reduce greenhouse gas (GHG) emissions,[1] humanity must also pursue carbon dioxide removal (CDR) at an unprecedented pace and scale.[2]

Local governments sit at the forefront of efforts to support communities, livelihoods, and landscapes, as they experience acute impacts of climate change. To meet these challenges, local governments can use resources in creative and efficient ways to further carbon removal strategies, emissions reductions and inclusive economic development in interconnected strategies targeted at building stronger, more resilient landscapes and communities. Subnational governments (municipal, county, state) can play a pivotal role in realizing the widespread deployment of CDR solutions and help establish best-practices for place-based CDR solutions that prioritize climate impact, community engagement, and landscape resilience (i.e., ensuring that landscapes can support desired functions, such as water filtration or healthy pollinator communities, even in the face of stressors and uncertainties).

There is no one-size-fits-all approach. Initiatives will be guided by specific local context (and will need to adapt to changing local realities over time), including the unique resources and opportunities available to individual jurisdictions. Recognizing these unique considerations, this document is neither prescriptive nor proscriptive in relation to specific carbon removal solutions or project implementation models. Rather, it suggests a four phase framework approach drawn from two 2022-2023 case studies: Boulder County's Climate Innovation Fund and the 4 Corners Carbon Coalition, where municipal and county governments funded CDR in a focused local context.

Local governments can use resources in creative and efficient ways to further carbon removal strategies, emissions reductions and inclusive economic development in interconnected strategies targeted at building stronger, more resilient landscapes and communities.

CDR & landscape resiliency are interconnected

Resilient landscapes can absorb significant climate disturbances and adapt to change, while less resilient landscapes are more vulnerable. Landscape resilience refers to the ability of ecosystems – along with the social, cultural, and economic systems that support communities – to sustain desired functions under changing conditions.

Because ecological and social systems are intrinsically connected, a localized approach to carbon removal can fundamentally strengthen landscapes and communities, and make them more resilient to climate change. A CDR strategy tailored to a specific region must therefore draw on local conditions as a basis for the planning and development of carbon removal projects that prioritize resilient communities and landscapes.[3]

Community engagement is essential to ensure the inclusion of diverse, local stakeholders, including under represented and marginalized groups, in decision-making processes that directly impact their lives. By elevating diverse perspectives and bolstering local organizations, a place-based strategy can aid in ensuring that community resilience is an essential component of climate action.[4]

Global climate concerns can be addressed locally

The Paris Agreement and local climate commitments

In December 2015, 196 countries adopted the Paris Agreement, establishing a treaty to limit a rise in global average surface temperature to no more than 2°C, with further ambition to keep warming below 1.5°C.[5] This global treaty helped galvanize both national and subnational government commitments towards climate targets to reduce economy-wide GHG emissions.

Carbon reduction and removal

Carbon management can mitigate the effects of climate change by slowing carbon emissions and removing carbon dioxide from the atmosphere. These strategies include reductions (e.g., using less energy), replacements (e.g., expanding renewable energy), and removals (e.g., drawing down atmospheric carbon dioxide into forests). These approaches may also have non-climate impacts including job creation or elimination, and improved or weakened environmental health and safety, among others. In the energy replacement example, developing renewable energy sources and decommissioning non-renewable power plants offers the opportunity to increase economic and community prosperity through a just transition plan that prioritizes employment growth and social development.[6]

Decarbonization alone is insufficient to meet global climate goals. CDR is also needed. Hard-to-abate sectors, such as cement, aviation, shipping, and steel, rely on fossil fuel energy and are projected to largely continue doing so. Carbon removal is necessary to balance these residual emissions.[7] Carbon removal can also reduce legacy or historic emissions that have contributed to excessive CO_2 concentrations in the atmosphere. Sea level rise and extreme weather events caused by the present levels of atmospheric CO_2, disproportionately impacts the lowest polluting countries.[8]

NATURE-BASED

Afforestation / Reforestation

Planting new trees, either where they grow naturally or in new areas

BENEFITS

Low cost ▪ High availability ▪ Support local communities ▪ Biodiversity/ habitat values

NATURE-BASED

Improved Forest Management

Managing working forests according to practices that increase carbon stocks and CO_2 drawdown rates

BENEFITS

Low cost ▪ High availability ▪ Major co-benefits

HYBRID

Biochar

Pyrolizing plant biomass to create a highly stable form of carbon that is then spread over land or used as a medium for other purposes

BENEFITS

Co-benefits from using biochar for soil amelioration or water filtration

HYBRID

Bioenergy w Carbon Capture & Storage

Multiple methods, but generally biomass combustion for electricity and heat followed by CO_2 capture and geologic sequestration

BENEFITS

High availability ▪ Potential uses for heat and byproducts generated

ENGINEERED

Carbon Mineralization

Injecting CO_2 directly from industrial waste streams into cement to harden it and store additional carbon within its mineral matrix

BENEFITS

High durability ▪ Improvements in strength properties of building materials through CO_2 hardening

ENGINEERED

Direct Air Capture

Engineered removal of carbon directly from the atmosphere using cycled chemical sorbents or electrochemical processes

BENEFITS

High durability when CO2 is stored underground ▪ Scalability ▪ Small land footprint

Figure 1. Sample of carbon removal technologies

CDR strategies are commonly categorized as nature-based, engineered, or hybrid solutions. Each of these major categories has advantages and disadvantages. Nature-based solutions are more cost-effective and readily available, and can be designed to have a host of environmental co-benefits that speak directly to landscape resilience concerns.[9] However, nature-based solutions store carbon for relatively short periods of time (decades to centuries) and face the risk of rapid, sudden carbon release (“reversal”) from natural disasters such as wildfires and human behaviors.

Currently, cost and energy needs limit engineered solutions, but engineered CDR has the potential to scale modularly to multiple regions, remove larger amounts of carbon, and store that carbon for long periods of time (centuries to millennia) with little to no risk of reversal. However, environmental co-benefits are often absent, or not considered or clearly articulated.[10]

In the coming decades, it is imperative to scale global CDR capacities to limit warming to levels conducive to ecological balance and human prosperity. The Intergovernmental Panel on Climate Change (IPCC) estimates cumulative removal needs of 100 to 1,000 billion metric tonnes of carbon dioxide ($GtCO_2$) globally by 2100,[11] with interim annual removal rates that approach 10 $GtCO_2$ by midcentury and twice that amount by the end of the century (Figure 2).[12] The recent IPCC Sixth Assessment Report from Working Group III (AR6 WIII report) reinforces the need for large-scale CDR as an essential pillar to limit warming to no more than 1.5°C, for which CDR also serves as a crucial tool for scenarios that limit warming to no more than 2°C by 2100.

"The deployment of CDR to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 or GHG emissions are to be achieved," according to the IPCC.[13] This requires rapid scale-up and massive deployment of all viable CDR methods, in stark contrast with the limited state of commercial deployment at present. Local action on this front can be impactful across scales.

The importance of local leadership

Subnational commitments

In December 2015, 196 countries adopted the Paris Agreement, establishing a treaty to limit a rise in global average surface temperature to no more than 2°C, with further ambition to keep warming below 1.5°C. This global treaty helped galvanize both national and subnational government commitments towards climate targets to reduce economy-wide GHG emissions.

Table 1. Selection of subnational government commitments to Paris Agreement in the U.S. (non-exhaustive)

Initiative	Description
Climate Mayors[14]	Bipartisan coalition of mayors driving climate leadership in their communities. The network (as of November 2022) includes: 182 mayors representing 39 states and more than 83 million Americans[15].
U.S. Climate Alliance[16]	Bipartisan coalition of 24 governors that seek to reduce GHG emissions 26-28% by 2025, 50-52% by 2030, and achieve net-zero emissions by 2050. The alliance (as of November 2022) includes: 24 governors that represent 59% of the U.S. economy, 54% of the U.S. population, and 42% of total U.S. GHG emissions.
We Are Still In[17] **& America Is All In**[18]	Network of diverse stakeholders that seek to halve U.S. emissions by 2030 and achieve net-zero emissions by 2050. Signatories (as of November 2022) include: 2,301 businesses, 947 faith groups, 412 colleges and universities, 294 cities and counties, 87 cultural institutions, 44 health care organizations, 12 tribes, and 10 states. This network represents 65% of the U.S. population (216 million Americans) and 68% of the U.S. GDP .

Commitments by subnational governments therefore play an indispensable and outsized role in driving climate action given the unique role that such entities play in numerous areas (Table 2).[19,20,21,22] And these subnational climate strategies are more attuned (and accountable) to local contexts, immediate climate change impacts, community concerns, and priorities for resilience and economic and quality of life considerations. In keeping with IPCC recommendations,[23] these subnational strategies would benefit from the incorporation of CDR strategies as well (Table 2) . Local governments can catalyze first-of-kind projects that create early market support and opportunities for nascent technologies, and foster local capacity for nature based removals and resilience projects.

Table 2. The unique roles of local governments in advancing climate action

As local experts
▪ Assessing local climate vulnerabilities and adaptation needs (70% of cities have already experienced harmful climate impacts to people and infrastructure, and 3.3 billion urban residents could be exposed to severe climate impacts by midcentury); ▪ Possessing knowledge and direct observation of local climate impacts; ▪ Facilitating collection of (& access to) climate data, can also help inform national inventories; ▪ Ensuring best-in-class science and a spirit for continuous improvement and knowledge sharing underpins strategies and solutions

As stewards
▪ Conducting community outreach and engagement; ▪ Promoting education and public awareness; ▪ Crafting climate risk reduction strategies; ▪ Driving development and implementation of laws, policies, strategies, programs, permitting/regulation, and fiscal measures that address climate change; ▪ Serving as a testbed for climate innovations through new technology demonstration and deployment projects; ▪ Building coalitions and forging partnerships (e.g., City of Flagstaff and Boulder County); and ▪ Sharing best practices and coordinating across subnational government actors. ▪ Fostering innovation and local capacity for climate mitigation action

As providers

- Enacting demand-pull procurement policies to drive consumption of low-carbon goods/materials and support innovative climate projects;
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- Exercising taxation authorities to raise funds for climate projects;
- Raising revenues through carbon pricing mechanisms at the local level

Climate finance and local government

Finance from subnational governments toward climate-related activities is on the rise. From 2009-2019, the Organization for Economic Co-operation and Development (OECD) reported that subnational governments across 33 countries increased their 'climate-significant' expenditures by an average of 2.3% per year,[24] including various modes of support for local waste management plans, water supply, soil pollution, and the mapping and planning of raw materials extraction, among other investments.[25]

Globally, capital flows for climate action at the municipal and county level through subnational governments amounted to an annual average of $384 billion between 2017 and 2018.[26] While these investments have impressive impact potential, the majority of this finance is directed towards green infrastructure and transport. But the need remains for climate finance targeted at carbon removal and landscape resiliency projects, which can additionally help meet net-zero commitments and bolster local ecosystems and economies when aligned with key principles for carbon mitigation and community priorities.[27]

Voluntary carbon markets (VCM) and private sector efforts to advance market commitments

To incorporate CDR into climate expenditures, subnational governments can engage with the voluntary carbon market (VCM), which deals in both carbon removal and avoidance/reduction credits. On the VCM, each carbon credit represents a metric tonne of CO_2, or an equivalent amount of other greenhouse gas emissions (also known as CO_2e) removed from the atmosphere or a tonne of avoided/reduced emissions. Carbon projects (e.g., reforestation or direct air capture) generate credits that are then transacted on the VCM through registries or brokers.

The VCM plays a vital role in providing revenue flows for emissions avoidance, emissions reduction (via reduction credits), and scaling up carbon removal methods. The VCM reached a total value of more than $1 billion in 2021 through the sale of more than 300 million metric tonnes of CO_2e worth of carbon credits across different project types. By 2030, estimates suggest that the VCM could scale to well over $100 billion per year depending on market dynamics and pricing scenarios.[28] While this market is currently experiencing rapid growth, the quantity of carbon removal projects listed on registries is scarce.

An analysis of the four largest voluntary market registries found that carbon removal projects accounted for only 3% of all projects that issued credits in 2021 and 2022, while projects that included a mix of emission reductions and removals accounted for 13%.[29] Beyond scarcity, a critical evaluation of the quality of these removal credits reveals the advertised supply volume of removal credits falls short due to myriad quality and credibility challenges.[30,31,32,33,34,35]

Local governments have an opportunity to prioritize the development and implementation of high-quality local or regional carbon removal projects following protocols and standards based on sound science to overcome scarcity and quality concerns and to ensure that CDR solutions speak to stakeholder concerns.

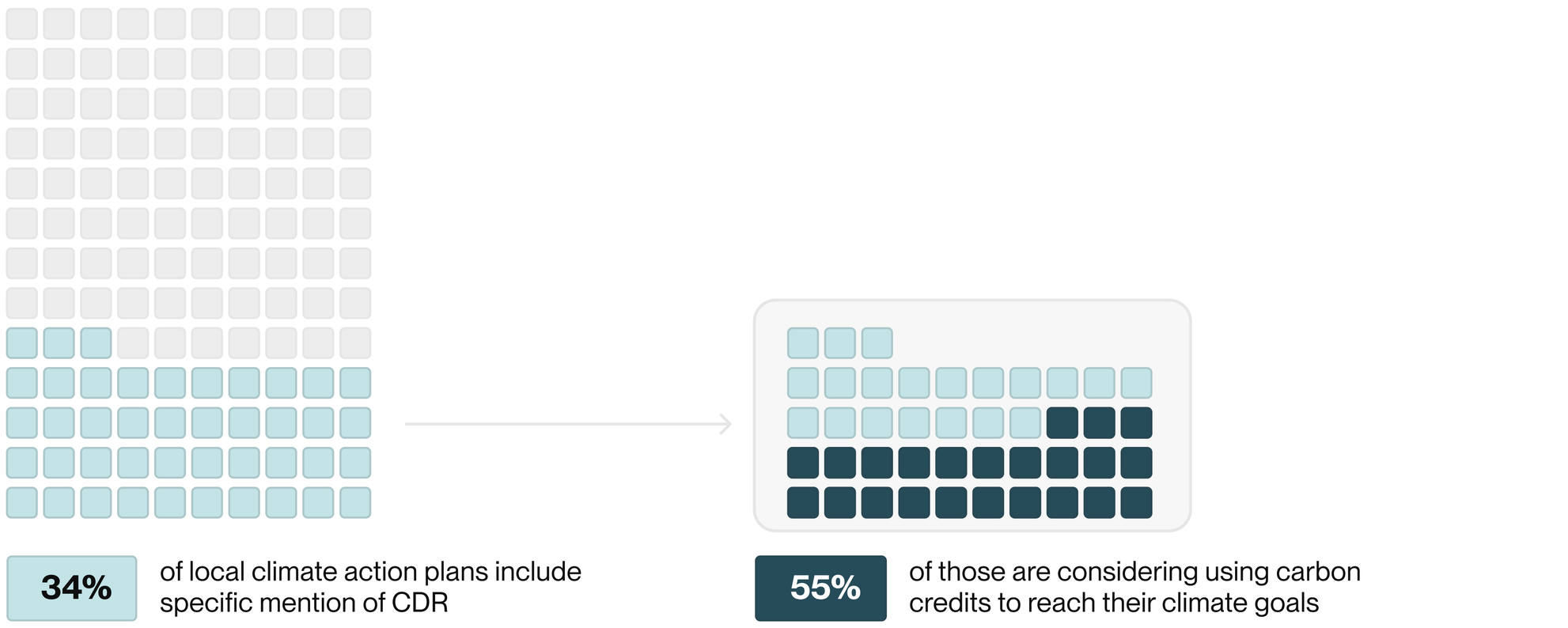
Local governments seeking to transact on the VCM to meet their climate commitments must rely on expert diligence to ensure sourcing of high-quality carbon credits. Cross-sector efforts to create a standardized approach for crediting a tonnes of atmospheric CO_2e removal have historically struggled to gain traction in an increasingly complex landscape of approaches, policies, and registries. Inadvertent purchase of low-quality credits can have adverse climate impacts and severe reputational repercussions, including claims of greenwashing – the use of false or outright misleading claims about the sustainability of a product or a service.[36] To avoid reputational risks, we recommend local governments consider the following guidelines; clear messaging of sustainability claims and goals, transparent reporting supported by data, and internal alignment on market participation and goals.

The path forward: The necessity of carbon removal

Interconnected benefits of place-based projects

A survey of 128 subnational governments,[37,38] of similar size (population of 76,000 or greater) to the four discussed in the case studies below (Boulder County CO, Flagstaff AZ, Santa Fe NM, and Salt Lake City UT) revealed only 34% of local climate action plans include specific mention of CDR. Of those, many describe CDR as a secondary benefit of a proposed goal or action. Cambridge MA, for example, intends to plant trees and optimize vegetation to shade buildings and reduce urban heat island effect, with the ancillary benefit of carbon sequestration.[39]

Of those subnational governments that include specific mention of CDR, 55% are considering using carbon credits to reach their climate targets. Many of these do not include plans for implementing in situ carbon projects. These plans generally view carbon credits as a method to mitigate emissions that cannot be abated and to keep local jurisdictions on track to meet climate targets by 2050. Appendix C contains a detailed list of surveyed local governments' whose climate action plans included specific mention of CDR.



As subnational governments incorporate CDR into climate expenditures, they have an opportunity to move beyond purchasing carbon credits for meeting climate commitments to ensuring investment in high-quality carbon projects that scale innovative solutions and speak to climate concerns that are specifically impacting the geographic area in question.

Local CDR investment must account for local context

CDR initiatives supporting climate goals at the subnational level must account for local context through strategic investments in projects that speak to relevant climate-related concerns. Resilient communities are essential components of resilient landscapes, and understanding networks across local economies, populations, and sectors is essential to mitigation.[40] Communities, ecosystems, and livelihoods are interlinked – resilient landscapes can help support resilient communities and livelihoods with ecosystem services such as erosion and flood control, water purification, and healthy soils. Climatic hazards will disproportionately affect the already fragile features of a community. And subnational governments should leverage CDR initiatives as an opportunity to simultaneously prioritize local projects that advance civic infrastructure, food, and water security, habitats, and community health. Prioritizing human capacity and identifying critical retraining and education needs are crucial for a local resilience framework.

An informed and prepared community can recover quickly from weather events and climate-related disturbances. Because resilient communities absorb major disturbances, they can act quickly to reduce negative impacts on human health, the environment, and the economy.[41] Boulder County, for example, experienced the devastating Marshall fire on December 30th, 2021, which had profound social, economic, and emotional costs.[42] Following the Marshall fire and related input from stakeholders, Boulder County decided to focus its carbon removal strategy on projects that optimized for both CDR and landscape resilience, wildfire mitigation in particular.

CDR will not be a one-size-fits-all solution. Rather, appropriate combinations of CDR strategies must be site-specific, informed by the needs and resources of a particular area. All stakeholders must rise to the challenge of developing these emerging place-based CDR solutions.

Strategies for project prioritization

In the case of CDR and resilience, these multifaceted climate solutions should weigh local community and environmental needs against quality criteria for carbon removals when selecting projects (Appendix A). Boulder County (discussed in more detail below), for example, prioritized investing in projects that would both draw down carbon dioxide from the atmosphere and improve the resiliency of local landscapes to climate change. The 4 Corners Carbon Coalition prioritized innovation towards green workforce development and technology scaling.

Community priorities, localized climate-risk, and benefit mapping should drive project criteria selection, rather than a privileging of one solution type over another (e.g., nature based versus engineered). Each has their challenges and benefits (e.g., price, storage duration, scalability). The quality and value of CDR solutions are not binary, rather nature-based and engineered approaches exist on a continuum.[43] Where a solution stands on that continuum should be measured by its effectiveness and potential co-benefits. Local governments must therefore take stock of local needs and resources and make science-based decisions to determine appropriate carbon removal strategies for their community.

As local-government initiatives continue to grow and mature, governments will likely find it best to invest in a diversified portfolio of carbon removal strategies. We suggest a diversified approach to carbon removal – nature-based, hybrid, and engineered solutions – to balance risk, ecosystem and community benefits, and the greatest cumulative carbon removal.[44]

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.

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