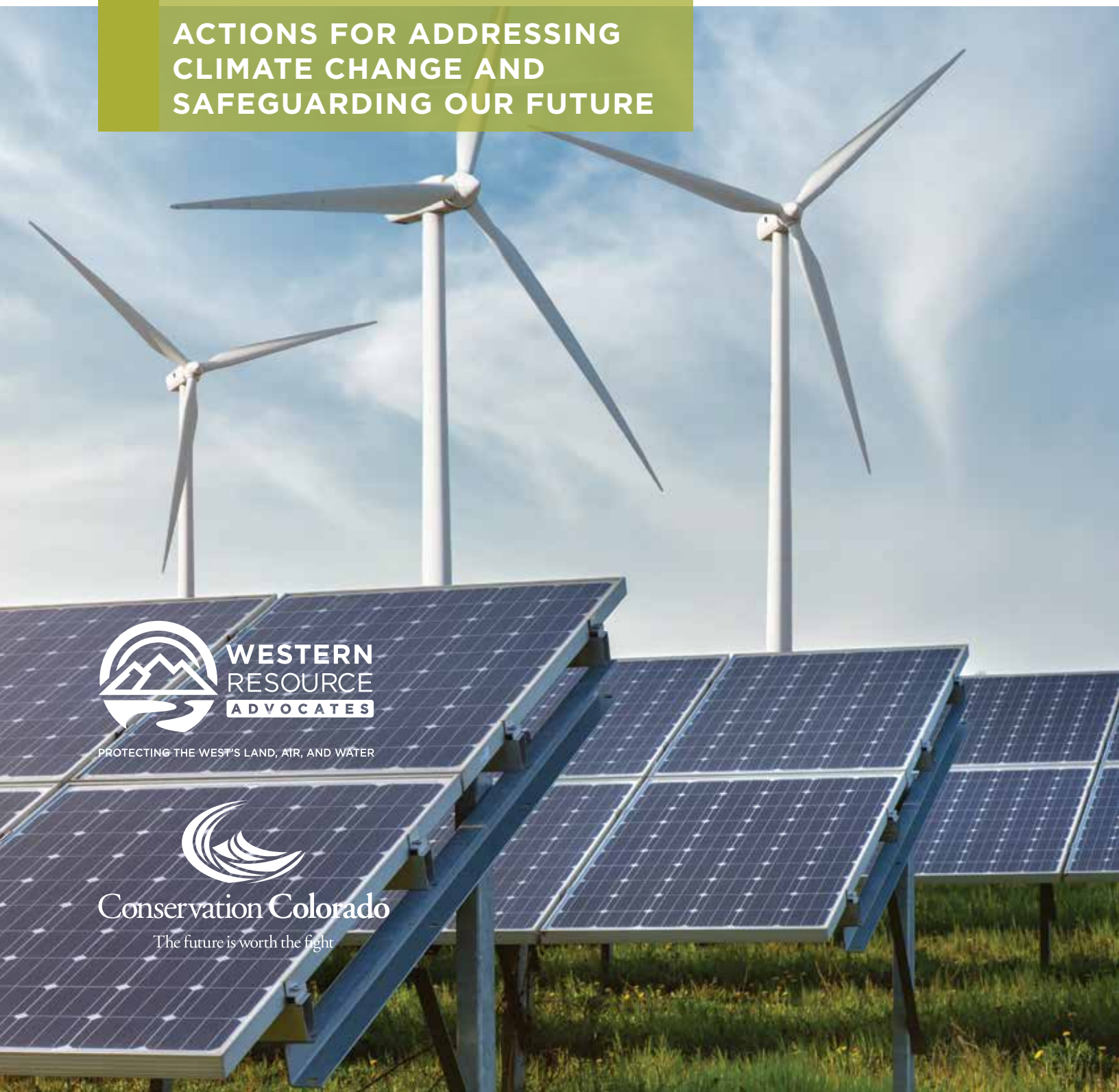
Colorado's Climate Blueprint

SEPTEMBER 2017

ACTIONS FOR ADDRESSING CLIMATE CHANGE AND SAFEGUARDING OUR FUTURE

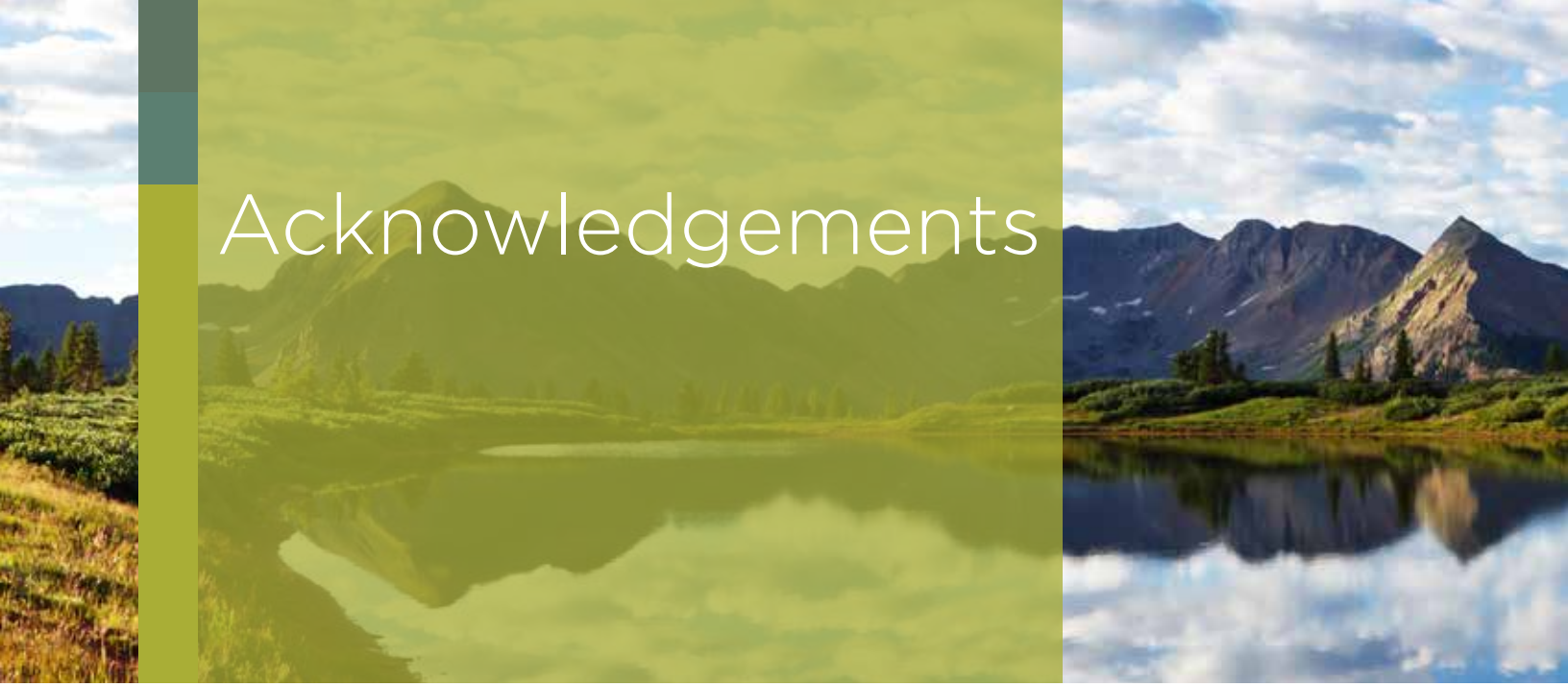


WESTERN RESOURCE ADVOCATES

PROTECTING THE WEST'S LAND, AIR, AND WATER

Conservation Colorado

The future is worth the fight



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This report is available online at westernresourceadvocates.org and conservationco.org

ABOUT WESTERN RESOURCE ADVOCATES

Founded in 1989, Western Resource Advocates is dedicated to protecting the West's land, air, and water to ensure that vibrant communities exist in balance with nature. We use law, science, and economics to craft innovative solutions to the most pressing conservation issues in the region. For more information visit www.westernresourceadvocates.org

ABOUT CONSERVATION COLORADO

Conservation Colorado is a grassroots organization that educates and mobilizes people to protect Colorado's environment and quality of life.

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Executive Summary

Colorado's farmers and ranchers depend on reliable water supplies to irrigate crops; our tourism sector depends on stable snowpack and healthy forests; our communities depend on reliable infrastructure; and our children depend on clean air. State actions are essential to address climate change and safeguard our communities, and our future.

Coloradans are already seeing the impacts of climate change in our daily lives: Hotter summers and more intense droughts, earlier spring snowmelt, forests decimated by the pine beetle epidemic, and more unpredictable weather are all manifestations of a changing climate. These changes impose real costs on our communities and our economy. Today, as the federal government rolls back protections for our health and environment, cuts funding for clean energy research, and promotes the fossil fuel industry, **state and local leadership on climate change is more critical than ever.**

Hundreds of cities and 14 states—including Colorado—have pledged to rein in their emissions in order to limit global warming to 1.5 to 2 degrees Celsius (1.5–2°C), the level scientists say is necessary to avoid the most catastrophic impacts of climate change. To achieve that goal, we must embark on an expansive effort to reduce carbon pollution.

Colorado Governor Hickenlooper's executive order on climate, issued in July of 2017, is a critical step forward for our state. Colorado state agencies, the legislature, cities, and businesses should adopt measures to make the executive order's ambitious emission reductions a reality. But addressing climate change is a long-term effort, and **future governors and legislators should build on the progress to date by establishing emission targets, regulations, and market incentives to drive the deep, long-term pollution reductions needed to safeguard our climate.**

Colorado is well-positioned to build on our clean energy successes by accelerating current efforts and advancing new policies. But our research shows that policies currently in place are projected to keep emission levels flat at best, not drive the reductions in carbon pollution that are needed to meet the goals of the executive order and the Paris Climate Agreement (Figure 1).

OUR RESEARCH SHOWS THAT COLORADO POLICIES CURRENTLY IN PLACE ARE PROJECTED TO KEEP EMISSION LEVELS FLAT AT BEST, NOT DRIVE THE REDUCTIONS IN CARBON POLLUTION THAT ARE NEEDED TO AVOID SEVERE IMPACTS FROM CLIMATE CHANGE.

Figure 1. Key Policies and a Market-Based Program Can Reduce Carbon Pollution Consistent with Limiting Warming to 2˚C

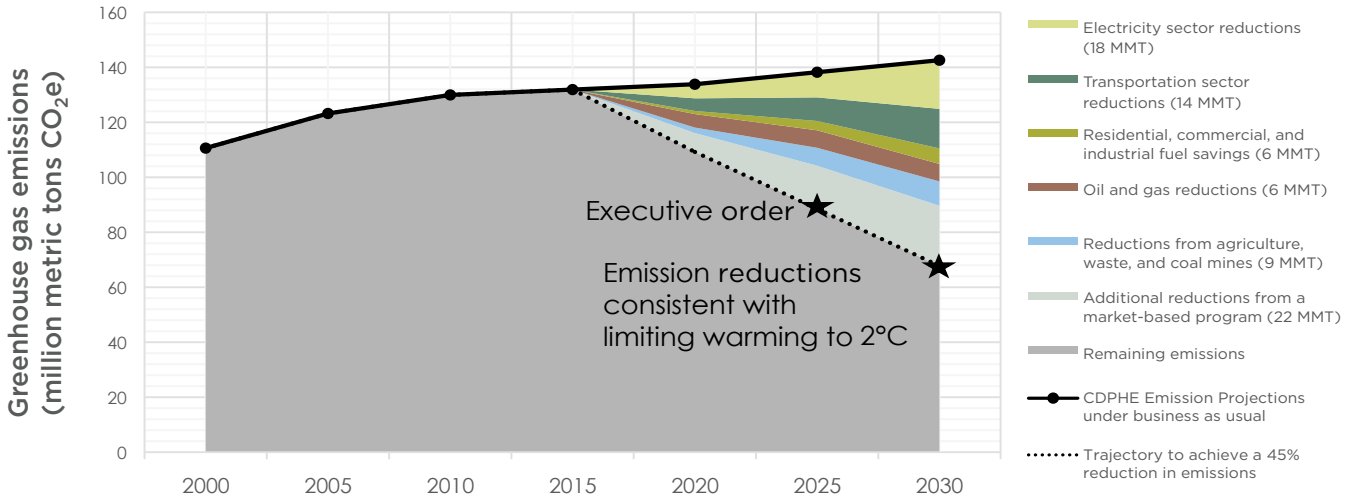


Figure 1. Colorado's emissions under "business as usual" are projected to rise (based on projections by the Colorado Department of Public Health and Environment); measures in each of the key sectors can reduce emissions significantly, and adopting a market-based policy will drive the deep reductions needed to be on an emissions trajectory consistent with limiting warming to 2°C. Emission reductions for each sector are shown in the legend, in million metric tons of CO_2 equivalent (MMT CO_2e).

As shown in Figure 1, we need visionary policies in the areas of electricity, transportation, energy efficiency, oil and gas, voluntary incentives, and a market-based carbon program to reduce carbon pollution and avert the most severe impacts of climate change.

In order to meet the goals of the governor's executive order and science-based targets for avoiding the most severe impacts of climate change, Colorado should:

1. Adopt statewide carbon pollution limits that reduce emissions at least 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050, consistent with limiting warming to 1.5–2°C.

   Achieving science-based climate goals requires near-term action to reduce emissions. Colorado should commit to reduce emissions at least 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050. Establishing these targets is critical: They will inform the type and scale of policies adopted by executive agencies and future legislatures, and provide key benchmarks for measuring success. The Colorado legislature and governor should move quickly to adopt binding emission targets for 2030 and beyond.

2. Advance policies that drive carbon pollution reductions in key sectors, including the electricity, transportation, industrial, and commercial sectors.

   Colorado should adopt policies that drive innovation and investment in new, clean technologies, accelerate the transition to a clean energy economy, and successfully achieve near-term reductions in carbon pollution. For example, over the next 18 months, **state administrative agencies can take these actions:**

- The Air Quality Control Commission should adopt rules to reduce greenhouse gas pollution from power plants and other industrial sources, and adopt California's more stringent fuel economy standards for vehicles, including a zero-emission vehicle sales requirement.
- The Public Utilities Commission should advance actions to retire older, coal-fired units and invest in clean energy resources, a modernized grid, and energy efficiency programs.
- The Air Quality Control Commission should advance regulations that reduce venting and flaring of methane and ensure the state has adequate monitoring in place to catch leaks of potent methane pollution.
- The Colorado Energy Office should explore opportunities to advance a program to enable voluntary carbon reductions in sectors like agriculture, waste management, and coal mine methane, similar to the Colorado Carbon Fund.

The Colorado legislature should also move important sector-specific policies forward, including but not limited to the following recommendations:

- Adopting up-to-date energy-efficient building codes.
- Maintaining and expanding policies and incentives to support electric vehicles and to ensure growing cities plan for new growth in a way that focuses on moving people, not just cars.
- Further supporting efforts to reduce carbon pollution in the power sector by advancing policies to enable greater levels of clean energy and energy efficiency.

3. Enact a market-based policy to reduce carbon pollution, such as a carbon tax or a cap-and-trade program, that can link with other states or jurisdictions and incentivize the most cost-effective investments in clean energy.

A market-based carbon policy can establish the framework for achieving deep, long-term pollution reductions. Market-based environmental policies have a long, successful track record of reducing pollution at lower costs and have been utilized in phasing out lead in gasoline, curbing acid rain, and reducing ozone-depleting chemicals through the Montreal Protocol. Collectively, these programs have saved billions of dollars compared to traditional regulations.

In addition to adopting carbon pollution reduction targets and key sector-specific policies, the Colorado legislature should direct the Air Quality Control Commission to implement a market-based carbon program for Colorado. Importantly, the commission should ensure that any market-based program not disproportionately impact working families and other frontline communities, who are more vulnerable to the impacts of climate change and to potential cost impacts due to the larger portions of their budgets spent on energy.

The benefits of acting on climate change are clear. Transitioning to a low-carbon economy takes dedicated, thoughtful leadership. Colorado's businesses, local governments, and communities have shown a willingness to lead—but the magnitude of the challenge and the opportunity for success calls for a broad, comprehensive statewide approach.

1. Introduction

Climate change has profound, pervasive impacts across Colorado's economy and our way of life. With warmer temperatures, Colorado will see more frequent and severe droughts and water shortages, which affect cities that depend on stable water supplies, farmers that provide food for our communities, and the rivers that support recreation and a vibrant tourism economy.

With drier soils and parched forests, wildfires will become more frequent and costly, as seen with the recent Waldo Canyon, High Park, and Black Forest fires in 2012 and 2013. Colorado communities on the frontlines of climate change, who already suffer disproportionate impacts from environmental issues, will be faced with mounting public health challenges, amplified by more frequent heat waves and extreme weather events. Higher temperatures, for example, are projected to increase the number of poor air quality days in urban areas, where many working families live; furthermore, those communities have less ability to respond to or recover from extreme weather events.

Climate change also has important consequences for global food supplies and economic stability, which has profound—if indirect—impacts on Coloradans. Residents of Colorado see the impacts of climate change today; as a result, seven out of ten Coloradans recognize global warming is happening and think we should regulate carbon pollution.[1]

Despite the urgent need to address carbon pollution and the impacts of climate change, in June 2017, President Trump abandoned the landmark Paris Climate Agreement, leaving it up to states, cities, and other entities across the nation to lead our country in tackling climate change. As the federal government rolls back regulations that protect our health and environment, cuts funding for clean energy research, and promotes the fossil fuel industry, state and local leadership is more critical than ever. States have long been "laboratories of democracy," and it is now up to the states to collaborate and innovate to develop climate policies that work.

Since June, hundreds of cities and 14 states, including Colorado, have responded, pledging to address carbon pollution, consistent with limiting warming to 1.5 to 2 degrees Celsius (1.5–2°C). In July 2017, Colorado Governor Hickenlooper released an executive order on climate change, which represents a critical step forward for our state. The executive order sets a goal for reducing emissions across Colorado's economy and establishes specific goals for the electricity sector, electric vehicles, and energy efficiency savings.

The executive order comes at a time when ambition to tackle climate change is mounting worldwide: The Paris Climate Agreement established global goals to limit warming to 2 degrees Celsius (3.6 degrees Fahrenheit) and to strive

AS THE FEDERAL GOVERNMENT ROLLS BACK REGULATIONS THAT PROTECT OUR HEALTH AND ENVIRONMENT, CUTS FUNDING FOR CLEAN ENERGY RESEARCH, AND PROMOTES THE FOSSIL FUEL INDUSTRY, STATE AND LOCAL LEADERSHIP IS MORE CRITICAL THAN EVER.

to limit warming to 1.5°C in order to avoid the most catastrophic impacts of climate change. Many nations have submitted plans to meet these goals, but to achieve them, we must step up our ambition and reduce our global emissions quickly. Scientists estimate the developed world must reduce emissions by 45–60% by 2030 and by 80–90% by 2050, compared to a baseline of 2005 emissions.[2] In short, the coming decade is critical. We need to act now to move our economy toward less carbon pollution and, over the next 30 years, spur innovation to reduce emissions to nearly zero.

Fortunately, Colorado has made progress towards meeting these climate goals, with policies such as our Renewable Energy Standard, energy efficiency goals, and methane emissions capture rules. Colorado's commitment to renewable energy and energy efficiency now supports 62,000 jobs[3] in the clean energy sector; the state is well-positioned to build on these past actions in order to secure a low-carbon future.

To reach our goal to limit warming to 1.5–2°C, Colorado needs to take three major steps:

1. Adopt statewide carbon pollution limits that reduce emissions at least 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050, consistent with limiting warming to 1.5–2°C.
2. Advance policies that drive carbon pollution reductions in key sectors, including the electricity, transportation, industrial, and commercial sectors.
3. Enact a market-based carbon policy, such as a carbon tax or a cap-and-trade program that can link with other states or jurisdictions and incentivize the most cost-effective investments in carbon pollution reductions.

In order to meet the goal of the Paris Climate Agreement and limit global warming to no more than 1.5–2°C, Colorado should do its part. **This report outlines the pathway that Colorado leaders should take to meet the climate goals set by Governor Hickenlooper, as well as the larger, longer-term goals of the Paris Climate Agreement, which Colorado has committed to by joining the U.S. Climate Alliance.**

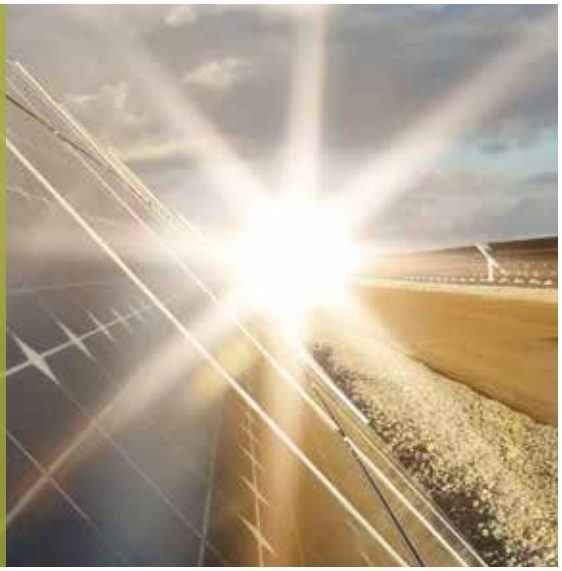
By undertaking a concrete set of actions to achieve those goals, Colorado will re-establish its position as a leader on clean energy and climate. Setting and achieving these emission targets provides a stable framework of planning for industry and can help business leaders prepare. And it sends a signal to the broader national and international community that U.S. states continue to make progress on climate, despite the pause in federal leadership.

SCIENTISTS ESTIMATE THE DEVELOPED WORLD MUST REDUCE EMISSIONS BY 45–60% BY 2030 AND BY 80–90% BY 2050, COMPARED TO A BASELINE OF 2005 EMISSIONS.

Importantly, actions that reduce carbon pollution have other benefits as well, including reducing pollutants that cause health problems. For example, cutting global warming pollution, like methane from oil and gas operations, also reduces volatile organic compounds that contribute to the formation of ground-level ozone, which has serious health impacts, including respiratory and cardiovascular issues and premature death. In the process of ensuring a stable climate, Colorado can improve local air quality and human health.

Addressing climate change requires a long-term commitment that will span governors, legislators, and even generations of Coloradans. If we do not act now, addressing climate change will become more challenging and more expensive. Today, we have a clear opportunity to establish a long-term, focused commitment to reducing emissions.

2. The Colorado Blueprint to Addressing Climate Change



Many of Colorado's cities and businesses have already adopted goals and strategies to address climate change. For example, the City of Denver has committed to reduce its greenhouse gas emissions 80% by 2050, and cities across Colorado—from Durango to Wray—have joined the Compact of Colorado Communities, committing to advance action on climate change at the local level. Similarly, in the wake of the U.S. leaving the Paris Climate Agreement, more than 100 Colorado businesses—including Western Union, Vail Resorts, and New Belgium Brewing—have pledged to meet the Paris goals and to address climate change.

But cities and businesses cannot do it alone. To meet the climate challenge, Colorado should:

1. Adopt carbon pollution reduction targets for the state that are consistent with limiting warming to 1.5–2°C.

2. Enact policies that reduce carbon pollution from key sectors, including transportation, electricity, industrial, and commercial sectors. Many of these policies should be adopted over the next 18 months and can successfully achieve key near-term emission reductions.

3. Employ market-based policies that drive deep cuts in emissions cost effectively and can link with other states or jurisdictions, such as a carbon tax or a cap-and-trade program.

Limiting Warming to 1.5–2°C and Avoiding the Most Severe Consequences of Climate Change Requires Significant, Near-Term Reductions in Carbon Pollution

Using global models, scientists have calculated how much carbon can be emitted into the atmosphere in order to limit warming to 1.5–2°C and avoid the most catastrophic impacts of climate change. This is the Earth's total "carbon pollution budget"—like any budget, the more we spend (or emit) today, the less we will have available to emit later. To have a likely chance (greater than 66%) of limiting warming to 1.5°C, scientists project that we have very little carbon left in our budget: **At current emission rates, we will use up the remainder of our total global carbon pollution budget in just four years.** To limit warming to 2°C, the global budget may last up to 20 years, but that scenario assumes that in 20 years, emissions immediately fall to zero—an improbable scenario.[4] To meet the temperature targets in a reasonable and cost-effective manner, emissions should be reduced steadily—starting now—over time.

Using this global carbon budget, modelers have developed different global emission reduction pathways that are consistent with limiting warming to 1.5°C and 2°C, and apportioned those reductions to developing and developed countries. The pathways require significant long-term reductions from all countries—for developed countries like the U.S., it means reducing economy-wide emissions 45–60% from 2005 levels by 2030 and 80–90% by 2050.[5] The higher, more ambitious level of emission reductions are consistent with limiting warming to 1.5°C, while the lower targets are consistent with 2°C of warming. Other emission reduction paths are possible, but **delaying action to reduce emissions today means we would need to make even steeper reductions—with higher costs—in the future.**

2.1 Adopt meaningful carbon pollution limits consistent with limiting warming to 1.5–2°C

Colorado should establish goals that align with limiting global warming to 1.5–2°C. Governor Hickenlooper's executive order is an important start and puts us on the right trajectory. However, Colorado should take the next step and commit to reducing emissions economy-wide by 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050.

The most critical action we must take to address climate change is to establish enforceable, statewide limits to carbon pollution. Setting these targets will require leadership by Colorado's governor and legislature or, in the absence of strong leadership, a vote of the people.

Concrete targets for reducing carbon pollution provide an important signal for businesses to make long-term investments in clean energy, encourage entrepreneurs to develop new technology, and drive state and local leaders to enact solutions. Establishing carbon pollution reduction targets will also spur executive agencies and legislators to adopt the sector-specific policies described in Section 2.2, which are necessary to make those targets a reality.

Governor Hickenlooper's executive order establishing a goal to reduce emissions 26% below 2005 levels by 2025 is squarely in line with the long-term emission reductions needed. But Colorado should look beyond 2025 and set goals to reduce carbon pollution that are consistent with science and the Paris Climate Agreement.

COLORADO SHOULD ADOPT A TARGET OF REDUCING EMISSIONS BY 45% BELOW 2005 LEVELS BY 2030 AND 90% BY 2050.

The science indicates that the U.S., along with other developed countries, needs to reduce emissions economy-wide by 45–60% below 2005 levels by 2030 and 80–90% below 2005 levels by 2050 (see the text box on p. 10), with the more ambitious levels of reductions consistent with limiting warming to 1.5°C.[6] We recommend Colorado adopt a target of reducing emissions by 45% below 2005 levels by 2030 and by 90% by 2050 (Figure 2). These emission reduction targets are ambitious, but grounded in science and informed by the level of action needed to maintain a stable climate. They are similar to the goals adopted in other U.S. programs, such as the Western Climate Initiative (including California, Ontario, and Quebec)[7] and the Regional Greenhouse Gas Initiative,[8] creating an opportunity for Colorado to potentially link with these programs in the future.

In addition to setting emission targets for 2030 and 2050, Colorado should establish benchmarks for measuring progress every three to five years. Regular benchmarks can inform whether a program should be enhanced or relaxed and whether the state's progress is consistent with the climate goals.

Figure 2. Emission Reduction Goals Needed to Limit Warming to 2°C

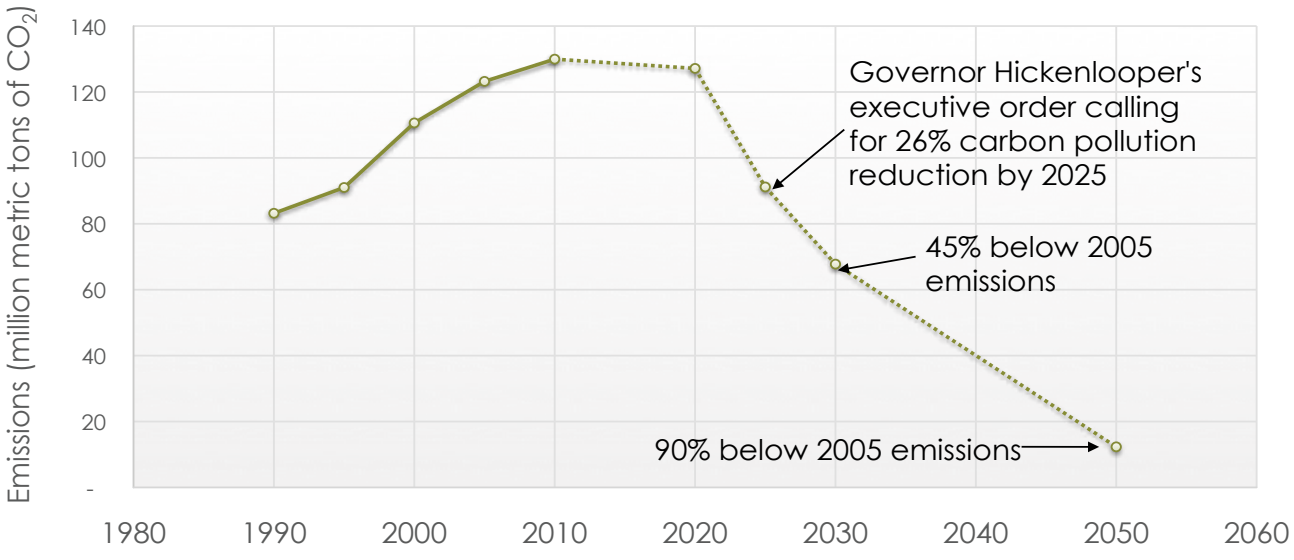


Figure 2. Recommended carbon pollution reductions in Colorado, consistent with limiting warming to 1.5–2°C.

Colorado has willing partners with whom to forge ahead on climate action and receptive markets for innovative technologies that mitigate climate change: In the U.S., Colorado and 14 other states and over 200 cities and counties have joined the U.S. Climate Alliance or the "We Are Still In" agreement, or adopted similarly ambitious climate goals. Globally, Canada, Chile, China, all members of the European Union, Japan, Korea, Mexico, New Zealand, and others have adopted market-based carbon programs, and many other nations have implemented sector-specific climate initiatives.[9] These states and nations will, like Colorado, be key markets for new low-carbon technologies and innovations.

2.2. Expand or enact policies that drive innovation across the economy

Colorado should enact policies to reduce carbon pollution and expedite the transition to a clean energy economy. This includes decarbonizing the state's fleet of power plants; our transportation system; residential, commercial, and industrial buildings; and land use and waste management. Over the next two to five years, a set of sector-specific policies, enacted through administrative agency action, legislation, and other venues can help achieve the emission reductions needed.

Currently, carbon pollution in Colorado is projected to grow steadily. The Colorado Department of Public Health and Environment (CDPHE) Greenhouse Gas Inventory, last published in 2014, indicates three sectors produce the majority of Colorado's carbon pollution: electricity, transportation, and fuel used by residential, commercial, and industrial entities for heating and manufacturing processes. Other sectors are also key sources of carbon pollution and are projected to grow quickly: for example CDPHE projected methane emissions from natural gas and oil systems and emissions from industrial processes to grow by more than 50% over the next 15 years.

CDPHE's projections form a useful benchmark, but the state's clean energy policies and key industries are also in the midst of a dynamic transition. CDPHE's Inventory did not incorporate recent clean energy policies, such as the 2010 Clean Air-Clean Jobs Act, the 2014 methane rule for oil and gas operations, or the 2013 expansion of the renewable energy standard. The power sector, in particular, is changing quickly and is projected to emit less pollution in the future than was projected by CDPHE just three years ago. This underscores the need for a current, up-to-date assessment of Colorado's greenhouse gas emissions and projections; Governor Hickenlooper's executive order directed CDPHE to complete that update. Despite the known gaps, CDPHE's 2014 Inventory provides a useful reference point for identifying and prioritizing policies to reduce carbon pollution in Colorado.

THREE SECTORS PRODUCE THE MAJORITY OF COLORADO'S CARBON POLLUTION: ELECTRICITY, TRANSPORTATION, AND FUEL USED BY RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL ENTITIES FOR HEATING AND MANUFACTURING PROCESSES

Figure 3. Key Policies and a Market-Based Program Can Reduce Carbon Pollution Consistent with Limiting Warming to 2˚C

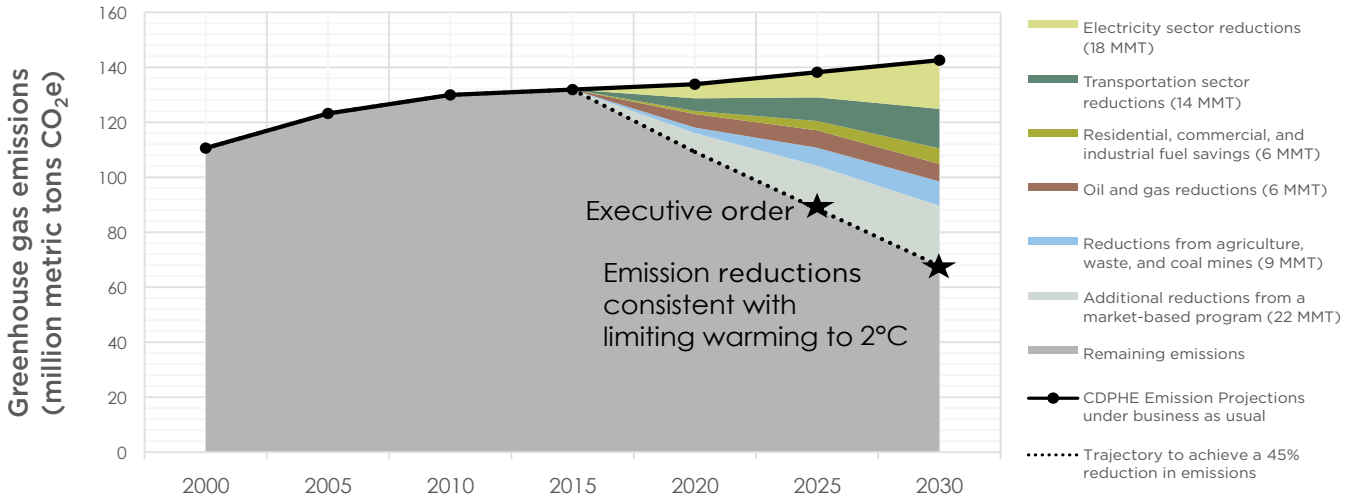


Figure 3. Colorado's emissions under "business as usual" are projected to rise (based on projections by the Colorado Department of Public Health and Environment); measures in each of the key sectors can reduce emissions significantly, and adopting a market-based policy will drive the deep reductions needed to be on an emissions trajectory consistent with limiting warming to 2°C. Emission reductions for each sector are shown in the legend, in million metric tons of CO_2 equivalent (MMT CO_2e).

In the following pages, we identify a set of policies that could cause emissions reductions in these sectors of our economy, summarized in Figure 3. These policies can spur investments in new technologies and provide an impetus for industry to invest in low-carbon resources. They can also protect working families and vulnerable communities from the impacts of air pollution and climate change, and help ensure all Coloradans have access to low-carbon choices, such as affordable, reliable public transportation and energy efficiency upgrades for existing homes.

The policies identified in this chapter cannot achieve all of the reductions necessary to meet emissions goals in 2030 or 2050. They represent important progress, however, and lay the groundwork for deeper, long-term reductions. Market-based policies can complement the sector-specific initiatives and will be critical for achieving the long-term goals, described in greater detail in Section 2.3.

2.2.1 Electricity: Rapidly transition to low-carbon energy supplies

RAPID DECARBONIZATION OF THE POWER SECTOR IS THE LINCHPIN OF ACHIEIVING OTHER ECONOMYWIDE EMISSION REDUCTIONS.

Emissions from the electricity sector in the state are already declining. But even more rapid de-carbonization of the sector is critical, because the power sector is the linchpin of achieving other economy-wide emission reductions. Low-carbon electricity will need to displace fossil fuels used today to power transportation, supply heat to buildings, and power industrial processes.

The electricity sector is also in a dynamic state of transition. Current Colorado utility plans indicate that the sector's emissions will be 26% lower in 2030 than they were in 2005 and significantly lower than CDPHE's projections in the Colorado Greenhouse Gas Inventory in 2014 (shown as "Utilities' current plans" in Figure 4).[11] Additional policies and actions to drive down emissions through 2030 can be implemented through the Public Utilities Commission, municipal and cooperative utilities' governing boards, and the Air Quality Control Commission.

Figure 4. Key Strategies in the Electricity Sector Can Reduce Greenhouse Gas Pollution by Over 50% by 2030

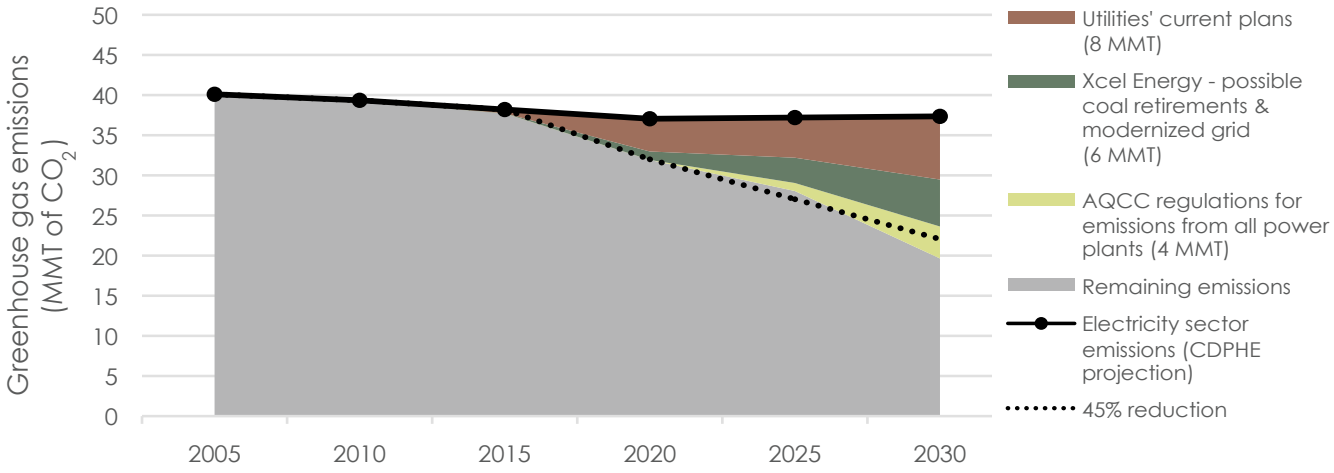


Figure 4. Utilities' current plans will reduce carbon pollution considerably, compared to projections in CDPHE's Greenhouse Gas Inventory. Policies to further reduce carbon pollution from this sector include approving Xcel Energy's proposal to retire older coal units and adopting a rule at the Air Quality Control Commission (AQCC) to limit carbon pollution from all power plants in the state.

To realize pollution reductions statewide that are consistent with limiting warming to 1.5–2°C, the electricity sector will likely need to reduce emissions more than 45% below 2005 levels by 2030. Actions to achieve this include:

1. The Public Utilities Commission should support utility efforts to reduce carbon emissions. The Public Utilities Commission (PUC) has broad authority to consider public health and the environment in evaluating regulated utilities' plans to invest in electric generation. Using this authority, the Colorado PUC can support utilities' efforts to retire coal-fired power plants and reduce carbon pollution. For example, if Xcel Energy can cost-effectively retire its older coal units, as well as making recently approved investments in a modern, advanced grid, the company could avoid approximately six million metric tons of carbon pollution. This represents significant emission reductions in the electricity sector and statewide.

2. The Air Quality Control Commission should adopt carbon pollution limits for all power plants and industrial sources. The Air Quality Control Commission (AQCC) within the Colorado Department of Public Health and Environment has the authority to address carbon pollution and should develop a rule regulating carbon pollution from power plants and other industrial sources. A rule adopted by the AQCC should adopt a stringency comparable to the reductions needed to limit warming to at least 2°C.

These two actions represent the most important near-term opportunity for reducing carbon pollution in the electric sector. However, there are important supporting policies that will enable the near- and long-term reductions in the power sector's greenhouse gas emissions. They include the following:

- **Investor-owned, municipal, and cooperative utilities must continue advancing energy efficiency.** Governor Hickenlooper's executive order goal to achieve 2% per year energy efficiency savings represents the right level of ambition and should be extended beyond 2020. To achieve this goal, the investor-owned utilities should exceed their current statutory goals for energy efficiency programs, and municipal and cooperative utilities should adopt similarly ambitious efficiency targets. These efficiency programs are important for reducing carbon pollution, but also protect customers from higher energy bills. Utilities and their regulators should ensure energy efficiency programs benefit low-income residents, which have traditionally been more challenging to reach.

- To minimize new electric demands, **local jurisdictions should adopt new, energy-efficient building codes**, as described in greater detail in the section, "Fossil fuel use in the residential, commercial, and industrial sectors." Colorado's economic growth means that cities will see continued development of new residential and commercial buildings—given the long lifetime of these investments, it is critical that new buildings are efficient and minimize new electricity demands.

- **Utilities should invest in modernizing the electric grid** to improve energy efficiency and support high levels of variable renewable energy and electric vehicle charging infrastructure. For example, Xcel Energy's efforts to optimize voltage on its distribution system will save approximately 2% of energy supplied. Similarly, installing smart meters can provide better information to customers, allowing them to see their energy usage in real time and reduce it accordingly. New appliance controls using smart data can achieve additional energy efficiency savings.

- **Utilities should work collaboratively to form a Western regional energy market**, critical to tapping the most affordable wind and solar resources across the region and reliably integrating higher levels of renewable energy. Colorado utilities and regulators should continue working to develop a regional market that can enhance adoption of these clean energy resources.

- Finally, **Colorado should ensure the transition to a clean energy economy is fair and equitable and does not negatively impact frontline communities.** This transition will impact certain communities, including those that have relied on mines or coal-fired power plants for jobs and local tax revenues. As the economy changes, the state should provide worker retraining, build new industries and infrastructure, and identify sources of funding to support local governments.

2.2.2 Transportation: Improve fuel efficiency, expand adoption of electric vehicles, and enhance public transportation options

Addressing emissions from the transportation sector is a key priority for Colorado. In 2010, transportation-related emissions represented 23% of Colorado's emissions, making it the second largest contributor to Colorado's emissions.[12] While carbon emissions in both the electricity and transportation sectors have declined since peaking in 2007,[13] carbon pollution from electricity generation is declining at a much faster rate. In short, Colorado state and local agencies need to tackle the transportation sector to achieve real progress on that sector's carbon pollution.

Transportation policies should:

- Increase the fuel efficiency of conventional, internal combustion engine vehicles.
- Expand adoption of electric vehicles.
- Increase access to public transportation for all residents, particularly low-income communities.
- Ensure that our growing cities proactively plan for a low-carbon transportation future.

Figure 5 illustrates the expected emission benefits of each of the key policies by 2030.

Figure 5. Key Strategies in the Transportation Sector Can Reduce Greenhouse Gas Pollution by 35% by 2030

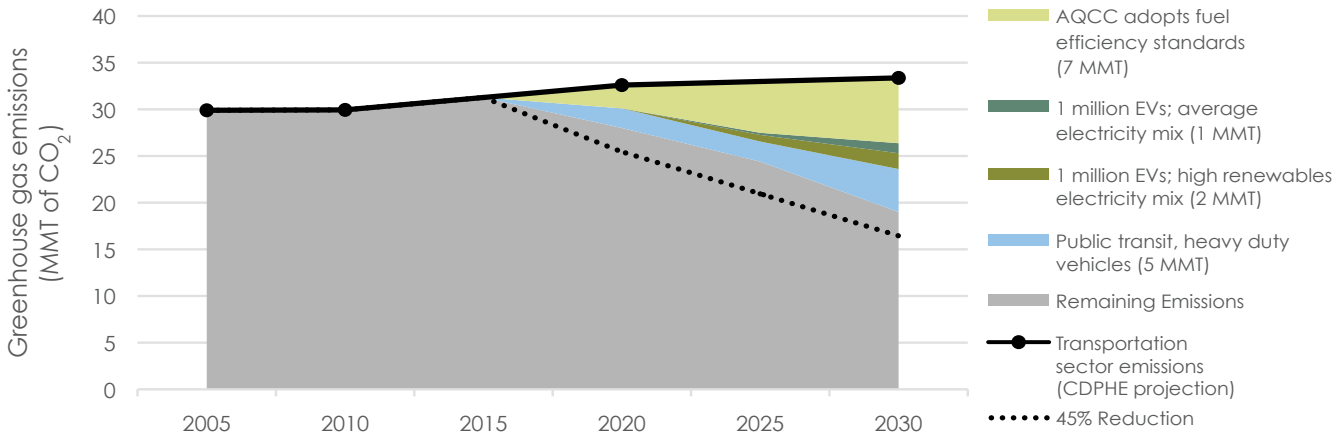


Figure 5. Transportation sector policies to reduce carbon pollution include adopting more efficient fuel standards, expanding electric vehicles, and reducing Coloradans' miles traveled through comprehensive transportation planning.

1. **The Air Quality Control Commission should adopt fuel efficiency standards.** Colorado, through existing authority at the Air Quality Control Commission or through legislative action, should adopt more ambitious fuel efficiency standards, ensuring that new cars sold in Colorado are more efficient, reduce emissions, and save customers money on fuel.

   The federal government establishes fuel efficiency standards (CAFE standards) for vehicles; historically, the federal government has allowed California to establish more stringent standards because of its need to address significant air pollution issues. States can choose to adopt the California fuel efficiency standards, and 12 states (representing a total of 40% of the U.S. population) have done so. (Colorado is not one of them.) In recent years, federal standards matched California standards; however, federal agencies are now considering weakening the federal fuel efficiency standards. In addition, California is beginning the process of developing stronger fuel efficiency standards for the period after 2025, which will once again result in the California standards being stronger than federal requirements. Adopting the more ambitious fuel efficiency standards could provide important carbon pollution reductions, particularly between 2020 and 2030.

2. **Colorado should establish a goal and enact policies to enable one million electric vehicles in Colorado by 2030.** Meeting an ambitious electric vehicle (EV) goal would require coordination between several Colorado agencies, including CDPHE, the Colorado PUC, and the Colorado Department of Transportation.[14] Colorado can achieve this target, in part, by continuing existing tax incentives and adopting the zero-emission vehicle mandate that 10 other states have adopted.[15]

   The state tax incentives to promote electric vehicles have been very effective. For example, Colorado ranked thirteenth in the nation in sales of electric vehicles over the 2011–2016 period.[16] To expedite the exchange of inefficient vehicles for low-emission EVs, Colorado could consider an electric vehicle "cash for clunkers" program, where additional incentives are provided for trading in an older, fuel-inefficient vehicle in exchange for a battery electric vehicle. Other jurisdictions have implemented similar programs, with great success.

   Ten other states have adopted sales requirements for zero-emission vehicles (which include battery electric and plug-in hybrid electric vehicles). These sales mandates, which are a component of the California fuel economy standards described above, would complement the tax incentives in the near term and could replace them in the future, when EVs become cost-competitive with conventional vehicles. Sales requirements may also make additional models of EVs available in Colorado, whereas those models are currently offered only in the 10 states with sales mandates.

3. **Colorado should ensure that electric vehicle charging infrastructure is widely available, affordable, and powered with renewable energy.** To enable widespread adoption of EVs, customers need confidence that charging stations will be readily available, convenient, and affordable. Several agencies play a key role in this: Electric utility regulators (the Public Utility Commission

and municipal boards) can ensure electricity rate design does not act as a barrier to fast EV charging, particularly through high demand charges. In addition, those regulators can enable and encourage electric utilities to support the growing EV market and invest in EV charging infrastructure. Cities and counties can establish building codes that ensure new buildings have EV charging capabilities or can be readily retrofitted.

The emissions benefits of EVs expand tremendously if they are powered with renewable energy. EV charging can pair well with renewables—charging when excess solar capacity is available during the day or excess wind is available at night. To realize significant greenhouse gas pollution benefits, electric utilities and the state should ensure that growing electric loads from EVs are met primarily with renewables.

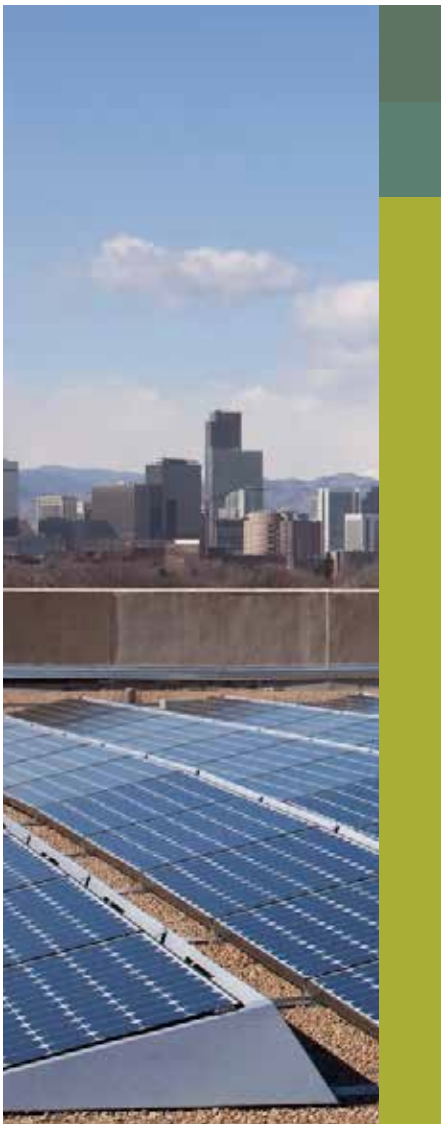
4. The state legislature should support and expand the authority of local and regional transportation planning. A key piece of reducing carbon pollution from the transportation sector lies in reducing the number of miles a person travels (vehicle miles traveled, or VMT). Between 2005 and 2013, per capita VMT fell by over 11% in Colorado, and since 2006, the total miles traveled by Coloradans fell by over 3.4%.[17] Those trends have reversed slightly in recent years, increasing the importance of a focus on local and regional transportation planning. Colorado should evaluate policies to ensure that land use planning addresses transportation issues and works to reduce vehicle miles traveled.[18] This includes improving access to safe walking and biking options and public transportation. This helps all residents, including those in low-income communities, have access to affordable, low-carbon transportation options.

2.2.3 Fossil fuel use in the residential, commercial, and industrial sectors: Improve efficiency of buildings and manufacturing operations

The residential, commercial, and industrial sectors use fossil fuels—primarily natural gas—to heat and cool building space, heat water or run appliances, and drive manufacturing processes. In 2010, fuel use by the residential, commercial, and industrial sectors represented 21% of Colorado's emissions, making it the third-highest contributor of greenhouse gas pollution. While Colorado's population has grown over the past decade, emission levels associated with fossil fuel use by residential and commercial customers has largely remained flat, while industrial energy use has grown steadily.[19] However, CDPHE projects greenhouse gas pollution from fuel used by all three sectors will continue to rise in the future under "business as usual."[20]

Each of these sectors has opportunities to achieve additional efficiency gains. The efficiency investments made today are important, paying dividends over the long term but also providing value now. In particular, programs that benefit low-income residents, such as Energy Outreach Colorado's home weatherization and efficiency programs, can reduce residents' energy bills and improve comfort and safety in the home.

Buildings and major appliances, like furnaces, are only replaced every 20–50 years; as a result, efficiency savings and reductions in pollution grow slowly. However, these efficiency improvements are critical to meeting a climate goal of reducing pollution 90% by 2050.



Policies that address these sectors include:

1. Local governments and the state legislature should work to enact energy-efficient building standards for new construction. Cities and counties should update local building codes to reflect the most up-to-date and energy-efficient code available; the Colorado Energy Office can continue to support this process. Alternatively, the state legislature can direct cities or counties with building codes to update them, as the legislature did in 2007. In addition to conventional building codes, new developments should be incentivized—either through local rebates or utility programs—to rely on electricity or zero-carbon sources of energy for building heat, such as solar thermal and geothermal energy, rather than natural gas.

2. Increase energy efficiency in existing buildings, through utility programs that incentivize efficiency improvements (e.g., reducing leaks and installing weather stripping and insulation in residential and commercial buildings), and city or county local building code requirements to ensure that when buildings undergo more significant renovations, larger investments (such as efficient windows, HVAC systems, and insulation) are required or incentivized.[21] In addition, when natural gas-fueled heating systems are replaced, programs should incentivize their replacement with zero-carbon systems. Many of these measures provide cost savings to customers, but their up-front capital costs

may deter individuals from investing in them. To address this issue, the Colorado legislature could enable Property Assessed Clean Energy (PACE) financing for residential buildings, a program that enables customers to add the cost of an efficiency improvement to the home mortgage. The state has already enabled PACE financing for commercial buildings.[22]

3. Utilities and regulators should develop incentives for industries to adopt the use of combined heat and power (CHP) and recycled energy to improve the efficiency of industrial processes. CHP, an approach whereby a facility generates electricity and uses the waste heat on-site, can improve the overall efficiency of an operation. CHP has faced challenges in Colorado, particularly with regard to electric utility rate structures; those issues should be resolved by utilities and regulators.[23]

2.2.4 Oil and natural gas: Improve monitoring and reduce leaks of methane pollution

When natural gas displaces coal or other more carbon-intensive fuels, it can provide emission benefits, enabling a more rapid transition to a low-carbon economy.[24] But significant amounts of potent methane pollution may be released in the drilling or mining of natural gas, reducing or potentially eliminating the overall carbon benefits of the fuel. Methane is a potent greenhouse gas, with 28–36 times the warming potential of carbon dioxide.[25] The reductions in carbon pollution needed by 2050 mean that oil and natural gas can only play a minimal role in meeting Colorado's future energy demands; however, as long as oil and gas are part of the state's energy mix, oil and gas operations must significantly curb methane emissions.

CDPHE estimated methane emissions from oil and gas operations in Colorado at 5.8 million tons of carbon dioxide equivalent[26] (CO_2e) in 2000, but emissions nearly doubled by 2010, when they represented almost 8% of Colorado's total carbon pollution.[27] Colorado's 2014 methane rule will reduce pollution by an estimated 1.6 million metric tons of CO_2e per year, primarily due to improved leak detection at new and existing wells and reduced emissions from storage tanks.[28] The methane rule was a model for the Bureau of Land Management (BLM) methane regulations and the Environmental Protection Agency (EPA) methane rules for new sources. If fully implemented, the federal rules could reduce emissions from oil and gas wells on federal and tribal lands in Colorado by an estimated 75,000 tons of CO_2e.

But both of these federal rules are in the process of being weakened or withdrawn by the Trump administration. And, as Figure 6 indicates, CDPHE's projected emissions of methane from the oil and gas sector are projected to climb significantly in the future.[29] In order to successfully reduce statewide carbon pollution 45% below 2005 levels by 2030, addressing emissions from the oil and gas sector is a critical near-term challenge for Colorado.

Figure 6. Significant Additional Policies Are Needed to Curb Methane Emissions from Oil and Gas Operations

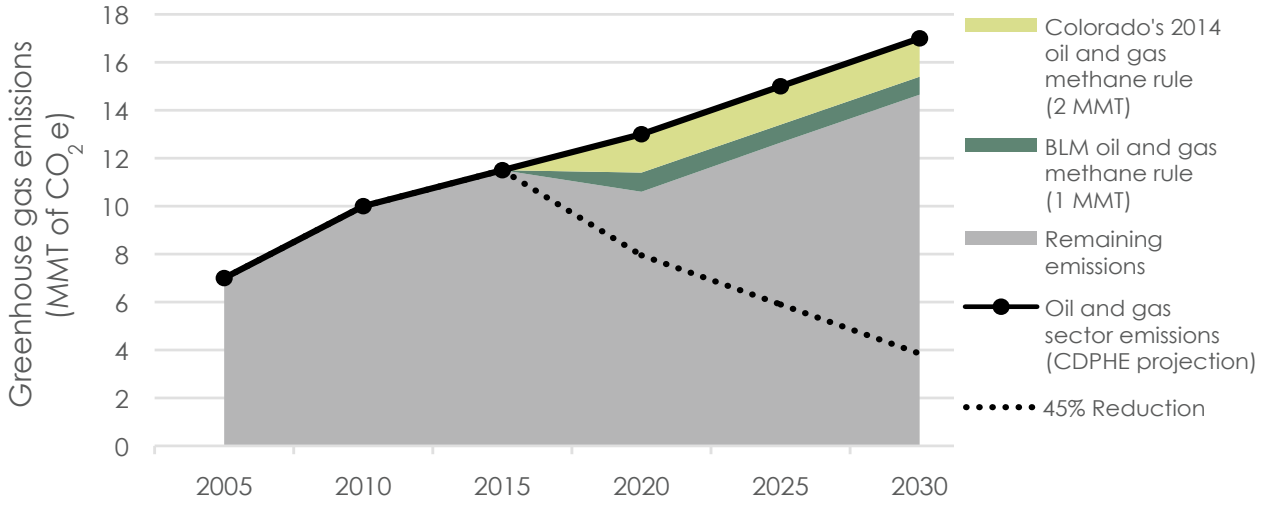


Figure 6. Existing Colorado and federal (BLM) policies are expected to provide reductions in methane emissions from oil and gas operations; additional incentives or regulations will be essential to achieve pollution reductions consistent with a 2°C climate goal. Note that emissions projections are based on CDPHE's Greenhouse Gas Inventory and may differ depending on the number of wells developed in the future.

An essential first step to addressing methane pollution is accurately quantifying emissions from the state's oil and gas infrastructure. Four issues make CDPHE's 2014 projection of greenhouse gas pollution from oil and gas wells uncertain. First, the inventory estimates the sector's emissions using well counts and standard emission rates, which may understate the impact of Colorado's 2014 rules on methane leak detection. Second, the inventory excludes key emissions from transmission and distribution, which could increase total sector emissions by as much as 35%.[30] Third, multiple studies have found great variation in actual methane emissions from oil and gas facilities, underscoring the uncertainty in the default emission rates used by CDPHE (and EPA). Finally, CDPHE's projections are based on future well counts, which are inherently uncertain. In short, over the next 18 months, the Colorado Oil and Gas Conservation Commission (COGCC) should collaborate with the CDPHE to improve the baseline data and future projections using Colorado-specific data.

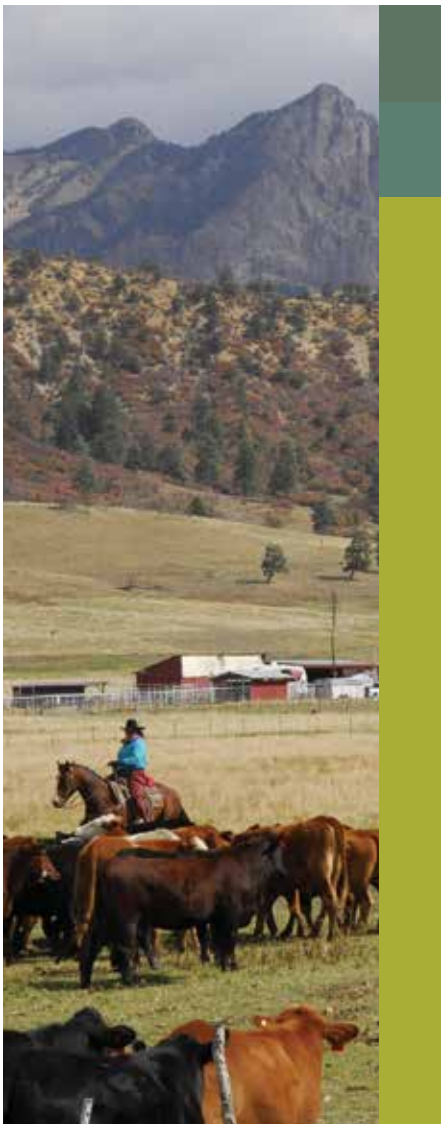
While improving the accuracy of current emissions and projections, Colorado agencies should pursue additional strategies to achieve reductions in methane pollution:

1. The Air Quality Control Commission should expand regulations to require oil and gas operators to reduce methane emissions. Oil and gas operators can reduce methane wasted through venting and flaring by installing new, efficient equipment. Stronger regulations to reduce waste from venting and flaring, and to require leak detection and repair at transmission and distribution compressor stations, would build on Colorado's 2014 methane regulations. In addition, the AQCC should require the electrification of equipment in any location where electric power is available nearby and require that tankless production be used at well sites. Companies will likely need a financial incentive—or regulatory requirement—to install this new equipment.

2. CDPHE should increase the frequency of leak detection and repair, which is required under existing rules, and require that all components, including pneumatic compressors, be evaluated. Similarly, the AQCC, working with CDPHE staff, should ensure the state has an adequate monitoring system in place to accurately track emissions of methane and other pollutants in order to quantify and credit reductions achieved by well operators.

As noted above, the current low price of natural gas does not incentivize well operators to invest in equipment to capture methane (which can then be sold on the market). A market-based price on carbon, described in greater detail in Section 2.3, would incentivize companies to reduce methane emissions.

Addressing methane pollution also tackles other harmful pollutants released by oil and gas operations and can provide important co-benefits for public health. Oil and gas wells, along with the transmission and distribution systems, emit significant amounts of volatile organic compounds (VOCs). VOCs directly impact human health and react with nitrogen oxides to form ozone, which has serious health impacts, including respiratory and cardiovascular issues and premature death. Notably, communities of color are most impacted by ozone and air pollution; as just one example, Latino children are three times as likely to suffer from asthma as white children. Installing equipment to capture wasted methane will also reduce emissions of other pollutants, improving air quality and public health, particularly in areas with high concentrations of oil and gas development.



2.2.5 Agriculture, waste management, and other sectors: Create a program of financial incentives or offsets

Certain sectors can play a key role in the transition to a low-carbon economy, but are not well-suited to regulatory approaches. In Colorado, greenhouse gas pollution from agriculture, waste management (landfills and wastewater treatment plants), and active or abandoned coal mines amounted to 15% of the state's total emissions in 2010. These sectors are composed of many small, diverse entities, with varied sources of carbon pollution.

To address these sectors' emissions, Colorado should incentivize emission reductions by creating a program of carbon "offsets," whereby individuals, businesses, or regulated industries can pay to reduce pollution in these sectors. For example, a power plant required to reduce its emissions or a business that aspires to be "zero-carbon" could fund an effort to install equipment to capture methane from a coal mine, enhance soil carbon sequestration on agricultural lands, or capture and reduce methane from a landfill.

There is precedent for such a program in Colorado: In 2007, the state created the Colorado Carbon Fund, which the Colorado Energy Office managed.[31] A similar program of offsets could facilitate important pollution reductions in each of these sectors, as shown in Figure 7 and described in more detail below. In developing a program of offsets, Colorado should ensure projects achieve real, verifiable reductions in carbon pollution and are certified to link with other jurisdictions' carbon markets.

Figure 7. A Program of Carbon Offsets Can Incentivize Greenhouse Gas Pollution Reductions in Agriculture, Waste Management, and Coal Mines

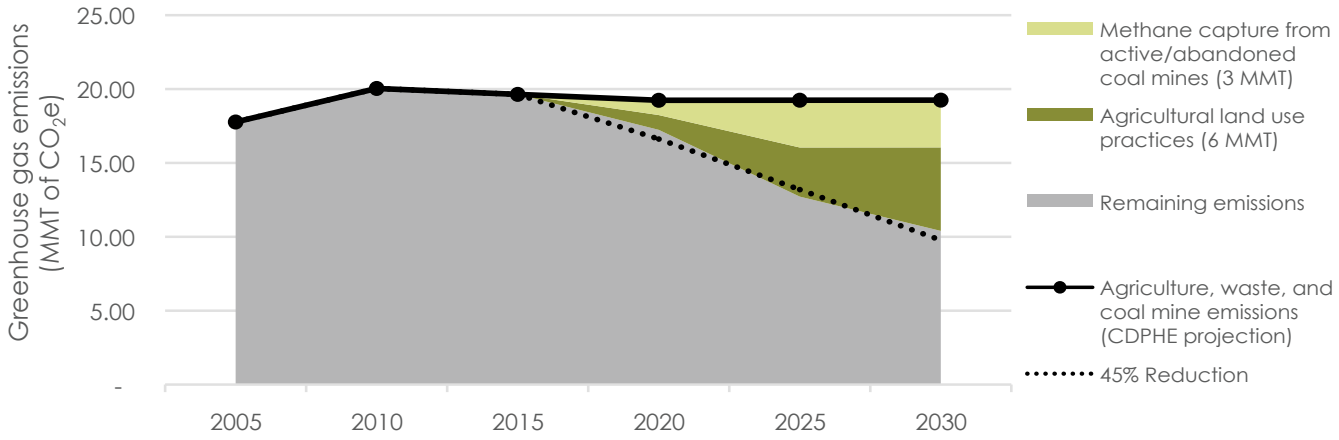


Figure 7. A program of carbon offsets or incentives should focus on reducing emissions from agricultural production, coal mine methane, and waste management facilities (landfills and wastewater treatment plants). Possible reductions from waste management have not been quantified.

1. Capture methane pollution from coal mines. Colorado has significant potential to capture methane from active or abandoned mines, reducing emissions of potent methane gases and using that methane to generate electricity. Electricity generated from coal mine methane is an eligible energy resource under the Colorado Renewable Energy Standard. As of 2016, the Elk Creek Mine in Gunnison County was the only facility capturing and generating electricity from its methane emissions, generating approximately three megawatts (MW) of power and selling carbon credits to the Climate Action Reserve. In 2016, the Colorado Energy Office estimated an additional 34 MW of capacity could feasibly be developed at remaining active and abandoned mines.[32] In addition to reducing carbon pollution, capturing coal mine methane can provide a resource to the mine (either by selling the electricity generated at the facility to a local utility or using it for on-site needs) and can improve mine safety. This recommendation is particularly timely in light of the potential expansion of the West Elk mine in Gunnison County. This mine should be an excellent candidate for methane capture.[33]

2. Reduce emissions from agricultural operations, by, for example, adjusting tilling practices, rangeland management, and application of nitrogen fertilizer.[34] Colorado's universities, extension offices, and partners at the U.S. Department of Agriculture have significant expertise in carbon management in agricultural systems. The Colorado Energy Office should work with these entities to develop a program to reduce agricultural carbon emissions.

3. **Reduce waste through robust statewide recycling and composting programs.** Colorado can significantly reduce the greenhouse gas pollution associated with clothing, food, and other goods by expanding recycling, composting, and reuse programs. Colorado's statewide recycling rate is only 12%, far below the national average of 34%. Expanding this rate of recycling can provide significant carbon benefits: For one ton of materials recycled, more than three tons of carbon pollution is avoided.[35] Reducing the amount of biodegradable materials, like food, paper, and grass clippings sent to landfills, represents a second opportunity. Nationally, nearly 40% of food is wasted[36]—reducing this food waste and diverting remaining waste to composting facilities can reduce carbon pollution, while creating a resource: compost or fertilizer that can be used in local farms and gardens. The Colorado Energy Office should work with local waste management agencies to expand recycling and composting programs.

4. **Reduce methane emissions from waste management facilities.** Colorado's landfills and wastewater treatment plants emit methane gas, which can be captured and used to generate electricity. For example, the Erie landfill generates up to five MW of renewable power from its landfill gas and avoids emissions of 30,000 metric tons of CO_2e per year.[37] Reducing and diverting waste from landfills—which can reduce or eliminate landfill methane emissions—should be the first priority. In addition to this, Colorado should support incentives or carbon offsets for projects that capture and reduce methane, focusing on wastewater treatment plants.

Reducing Carbon Pollution Can Be Cost-Effective and Protect Colorado's Economy

A stable climate is critical to a thriving economy. Many of the policies and measures that reduce carbon pollution are cost-effective to implement today, and help limit the future impacts—and costs—of climate change. For example, in many places renewable energy is cost-competitive with fossil fuel power plants;[1] energy efficiency programs implemented by utilities and retrofitting buildings to save energy also often save customers money.[2] Colorado's 2014 rules for methane pollution from oil and gas operations have had limited cost impacts, in part because by reducing leaks of methane pollution, operators could capture and deliver more natural gas to the market.[3] Over the long term, market-based carbon policies can minimize costs associated with transitioning to a clean energy economy, because these policies provide financial incentives to businesses and individuals to adopt the lowest-cost measures first.

Importantly, inaction on climate change is not free: more days of extreme heat affect public health and worker productivity and drive up electricity costs, as customers' air conditioning demands rise. More frequent or intense wildfires pose rising costs for firefighters, as well as public health costs in downwind communities. And the impacts and disruptions caused by extreme weather events in neighboring states impose costs—even if indirect—on Coloradans.[4]

[1] Lazard. 2016. Lazard's Levelized Cost of Energy Analysis–Version 10.0. December. https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf.
[2] See, e.g., McKinsey & Company. 2013. Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve. September. http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/pathways-to-a-low-carbon-economy.
[3] See, e.g., Keating, Chris. April 10, 2016. "The Colorado Case Study On Methane Emissions: Conversations With The Oil And Gas Industry." CDPHE expected the rule to cost $42.5 million per year to implement, and reduce methane emissions by 1.6 million metric tons of CO2e per year. Colorado Department of Public Health and Environment. 2014. "Revisions to Colorado Air Quality Control Commission's Regulation Numbers 3, 6, and 7 Fact Sheet." Revised October 20. https://www.colorado.gov/pacific/sites/default/files/AP_Regulation-3-6-7-FactSheet.pdf.
[4] Gordon, Kate. 2014. Risky Business: The Economic Risks of Climate Change in the United States. June. https://riskybusiness.org/site/assets/uploads/2015/09/RiskyBusiness_Report_WEB_09_08_14.pdf.

2.2.6 Summary of policies that reduce pollution across key sectors

The sector-specific policies outlined above represent ambitious actions and will require significant political leadership and vision. They are important for meeting the long-term pollution reduction goals. **Sector-specific policies reduce carbon pollution and:**

- ✓ **Spur innovation**, incentivizing companies to invest in developing or commercializing new technologies. To achieve future carbon reductions, we will need new technologies and companies investing to develop them.
- ✓ **Address traditional market barriers.** For example, property owners have little financial incentive to invest in energy efficiency upgrades for rental properties, where tenants pay the energy bills. Local building or property rental codes can ensure that property owners make those investments, protecting tenants and addressing the carbon pollution from those buildings.
- ✓ **Protect low-income customers and frontline communities**, ensuring that all consumers have access to affordable, low-carbon choices, such as access to reliable public transportation or the opportunity to invest in clean energy.

If fully implemented, the sector-specific policies described will achieve very meaningful progress toward reducing Colorado's emissions. Additional policies and new, innovative technologies will be needed, however, to achieve the remaining emission reductions between now and 2030 (Figure 8), and the deep reductions in carbon pollution needed by 2050. Colorado policymakers should remain cognizant about maintaining a culture of innovation, spurring research, development, and investment in new, clean technologies.

As described in more detail in the following section, **adopting a market-based carbon policy can help achieve the remaining reductions in carbon pollution, while ensuring Colorado achieves the emission targets in the most cost-efficient manner possible.**

Figure 8. Key Policies and a Market-Based Program Can Reduce Carbon Pollution Consistent with Limiting Warming to 2˚C

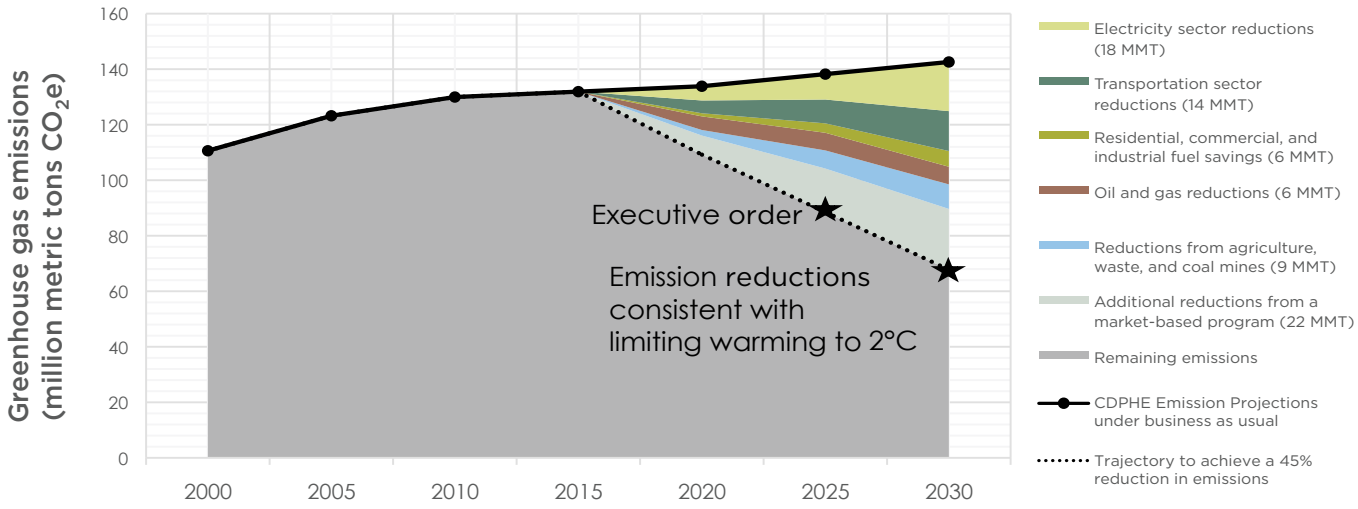


Figure 8. The sector-specific policies can achieve significant emission reductions, but the policies outlined here will not be sufficient—on their own—to meet the deep reductions needed to limit warming to 1.5–2°C. A market-based policy can ensure Colorado achieves these emission goals.

2.3. Implement a market-based policy that drives deep cuts in carbon pollution

The sector-specific policies outlined in the previous section are not, on their own, expected to cut carbon emissions to the amount needed by 2030 or 2050. To achieve those deeper reductions, Colorado needs a market-based policy, such as a carbon tax or a cap-and-trade system, to augment sector-specific policies and achieve a 45% reduction in greenhouse gas pollution by 2030 and a 90% reduction by 2050.

A market-based carbon policy puts a price on carbon, so businesses and consumers realize the cost of emitting carbon pollution and can make rational choices whether—and how—to reduce their pollution. Market-based policies provide flexibility for businesses to calculate whether to reduce their emissions or pay to continue emitting, and they incentivize businesses to make the cheapest reductions first, lowering prices for consumers. A broad, market-based carbon policy provides the overarching framework that links the sector-specific policies described in Section 2.2, so that if one sector is able to achieve more substantial emission reductions than another sector, it is rewarded.

Market-based environmental policies have a long, successful track record of reducing pollution at lower costs: Phasing out lead in gasoline, curbing pollutants that cause acid rain, and reducing ozone-depleting chemicals under the Montreal Protocol are all examples of market-based environmental programs. Collectively, these programs have saved billions of dollars from the costs of traditional regulatory approaches.[38] Existing U.S. market-based carbon policies, including California's cap-and-trade program and the northeast states' Regional Greenhouse Gas Initiative (RGGI) have met their objectives at lower than expected costs.[39]

While Colorado can likely achieve significant emission reductions through the sector-specific policies and regulations described in Section 2.2 in a cost-effective manner, in the long term—reducing emissions 90% below 2005 levels by 2050—that approach alone is likely to be more expensive than a market-based approach. The remainder of this section describes the market-based carbon policies that Colorado could pursue.

A market program to address carbon pollution should be:

- ✓ **Transparent**—providing clear market signals to regulated entities
- ✓ **Enforceable**—ensuring that polluters comply with the regulation through effective tracking mechanisms
- ✓ **Easy to administer**—reducing the cost of implementation, avoiding market manipulation, and providing for timely implementation
- ✓ **Effective**—achieving the emissions reductions needed
- ✓ **Linkable**—providing an opportunity to expand the scope of the market to other states or nations
- ✓ **Flexible**—allowing for adjustments to stringency in response to the policy's effectiveness at reducing emissions or developments in the underlying science and urgency, while maintaining its political durability across several decades
- ✓ **Equitable**—ensuring that vulnerable communities, especially working families, do not suffer from the potential impacts of a price on carbon

Market-based carbon policies have generally taken two forms: a carbon tax or a cap-and-trade program. Both can effectively reduce carbon pollution.

A *carbon tax* sets a price on each ton of carbon pollution. It can be revenue-raising or revenue-neutral, in which case all revenues are returned to residents through rebates (a "fee and dividend" system) or by reducing other taxes. A carbon tax may be administratively easier to implement than a cap-and-trade program, particularly in certain sectors (e.g., industrial emissions), but setting the level of the tax may be politically contentious and challenging to get correct. A carbon tax provides price certainty, but does not create a cap on how much pollution may be emitted. However, modifying a traditional carbon tax with mechanisms designed to assure environmental integrity can improve emissions certainty. For example, a tax can automatically increase if the state's emissions are above its targets or decrease if emissions are below the targets. In Colorado, the Taxpayer's Bill of Rights (TABOR) may not allow automatic changes to a tax level. To date, British Columbia and Alberta, Canada, and several European countries have adopted carbon taxes.

A *cap-and-trade* program establishes a limit on emissions, creates an obligation for polluters to hold a permit (or allowance) for every ton of carbon pollution emitted, distributes or auctions allowances, and allows polluters to buy, sell, and trade allowances. A cap can provide emissions certainty, but generally does not provide price certainty. Cap-and-trade programs can be modified to provide price certainty by establishing a price floor for allowances or setting triggers to release additional allowances (or reserves) into the market, if prices rise to a certain level. Enacting a cap-and-trade program may be administratively more complex, particularly with regard to distributing allowances, and this allowance distribution may be politically contentious. A number of programs have successfully adopted the cap-and-trade mechanism, including the Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative, which includes California, the European Union's Emissions Trading System, and the acid rain program in the northeastern U.S.

Driving Innovation

A carbon price—just like sector-specific policies—can help incentivize businesses and entrepreneurs to develop or commercialize new, low-carbon technologies. New technologies will be essential to meeting the climate challenge—we will need better batteries for electric vehicles, new forms of energy storage to integrate high levels of renewable electricity, and more efficient appliances.

The technology development we are likely to see over the next 20–30 years may be difficult to predict. Similarly, no one predicted the changes in the energy sector that have occurred over the last 20 years. For example, in 1997, the U.S. Energy Information Administration projected that in 2015, the U.S. would have five gigawatts (GW) of wind capacity and would generate 2.5 million megawatt hours (MWh) of energy from solar.[40] At the end of 2015, the U.S. had 74 GW of wind capacity[41] and generated approximately 40 million MWh of solar electricity;[42] the projections made in 1997 were off by a factor of 15.

New technologies can be incentivized by carbon policies, if those policies are predictable (that is, businesses expect them to continue for decades or long enough to invest in new technology). Historically, however, new technologies have developed from significant investments in research and development by the national labs, Department of Defense, and universities. One possible role for revenues from a carbon price would be to fund research and development of new, low-carbon technologies and to support businesses that develop new technologies. For example, Alberta, Canada, enacted its carbon fee in 2009 and a carbon tax in 2017, and has invested over $300 million in developing new, low-carbon technologies.[43]

In evaluating a market-based carbon program, decision-makers should evaluate four key questions:

1. What type of program can effectively reduce emissions? A revenue-neutral carbon tax, in absence of sector-specific programs, would need to be set at a high level[44] to drive the behavioral changes and investments needed to reduce greenhouse gas pollution. This issue could be addressed by enacting sector-specific programs or using a portion of carbon tax revenues to reduce emissions.

2. What type of program can link with other states, achieving the most cost-effective reductions over time? Linking with other states would enable the most cost-effective emissions reductions, whether those occur in Colorado or another state. A traditional cap-and-trade program is likely to readily link with existing programs in California and the Northeast, but a carbon tax could link as well. For example, a polluter faced with paying a carbon tax could purchase an allowance from a cap-and-trade program (representing one ton of carbon emissions) and reduce the amount of pollution for which it is taxed by one ton.

3. Should a market-based policy be revenue-neutral or raise revenue? In both RGGI and California, states auction most or all of the program's allowances, raising significant revenue. States have used that revenue to expand energy efficiency programs, mitigate program impacts on low-income customers, and subsidize other low-carbon infrastructure. Revenues can also be used

to address the impacts of climate change, mitigate the impacts of this transition on certain communities, such as mining towns and low-income communities, or support low-carbon technology development (see the text box on p. 29). Alternatively, states can return revenue to customers in the form of an annual or quarterly dividend. Under a revenue-raising program, the money raised may be significant—in 2010, Colorado's energy sector and industrial processes45 emitted approximately 110 million metric tons of CO2e; at that rate, a $20 per ton carbon price would raise nearly $2.2 billion in one year.

4. How can we ensure that a market-based policy is equitable and does not adversely impact the communities that already stand to suffer the most from climate change? A price on carbon could affect the prices of electricity, gasoline, natural gas for heating, and other energy sources because fossil fuel companies would most likely pass the costs along to consumers. Lower-income residents would be most impacted, as energy costs are a larger proportion of their budgets. However, policymakers can design a price on carbon with a goal of mitigating these impacts. This can be done in multiple ways; for example, British Columbia implemented a "Low Income Climate Action Tax Credit," and Alberta returns tax revenues as a dividend to low-income residents.

Finally, in Colorado, the Taxpayer's Bill of Rights (TABOR) may create a unique challenge to enacting a market-based policy. Voter approval is needed to raise most kinds of state revenue. The state may, however, establish an Enterprise Fund dedicated to a carbon reduction program. In an Enterprise Fund, the revenues raised by pricing carbon cannot be applied to the general fund or other state budgetary needs, but could provide a valuable source of revenue for reducing carbon pollution and mitigating the effects of climate change.

In sum, a market-based carbon program can play an important role in meeting the deep, economy-wide emission reductions needed over the next 30 years. The design of the market-based policy is important, both for its effectiveness and long-term durability; leadership in Colorado agencies and the legislature should begin evaluating the possible program designs described here.

3. Strategies for Moving Forward

Colorado can advance its climate policy through several avenues: administrative agency action, legislative action, and voter-sponsored ballot initiatives. While this report addresses state-based actions, local government agencies and the business community also play a critical role in driving the transition to a low-carbon economy.

3.1. Agency actions

Several of Colorado's administrative agencies have broad authority to advance low-carbon policies. We recommend agencies pursue several near-term actions:

- The Air Quality Control Commission adopt rules to reduce carbon pollution from power plants and industrial sources, and adopt California's more stringent fuel economy standards for vehicles, including a zero-emission vehicle sales requirement.
- The Public Utilities Commission approve investor-owned utility investments in clean energy resources, consistent with Governor Hickenlooper's executive order on clean energy issued in July 2017.
- The Air Quality Control Commission advance regulations and incentivize industry investments that reduce greenhouse gas pollution.
- The Colorado Energy Office develop a program to enable voluntary carbon offsets in sectors like agriculture, waste management, and coal mine methane, similar to the Colorado Carbon Fund.

These agency actions can—and should—start now.

3.2. Legislative actions

Colorado's state legislature should also undertake bold climate action through a comprehensive legislative initiative. A legislative initiative should:

- Establish enforceable carbon pollution limits for 2025, 2030, 2040, and 2050, and establish regular benchmarks every three to five years to measure progress. At a minimum, the carbon pollution reductions should be consistent with Governor Hickenlooper's executive order for 2025 and reduce carbon pollution by 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050.

- Direct CDPHE to develop a plan that outlines the key measures and policies for the state, as well as enforcement measures.

In addition, the legislature should adopt several of the policies described in Section 2.2 that will enable the transition to a low-carbon economy, including but not limited to:

- Adopting up-to-date energy-efficient building codes.

- Maintaining or expanding policies and incentives to support electric vehicles.

- Directing local and regional jurisdictions to ensure that transportation planning and community planning reduce vehicle miles traveled.

- Further supporting decarbonization of the power sector by advancing policies to enable greater levels of clean energy and energy efficiency.

4. Conclusion

Colorado should seize this opportunity to lead in the West on a comprehensive climate initiative. The statewide policy should have three key pillars:

1. Establish science-based carbon pollution limits to ensure Colorado does its part to limit warming to 1.5–2°C. Colorado should strive to reduce emissions at least 45% below 2005 levels by 2030, and 90% below 2005 levels by 2050.

2. Enact a series of sector-specific policies that drive reductions in carbon pollution in the electricity, transportation, and oil and gas sectors; reduce energy used by residential, commercial, and industrial sectors; and incentivize carbon pollution reductions in sectors such as agriculture, coal mine methane, and waste management.

3. Create a market-based mechanism to pursue the most cost-effective carbon pollution reductions throughout the state, spurring long-term innovation and incentivizing businesses to meet and exceed established greenhouse gas pollution reduction targets.

The benefits of acting on climate are clear. Colorado's communities depend on a stable, safe climate; our farmers and ranchers depend on reliable water supplies to irrigate crops; our tourism sector depends on flowing rivers, stable snowpack, and healthy forests; and public health depends on clean air. Transitioning to a low-carbon economy takes dedicated, thoughtful leadership. Colorado's businesses, local governments, and communities have shown a willingness to lead—but the magnitude of the challenge and the opportunity for success calls for a comprehensive, statewide approach.

End Notes

[1] Howe, Peter D., Matto Mildenberger, Jennifer R. Marlon, and Anthony Leiserowitz. 2015. "Geographic Variation in Opinions on Climate Change at State and Local Scales in the USA." Nature Climate Change 5: 596–603. doi:10.1038/nclimate2583.

[2] The more aggressive pollution reductions are consistent with limiting warming to 1.5°C, while the less stringent reductions are consistent with 2°C of warming. The box on p. 10 provides greater detail on how temperature goals translate into emission reduction targets.

[3] Environmental Entrepreneurs. 2017. Clean Jobs Colorado. https://www.e2.org/cleanjobscolorado.

[4] Figueres, Christiana, Hans Joachim Schellnhuber, Gail Whiteman, Johan Rockström, Anthony Hobley, and Stefan Rahmstorf. 2017. "Three Years to Safeguard our Climate." Nature 546: 593–595. June 28.

[5] Climate Interactive. 2016. "Deeper, Earlier Emissions Cuts Needed to Reach Paris Goals." Press release of May 18. https://www.climateinteractive.org/wp-content/uploads/2015/12/Stronger-Pledges-May-2016.pdf.

[6] Ibid.

[7] The Western Climate Initiative targets are based on a 1990 baseline; however, California's emissions in 2005 were similar to the state's emissions in 1990, and the state has established a goal of reducing emissions 40% below 1990 levels by 2030.

[8] RGGI currently requires emission reductions of 2.5% per year from the electricity sector; if that level of reduction continues, RGGI's emissions in 2030 will be 64% below 2005 levels. However, RGGI is in the process of evaluating increasing the annual reduction to 3-3.5% per year; additionally, some members of RGGI are discussing expanding to include emissions from the transportation sector.

[9] World Bank Group, Ecofys, and Vivid Economics. 2016. State and Trends of Carbon Pricing 2016. Washington, DC: World Bank. http://hdl.handle.net/10986/25160.

[10] Greenhouse gas emissions from "mobile combustion" and "stationary combustion" represent less than 1% of total emissions and are not shown. Estimates for greenhouse gas emissions in 2015 and 2025 were not published by CDPHE; figures here reflect averages between 2010 and 2020, and between 2020 and 2030, respectively.

[11] CDPHE's Greenhouse Gas Inventory estimates future electricity sector emissions using standard EPA factors and population growth estimates. It does not reflect key Colorado policies, such as the Clean Air-Clean Jobs Act, the 2013 expansion of the Renewable Energy Standard, or utilities' plans to add more renewables and reduce generation at existing fossil-fueled power plants.

[12] Colorado Department of Public Health and Environment. 2014. Colorado Greenhouse Gas Inventory—2014 Update, Including Projections to 2020 & 2030. https://www.colorado.gov/pacific/sites/default/files/AP-COGHGInventory2014Update.pdf. 2010 is the most recent year of data available (U.S. Energy Information Administration data, which is available through 2014, does not include land use, agriculture, methane from oil and gas operations, and other sources).

[13] U.S. Energy Information Administration. 2016. "Colorado Carbon Dioxide Emissions from Fossil Fuel Consumption (1980-2014)." Released November 3. Available for download at https://www.eia.gov/environment/emissions/state/.

[14] This goal is also consistent with the Colorado Energy Office's high EV goal. See BCS, Inc. 2015. Electric Vehicle Market Implementation Study. Prepared for Colorado Energy Office. https://www.colorado.gov/pacific/sites/default/files/atoms/files/EV%20Market%20Study%202015_0.pdf.

[15] California Air Resources Board. 2017. "Zero Emission Vehicle (ZEV) Program." Updated August 16. https://www.arb.ca.gov/msprog/zevprog/zevprog.htm.

[16] Clean Technica. 2017. "US Electric Car Sales by State — Who's #1, Ohio or California?" May 4. https://cleantechnica.com/2017/05/04/us-electric-car-sales-state-whos-1-ohio-california/.

[17] Southwest Energy Efficiency Project. 2015. Driving Trends and Transportation Funding In the Southwest: Budgets Can Support Further Reductions in Driving. August. http://www.swenergy.org/data/sites/1/media/documents/publications/documents/Driving_Trends_and_Transportation_Funding_Aug_2015.pdf.

[18] See, for example, California's SB 375, which establishes transportation-related emissions goals and ensures that local plans are consistent with those emissions goals.

[19] U.S. Energy Information Administration. 2016. "Colorado Carbon Dioxide Emissions from Fossil Fuel Consumption (1980-2014)." Released November 3. Available for download at https://www.eia.gov/environment/emissions/state/.

[20] Colorado Department of Public Health and Environment. 2014. Colorado Greenhouse Gas Inventory—2014 Update, Including Projections to 2020 & 2030. https://www.colorado.gov/pacific/sites/default/files/AP-COGHGInventory2014Update.pdf.

[21] McKinsey & Company. 2013. Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve. September. http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/pathways-to-a-low-carbon-economy.

[22] See a summary of Colorado Commercial Property Assessed Clean Energy, available at http://copace.com/.

[23] See, for example, U.S. Department of Energy. n.d. "CHP Technical Assistance Partnerships: Southwest." Accessed August 15, 2017. http://www.southwestchptap.org/states-co.

[24] For example, a combined-cycle natural gas plant emits less carbon pollution than a coal plant.

[25] U.S. Environmental Protection Agency. 2017. "Understanding Global Warming Potentials." Updated February 14. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

[26] Because one ton of methane has a much higher global warming potential than one ton of CO_2, emissions from methane (and other global warming gases) are typically converted into CO_2-equivalents, or CO_2e. The IPCC's fourth assessment (AR4) established a 100-year global warming potential of methane at 21 times that of CO_2; more recent scientific analyses estimate the global warming potential is higher, at 28–36 times CO_2 over a 100-year period. See U.S. Environmental Protection Agency. 2017. "Understanding Global Warming Potentials." Updated February 14. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

[27] Colorado Department of Public Health and Environment. 2014. Colorado Greenhouse Gas Inventory—2014 Update, Including Projections to 2020 & 2030. https://www.colorado.gov/pacific/sites/default/files/AP-COGHGInventory2014Update.pdf.

[28] Ibid. See also Colorado Department of Public Health and Environment. 2014. "Revisions to Colorado Air Quality Control Commission's Regulation Numbers 3, 6, and 7 Fact Sheet." Revised October 20. https://www.colorado.gov/pacific/sites/default/files/AP_Regulation-3-6-7-FactSheet.pdf.

[29] Note that these projections are based on the number of wells in the state, which may change rapidly, based on the oil and gas market.

[30] Colorado Department of Public Health and Environment. 2014. Colorado Greenhouse Gas Inventory—2014 Update, Including Projections to 2020 & 2030 (pp. 136–137). https://www.colorado.gov/pacific/sites/default/files/AP-COGHGInventory2014Update.pdf. The Inventory estimates that in 2010, emissions from natural gas transmission infrastructure could be 0.75–1.0 MMT CO_2e and emissions from distribution lines could amount to 0.5–1.4 MMT CO_2e.

[31] Today, the State of Colorado no longer operates the Colorado Carbon Fund, which is now managed by Natural Capitalism Solutions.

[32] Colorado Energy Office. 2016. Coal Mine Methane in Colorado Market Research Report. Prepared by Ruby Canyon Engineering, March. https://www.colorado.gov/pacific/sites/default/files/atoms/files/Coal%20Mine%20Methane%20Report%202016.pdf.

[33] In addition to incentives, Colorado may need to address other policy or financial barriers to developing certain projects, such as supporting and streamlining permitting for coal mine methane projects on state and federal lands. The Colorado Energy Office outlines a more detailed set of policy recommendations in its report cited immediately above.

[34] See, for example, U.S. Department of Agriculture. 2013. Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States. Prepared by ICF International, February. https://www.usda.gov/oce/climate_change/mitigation_technologies/GHG_Mitigation_Options.pdf.

[35] U.S. Environmental Protection Agency. 2017. "Greenhouse Gases Equivalencies Calculator - Calculations and References." Updated July 7. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

[36] Natural Resources Defense Council. 2012. Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Land. Report IP:12-06-B, August. https://www.nrdc.org/sites/default/files/wasted-food-IP.pdf.

[37] Colorado Energy Office. n.d. "Methane Capture." Accessed August 15, 2017. https://www.colorado.gov/pacific/energyoffice/methane-capture.

[38] Center for Climate and Energy Solutions. 2015. "Market Mechanisms: Understanding the Options." April. https://www.c2es.org/publications/market-mechanisms-understanding-options.

[39] In both jurisdictions, allowance prices (the price per ton of CO_2) have been at or near the price floor set by the regulation, and RGGI has reduced its carbon cap twice. Some reductions were achieved through complementary sector-specific programs, and some of the low-cost emissions reductions were driven by market forces, such as cheap natural gas displacing coal. Long term, the types of technology innovations that reduce carbon can be incentivized with a market-based carbon policy.

[40] U.S. Energy Information Administration. 2017. "Electric Power Monthly, Table 1.1.A. Net Generation from Renewable Sources: Total (All Sectors), 2007 – March 2017." Release date July 25. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01_a.

[41] U.S. Department of Energy. 2016. 2015 Wind Technologies Market Report. August. https://energy.gov/sites/prod/files/2016/08/f33/2015-Wind-Technologies-Market-Report-08162016.pdf.

[42] U.S. Energy Information Administration. 2017. "Electric Power Monthly, Table 1.1.A. Net Generation from Renewable Sources: Total (All Sectors), 2007 – March 2017." Release date July 25. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01_a.

[43] Investment figure is current as of May 2016. Climate Change and Emissions Management (CCEMC) Corporation. 2016. Annual Report 2015/2016. http://annual-report-2016.eralberta.ca/.

[44] Oregon Legislative Revenue Office. 2014. Economic and Emissions Impact of a Clean Air Tax or Fee in Oregon (SB306). Research Report #4-14, December. https://www.pdx.edu/nerc/sites/www.pdx.edu.nerc/files/carbontax2014.pdf. The price levels needed to induce significant emission reductions are likely to be prohibitively high, politically.

[45] This includes emissions from electricity, transportation, oil and gas, and industrial sources. These sources reflect 85% of the state's total emissions in 2010 and are typically the sources included under a carbon tax or cap. Emissions from agriculture, coal mine methane, and waste management are typically excluded from a carbon tax or cap.

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