Colorado Greenhouse Gas Pollution Reduction Roadmap

January 14, 2021

GOVERNOR JARED POLIS

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FREQUENTLY USED ABBREVIATIONS AND ACRONYMS

ACRE3	Advancing Colorado's Renewable Energy and Energy Efficiency Program
ACRO	Agricultural Climate Resilience Office of the Colorado Department of Agriculture
AgEE	Agricultural Energy Efficiency program of the Colorado Energy Office
APCD	Air Pollution Control Division of the Colorado Department of Public Health and Environment
AQCC	Air Quality Control Commission
BE	Beneficial Electrification
CCEF	Colorado Clean Energy Fund
CCHS	Colorado Collaborative for Healthy Soils
CCUS	Carbon Capture, Use and Sequestration
CDA	Colorado Department of Agriculture
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CEO	Colorado Energy Office
CEP	Clean Energy Plan
CH4	Methane
CFS	Clean Fuel Standard
CO2	Carbon Dioxide
$CO2_e$	Carbon Dioxide Equivalent

COGCC	Colorado Oil and Gas Conservation Commission
CRO	Colorado Resiliency Office
CSG	Community Solar Garden
CCUS	Carbon Capture Utilization and Storage
DER	Distributed Energy Resource
DNR	Colorado Department of Natural Resources
E3	Energy + Environmental Economics Consulting Firm
EERS	Energy Efficiency Resource Standard
EPA	Environmental Protection Agency
ERP	Electric Resource Plan
EV	Electric Vehicle
HB 19-1261	Colorado House Bill 1261 (2019), the Climate Action Plan
HDV	Heavy Duty Vehicle
IECC	International Energy Conservation Code
IPCC	The United Nations Intergovernmental Panel on Climate Change
JTAC	Just Transition Advisory Committee
LDAR	Leak Detection and Repair
LDV	Light Duty Vehicle
MDV	Medium Duty Vehicle
NOAA	National Oceanic and Atmospheric Administration
NWL	Natural and Working Lands

OJT	Colorado Office of Just Transition
PRPA	Platte River Power Authority
PUC	Public Utilities Commission
RPS	Renewable Portfolio Standard
SB19-077	Colorado Senate Bill 077 (2019)
SB19-181	Colorado Senate Bill 181 (2019)
SIP	State Implementation Plan
SLB	State Land Board
STIP	Statewide Transportation Improvement Program
TAG	Technical Advisory Group
TDM	Transportation Demand Management
VMT	Vehicle Miles Traveled
WAP	Weatherization Assistance Program
ZEV	Zero Emission Vehicle

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RECOGNITION

The State of Colorado thanks the many Coloradans who provided input on the Roadmap throughout its development. A special thanks to the Technical Advisory Group— Dr. Morgan Bazilian, Jill Cooper, Dr. Bryan Hannegan, Jeff Lyng, Dr. Keith Paustian, Dr. Gabriella Petron, and Lee White— for their generous support throughout the development process, including discussions about modeling approaches and reviews of draft reports. The state would also like to recognize the work of state climatologist Russ Schumacher, who reviewed the comment draft and provided feedback on the impacts of climate change in Colorado. Finally, Colorado would like to recognize the support of Dr. Martin Keller for his role as observer to the process.

ADDITIONAL MATERIALS

Several additional materials related to the Roadmap have not been included with the published version of the report but are available from the Roadmap website. These additional online materials include the following documents and technical appendices:

E3 Technical Appendix

The state hired Energy + Environmental Economics (E3) to model potential pathways, or scenarios, that would make progress toward meeting emissions reduction targets. E3 used its PATHWAYS model, which is built using bottom-up data for all emissions produced and energy consumed in Colorado, to model GHG emissions from all sectors of the economy and its RESOLVE model to develop least-cost electricity generation portfolios. The technical appendix provides greater detail about the modeling and the inputs used to build these modeled scenarios.

State of Colorado Technical Appendix

During the course of the development of the Roadmap, the Air Quality Control Commission and other stakeholders requested details on policies and near term actions the state might take to meet the GHG reduction goals. The state's Technical Appendix outlines how state staff aligned the sector emissions projections produced by E3 with the emissions reductions from near term strategies that Colorado expects to pursue.

Roadmap Outreach Plan and Feedback

This document includes the Stakeholder Outreach Plan, a description of the Technical Advisory Group, and the results of outreach activities.

Question and Answers on the Roadmap

This Q&A summary provides responses to the more frequently asked questions about the Roadmap.

GOVERNOR'S INTRODUCTORY LETTER

When we began developing the Colorado Greenhouse Gas Pollution Reduction Roadmap more than a year ago, the world looked very different. Over the past 12 months, the global COVID-19 pandemic has changed nearly every aspect of our lives, challenged our public health system, and strained our economy. Coloradans have faced devastating consequences, from losing a job to losing a loved one, and everything in between. We have seen firsthand the impacts of a changing climate in our own backyard as we experienced the worst wildfire season in Colorado's history. Extreme, statewide drought laid the foundation for these fires, and has made conditions even more challenging for farmers, ranchers, our outdoor recreation industry, and many other sectors of our economy.

But despite everything we've faced this year, our commitment to climate action and clean air has not wavered. In fact, there is an even greater sense of urgency. Looking forward, we know that clean energy will be critical to helping us build a more sustainable and just economy as we begin to recover from this pandemic. It's not just about improving quality of life today, but protecting the Colorado we know and love for generations to come.

Thanks to Colorado's history of leadership on clean energy, including what we've accomplished together over the last two years, we are already on a path to achieving half of the emissions reductions needed to meet our 2025 and 2030 targets. And to build on that momentum, this Roadmap identifies a comprehensive set of actionable strategies that will help propel us toward our goals. These near-term actions keep environmental justice and equity considerations at the center, while reducing local air pollution, generating economic growth, and creating high quality jobs.

One of my primary goals when announcing my candidacy for Governor included a swift transition to 100% renewable energy by 2040, and since taking office we have supported an unprecedented growth of renewables. By working collaboratively with electric utilities that operate over 99% of the fossil-based generation of emissions in Colorado, those utilities have committed to reducing greenhouse gas pollution at least 80% by 2030, while maintaining reliability and saving customers money. And we are building on this expansion with a host of new policies, standards, investments, innovations and partnerships across the economy.

Finally, I want to acknowledge the countless public stakeholders, including members of our Technical Advisory Group, who provided invaluable expertise and insight over the past 12 months, as well as the dozens of employees who closely collaborated across state government and worked tirelessly to finalize the Roadmap. To be successful we are going to need the continued engagement and perspective from diverse stakeholders across the state. We look forward to the critical work that lies ahead.

Jared Polis
Governor
State of Colorado

EXECUTIVE SUMMARY

To address climate change, the Polis Administration has prioritized action on a just and equitable transition to renewable energy and pollution reduction that diversifies and strengthens our economy, creates good-paying, local jobs, and improves the health and well-being of our communities. **This work is motivated by an imperative to protect the health and safety of all Coloradans, as well as the unprecedented opportunity to drive innovation and ensure prosperity for future generations.**

In the 2019 legislative session Colorado passed House Bill 19-1261, the *Climate Action Plan to Reduce Pollution* ("Climate Action Plan"),[i] which includes science-based targets of reducing statewide greenhouse gas pollution 26% by 2025, 50% by 2030, and 90% by 2050 from 2005 levels. To ensure that

Colorado continues to make progress toward these targets, Governor Polis directed state agencies to develop this comprehensive *Greenhouse Gas Pollution Reduction Roadmap* ("Roadmap").

As a result of prior policies, economic shifts, and legislative, regulatory, and other actions taken by this administration, Colorado is already on a pathway to achieving half of the emissions reductions needed to meet the 2025 and 2030 targets. The Roadmap delivers a list of near term actions the state will pursue over the next one to two years to make significant progress toward the 2025 and 2030 Climate Action Plan goals. The Roadmap also analyzes further actions that can help put the state on a solid path to meeting the 2050 goal.

Reducing greenhouse gas pollution across our economy to meet the state's science-based goals will be no small task. While we have taken a number of historic steps, we have much work to do to protect the Colorado way of life for generations to come. This work will continue to be multi-faceted and will require the ongoing expertise and engagement of all Coloradans.

The Roadmap represents the work of many state agencies including the Colorado Energy Office and the Departments of Agriculture, Natural Resources, Public Health and Environment, and Transportation. Additional support was provided by the Department of Local Affairs, the Colorado Resiliency Office and the Office of Just Transition. Colorado hired Energy + Environmental Economics ("E3"), a leading national consulting firm with expertise in GHG modeling, to develop a model of the state's economy-wide emissions by sector. Technical staff from the Climate Change Unit at the Colorado Department of Public Health and Environment provided additional analysis of projected emissions reductions from near term policy recommendations.

The development of the Roadmap started in late 2019 with a review of Colorado's 2015 Greenhouse Gas Inventory, which was updated in 2019, and an evaluation of the data used to project future GHG emissions for Colorado in the Environmental Protection Agency's State Inventory Tool. The state agencies, in consultation with E3 and other outside experts from a Technical Advisory Group, began gathering updated state-level data and refining modeling methods to establish a more accurate accounting of greenhouse gas emissions in Colorado in 2005. Among other changes to prior analyses, the state agencies revised estimates of 2005 emissions from oil and gas operations upwards from EPA stock assumptions to reflect more recent scientific information about methane emissions.

Using this updated data and E3's modeling tools, the Roadmap team constructed a **Reference Case**, which represents a projection of the state's GHG emissions based on policies that were in place prior to 2019. The Reference case assumes no new policies or actions to reduce emissions. That assessment found that the four largest emitting sectors were the same in 2020 as 2005. As shown below in Figure 1, in 2020 transportation displaced electricity generation as the largest source of pollution. Electricity generation, oil and gas production, and fossil methane use in the residential, commercial and industrial sectors remain the other three largest emitters. In the transportation sector, passenger vehicles are the largest contributor to emissions in the state. Electricity generation emissions largely come from coal-fired power plants with a small portion from fossil methane gas-fired

Roadmap Modeling Cases

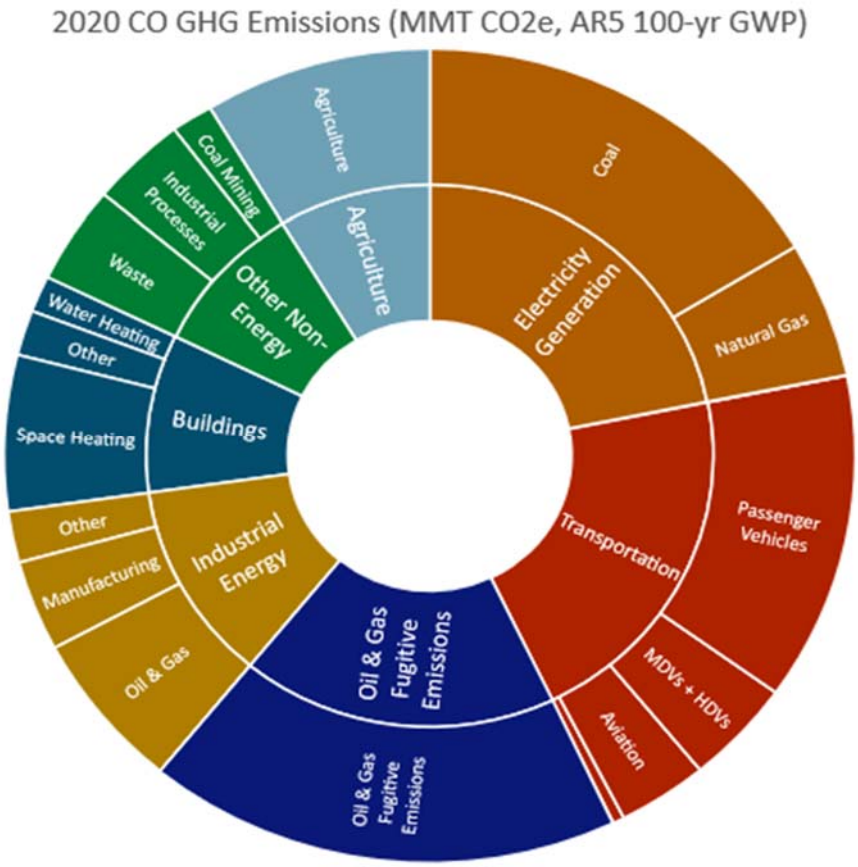
Reference Case
Modeled emissions reductions based on all existing state policy prior to 2019

2019 Action Scenario
Modeled emissions reductions based on prior state policy and legislative, administrative, and voluntary actions adopted in 2019

1261 Targets Scenario
Modeled an illustrative path Colorado could take to meet the GHG reduction targets in HB 19-1261,

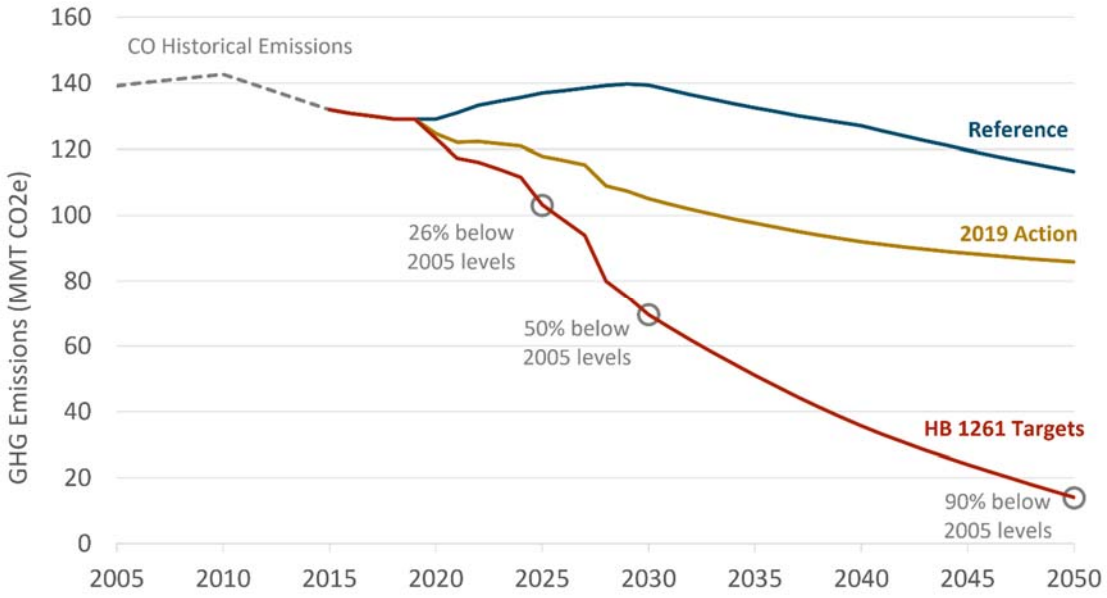
power plants. Emissions from the oil and gas sector include fugitive methane emissions from upstream and downstream operations in Colorado as well as on-site combustion of fossil fuels in industrial operations.

Figure 1: 2020 CO GHG Emissions (MMT CO2e, AR5 100-yr GWP)



To better understand the impacts of recent policy changes, E3 evaluated projected pollution reductions resulting from legislation passed in 2019 and 2020 and from administrative actions to date by the Polis Administration— *The 2019 Action Scenario. This evaluation showed that the state's actions in the last two years to address climate change, when added to prior actions, put Colorado on trajectory to achieve approximately half of the emissions reduction needed to meet the 2025 and 2030 goals.*

Figure 2: Scenario Projections of Colorado's Potential GHG Emissions



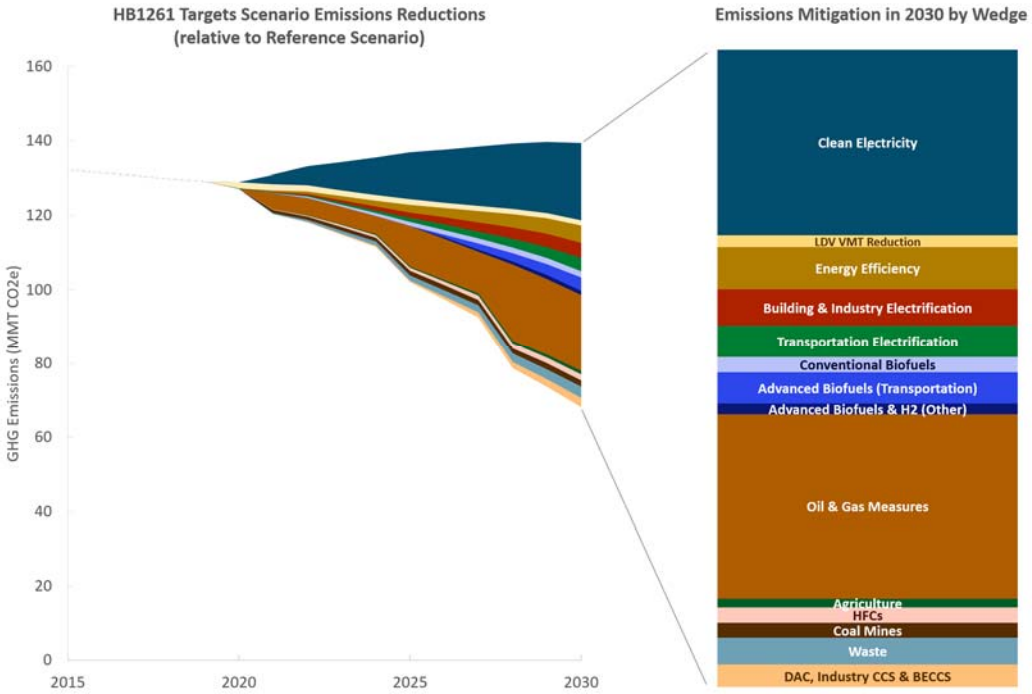
While the state has made significant progress toward meeting the 2025 and 2030 goals, the analysis showed that additional actions are needed to reach the targets. E3 modeled an illustrative scenario, the **HB 1261 Targets Scenario,** to represent one approach Colorado could take to meet the Climate Action Plan targets through 2050. Based on these analyses, the Roadmap proposes administrative, regulatory, legislative, procurement, incentive-based, and other measures to reduce emissions in different sectors of the state's economy to achieve GHG pollution reductions in a cost-effective and equitable way. **Modeled Emissions Trajectories.**

That path to reaching the state's emissions goals builds on the significant transition that is already underway toward clean, low-cost renewable energy and will accelerate as we implement policies to shift the way we move people and goods, and light and heat our homes and businesses from fossil fuels to clean energy. A key to making equitable progress toward our goals is to promote investments needed to modernize our economy more

quickly in disproportionately and historically impacted communities. Transitioning toward a resilient, low carbon economy will require investments, regulations, and other measures by the state as well as federal and local governments. The transition also will require business investment and leadership and the engagement of the nearly six million Coloradans who own more than five million vehicles and almost 2.5 million housing units. The Climate Action Plan provides the Air Quality Control Commission with authority to consider progress made through all of these means as it considers the need to develop regulations:

"The implementing rules may take into account other relevant laws and rules, as well as voluntary actions taken by local communities and the private sector, to enhance efficiency and cost-effectiveness, and shall be revised as necessary over time to ensure timely progress toward the 2025, 2030, and 2050 goals."

Figure 3: Representative Pollution Reductions in 1261 Target Scenario to Meet 2030 Climate Goals



The Roadmap describes actions Colorado has taken to address climate change, analyzes the current trajectory for GHG emissions, and presents a suite of actions the state can pursue in the near term to make progress toward the Climate Action Plan goals.

KEY FINDINGS

- The largest sources of GHG pollution in Colorado are transportation, electricity generation, oil and gas production, and fuel use in residential, commercial and industrial spaces.
- Achieving Colorado's 2025 and 2030 GHG emissions targets is feasible with existing technologies but will require actions, laws, and policies beyond those Colorado has taken already.
- Achieving the 2030 goals will rely on deep reductions in pollution from electricity generation by continuing the transition to renewable energy, as well as deep reductions in methane pollution from the oil and gas industry, which makes up the largest source of non-combustion emissions in the state.
- Making changes to transportation planning and infrastructure to reduce growth in driving is an important tool.
- Electrification of end uses in buildings and transportation will play an important role in achieving these targets, with action needed in the near term to accelerate the transition.
- By 2050, very high levels of electrification of vehicles will be needed, with nearly 100% of all cars on the road being electric and a 100% market share for zero emissions trucks among new sales.
- Reducing methane emissions from landfills, sewage plants and other sources, and enhancing waste reduction, recycling and diversion efforts, is necessary, especially to reach emissions targets after 2030.
- Protecting, restoring, and enhancing the resilience of Colorado's natural and working lands is critical for sequestering carbon.
- Policy transitions to reduce GHG pollution will reduce air quality burdens that disproportionately impact lower income communities and communities of color.
- Policies will need to be designed carefully to ensure that benefits are distributed equitably.

Air Quality Control Commission Greenhouse Gas Subcommittee

E3 provided a projection of Colorado's GHG emissions and modeled scenarios for how the state could reduce emissions in different sectors of the economy, but was not tasked with developing detailed policy proposals. During the development of the Roadmap, the Air Quality Control Commission convened a GHG subcommittee to investigate near term strategies Colorado could adopt to reduce GHG pollution in different sectors. This level of more detailed policy development was originally intended to occur after the GHG Roadmap was completed, but the state agencies agreed with AQCC and other stakeholders that the presentation of more detailed near term action plans will accelerate the transition and better enable Colorado to make progress toward its goals. Those actions are now included in this Roadmap.

To support the AQCC subcommittee, the Air Pollution Control Division ("APCD") staff evaluated potential GHG reductions resulting from near term AQCC rulemakings, PUC proceedings, legislative actions, and other approaches. This spreadsheet-based analysis provides an assessment of emissions reduction based on how the state is likely to implement policies and adds to the level of analysis E3 provided in its scenario modeling. The APCD's analysis grouped emissions into three broad categories: Energy Production (Electricity and Oil and Gas); Energy Consumption (Transportation and Residential, Commercial, and Industrial fuel use); and Non-Energy (Agriculture, Coal Mine Methane, Waste, HFCs) to evaluate emissions reductions by policy approach in a sector. Energy production and consumption encompass the largest emitting sectors and cover greater than 80% of Colorado GHG emissions.[ii]

The APCD staff developed a spreadsheet tool that builds emissions reductions from particular policies and actions based in sectors based on where the greatest short-term emissions reductions were possible. The APCD

approach reflects a more granular approach to developing individual legislation, regulatory policy, and other approaches than E3 used in developing its HB 1261 Targets Scenario.

As a result of the differences in approach, the APCD analysis presents lower potential near term emissions reductions in certain sectors than E3 modeled in the HB 1261 Targets Scenario, but shows greater potential reductions in others. In the residential, commercial, and industrial fuel use sector APCD showed lower potential reductions based on assumptions about the length of the transition for home and business owners to adopt heat pumps and other lower emitting technologies. The difference in achievable potential in transportation emissions is based on APCD using a more conservative assumption about the number of electric vehicles that Colorado consumers will buy under existing policies. APCD also assumed lower reductions from coal mine methane than assumed in the HB 1261 Targets Scenario. However, based on changes in the oil and gas industry and the requirements of Senate Bill 19-181, the APCD tool shows deeper reductions in the oil and gas sector for 2025 than E3 modeled in its scenarios.

The AQCC adopted a resolution establishing a process for review and publication of metrics critical to tracking progress toward the statewide goals established in HB19-1261.[iii] The resolution also adopted provisional sector specific targets for 2025 and 2030 that are based on APCD's work. The AQCC is expected to finalize the resolution after the release of the Roadmap. The table below shows the AQCC's provisional targets, which are informed by the near term actions identified in the Roadmap.

NEAR TERM ACTIONS TO REDUCE POLLUTION

Sector	Revised 2005 Baseline (MMT CO2e)	2025 Target (MMT CO2e)	2030 Target (MMT CO2e)
Electricity	40.28	21	8
Oil and Gas	20.17	13	8
Transportation	30.71	23	18
Residential, Commercial, Industrial Energy Use	24.65	26	20
Other	23.42	19.9	15.6
Total	139.22	102.9	69.6
Percent Reduction	--	26%	50%

The E3 scenario analysis and APCD spreadsheet tool show that reductions across multiple sectors of the economy provide pathways to making progress towards the 2025 and 2030 targets. Based on E3's HB 1261 Targets Scenario, this comprehensive approach also helps lay a strong foundation for reaching the deeper reductions needed between 2030 and 2050. There is no single "silver bullet" solution; the modeling shows that a "silver buckshot" approach of reductions across all the major sectors is needed.

The analysis in the Roadmap finds that Colorado can meet its science-based GHG pollution reduction targets with existing technologies. Decarbonizing the leading sources of pollution will require investments and innovation as well as a broad suite of new policies, standards, and partnerships.

Even as the state works toward an 80% pollution reduction in electricity generation by 2030 through utility actions and enforceable electric resource plans, Clean Energy Plans, and Regional Haze rules, there is a need

to create incentives and pathways to spur further investment in pollution reductions beyond 80%. During the rapid transition to clean, renewable energy for the production of electricity, it is important to promote further investment and innovation in the electrification of new sectors, such as transportation and buildings. These efforts, along with increased energy efficiency, will expand the impact of clean electricity across the economy.

With the transportation sector now being the leading source of GHG emissions and a significant contributor to local air pollution that disproportionately impacts lower-income communities and communities of color, a key priority is to increase the number of electric vehicles, including trucks and buses, on Colorado roads. Establishing new standards that stimulate investment and remove barriers to EV ownership will make it easier and more affordable to drive an EV. Additionally, changing the way we make development decisions, including for land use, housing, and infrastructure, can enhance accessibility, cut pollution, and reduce the need to drive. To ensure that this transition is equitable and broad-based, the state needs to develop policies and programs that will benefit communities that have been most heavily impacted by the pollution from transportation infrastructure, including highways and refineries.

Progressing towards the state's GHG goals requires deep methane emissions reduction from the oil and gas industry, landfills, sewage treatment plants, coal mines, and other sources. Methane is a potent contributor to climate change, with each ton creating 28 times more warming than a ton of CO2 over 100 years (and even higher in the short term). Given the importance

of achieving reductions of this potent greenhouse gas, the APCD staff anticipate proposing regulations to the AQCC in 2021 that will achieve over a 30% reduction across the oil and gas sector by 2025 and over 50% (12 million CO2e tons) by 2030. If adopted, these regulations will result in oil and gas sector emissions of roughly 8 million tons in 2030, down from 20 million tons in 2005.

Additionally, regulatory measures, such as those finalized in the Colorado Oil and Gas Conservation Commission Mission Change rulemaking, that eliminate routine flaring, require equity-focused siting analysis, minimize emissions, and prioritize vulnerable populations and disproportionately impacted communities, are designed to make important progress in GHG reductions and equity benefits.

The majority of Colorado homes and businesses use fossil methane gas to heat water and indoor air. Fossil methane use is also a key source of pollution from the industrial sector. To advance near term GHG goals, Colorado needs to reduce fuel use in buildings and industrial processes through increasing energy efficiency, transitioning water and home heating and industrial operations to electricity where it is cost-effective, and reducing the GHG intensity of the gas that serves these uses. In the residential sector, this shift will provide additional co-benefits that include more comfortable homes and better indoor air quality. Requiring utilities to transition to lower emissions gas will create an incentive for investments in the development of biogas from sources such as agricultural operations and sewage treatment plants as well as spur investment in green hydrogen production.

The state will also need to implement its actions to reduce HFCs (refrigerants and aerosols), and advance climate-smart strategies on natural and working lands. Colorado's natural and working lands include our forests, grasslands, agricultural croplands and rangelands, wetlands, riparian areas,

and urban greenspaces. Natural and working lands are both sources of GHG pollution, including emissions from wildfires, agricultural equipment and fertilizer use, and serve as carbon sinks by holding or sequestering carbon in plants and soils. Colorado must work to increase access to energy efficiency and renewable energy on farms and ranches by increasing utilization of the Agricultural Energy Efficiency program and expanding the Advancing Colorado's Renewable Energy and Energy Efficiency program. This program is designed to achieve a number of goals, including supporting voluntary participation in such efforts as Field to Market, Soil Health Partnership, and Precision Agriculture programs, and protecting, restoring, and enhancing carbon sequestration on farms, ranches, and other natural and working lands.

Colorado also needs to continue efforts to better manage waste streams through diversion, composting, and other initiatives, especially for organic wastes that can form methane in landfills. In 2019, recycling and composting in Colorado reduced greenhouse gas emissions by 1.92 million metric tons of CO2e, which is the one-year equivalent of either removing 407,000 cars from the road, or removing 148,000 homes from the grid, or conserving 2.34 million barrels of oil or 113 million gallons of gasoline. Because Colorado's recycling and waste diversion rates have been below the average of other states, recycling and waste diversion provide critical opportunities to reduce emissions.

In coordination with the E3 modeling showing potential pathways to achieve emission reduction targets, APCD and AQCC have engaged in a more granular, bottom up process of evaluating the emissions reductions associated with potential near term strategies and policy actions. The state has used this analysis to develop a set of recommended regulatory, legislative and programmatic strategies for enactment in 2021 and 2022.

Near Term Actions by Sector

The table below summarizes near term actions that the administration will pursue to achieve sector specific GHG emissions reductions that help Colorado make progress toward meeting the state's climate goals.[iv] The section on near term actions, starting at page 33 in the report, describes these strategies in greater detail and explains why these strategies were selected. As we pursue these steps, we will continue our commitment to climate equity and environmental just through enhancing engagement with stakeholders in disproportionately impacted communities; building on partnerships with Sovereign Tribal nations through consultation and enhanced engagement; and, reducing barriers to public participation in AQCC rulemaking process. We will also build evaluation of potential equity impacts into rulemaking processes and invest more resources in climate equity and environmental justice.

Table 1: Near Term Actions to Reduce GHG Pollution

Sector	Near Term Actions	Targeted 2030 Emissions Reductions From 2005 baseline Million Metric Tons
Electricity	• **Adopt Clean Energy Plans and Electric Resource Plans, including evaluating plans using the full social cost of carbon emissions.** • **Incorporate coal plant retirements from utility commitments and adopted utility plans into AQCC Regional Haze rulemakings.** • **Evaluate mechanisms such as performance based regulation and**	**32.3 mmt**

	other tools to create incentives for deeper emissions reductions and serving beneficial electrification loads with zero carbon generation.	
Transportation	• **State GHG pollution standards for transportation plans.** • **Trip reduction/Transportation Demand Management (TDM) requirements and encouraging telecommuting for large employers.** • **Clean trucking strategy with multiple components including infrastructure investments, incentives for fleet turnover, and evaluation of regulatory options. More details are on page 57 of the report.** • **Secure new revenue to fund infrastructure and incentives to transition to electric cars, trucks, and buses.** • **Offer incentives for land use decisions by local governments that reduce vehicles miles traveled, reduce GHG and other pollutants, and support greater access to housing near jobs.** • **Indirect source standards for some types of new development.** • **Expand public transit, including front range rail and RTD completing the statutorily required Fastracks system that**	**12.7 mmt**

	voters passed in 2004 including Northwest Rail (2025 Ridership: 8,600-10,100)..[v] • **Develop an EV Equity study to ensure access to EV's for all Coloradans.** • **Provide input into development of new clean car standards by both the federal government and for state-based standards.**	
Residential, Commercial, and Industrial Fuel Use (Gas utilities)[vi]	• **Expand energy efficiency investments from gas utilities to support building shell improvements.** • **Set carbon reduction targets and biogas requirements for gas utilities.** • **Require large commercial buildings to track energy use and make progress toward energy and pollution performance standards.** • **Support adoption of advanced building codes.** • **Require regulated electric utilities to create programs that support customer adoption of electric**	**4.7 mmt**

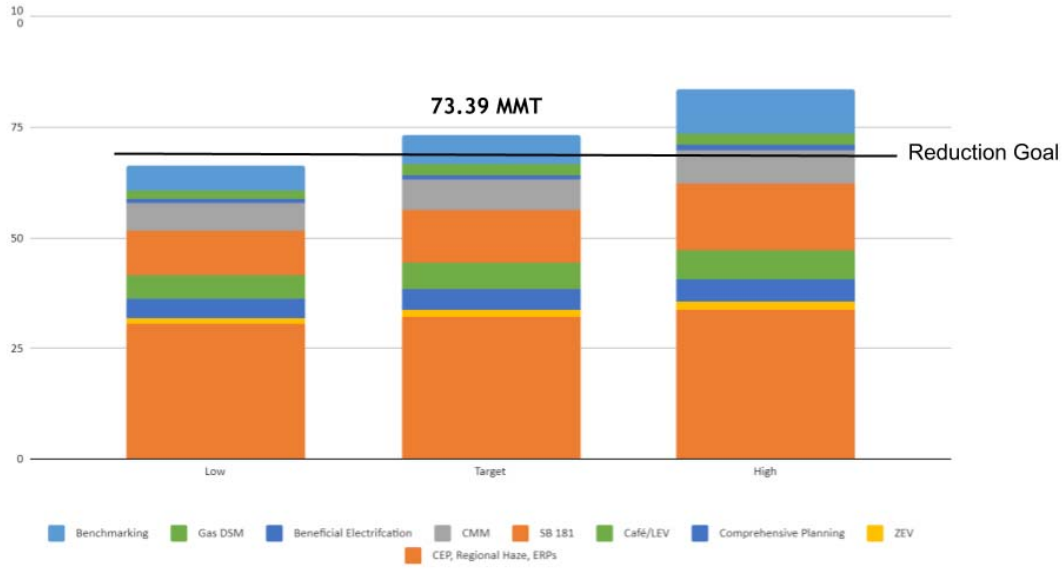
	heat pumps and other forms of beneficial electrification. • Expand access to financing programs for building retrofits by capitalizing a green bank, expanding existing programs and advocating for utility on-bill finance programs. • AQCC action on industrial energy and emission audits requirements and Best Available Control Technology requirements, setting the stage for future performance requirements.	
Oil and Gas	• AQCC rulemaking to achieve methane pollution reductions from the oil and gas industry - at least 33% reduction in total emissions by 2025 and over 50% by 2030. • COGCC implementation of new rules that eliminate routine flaring, require minimizing emissions, and track pre-production and production air emissions.	12.2 mmt
Natural and Working Lands	• Develop a comprehensive emissions inventory. • Develop a Natural and Working Lands Strategic Plan. • Increase producer utilization of Agricultural Energy Efficiency (AgEE) program.	1.0 mmt[vii]

	• Expand Advancing Colorado's Renewable Energy and Energy Efficiency (ACRE3) program. • Improve soil function and carbon sequestration through regenerative farming practices. • Support voluntary participation in such efforts as Field to Market, Soil Health Partnership and Precision Agriculture programs.	
Waste	• Reduce methane emissions from coal mines, landfills, sewage treatment plants, and agriculture through continued reductions in coal extraction, utility biogas incentives[viii], potential AQCC rulemaking and grants for waste reduction and diversion through the Front Range Waste Diversion Enterprise and CDPHE. • Improve recycling end markets and recycling and reuse.	7.5 mmt
Industrial Process Emissions[ix]	• Federal HFC reduction provisions adding to AQCC rules (refrigerants, aerosols, etc.)	0.3 mmt

Other Actions	• **Advance the Governor's FY 2021-22 budget, which includes a number of innovative funding proposals that will help protect Coloradans from the existential threat of climate change, improve air quality, and position Colorado to seize the economic benefits of a renewable energy economy. More detail on the budget is included on page 92.** • **Convene a task force on Carbon Capture, Utilization and Storage (CCUS) starting in mid-2021, which will report to the Governor within a year on recommended framework, including policies and actions steps for advancing CCUS in Colorado.** • **Support local government and private sector climate action efforts.**	**0.3 tons**

The table above shows potential emissions reductions from the APCD's analysis by sector of the economy. In addition to creating a Target case for emissions reduction achievable from the near term actions, the APCD staff developed a Low and High case based on different assumptions about policy implementation. The chart below shows that in 2030 the Target case results in a 53% reduction compared to a goal of a 50% reduction (represented by the solid black line). Even the Low case achieves a roughly 66 MMT reduction, leaving a small emissions gap of less than 3% from the goal.

Figure 4: Comparison of State Pollution Reduction Cases



Near Term Action by Venue and Timeline

The chart below provides a list of near term actions over the next two years arranged by venue (e.g., regulatory agency or legislature) and by year the state anticipates the action being initiated (unless noted otherwise).

Table 2: Near Term Actions to Reduce GHG Pollution by Venue and Timeline

	Fall / Winter 2020	Spring 2021	Summer 2021	Fall 2021	Winter 2021	2022
Public Utilities Commission (PUC)[x]	Tri-State Electric Resource Plan Xcel Transportation Electrification Plan	Xcel Clean Energy Plan Black Hills Transportation Electrification Plan	Xcel Renewable Energy Plan Black Hills Energy Efficiency Plan Black Hills Renewable Energy Plan			Black Hills Clean Energy Plan
Air Quality Control Commission (AQCC)	Regional Haze Rules Ozone Plan Oil and Gas Well Monitoring Rules Outreach on 2021 Oil and Gas Rules	Regional Haze Rules Phase 2 Stakeholder Processes for Transportation, Industrial, Oil and Gas Rules	Transportation Emission Rules (GHG standards for Transportation Plans and Trip Reduction Plans) Industrial Energy and Emissions Audits Rules	Greenhouse Gas emission reduction progress evaluation	Oil and Gas Emission Reduction Rules Structures/ Building Emission Reduction Rules	Transportation Emission Reduction Rules

Colorado Oil and Gas Conservation Commission (COGCC)	**Mission Change Rulemaking: 200 Series - general and record keeping; 300 Series - permitting process; 400 Series - operational practices; 500 Series - hearing process; 600 Series - safety (and residential setbacks); 800 Series - underground injection control wells; 900 Series - environmental and Exploration & Production waste management; and 1200 Series - wildlife (and riparian setback).**	**Rulemaking: 700 Series - financial assurance (bonding); Imposing permit fee; and requiring worker certification (These three topics complete mandatory SB 19-181 rulemakings.)**		**Greenhouse Gas emission reduction progress evaluation, in coordination with CDPHE**		
Other State Agency Actions	**Clean Trucking Strategy Initiated Just Transition Plan Completed**	**Convene taskforce on Carbon Capture, Utilization and Storage Study on how to incentivize progress on land use decisions Climate Equity Framework Completed**	**Clean Trucking Technical Analysis Completed**	**Natural and Working Lands Task Force Pathways Analysis Completed Electric Vehicle Equity Plan Completed**	**Draft Natural and Working Lands Strategic Plan Completed**	

Legislation		**Transportation** • New revenue to fund infrastructure and incentives to transition to low and zero emissions cars, trucks and buses. **Buildings and Gas Utilities** • Set carbon reduction targets for gas utilities. • Set biogas requirements for gas utilities. • Require existing large commercial buildings to track energy use and make progress toward energy and pollution performance standards. • Require regulated electric utilities to create programs that support beneficial electrification. • Expand energy efficiency investments from gas utilities. **Governor's Proposed FY 21-22 Budget Proposal** • Clean Energy Finance ($40 M) • Wildfire relief, mitigation and prevention ($78 M) • Supporting local government investment in renewables and efficiency ($5 M) • Climate Resilience Office at the CO Department of Agriculture • Building the capacity of Colorado's Office of Just Transition			

Leadership and Innovation Required to Meet 2050 GHG Goal

The Roadmap not only models pathways to 2025 and 2030 GHG pollution reductions but examines how Colorado can make progress toward the longer term goal of meeting a 90% GHG pollution reduction by 2050. It is important to recognize that the modeling gets more uncertain over this longer time horizon and that the 1261 Targets Scenario for 2050 is best viewed as an illustrative scenario showing one reasonable pathway toward the state's 2050 emission goals. This is particularly true given the uncertainties in how technologies such as long duration energy storage, green

hydrogen production, carbon capture utilization and storage, and advanced biofuels will develop over the coming decades.

KEY FINDINGS FOR 2050 GOALS

- All sectors have an important role to play in emissions reductions if the state is to reach 90% reductions by 2050. Every sector that is a significant energy producer or consumer— including electricity generation, oil and gas production, transportation, buildings and industry— would need to achieve reductions of 90% to 100%.
- In the illustrative scenario, our two largest utilities, Xcel Energy and Tri-State, meet energy needs with zero-carbon electricity by 2050 while smaller utilities reduce emissions 80% compared to 2005 levels. This is a conservative assumption.
- In transportation, we will need to transition to close to 100% electric cars on the road by 2050 and 100% market share for new vehicle sales of zero emissions trucks and buses by 2050. Achieving this will require close to 100% of new car sales to be electric by 2040. In addition, we need to continue pursuing strategies that reduce vehicle miles traveled.
- Unlike the 2030 goal, achieving the 2050 goal likely will require further technical innovation and economies of scale to bring costs down and allow deployment at scale in a number of sectors. Important technologies may include green hydrogen, long duration energy storage, carbon capture and storage, advanced biofuels, and synthetic fuels based on air capture of carbon.
- In the buildings sector, the 1261 Targets Scenario for full decarbonization by 2050 is based on a large-scale shift to the use of electric heat pumps, powered by zero carbon electricity, for space and water heating. There may be other pathways, depending on technological developments, which is why the near term actions support a wide variety of strategies for the buildings sector.
- Land conservation, restoration, and climate-adaptive ecosystem management will be critical for maintaining and enhancing resilient carbon sequestration on natural and working lands. Achieving these activities at sufficient pace and scale will require significantly scaled up technical assistance, research, and financial incentives.
- In agriculture, all sectors of the industry can adopt GHG reduction strategies in addition to sequestration targets. The development of markets that pay producers for ecosystem services may be an increasingly important tool to help producers remain viable while helping to reach our shared climate goals.

This Roadmap has been developed to meet the requirements of Colorado Revised Statute § 24-20-111, which calls for development of a state climate plan setting forth a strategy to address climate change and reduce greenhouse gas emissions, while taking into account previous state actions and efforts as well as voluntary actions taken by the private sector and local governments.

The GHG Roadmap represents a significant step forward for climate action and pollution reduction planning at the state level and advances Colorado's policy and programmatic vision for pursuing timely, enduring, and equitable strategies. Progressing toward our goals will continue to be iterative and multi-faceted. We look forward to continuing engagement from a diverse set of stakeholders from across the state.

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COLORADO'S ROADMAP TO GREENHOUSE GAS POLLUTION REDUCTION

Introduction

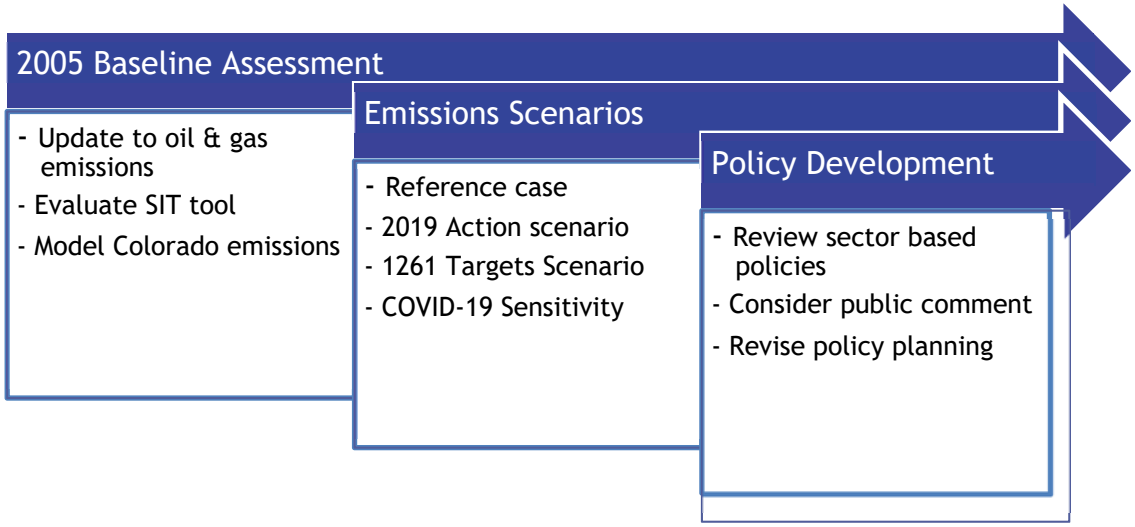
Vision

Since 2004, when Colorado became the first state to adopt a voter-approved renewable energy standard, the state has been at the forefront of the renewable energy transition. Governor Polis ran on a platform of achieving 100% renewable energy by 2040, reducing pollution and ensuring that Colorado does its part to confront the climate crisis. Fighting climate change and reducing harmful air pollution protects the health, safety, and welfare of all Coloradans today and for generations to come. The transition to a cleaner and more just economy provides an unprecedented opportunity to drive innovation and harness consumer and economic benefits.

Over the past year, Colorado and the nation have grappled with a number of profound challenges: the COVID-19 pandemic and ensuing economic impacts, heightened attention to systemic injustices against Black, Indigenous, and people of color, and historic fires driven by drought and heat that have worsened from a warming climate. Despite these challenges, Colorado's commitment to renewable energy, climate action, and clean air has not wavered. The investment it will take to build the clean, renewable energy Colorado needs, to shift to cleaner trucks, buses and cars, and to

reduce energy use in homes and businesses is critical to building a more just and equitable economy and society, protecting the health and safety of all communities across the state, and safeguarding the Colorado way of life.

Figure 5: Roadmap Development Process



To better plan for and mobilize what Colorado can do to meet these goals, the governor directed state agencies to work together to produce a Roadmap to reduce greenhouse gas pollution. As shown in Figure 5, the Roadmap process started with modeling and analysis. It then identified policy actions and other steps the state can prioritize to meet GHG pollution reduction and air quality goals. Those policy proposals were refined in response to stakeholder feedback and are aligned with the equity framework in this document.

We know that Coloradans are already experiencing negative impacts from climate change and we know that Black and Latino Coloradans, Indigenous people, lower-income residents, and those living near multiple sources of pollution experience disproportionate impacts from pollution linked with climate change. To promote equity and justice, the state must work with impacted communities to intentionally and strategically design and implement programs and policies that reduce GHG and invest in impacted communities.

The state's partnerships with the sovereign Nations of the Southern Ute Indian Tribe and Ute Mountain Ute Tribe are an important component of implementing the strategies found in this Roadmap. Strengthening government-to-government relationships through formal consultation, staff peer-to-peer information exchange, and enhanced stakeholder outreach and engagement with members of the Tribes will support successful climate action for all involved. Thoughtful consultation on sector-specific initiatives, such as oil and gas regulation, electric vehicle charging infrastructure investments, and renewable energy project development, will help ensure that potential impacts of state GHG reduction policies and programs are carefully considered.

In order to be meaningful partners in the vital work to improve equity in the United States, we need to first acknowledge that, as state government, we represent an institution that has a history of being a part of the problem when it comes to inequalities in communities. From the beginning of our country, government at the local, state, and national levels have played a role in creating and maintaining racial inequity, including everything from determining who is a citizen, who can vote, who can own property, who is property, and where one can live, just to name a few. Governmental laws, policies, and practices continue to create a racial and human hierarchy and determine, based on race, economic class, access to power, and other characteristics, who benefits and who is burdened. But even with this painful past, Colorado and other communities around the country are working to try to undo harmful policies and practices. It is our sincere goal to work together to build equity and justice principles into systems and processes addressing climate change in Colorado.

We understand that the State of Colorado is on indigenous lands and recognize the 48 contemporary Tribes with homelands in Colorado.
As part of our work to build equity and justice into Colorado's climate change initiatives, it is essential that we acknowledge the Tribal Nations that are Colorado's first inhabitants and first stewards of these lands. As we work to ensure wellbeing and resilience of the places we live, work, and play, it is important that we partner with Tribes and do so in a manner that honors their status as sovereign nations and upholds Colorado's, State-Tribal government-to-government relationships.

State government cannot do this work alone. It is going to take the commitment, expertise, and engagement of Coloradans from diverse perspectives and from across the state to further refine, mobilize, and implement actions identified in this Roadmap. This work involves transforming our collective approach to powering, moving, heating and lighting in our state. Achieving these goals will require action not only from state government, but investments and actions from individuals, businesses, and local governments.

GHG Pollution, Air Quality, and Climate Justice

Reducing GHG emissions will improve Colorado's air quality because many sources of climate pollution are also responsible for local and regional air pollution that damages public health. Targeting reduction to communities historically most impacted will further equity goals.

Transportation is not only the top source of GHG pollution but is also a leading source of nitrogen oxides, one of the precursors to ground level ozone, and particulate matter, a damaging pollutant and contributor to ozone. These pollutants are concentrated in places like North Denver and Commerce City. Equitable investing in EVs and EV infrastructure can address this.

Oil and gas production is the leading source of volatile organic compounds (another ozone precursor) and a top source of methane, a potent greenhouse gas. Reducing pollution from production in Denver-Julesburg basin will reduce ozone across the Front Range and lessen related health impacts.

Hotter days, a direct result of climate change, worsen the formation of ground level ozone. Addressing climate change and working to mitigate temperature increases can help address these problems.

Background on Climate Science

Climate change results from certain gases, including carbon dioxide and methane, absorbing energy from the infrared radiation emitted by the Earth and trapping heat. This heat trapping effect, the "greenhouse effect," causes atmospheric warming resulting in changes to the climate, including more frequent and intense extreme weather events.[xi]

Current measurements show atmospheric CO_2 at 415 parts per million. The National Aeronautics and Space Administration ("NASA"), concludes that CO2 concentrations have increased 47% from pre-industrial levels.[xii] The scientific consensus concludes that human caused emissions of greenhouse gases, primarily from the burning of fossil fuels, is causing atmospheric warming.

Figure 6: CO_2 in the atmosphere and annual emissions (1750-2019). Source: NASA.

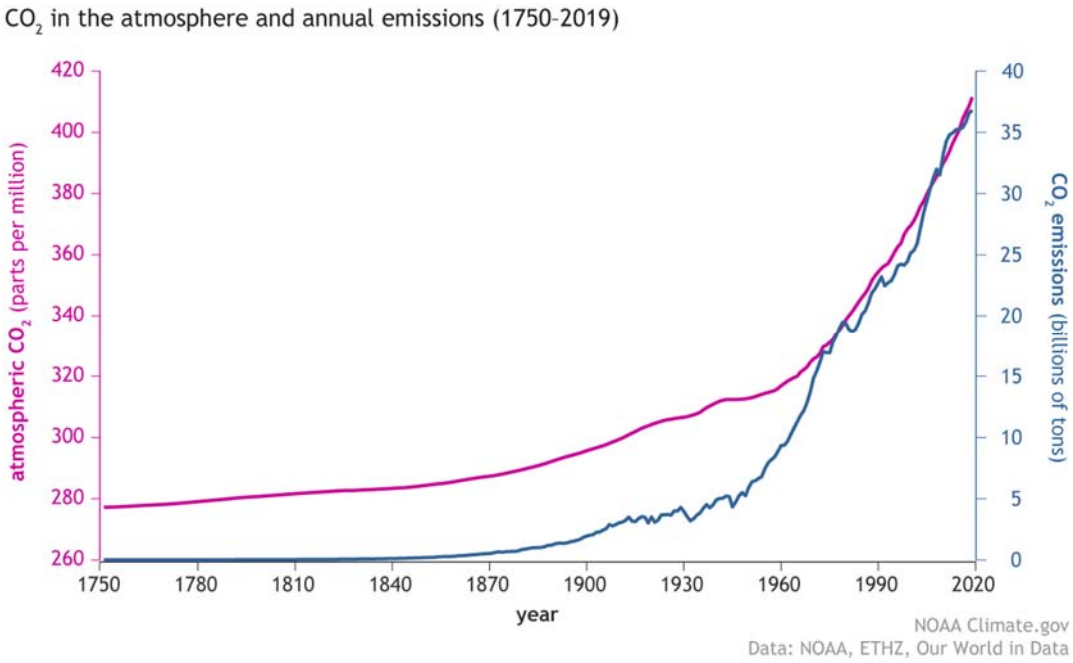
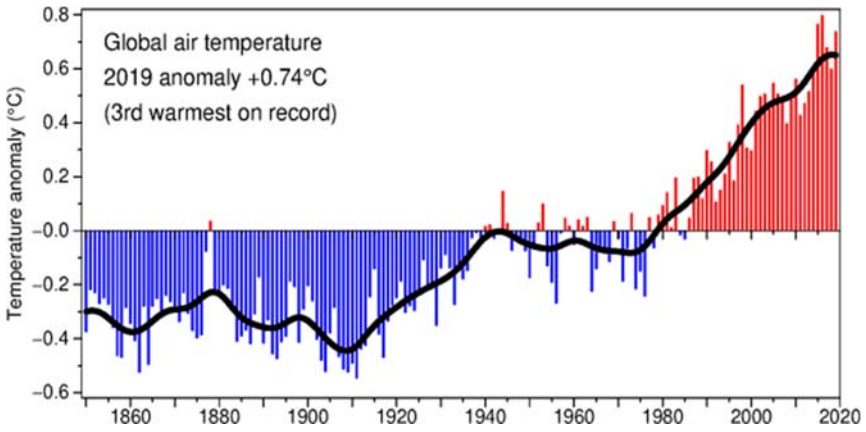


Figure 7 shows the change in average global air temperature (the thick black line), which has increased since the 19th Century. The steepest increases have come over the last half-century. The chart also shows that

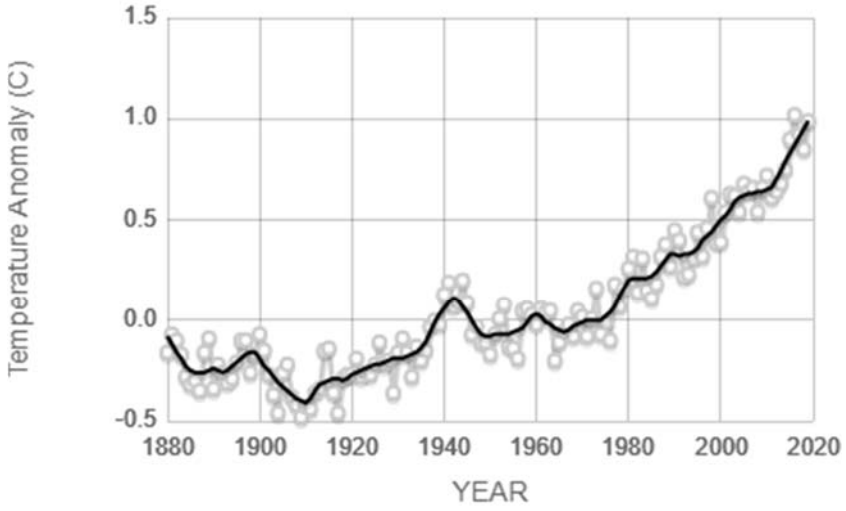
average temperatures are warmer (in red) and warmer by increasing amounts over that same period.

Figure 7: Global Air Temperature. Source: University of East Anglia.



Similar results of warming are shown in Figure 8 (below), which represents the changes in global surface temperature compared to the average temperatures from 1951-1980.

Figure 8: Change in Global Surface Temperature. Source: NASA.



Source: climate.nasa.gov

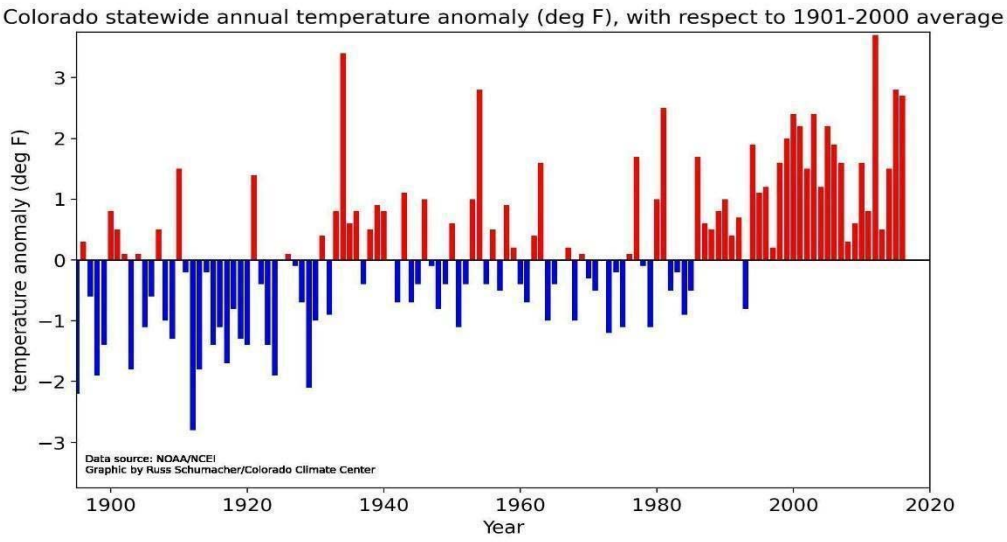
The United Nations Intergovernmental Panel on Climate Change ("IPCC") *Special Report on the Impact of Global Warming of 1.5°C* concludes that human activity is estimated to have caused a 1.0°C global temperature increase by above pre-industrial levels. The IPCC report notes that climate-related risks to health, livelihoods, food security, water supply, and economic growth are projected to increase with global warming of 1.5°C and increase further with warming to 2°C.

According to the IPCC report, disadvantaged and vulnerable populations, indigenous peoples, and communities that are dependent on agriculture are at a disproportionately higher risk of adverse consequences from warming. The IPCC report explains that lowering the levels of carbon-dioxide and other greenhouse gases starting immediately improves the chance that global warming can be limited to 1.5°C and thus avert worsening impacts. The report finds that delaying actions to reduce greenhouse gas pollution increases the challenge and cost of meeting the goal of keeping temperature increases to below 1.5°C. Further, not investing in lower-emitting technologies risks locking in a greenhouse gas-emitting infrastructure.

Climate Change in Colorado

Colorado's climate is changing. The state has warmed 2°F since the beginning of the 20th century.[11] Colorado Climate Center analysis of National Oceanic and Atmospheric Administration ("NOAA") data (Figure 9) shows that over the last 30 years Colorado has experienced an increasing frequency of hotter than average days as represented by the red bars on the graph. NOAA states that,

Figure 9: Colorado Statewide Temperature Anomalies. Source: Colorado Climate Center.

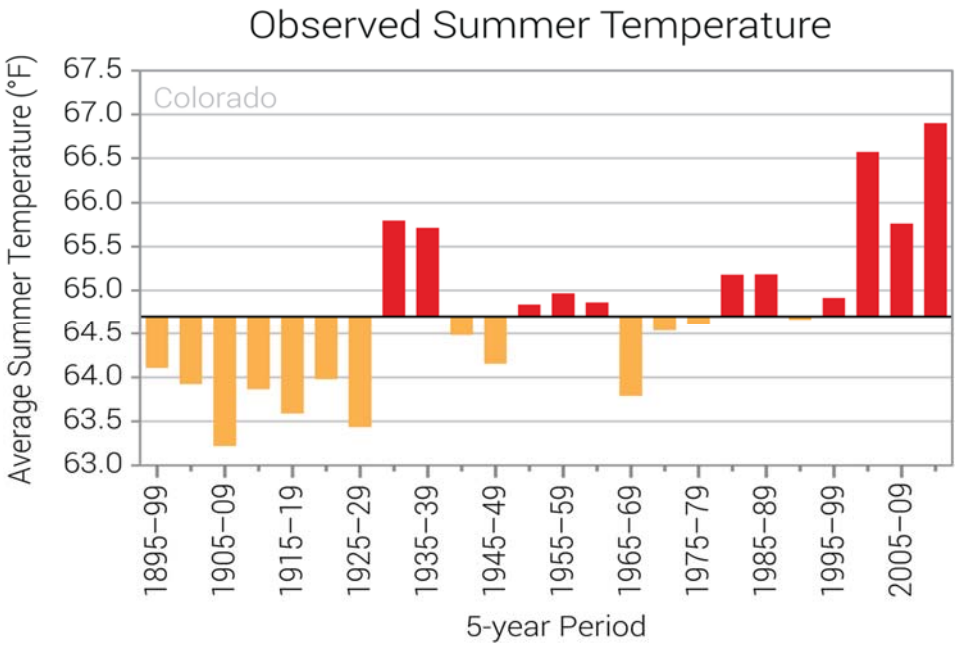


"Average annual temperatures for Colorado have remained consistently higher than the long-term average (1895–2015) over the past two decades."[xiii]

In Colorado, nine of the twelve warmest years on record have occurred since 2000. In addition, recent data from NOAA's Center for Environmental Information shows that Colorado's summer temperatures over the last three decades are the highest on record (Figure 9). The data also shows that Colorado's recent average summer temperatures are even higher than the extreme heat of the 1930s Dust Bowl era.[xiv] In western Colorado, the combination of heat and a lack of precipitation in the most recent three

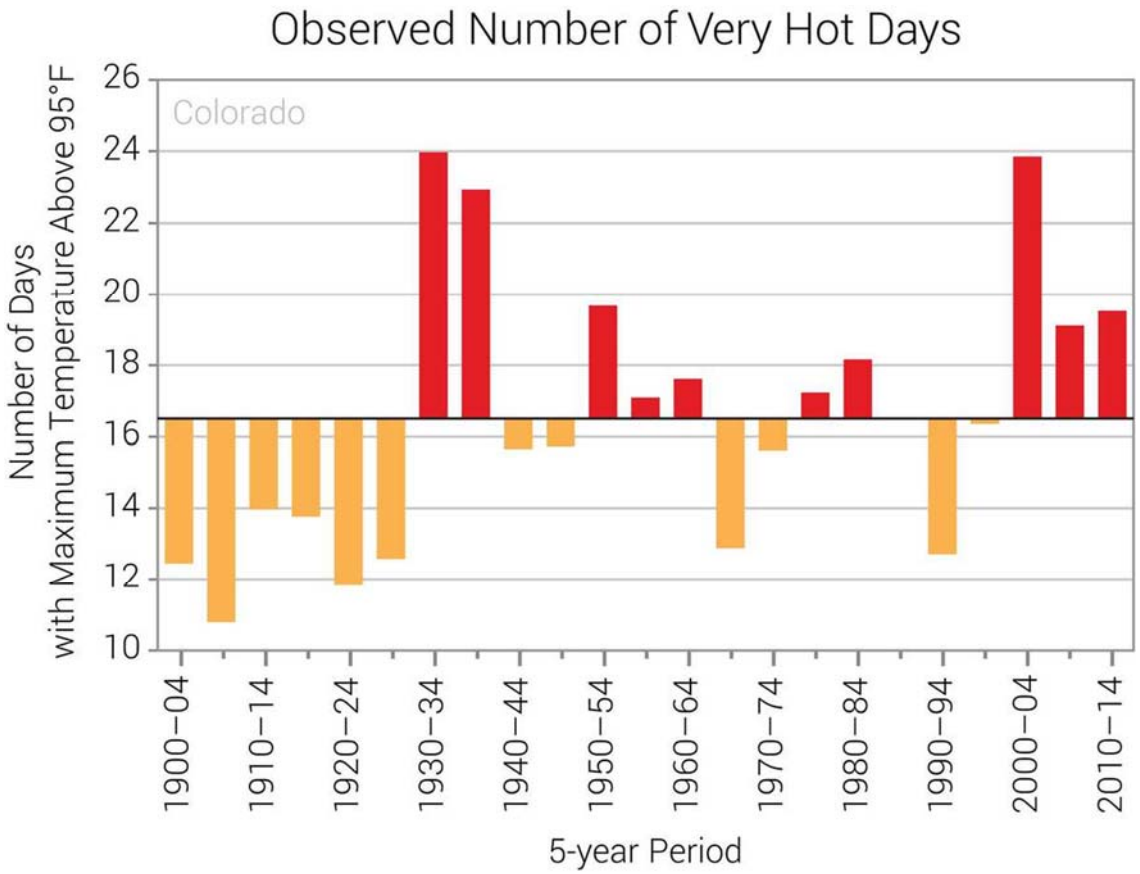
monsoon seasons (July-August of 2018, 2019, and 2020) have been the worst on record.

Figure 10: Summer Temperatures in Colorado. Source: CICS-NC and NOAA NCEI.



Data shows that not only are average days getting hotter, but that Colorado is experiencing an increasing number of extreme heat days. NOAA defines "very hot days" as having a temperature above 95°F. While NOAA notes that temperatures vary across the state, it concludes that, "The number of very hot days has been above average since 2000"[xv] as reflected in Figure 11.

Figure 11: Observed Very Hot Days in Colorado. Source: Source: CICS-NC and NOAA NCEI.



Changes to Colorado's climate from warming is causing an increasing trend of heat waves, droughts, wildfires, and more frequent and severe floods. In addition, the warming, along with other factors, has led to peak runoff from snowmelt coming one to four weeks earlier. Earlier runoff is increasing ecosystem stress through reduced stream flows, high evapotranspiration rates, drier soils, and increasing disease prevalence. Warming temperatures and drier soils also increase the likelihood of large wildfires. The 20 largest wildfires in recorded history in Colorado have all occurred since 2000, with the three largest burning in 2020. The record for the largest amount of acreage burned— over 650,000 acres, was set in 2020.

Future estimates project that temperatures could rise an additional 2.5 to 5°F by 2050.[xvi] As a result of continued warming, Colorado is projected

to become more arid, increasing the severity of droughts and wildfires. However, projections also indicate an increase in extreme precipitation events because of increases in the atmospheric water vapor (due to rising sea surface temperatures), which could result in more frequent and intense flooding in the state.[xvii]

Rising temperatures and a changing climate will impact key natural resources and environments in the state and industries that depend on them such as farming, ranching and outdoor recreation.

Agriculture is a key driver of Colorado's economy. According to a 2020 study, agriculture in Colorado is a nearly $47 billion industry that employs 195,000 people.[xviii] With more than 38,000 farms operating on more than 32 million acres of private land and 20 million acres of leased federal and state land, the success of the state's farms and ranches is tied to the health of Colorado's climate and land.[xix] As Colorado's climate changes, Colorado's farmers and ranchers face increasing challenges. Earlier spring snowmelt is decreasing instream flows in many basins and warmer and drier summers means that even less water is available in the later part of the season. Hotter days and warmer nights are increasing soil dryness, which will become worse with time. Together, the changes that result from a warmer, dryer climate in Colorado could reduce crop yields, force ranchers to reduce herd size, and increase incidences of invasive weeds and pests. In addition, these impacts will result in more and larger wildfires— in 2020 alone the state saw the three largest wildfires in its history. The 2015 *Colorado Climate Plan* concluded "the Colorado of the future is unlikely to look like that of the past."[xx]

The state's mountains and rivers are not only a symbol of Colorado, but the ski resorts, parks, and gold-medal fishing waters are a leading source of tourism, jobs, and revenue for the state. According to a 2018 report from Colorado Parks and Wildlife,[xxi] outdoor recreation resulted in $62.5 billion in spending and contributed $35 billion to the state's Gross Domestic Product.

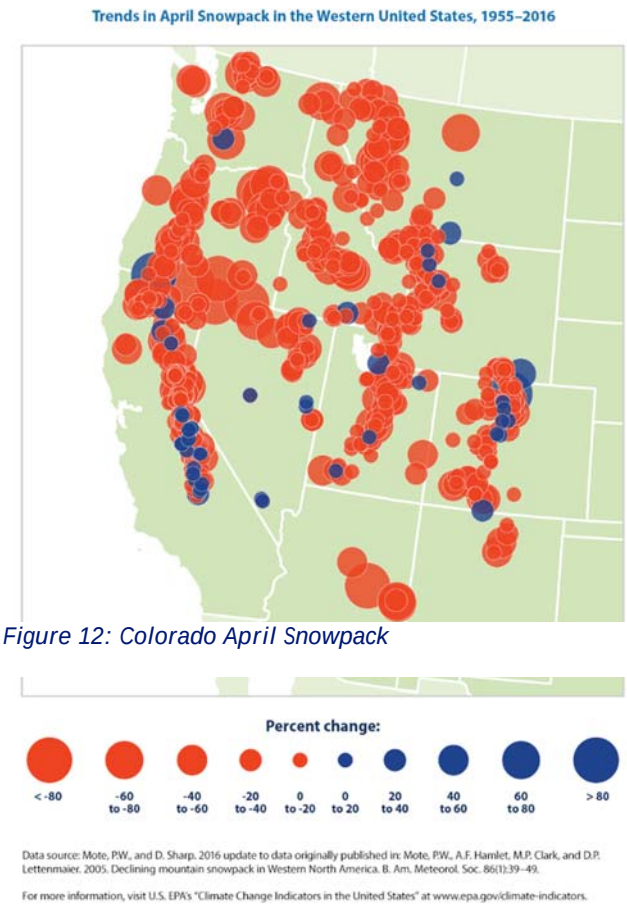


Figure 12: Colorado April Snowpack

The more than 500,000 jobs in outdoor recreation represent 18.7% of the state's employment. But Colorado's skiing is vulnerable to decreased snowpack and early melt, reducing the number of skiable days. Figure 12 shows that in many parts of Colorado's mountains, spring snowpack is declining, which may result in fewer ski days and fewer mountain visits. In addition, lower instream flow can increase water temperatures impacting signature fish species and impacting gold-medal fishing areas. In short, Colorado's outdoor recreation industries are vulnerable to the warming temperatures resulting from the changing climate.

Table 3 summarizes key changes to Colorado's natural resources from climate change and some of the impacts that those changes will have.

Table 3: Impacts of Climate Change in Colorado

Water	• Decreased snowpack and earlier runoff • Less water availability • Lower water quality • Risks of increased flooding
Soil	• Increased drought and drier soil • Decrease crop yields • Smaller herd size
Forest Health and Wildfires	• Increased insect, disease, and drought impacts on trees & crops • Increased risk of wildfires • Increased area burned
Public Health	• Summer heat-related health risks • Health impacts from higher ozone levels due to hot summer days • Increased risk of asthma and other respiratory diseases • Increased risk of vector-borne diseases
Wildlife	• Heat, drought, and reduced snowpack impact wildlife populations • Increases in invasive species

Disproportionate Impacts and Climate Equity in Colorado

House Bill 19-1261, Colorado's Climate Action Plan, directs the AQCC to identify communities disproportionately impacted by climate change to ensure that the actions the state takes to reduce emissions include strategies to reduce harmful air pollution affecting those communities. In identifying these communities, the AQCC is directed to consider communities of color, low-income residents, and tribal or indigenous populations. The statute also identifies that disproportionate impacts may result from increased vulnerability to environmental degradation, lack of opportunity for public participation, or other factors. The AQCC is required to prioritize and direct the benefits of regulatory compliance, including economic, health, environmental, and resiliency benefits, to disproportionately impacted communities. Furthermore, the statute requires the state to solicit stakeholder input on advantages of different regulatory measures, specifically soliciting input from disproportionately impacted communities, and requires the state to evaluate any impacts of potential rules on those communities.

As Colorado designs policies to meet its GHG targets, the state must recognize that the effects of air pollution and climate change on human health, safety, and economic prosperity do not affect all people equally. People of color, the sovereign Tribes in Colorado, lower-income individuals, historically underrepresented groups, and those experiencing multiple

environmental burdens and social factors, such as systemic racism, are often most severely impacted.

Studies show that lower-income individuals and people of color experience increased health impacts and premature death due to exposure to particulate matter in the air.[xxii] Individuals and families who may already be dealing with chronic health conditions, inadequate healthcare or insurance, or a lack of access to trustworthy information may be more vulnerable to impacts from air pollution and climate change.[xxiii] Communities that face impacts from pollution often face multiple impacts and a greater frequency of more intense exposure to pollution— often including the confluence of industrial facilities, highways, and other sources of air pollution— and a correlation to higher frequency of upper respiratory health problems and other dangerous health impacts. These communities frequently face additional factors that compound the negative impacts of pollution like homes with poor ventilation and, in the current environment, factors that increase the risks associated with COVID-19, such as more crowded living conditions, doing essential work, or working in occupation that cannot be done remotely. Especially in communities with inadequate or poorly maintained infrastructure, with less access to air conditioning, and with greater reliance on public transportation for mobility, high levels of particulate pollution, very hot days, and natural disasters can be dangerous, or even deadly.

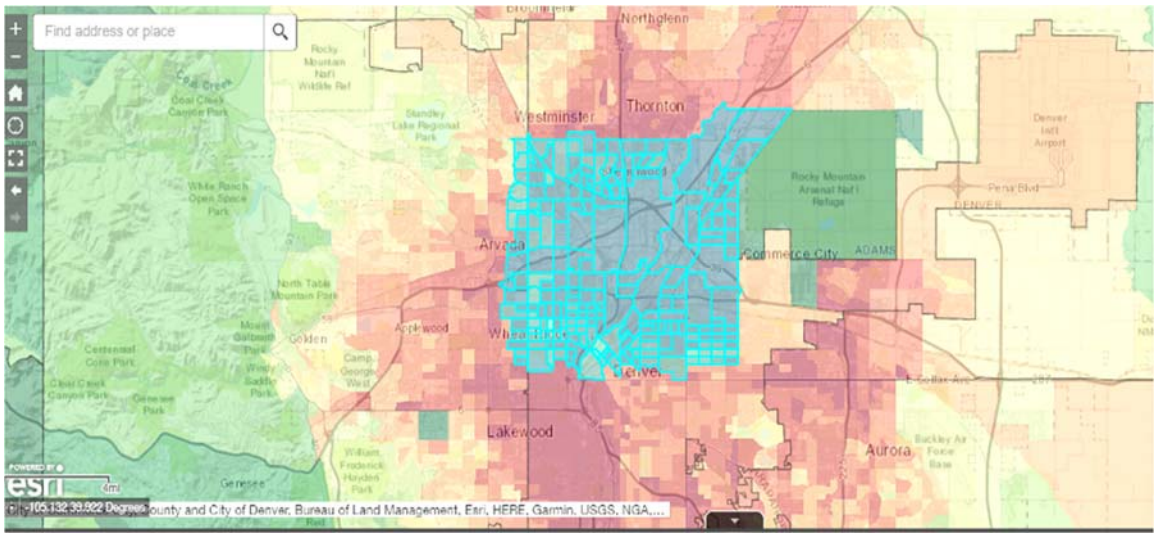
Greenhouse gas reduction policies and programs must be developed with direct input and consideration from disproportionately impacted communities, along with significant analysis to improve understanding of how those policies will impact those communities. Climate action and air quality improvement strategies that are informed by community concerns and priorities, and that are designed creatively to promote equity and enhance quality of life will encourage buy-in and result in lasting change.

CDPHE is using data mapping to identify impacted communities by showing the geographic distribution of specific demographic data, cumulative environmental burdens, and certain health conditions across the state. In the map below, areas in darker red have higher impacts, often resulting from experiencing a multiple of these factors. The data viewer will be a tool to help the state prioritize community engagement efforts and be a lens through which state agencies and stakeholders can consider potential impacts of policy and regulatory decisions.

Colorado's Climate Equity Framework

To ensure that climate policies and programs effectively promote racial equity and economic justice, they must be designed intentionally and strategically and with input from impacted communities.

The **Climate Equity Framework** is a guidance document that helps identify disproportionately impacted communities across Colorado, based on statutory guidelines from HB 19-1261. The



Area in darker red have higher health and impacts.

Framework details best practices for effective outreach and engagement. It also identifies ways to improve access to participation in rulemaking processes, such as providing meetings and materials in common spoken languages such as Spanish, providing evening meetings, and making the public comment process as simple and convenient as possible. The framework also provides a set of questions to be asked before rule concepts and language are developed and during rulemaking proceedings to make sure equity considerations are meaningfully demonstrated in the outcomes. CDPHE will use the equity framework to guide processes at the AQCC and other commissions. The Colorado Oil and Gas Conservation Commission also adopted regulations in November 2020 to incorporate environmental justice into its permitting decisions. These measures are one part of the state's commitment to creating a foundation for equitable climate action.

Key equity principles shaping Colorado's climate response:

Principle 1: Equitable Representation - The GHG policy process should make it possible for any interested person to easily participate. Policies that impact communities should be shaped by community input.

Principle 2: Prioritizing Benefits - For GHG reduction strategies with the potential to provide direct benefits to individuals or communities, disproportionately impacted communities should be prioritized.

Principle 3: Economic Impacts - GHG reduction strategies should reduce costs, including currently externalized costs, and increase economic benefits, especially for disproportionately impacted communities wherever possible.

Principle 4: Health Impacts - GHG reduction strategies should minimize negative health impacts and improve health for disproportionately impacted communities.

Principle 5: Access to Solutions - GHG reduction strategies should ensure that clean technologies are made available to everyone who wants them, in ways that make sense for them.

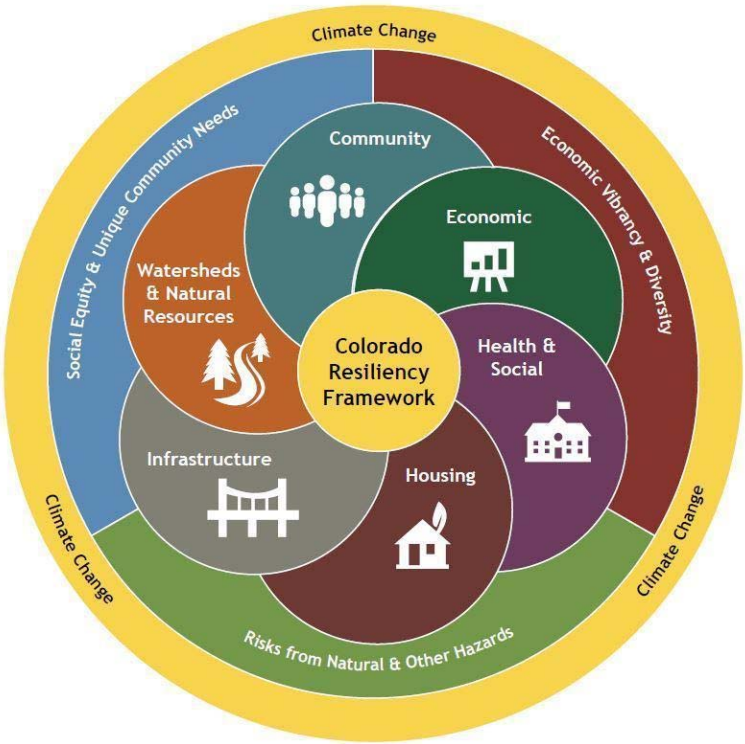
Principle 6: Building Resilience - GHG reduction strategies should improve resilience and quality of life for disproportionately impacted communities.

Resilience Planning in Colorado

Climate change poses one of the biggest threats to Colorado's resiliency to future shock events and long-term stressors. With prolonged and more intense drought, more frequent and larger wildfires, and more frequent and intense flooding, climate change will continue to disrupt every part of our communities if left unaddressed.

Colorado continues to plan for how to address these and other climate-related threats. As a central part of this work, the Colorado Resiliency Office updated the Colorado Resiliency Framework ("Framework") in 2020.

Figure 13: Colorado's Resilience Framework



With the release of the Framework in 2015, Colorado led the nation as the first state to develop and implement a framework for holistically addressing risks and vulnerabilities to acute shock events (like a wildfire or

pandemic) and long-term stressors (like climate change, housing affordability or aging infrastructure), particularly those related to natural hazards including wildfire, drought, and flooding.

With the five-year update in 2020, the Framework includes priority strategies that address the impacts of Climate Change in three major areas of focus: Risks from Natural & Other Hazards, Social Equity & Unique Community Needs, and Economic Vibrancy & Diversity. The Framework contains an inner circle of six overlapping resiliency sectors to be considered holistically in developing resiliency solutions. As a result, the Framework's priority areas of focus are defined as having Climate & Natural Hazard Resiliency, Building & Infrastructure Sustainability, Agriculture & Food Security, Housing Attainability, a Future-Ready Economy & Workforce, and Community Capacity. These strategies will enable state departments and partners to:

- Identify and mitigate risk to Colorado communities
- Enhance resiliency planning and capacity in Colorado communities through equitable engagement and regional collaboration
- Develop, align, and streamline policies to empower resiliency
- Create a culture of inclusivity that fosters resiliency, equity, and holistic solutions, and an inherent sense of responsibility to one's community
- Ingrain equity and resiliency into investments in Colorado

The Roadmap: Purpose and Process

In the 2019 session, the Colorado General Assembly passed 14 pieces of legislation aimed at advancing clean energy and reducing the state's greenhouse pollution. House Bill 19-1261 the *Climate Action Plan to Reduce Pollution*,[xxiv] concluded:

> **Colorado is already experiencing harmful climate impacts, including declining snowpack, prolonged drought, more extreme heat, elevated wildfire risk and risk to first responders, widespread beetle infestation decimating forests, increased risk of vector-borne disease, more frequent and severe flooding, more severe ground-level ozone pollution causing respiratory damage and loss of life, decreased economic activity from outdoor recreation and agriculture, and diminished quality of life. Many of these impacts disproportionately affect rural communities, communities of color, youth and older adults and working families. Reducing statewide greenhouse gas pollution as outlined in this subsection (2) will protect these frontline communities, first responders, and all Colorado residents from these and other climate impacts.**

To reduce the potential that the state will see more severe impacts from climate change, Colorado's *Climate Action Plan* sets science-based targets for GHG pollution reductions of 26% by 2025, 50% by 2030, and 90% by 2050 from a 2005 baseline, and delegates authority to the Air Quality Control Commission to enact rules to make progress towards these goals. The statute also directs the AQCC to include strategies designed to reduce harmful air pollution affecting disproportionately impacted communities.

A key to equitable progress toward these goals is to promote the investment needed to modernize the economy more quickly in disproportionately and historically impacted communities. Transitioning towards a resilient, low carbon economy requires investments, regulations, and other measures by the state as well as federal and local governments. It will also require business investment and leadership and the engagement of the nearly six million Coloradans with more than five million vehicles and almost 2.5 million housing units.

HB 19-1261 provides that the Air Quality Control Commission can consider progress made through all of these means in developing regulations: "The implementing rules may take into account other relevant laws and rules, as well as voluntary actions taken by local communities and the private sector, to enhance efficiency and cost-effectiveness, and shall be revised as necessary over time to ensure timely progress toward the 2025, 2030, and 2050 goals."

2019 Colorado Legislative Action Addressing Climate Change

Climate Policy

Senate Bill 19-096: Collect Long-term Climate Change Data
Requires the AQCC to collect and report on GHG pollution, forecast future emissions, and adopt a state-wide GHG reporting rule by June 1, 2020 and to begin proposing rules to address emissions by July 1, 2020.

House Bill 19-1261: Climate Action Plan to Reduce Pollution
Establishes GHG pollution reduction goals of 26% by 2025, 50% by 2030 and 50% and 2050 from 2005 level. The bill allows the AQCC to consider other actions, including other statutes, administrative or regulatory policies, local plans and rules, and voluntary efforts as it promulgates rules to reduce pollution and ensure an equitable distribution of benefits.

Energy Efficiency

House Bill 19-1231: New Appliance and Water Efficiency Standards
Updates and adopts energy efficiency and water efficiency standards for certain appliances and plumbing fixtures.

House Bill 19-1260: Building Energy Code
Requires cities or counties to adopt one of the 3 most recent energy conservation codes when they update building codes.

Electric Vehicles

Senate Bill 19-077: PUC Electric Vehicle Infrastructure Programs
Starting in 2020, requires regulated electric utilities to file a plan every three years to invest in electric vehicle infrastructure and to support customers' investments in electric vehicles.

Senate Bill 19-239: Address Impacts of Transportation Changes
Required CDOT to convene and consult with a stakeholder group to examine impacts of new transportation technologies and business models, identify means of addressing impacts, and report findings and make recommendations to the general assembly (completed in 2019).

House Bill 19-1159: Modification to EV Tax Credits
Extends the tax credits for purchase of an EV or hydrogen fuel cell vehicle through 2025.

House Bill 19-1198: EV Grant Fund
Allows CEO to provide grants for and to offset operating costs for charging stations.

Modernizing Utilities and Oil and Gas Development

Senate Bill 19-181: Protect Public Welfare Oil and Gas Operations
Changes authority over surface impacts of oil and gas development and directs adoption of rules to minimize air pollution from oil and gas operation and strengthen protections for health, safety and the environment.

Senate Bill 19-236: Public Utilities Commission (PUC)
Directs the PUC to use a social cost of carbon in utility resource planning, to investigate utility rates, utility regulatory models, and the impacts of joining an organized electricity market. Requires the PUC to promulgate rules addressing utility resource and distribution system planning. Requires utilities to submit a workforce transition plan when proposing retirement of a coal-fired power plant. Requires Xcel Energy to file a plan to reduce carbon emissions by at least 80% by 2030 and permits other utilities to file plans to meet that target.

House Bill 19-1003: Community Solar Gardens Modernization Act
Increases the size of an individual community solar garden (CSG) to 5 megawatts and removes certain location restrictions.

House Bill 19-1272: Housing Authority and New Energy Improvements
Clarifies that housing authorities may use the Colorado Commercial Property Assessed Clean Energy(C-PACE) program to finance energy improvements.

House Bill 19-1314: Just Transition from Coal-Based Energy Economy
Creates the Just Transition Office, provides support to coal workers, provides grants for communities impacted by the coal transition, and requires electric utilities that propose to retire a coal-fired power plant to file a workforce transition plan with the Just Transition Office.

Legislation enacted in 2019 also directs the AQCC to conduct enhanced and more frequent collection of greenhouse gas pollution data from sectors across the state's economy and to report that data to the public. The data reporting is to include historic emissions and an improved forecast of future emissions. The ongoing tracking and reporting of emissions, including projections of potential future emissions, will help ensure that Colorado remains on track toward meeting its goals.

After the passage of this legislation, Governor Polis directed state agencies to work together to develop a Roadmap for pollution reduction to inform how Colorado can make progress toward the emission targets in the *Climate Action Plan*. To achieve this goal, the Roadmap assesses the various sources of the state's greenhouse gas pollution and identifies policy actions and other strategies Colorado can prioritize to reduce greenhouse gas emissions while also reducing other air pollutants, cultivating a strong economy, and addressing inequities in economic and health outcomes.

State agencies, including the Colorado Energy Office and the Departments of Public Health and Environment, Agriculture, Natural Resources, and Transportation, with additional support from other agencies, worked together to develop the Roadmap. In addition, Colorado hired Energy + Environmental Economics, a leading national consulting firm, to provide greenhouse gas modeling used in the Roadmap.

The development of the Roadmap included (i) an assessment of the 2005 baseline, (ii) the modeling of different emissions scenarios, and (iii) the development of policies Colorado can implement with a focus on early action to address the 2025 and 2030 GHG reduction goals.

The Roadmap evaluation finds that as a result of prior policies as well as legislative, regulatory and other actions taken during the last two years, Colorado is on a path to a greenhouse gas reduction of 13% in 2025 and 26% in 2030. The evaluation shows that additional actions are needed and the

Roadmap identifies administrative, regulatory, legislative, investment, procurement, incentive-based, and other measures to progress towards the 2025 and 2030 GHG reduction goals in an equitable and cost-effective way.

Phase I - Developing the 2005 Baseline

The *Climate Action Plan* sets targets for GHG pollution reductions measured from a 2005 baseline. The 2019 *Colorado Greenhouse Gas Inventory Update Including Projections to 2020 & 2030*, which reassessed the state's 2005 emissions, identified that, "There is still considerable uncertainty in much of the activity data, the emission factors, and many calculation methods" of the approach used in the modeling for that report.[xxv] To resolve those issues and harmonize E3's modeling with the state inventory, the development of the Roadmap began in December 2019 when state agencies and E3 began gathering data and reassessing the 2005 baseline greenhouse gas emissions inventory for Colorado. In addition, the agencies and E3 worked with a Technical Advisory Group of Colorado-based experts (see sidebar) to evaluate the design of the Roadmap analysis, including model inputs and assumptions. The state also met with other stakeholders conducting emissions modeling exercises to understand the similarities and differences in their respective efforts. As part of this process, the Roadmap team adjusted baseline inventories of oil and gas methane emissions upwards to better reflect current scientific understanding of emissions.

Technical Advisor Group

Early in the process, the State sought input and feedback from a Technical Advisory Group:

Dr. Morgan D. Bazilian - Director, Payne Institute, Colorado School of Mines

Jill Cooper - Senior Principal, Geosyntech

Dr. Bryan Hannegan - President and CEO, Holy Cross Energy

Jeffrey Lyng - Director of Energy and Environmental Policy, Xcel Energy

Dr. Keith Paustian - Distinguished Professor Department of Soil and Crop Sciences, Colorado State University

Dr. Gabrielle Petron - Research Scientist NOAA ESRL Global Monitoring Division

Tracy Winfree - Senior Program Manager CDR

Lee White - Managing Director Stifel Public Finance

Additional documentation about the Roadmap process and technical appendices are available from the Roadmap webpage.

Phase II - Building the Baseline and Early Policy Development

In early 2020, E3 began modeling the trajectory of Colorado's greenhouse gas pollution under a **Reference Case Scenario**. This reference case models an emissions trajectory based on policies and actions taken prior to 2019.

E3 also modeled a **2019 Action Scenario** to show the GHG emissions reductions from utility commitments, legislation, and administrative actions taken since January 2019. This evaluation, initially done prior to the COVID-19 pandemic, shows that Colorado is on course to achieve a 13% reduction in GHG pollution by 2025 and nearly halfway to the 2030 target of a 50% reduction from 2005 levels. Because the 2019 Action Scenario showed that Colorado needs to take additional actions to meet its goals, the state directed E3 to model an illustrative target scenario that shows one possible set of investments and transitions across the economy that meets the targets established in the *Climate Action Plan* (**1261 Targets Scenario**).

Table 4: Key Assumptions in the Reference and 2019 Action Scenarios

Sector	Measure	Reference Scenario	2019 Action Scenario
Buildings and Industry	Energy Efficiency	Utility efficiency programs; appliance standards	2019 New Appliance Standards (HB 1231)
Transportation	CAFE Standards	Extended through 2026	
	Zero Emission Vehicles (ZEVs)	Economic adoption (EIA), 9% sales by 2030	Navigant modeled scenario, 42% sales by 2030
Electricity Generation	Coal Retirements	Planned retirements (pre-2019 announcements)	Recent announcements (Craig 2 and 3)
	Distributed Solar	Projected trends in rooftop solar adoption	
	Carbon Targets	N/A	80% GHG Reductions by 2030, Tri-State and Xcel targets by 2050, SB 236
Oil & Gas	Control regulations	Post 2018 regulation impacts not currently modeled	
Waste and Refrigerants	Total Emissions	Grow with population, no measures	
Agriculture and Coal Mine Methane	Total Emissions	Remain constant, no measures	

Throughout the winter of 2019 and spring of 2020, the Roadmap team continued meeting with members of the Technical Advisory Group to discuss the on-going modeling efforts. In February, the state agencies also provided the first of a series of regular updates on the status of the Roadmap to the AQCC. These updates included a discussion of any revisions to methodological assumptions, key findings, and potential policies the state might evaluate for early action. AQCC provided time for public comment on the Roadmap at each monthly meeting where the Roadmap team provided an update. In

addition to extensive written comments the AQCC also heard 23 public comments in February, 66 comments in April, and 47 comments in October regarding the draft Roadmap.

During this phase, the Roadmap project team began holding meetings with different groups. Over the course of the development of the project more than 60 meetings were held with groups representing local governments, the Southern Ute Indian Tribal leadership and environmental program staff, the Ute Mountain Ute Tribal environmental program staff, the business community, environmental advocacy organizations, the outdoor recreation industry, utilities, the oil and gas industry, mining, farmers and ranchers, and organizations representing disproportionately impacted communities.

Feedback from these meetings led to several changes in the report. First, as the COVID-19 pandemic began to take hold, the Roadmap team heard from many groups that the modeling needed to reassess certain assumptions in light of changes to oil and gas development, driving habits, and the state's economy from COVID-19. The Roadmap includes this sensitivity analysis, which is designed to show a reasonable potential of the impacts of the COVID-19 pandemic on the state's overall GHG emission trajectory. Also in response to feedback, the Roadmap team conducted further review of the baseline emissions from oil and gas development, ultimately revising the numbers to align with best current information and practices.

The team also received feedback that the Roadmap should include a more targeted assessment of pollution reduction from any specific policies that the state is considering for early action to demonstrate that those policies will ensure progress toward the 2025 and 2030 goals. That analysis is now included in this report and referred to throughout as the state modeling or Colorado modeling.[xxvi]

Phase III - Refinement of Policy Alternatives

During the course of summer 2020, E3 and state agency staff began the third phase of the project, modeling emissions reductions across sectors of Colorado's economy that would enable the state to make progress toward meeting the *Climate Action Plan* goals. The state team also began to evaluate potential additional administrative, regulatory, legislative, procurement, incentive-based, and other measures to advance toward the 2025, 2030, and 2050 GHG reduction goals in an equitable and cost-effective way.

Through the summer months the state staff continued providing updates to an AQCC subcommittee and meeting with stakeholder groups. State agencies held a virtual, online public listening session in August 2020. More than 300 Coloradans joined the two-hour event, which was hosted in Spanish and English. The state held a second listening session in October, which over 200 people attended. Over the course of the Roadmap development process, CEO received roughly 370 public comments through the Roadmap webpage.

Throughout the process, the Roadmap has been developed to help inform policy making and to ensure progress toward meeting the emissions targets in the Colorado Climate Action Plan. Making progress toward these emission targets will be a total state effort involving agencies and departments across state government. It will also be iterative and multi-faceted in nature and require a broad portfolio of investments, incentives, and regulatory and legislative strategies. Because the state government cannot do it alone, it is the intention to partner with a diverse array of local governments and public and private partners.

The GHG Roadmap represents a significant step forward for climate action and pollution reduction planning at the state level, advancing Colorado's policy and programmatic vision for pursuing timely, enduring and equitable strategies. Progressing toward these goals will continue to be

iterative and multi-faceted, as continued engagement is encouraged from a diverse set of stakeholders from across the state.

Community Engagement Highlights

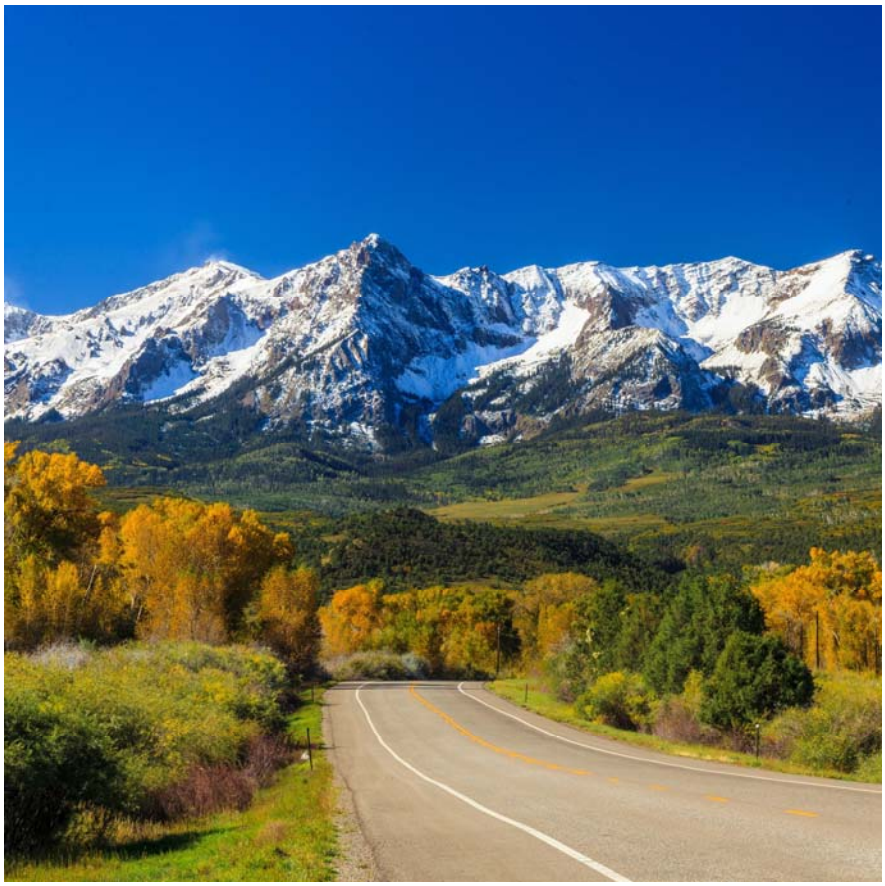
~600 community members participated in feedback sessions

+2,200 emails received

+50 small group meetings held

Key findings

- The largest sources of GHG pollution in Colorado are transportation, electricity generation, oil and gas production, and fuels use in the residential, commercial and industrial space.
- Achieving Colorado's 2025 and 2030 GHG emissions targets is feasible with existing technologies, but would require actions, laws, and policies beyond those Colorado has taken already.
- Achieving the 2030 goals would rely on deep reductions in pollution from electricity generation by continuing the transition to renewable energy, as well as deep reductions in methane pollution from the oil and gas industry, which makes up the largest source of non-combustion emissions in the state.
- Making changes to transportation planning and infrastructure to reduce growth in driving is an important tool in reducing emissions.
- Electrification of end uses in buildings and transportation will play an important role in achieving these targets, with action needed in the near term to accelerate the transition.
- By 2050, very high levels of electrification of vehicles will be needed, with nearly 100% of all cars on the road being electric and a 100% market share for zero emissions trucks among new sales.
- Reducing methane emissions from landfills, sewage plants and other sources, and enhancing waste reduction, recycling and diversion efforts, is also necessary, especially to reach emissions targets after 2030.
- Protecting, restoring and enhancing the resilience of Colorado's natural and working lands is critical for sequestering carbon.
- These transitions will reduce air quality burdens that impact lower income communities and communities of color disproportionately.
- In each of the sectors, policy will need to be carefully designed to ensure that benefits are distributed equitably.



The policies in this Roadmap build on earlier commitments Colorado made to address the climate crisis, including leading the transition to renewable energy, adopting aggressive goals for clean and electric vehicles, and passing legislation to clean up or retire coal-fired power plants. This work would not have been possible without a strong partnership among the General Assembly, public interest groups, private sector leaders, local governments, and the public. The findings in this Roadmap are supported by the analysis conducted by E3 and the additional work done by the state Air Pollution Control Division.

NEAR TERM ACTIONS TO REDUCE POLLUTION

The Roadmap incorporates and builds on the existing legislation and policy framework. The Roadmap assesses the sources of the state's greenhouse gas pollution and identifies a series of policy actions the state can take to reduce GHG pollution. The report focuses primarily on near term action, meaning action that may be implemented over the next one to two years to make progress toward Colorado's 2025 and 2030 GHG targets. The Roadmap also considers a range of other actions that help ensure that Colorado is on a pathway to meet its 2050 target of a 90% reduction in GHG pollution from its 2005 level.

The plan presented here was developed with the help of ten months of conversations with disproportionately impacted communities, community leaders, Colorado's farmers and ranchers, the Southern Ute Indian Tribe, the Ute Mountain Ute Tribe, faith groups, business leaders, environmental organizations, industries affected by the transition, and other Coloradans. State agencies received feedback on a wide array of topics, including recommendations on how to model GHG pollution and what policies should be considered to reduce those emissions.

Making progress towards Colorado's 2025 and 2030 GHG pollution reduction goals is feasible but will require continuing the transition to renewable electricity generation to achieve an 80% reduction below 2005 levels by 2030, reducing methane emissions from the oil and gas sector more than 50% by 2030, increasing investments in energy efficiency and expanding electrification of buildings and industry. Reducing pollution from transportation requires a transition to electric vehicles and reductions in VMT, but by the end of the decade will also require expanding the use of clean fuels such as biogas. The state will also need to seek reductions in non-

combustion GHGs, through leak reduction from fossil gas utilities and oil and gas development, waste diversion to minimize organics in landfills, and through capture of biogas from sources like landfills, wastewater treatment plants, and farms. Significant reductions in methane emissions from the oil and gas industry may also be necessary. The following diagram shows the major sources of GHG pollution in Colorado.

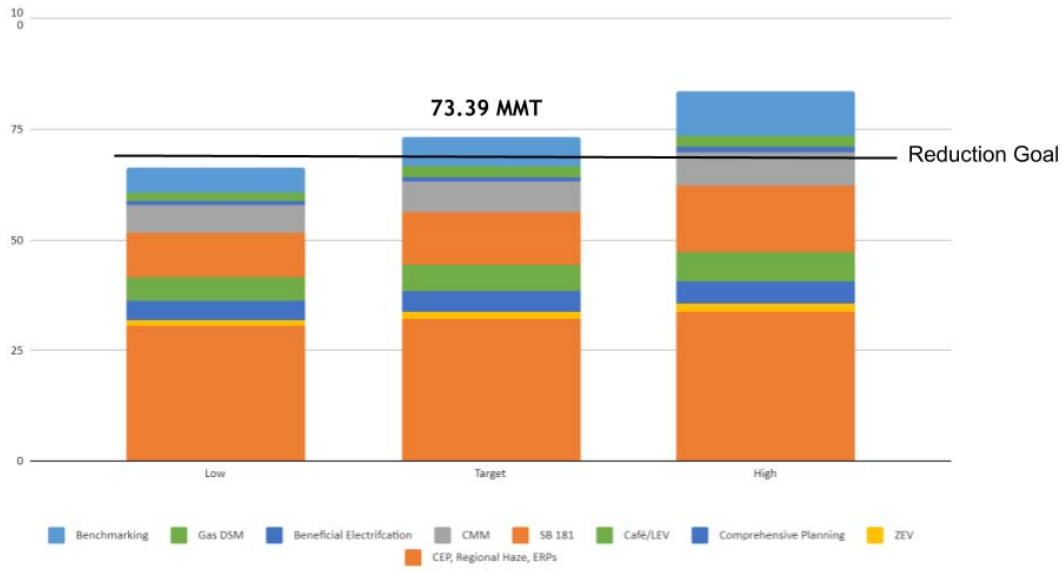
Figure 14: 2020 CO GHG Emissions (MMT CO2e, AR5 100-yr GWP)

Summary of Near Term Action Plan

Colorado's largest four sources of GHG pollution are transportation, electricity generation, oil and gas, and fuel use in buildings and industry.

As shown in figure 15 (below), two sectors— electricity generation and oil and gas— account for approximately two thirds of the total 2030 reductions needed to reach the state climate goals.

Figure 15: Comparison of State Pollution Reduction cases



Colorado projects a 32 million ton reduction in emissions from electricity and a 12 million ton reduction in emissions from the oil and gas industry under the near term action plan. These sectors play such a large role in the near term reductions for several reasons. First, each is a large source of current emissions. Second, reductions can be achieved at a reasonable cost with existing technology. Third, in each of these sectors the majority of the emissions come from a small number of emitting sources. This can be contrasted with the transitions that are necessary to achieve savings in the

built environment and transportations sectors, which will come through the actions of millions of Coloradoans making individual decisions and investments.

For electricity, the dramatic decline in the cost of wind, solar, and battery storage has made deep emissions reductions possible, often at a cost savings. The costs of new utility scale wind and solar, with some associated battery storage, are lower than the cost of operating existing coal generation. This shift is allowing utilities to retire coal generation and replace it with wind, solar and storage, using existing natural gas generation (or in some cases small additions of gas combustion turbines) as backup to the renewables. There is high confidence that the state's utilities can achieve the target of at least an 80% reduction by 2030 without significant rate increases to their customers. The six utilities that operate more than 99 percent of the state's fossil-fired generation, Xcel Energy, Tri-State Generation and Transmission, Colorado Springs Utilities, Platte River Power Authority, Black Hills Energy, and Holy Cross Energy, have already committed to resource plans that meet or exceed an 80% GHG reduction by 2030.

The state is not proposing to require reductions greater than 80% by 2030 across the board, although it is hopeful that the 80% reductions might be reached earlier or exceeded by 2030. Despite the low costs of renewables, getting all the way to 100% carbon free generation across the entire state will require some combination of technological development and price declines for long duration storage and firm zero carbon generation as well as broader access to regional markets for electricity and greater integration of flexible demand into the grid. Despite these challenges, some utilities have committed to deeper, cost effective reductions by 2030. Platte River Power Authority has adopted a plan for 90% reductions and Holy Cross Energy has committed to 100% carbon free power by 2030. State agencies will engage in the PUC process to consider Xcel Energy and Tri-State's electric resource and

clean energy plans to help ensure the maximum level of cost effective emissions reductions.

The oil and gas production, processing, and transmission sector has many opportunities to reduce methane emissions at relatively low cost. The E3 analysis found a cost of only $4/ton CO2e. Many leading oil and gas producers have made environmental, social, and governance commitments that include reducing methane emissions to 0.2% of production volume by 2025. Major advances have been made towards the ability to do continuous emissions monitoring. Based on the commitments made and technologies available, setting a regulatory requirement for a greater than 50% emissions reduction by 2030 is feasible. This will result in a roughly 12 million ton reduction by 2030. A CDPHE-led stakeholder process will allow a full exploration of how best to structure this requirement, leading to an AQCC rulemaking in late 2021.

The other two largest sources of emissions (transportation and fuel use in buildings and industry) are very different in character from electricity and oil and gas. The reductions in transportation are comparable in magnitude to those from oil and gas, approximately 12 million tons CO2e by 2030, but about half of this is from the gradual turnover of older to new cars and trucks that meet existing federal and state vehicle emissions standards. The future actions in the near term action plan will lead to approximately 6 million tons of additional reductions by 2030. The reductions from fuel use in buildings and industry will be about 4.7 million tons by 2030.

Reducing emissions from vehicles and fuel use in buildings and industry will require changes to transportation planning and land use decisions made not only by the state but by numerous local governments. The transition will also require millions of individuals and businesses to make decisions about how they travel, the vehicles they use, and about energy use in their homes and businesses. These are not sectors that can be addressed through

overarching rules or emissions caps. While there is a role for regulation in areas such as vehicle standards, requirements for gas and electric utilities to support end use energy efficiency and electrification and make use of biogas, industrial energy and emission audit requirements, and building codes and performance standards, many of the necessary changes will require incentives to encourage action, public investment, outreach and education and industry leadership through efforts such as national-scale electric vehicle production. These sectors also have a relatively long stock turnover time, with cars lasting 15 years or longer, trucks often being used for decades, and the time between major upgrades of buildings often being in the decades. Because of this, it is important to begin action now. Even though the emissions reductions from these near term actions will be relatively modest in the near term, they will grow to become very significant in the period after 2030.

The near term action recommendations also target reductions in methane emissions from waste through expanded waste diversion, recycling, and incentives and regulations targeting capturing and using waste methane. Emissions reductions from capturing and using methane are shown in the buildings and industrial fuel use category, since they will primarily displace fossil methane use in these sectors. The large reduction in emissions in the waste category (7 million tons) comes mostly from reductions in coal mine methane. This is because active mines emit far more than inactive mines, so as demand for coal drops and mines close, methane emissions drop significantly. The state agencies also received substantial feedback from a variety of stakeholders that the Roadmap should more actively address carbon capture utilization and sequestration (CCUS). The state is planning to create a task force to examine issues related to the potential development of CCUS in Colorado.

We also know that natural and working lands have an important role to play but are not yet able to quantify the impact of policies in this area. We

are pursuing a portfolio of measures to enhance our understanding and begin action in these areas.

Finally, in every one of these areas it is important to address how they can be implemented in an equitable manner. This needs to be addressed in each policy, but also in a holistic way, and the state intends to pursue strategies designed to enhance the opportunities for key stakeholders from disproportionately impacted communities to provide input and help design these policies.

We also note that many stakeholders have pointed out that while there is a high level analysis of the marginal costs of emissions abatement, the Roadmap does not provide a detailed cost benefit analysis for each regulatory proposal. This is true, but inevitable for such a broad analysis. As each proposal is brought to the appropriate regulatory body, the policy will be subject to the full review process required for adoption including costs and benefits. For example, under state law, rules brought to the AQCC will require rigorous regulatory and economic impact analysis, and participating parties may request full cost benefit analysis as part of the process.

Table 5 presents a summary of the near term actions by sector that the administration will pursue (this table also appeared in the Executive Summary). These actions are discussed in more detail in this section following the table.

Table 5: Near Term Actions to Reduce GHG Pollution

Sector	Near Term Actions	Targeted 2030 Emissions Reductions From 2005 baseline Million Metric Tons
Electricity	• **Adopt Clean Energy Plans and Electric Resource Plans, including evaluating plans using the full social cost of carbon emissions.** • **Incorporate coal plant retirements from utility commitments and adopted utility plans into AQCC Regional Haze rulemakings.** • **Evaluate mechanisms such as performance based regulation and other tools to create incentives for deeper emissions reductions and serving beneficial electrification loads with zero carbon generation.**	**32.3 mmt**
Transportation	• **State GHG pollution standards for transportation plans.** • **Trip reduction/Transportation Demand Management (TDM) requirements and encouraging telecommuting for large employers.** • **Clean trucking strategy with multiple components including infrastructure investments, incentives for fleet turnover, and evaluation of regulatory options. More details are on page 57 of the report.**	**12.7 mmt**

	• **Secure new revenue to fund infrastructure and incentives to transition to electric cars, trucks, and buses.** • **Offer incentives for land use decisions by local governments that reduce vehicles miles traveled, reduce GHG and other pollutants, and support greater access to housing near jobs.** • **Indirect source standards for some types of new development.** • **Expand public transit, including front range rail and RTD completing the statutorily required Fastracks system that voters passed in 2004 including NW rail (2025 Ridership:8,600-10,100).**[xxvii] • **Develop an EV Equity study to ensure access to EV's for all Coloradans.** • **Provide input into development of new clean car standards by both the federal government and for state-based standards.**	

Residential, Commercial, and Industrial Fuel Use (Gas utilities)[xxviii]	• **Expand energy efficiency investments from gas utilities to support building shell improvements.** • **Set carbon reduction targets and biogas requirements for gas utilities.** • **Require large commercial buildings to track energy use and make progress toward energy and pollution performance standards.** • **Support adoption of advanced building codes.** • **Require regulated electric utilities to create programs that support customer adoption of electric heat pumps and other forms of beneficial electrification.** • **Expand access to financing programs for building retrofits by capitalizing a green bank, expanding existing programs and advocating for utility on-bill finance programs.** • **AQCC action on industrial energy and emission audits requirements and Best Available Control Technology requirements, setting the stage for future performance requirements.**	**4.7 mmt**

Oil and Gas	• **AQCC rulemaking to achieve methane pollution reductions from the oil and gas industry - at least 33% reduction in total emissions by 2025 and over 50% by 2030.** • **COGCC implementation of new rules that eliminate routine flaring, require minimizing emissions, and track pre-production and production air emissions.**	**12.2 mmt**
Natural and Working Lands	• **Develop a comprehensive emissions inventory.** • **Develop a Natural and Working Lands Strategic Plan.** • **Increase producer utilization of Agricultural Energy Efficiency (AgEE) program.** • **Expand Advancing Colorado's Renewable Energy and Energy Efficiency (ACRE3) program.** • **Improve soil function and carbon sequestration through regenerative farming practices.** • **Support voluntary participation in such efforts as Field to Market, Soil Health Partnership and Precision Agriculture programs.**	**1.0 mmt**[xxix]
Waste	• **Reduce methane emissions from coal mines, landfills, sewage treatment plants, and agriculture through continued reductions in coal extraction, utility biogas incentives**[xxx]**, potential AQCC**	**7.5 mmt**

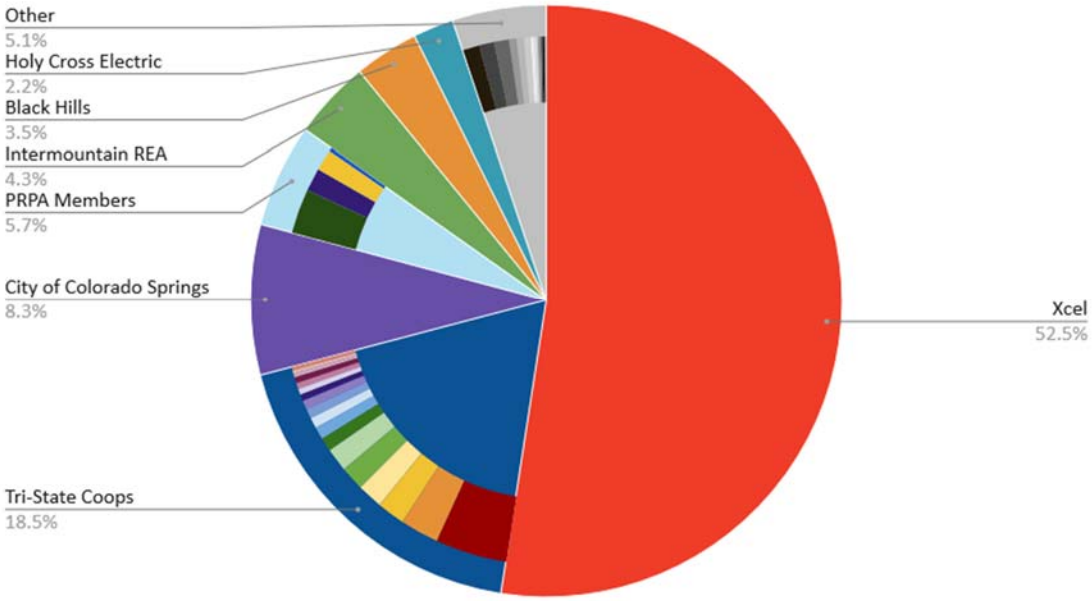
	rulemaking and grants for waste reduction and diversion through the Front Range Waste Diversion Enterprise and CDPHE. • Improve recycling end markets and recycling and reuse.	
Industrial Process Emissions[xxxi]	• Federal HFC reduction provisions adding to AQCC rules (refrigerants, aerosols, etc.)	**0.3 mmt**
Other Actions	• Advance the Governor's FY 2021-22 budget, which includes a number of innovative funding proposals that will help protect Coloradans from the existential threat of climate change, improve air quality, and position Colorado to seize the economic benefits of a renewable energy economy. More detail on the budget is included on page 92. • Convene a task force on Carbon Capture, Utilization and Storage (CCUS) starting in mid-2021, which will report to the Governor within a year on recommended framework, including policies and actions steps for advancing CCUS in Colorado. • Support local government and private sector climate action efforts.	**0.3 tons**

Electric Utility Sector

Colorado's utility sector is composed of 54 electric utilities and 12 gas utilities that provide the electricity and fossil methane that heat our homes and businesses and power the state's economy. As shown in the previous table of near term actions, the largest single opportunity for near term reductions is in the electricity sector, where the Roadmap is targeting an 80% reduction, or 32 million tons, below 2005 emissions levels by 2030. Utilities representing more than 99% of the state fossil generation have already committed to resource plans that meet or exceed an 80% GHG pollution reduction by 2030.

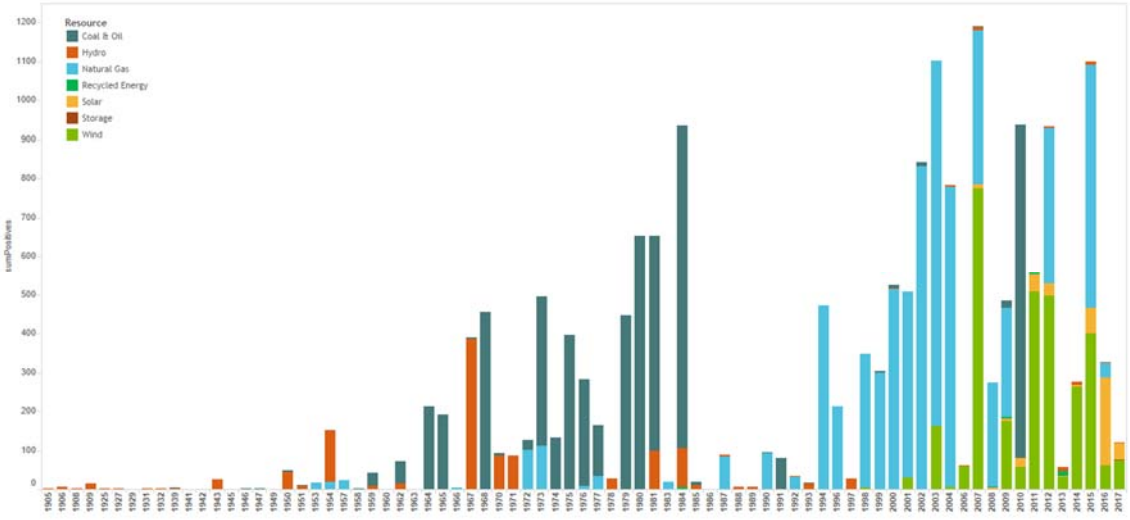
Xcel Energy is the state's largest electric and gas utility. As shown in Figure 16, Xcel accounts for roughly 52% of the state's electricity sales. Colorado Springs utility and Platte River Power Authority ("PRPA") are the second and third largest retail utilities in the state with a combined sales share of roughly 14%. Tri-State Generation and Transmission provides electricity to other utilities across Colorado and three other states.

Figure 16: Percent of Total Electric Sales in Colorado by Utility (2018 MWh)



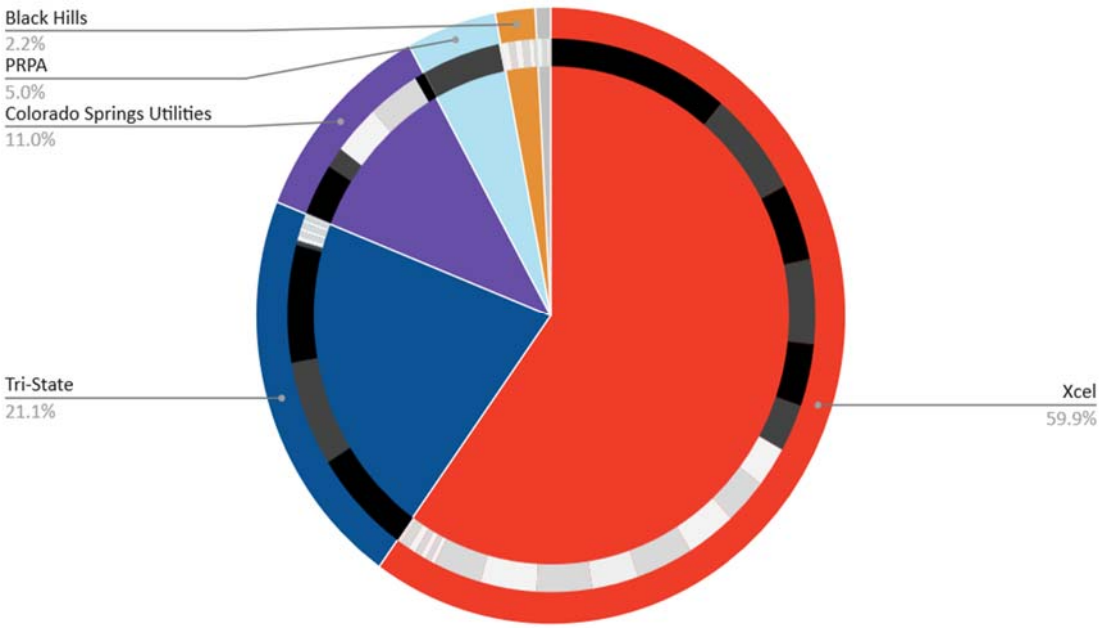
As shown in the figure below, Colorado has historically depended on coal-fired power plants to provide electricity. Starting in the 1990s, the state saw more investment in gas-fired generation. Then, in 2004, with the passage of a renewable portfolio standard, Colorado began to see increasing investment in wind and solar. As investments in wind and solar grew nationally and prices declined, the state saw additional growth in renewable resources. Colorado is positioned to further this transition by accelerating the retirement of fossil-fired generation, reducing GHG emissions, and meeting renewable generation goals.

Figure 17: Colorado Electric Generator Capacity by Type and Year Installed



Based on a recent analysis by the Colorado Energy Office, roughly 99% of the fossil-fired generation in the state is operated by only five utilities: Xcel Energy, Tri-State, Colorado Springs, PRPA, and Black Hills.

Figure 18: Percent of Fossil Fuel Generation in Colorado by Plant Operator (2019, MWh)



Clean Energy Plans and Voluntary Fossil-Plant Retirements

The current legal and regulatory framework in Colorado creates a pathway for the state's electric utilities to reach an 80% reduction in carbon emissions from 2005 levels by 2030. Legislation passed in 2019 requires Colorado's largest investor owned utility, Xcel Energy, to file a Clean Energy Plan with the Public Utilities Commission. The PUC ordered Xcel Energy to file its plan no later than March 31, 2021. By law, a Clean Energy Plan must demonstrate an 80% reduction in CO_2 emissions associated with the utility's Colorado sales in 2030, as measured from a 2005 baseline. Because a CEP is part of the utility's resource planning, the Clean Energy Plan will include power plant retirements and additions through 2030. The PUC can also consider whether it is economically beneficial to retire fossil-fired power plants earlier than scheduled retirement dates. Because of legislative changes in 2019, the retirements and additions will be evaluated, in part, using a social cost of carbon, which quantifies the impacts of GHG pollution and will therefore make it more expensive for a utility to use fossil fuel fired

power plants. Legislative changes in 2019 also authorized Xcel Energy to utilize a loan refinancing mechanism known as securitization, that could create savings for the benefit of ratepayers, communities, and workers directly impacted by the early retirement of fossil-fired power plants.

Colorado's second largest utility, Tri-State Generation & Transmission, submitted a resource plan to the PUC in December 2020 that targets an 80% reduction in emissions from the generation that serves load in Colorado. In the evaluation by the PUC of Tri-State's resource plan, the full social cost of carbon is required to be taken into account.

The combination of a 2030 GHG pollution reduction target and the potential for any utility to file a Clean Energy Plan provides an important framework to implement enforceable emissions reductions. Under the Clean Energy Plan statute, other utilities are permitted to file with the PUC Clean Energy Plans (CEPs) that meet the minimum target of reducing GHG emissions 80% by 2030. A utility with an approved CEP that demonstrates that they will achieve these reductions is given a "safe harbor" from further regulation of GHG emissions through 2030. The administration has worked with utilities to adopt plans that achieve at least an 80% emissions reduction. Platte River Power Authority has adopted a resource plan that will achieve a 90% emissions reduction by 2030 and Colorado Springs Utilities has adopted a resource plan that will achieve an 80% reduction. Holy Cross Energy has committed to 100% carbon free power by 2030. In January of 2021 Black Hills announced its intent to file a clean energy plan that will achieve an 80% pollution reduction by 2030. The administration continues to work with these utilities to file these plans as CEPs, making these voluntary commitments

Major Colorado utilities with commitments to meet clean energy goals of an 80% GHG emissions reduction by 2030:

Black Hills Electric

Colorado Springs Utilities

Platte River Power Authority

Tri-State G&T

Xcel Energy

enforceable to achieve deep pollution reductions and a quick transition to renewables.

Through the mandatory and voluntary filing of CEPs, a clear and complete picture of the ongoing transition of the Colorado electric utility sector will be publicly available and tracked to ensure the electricity sector achieves emissions reductions consistent with the modeling performed for this report. For those utilities not filing CEPs, the APCD will monitor ongoing reduction efforts to evaluate the need and benefits of pursuing any AQCC regulatory action needed to meet the state's goals. The APCD will include its evaluation of utility reduction efforts as part of the tracking included with the GHG Dashboard.

There may be opportunities to create additional regulatory mechanisms that can provide incentives for utilities to make even deeper GHG emissions reductions. For investor owned utilities, performance based regulation may be one option. Traditional utility regulation creates an incentive for a utility to make large capital investments such as building new power plants. Under a performance based regulatory framework, a utility earns based on achieving specific outcomes determined by state regulators. Such outcomes can include cost performance, meeting state pollution reduction or environmental goals, just transition outcomes, and environmental justice goals. Because performance based regulation is outcome driven, it may better enable the creation of financial mechanisms that can drive utilities to seek deeper GHG pollution reductions or incentivize the use of zero carbon resources to serve new electrification loads. There may also be other mechanisms that could be explored to incentivize deeper reductions, including from utilities whose rates are not regulated by the PUC.

The implementation of CEPs and the movement away from coal-powered electricity in the state also has significant benefits for human health. Reducing the co-pollutants from coal combustion, including

particulate matter (PM10 and PM2.5), Sulphur dioxide (SO2), ozone-generating oxides of nitrogen (NOx), and volatile organic compounds (VOCs), will improve health conditions such as asthma, chronic obstructive pulmonary disease, and other respiratory and cardiovascular diseases. These conditions are aggravated by exposure to the co-pollutants of coal combustion and are experienced more frequently by communities of color and low-income Coloradans.

Regional Haze Rule

Several of the announced early retirement dates for coal-fired electric generating units in Colorado will become codified through inclusion in Colorado's Regional Haze State Implementation Plan ("SIP"), providing legal certainty that these retirements will take place. The federal Regional Haze rules call for state and federal agencies to work together to improve visibility in 156 national parks and wilderness areas across the United States. In Colorado, there are 12 "Class I" areas that fall under the Regional Haze rule. EPA approved Colorado's first 10-Year Regional Haze SIP in 2012. Colorado's next Regional Haze SIP is due to EPA in July 2021. The AQCC has completed rulemaking that includes closure dates for 11 sources, mostly electric generating units at power plants around the state and a coal mine on the western slope. The intent is not to supplant the resource planning function of the utility governing boards and the PUC, but rather to take the coal plant retirement dates that have been established through these processes and incorporate them into the regional haze plan, making them enforceable. The projected emission reductions from these closures are up to 35,773 tons per year for visibility impairing pollutants (NOx, SO2, and PM). While the SIP is focused on these pollutants, it will have the co-benefit of locking in the associated GHG pollution reductions.

The table below (Table 6) projects an annual CO2e reduction of 21.7 million metric tons per year from coal plant retirements included in the Regional Haze rulemaking. The state bases these calculations on the

facilities' most recent representative three years (2016-2018) of operation. The retirements included in the Regional Haze SIP are not inclusive of all changes in the electric sector. The type and quantity of replacement resources and transmission improvements will likely be determined through each utility's resource planning process. We note that this does not yet include either the recent announcement from Xcel Energy that it plans to retire Hayden Unit 1 in 2028 and Hayden Unit 2 in 2027 or any additional or accelerated retirements that Xcel Energy may propose or that the PUC may require as part of Xcel Energy's March 2021 Clean Energy Plan. These changes likely would be included in the second phase of the Regional Haze rule at the AQCC.

Table 6: CO2e Reductions from Regional Haze Generating Unit Retirements

Facility/Unit	CO2e Reduction (metric tons)	Closure Date	Utility
Drake Unit 5	4,275	1/1/2017	Colorado Springs
Valmont	601,866	9/1/2017	Xcel Energy
Nucla	175,343	9/1/2019	Tri- State
Drake Unit 6	446,247	12/31/2022	Colorado Springs
Drake Unit 7	755,376	12/31/2022	Colorado Springs
Comanche Unit 1	2,090,251	12/31/2022	Xcel Energy
Comanche Unit 2	2,287,504	12/31/2025	Xcel Energy
Craig Unit 2	2,821,418	9/30/2028	PacifiCorp, Platte River Power Authority, Salt River Project, Tri-State Generation and Transmission Association, and Xcel Energy
Cherokee Boiler 4	1,427,354	12/31/2028	Xcel Energy
Rawhide Unit 1	1,963,468	12/31/2029	Platte River Power
Nixon Unit 1	1,242,179	12/31/2029	Colorado Springs
Craig Unit 3	2,445,888	12/31/2029	Tri-State
TOTAL	20,364,765	Metric tons	

Transportation Sector

The state is targeting a 12.1 million ton reduction from transportation by 2030. E3 projects that approximately half of this, 6 million tons, is the result of prior vehicle emissions policies which are resulting in older vehicles being replaced by cars and trucks built that meet current fuel economy and emissions standards. Despite the rise in population and vehicle miles traveled, the vehicle improvements required under these policies are resulting in modest reductions in GHG emissions. The state projects that the other 6 million tons will come from additional actions, including public investment, incentives, changes to transportation planning designed to reduce the growth of vehicle miles traveled, regulatory requirements, and increased adoption of zero emissions cars, trucks and buses.

Zero Emission Vehicles

The transportation sector is the single largest source of GHG pollution both nationwide and in Colorado. Nearly 60% of these emissions come from light-duty vehicles— the majority of cars and trucks that Coloradans drive every day. Pursuing the near-complete electrification of these vehicles by 2050, with an interim target of nearly 1 million light-duty EVs in service by 2030, will significantly reduce the state's overall GHG emissions while reducing harmful pollutants, saving consumers money, and producing complementary benefits to the state's rapidly decarbonizing electrical grid.

In April of 2020, the state released an updated Electric Vehicle Plan that establishes goals for zero emission vehicle adoption statewide, including having at least 940,000 EVs on the road by 2030 (including at least 1,000 transit vehicles), reaching near full electrification of the light-duty fleet by

2050, and reaching 100% zero emissions from new medium- and heavy duty fleets by 2050.

Because light duty vehicles tend to remain on the road for ten years or more, the plan identifies a number of strategies designed to increase consumer awareness, ensure equity in access to EVs, and continue the build out of the charging and fueling infrastructure needed to support widespread EV adoption. Achieving near full electrification by 2050 will require that EVs make up a high share of new vehicle sales in prior decades. To enable consumers to more confidently shift to EVs, potential regulatory action along with a number of complementary state actions will be essential, including ensuring consumer incentives to bring down the initial purchase price of vehicles, building out a statewide network of charging stations to ensure that EV drivers are able to easily access charging when needed, and accelerating the turnover of fleet vehicles, including in government fleets, to more rapidly get the oldest and most polluting vehicles off Colorado roads. Together, these actions will be critical to meeting the emissions reductions in the transportation sector.

It is critical that the transition to EVs provide benefits to low and moderate income Coloradans as well as rural and disproportionately impacted communities. While some benefits are universal— all of us benefit from lower levels of GHG pollution— other benefits, such as reduced fueling and maintenance costs and better vehicle performance are specific to those driving EVs. Lower levels of local air pollution and vehicle noise are specific to geographical areas with greater levels of EV adoption.

In 2021, the Colorado Energy Office will be conducting a stakeholder process leading to a study on EV Equity that will baseline, define, and map frontline communities that are or may be disproportionately affected by transportation pollution or experience barriers preventing their ability to equitably access electric transportation or the benefits of transportation

electrification. The report will assess barriers to EV adoption and will examine strategies to remove those barriers. Transportation air pollution, including MDV and HDV emission impacts, will be evaluated and summarized via mapping. Criteria to evaluate and prioritize potential programming, with stakeholder engagement, will be developed.

With this context in mind, the following set of strategies will be pursued in the transportation sector to achieve the GHG emissions reductions necessary to make progress toward the 2025 and 2030 targets.

- Post-2025 Clean Car Standards: In November 2018, the AQCC adopted Regulation 20 on Low Emission Vehicle ("LEV") standards for new light and medium duty vehicles sold in Colorado beginning in model year 2022. With that action, Colorado joined twelve other states and the District of Columbia in adopting California's vehicle standards under Section 177 of the Federal Clean Air Act. Currently, regulations requiring improvements in vehicle efficiency or Zero Emission Vehicle adoption beyond 2025 are not in place at either the federal level or in California. It is likely that both the federal government and California will soon pursue post-2025 standards. Colorado could adopt any future California standards as a means to reach deeper emissions reductions after 2025. The state can participate in the development of California and federal standards. Because adoption of policy in Colorado is contingent on California or the federal government adopting new standards that do not exist yet, it is likely a few years out before Colorado could consider updating its regulations. For those reasons, post-2025 vehicle standards are not included in the summary chart. However, the state will actively engage in rulemaking proceedings to help shape federal or state-based standards in the near term and will then make a decision on whether the new federal standards meet Colorado's needs or whether the state should initiate a rulemaking at the AQCC to adopt the state-based standards. The state's active

engagement in shaping future standards is included in the summary of near term action.

- EV Incentives for Consumers, including Low-Income Consumers: Current EV tax credits in Colorado are only available for the purchase or lease of new vehicles. Many consumers, particularly those in lower-income communities, are not able to use these incentives. Further, individuals and households must have the ability to carry these costs until they can be credited on the following year's taxes. Establishing new incentives that cut across electrification of multiple modes will help spread the benefits of transportation electrification more equitably to all Coloradans. Enabling incentives to be applied at the point of sale or lease will also ensure that these incentives can meaningfully reduce costs for Coloradans. One example of this approach comes from a recent PUC proceeding in which the Colorado Energy Office proposed that Xcel Energy, the state's largest utility, offer to its customers a rebate on new or used vehicles that would apply through the dealer at the time of purchase or lease. The proposal includes a recommendation to earmark a percentage of available rebate funds for used vehicles and for income-qualified households and would provide a larger rebate for income-qualified customers. The PUC approved a roughly $110 million TEP, which included $5 million in vehicle rebates for lower-income customers.

- Electric Bikes and Micromobility: The Colorado Energy Office is currently developing a pilot electric micromobility project to provide electric bikes and scooters to lower-income essential workers who have been negatively impacted by COVID-19-related public transit disruptions. This pilot project could result in subsequent scaling of this model potentially through legislation.

- EV Charging Infrastructure Incentives: Colorado has supported the build-out of publicly-accessible EV charging infrastructure at workplaces, public buildings, and along major travel corridors for years through the Charge Ahead Colorado and Alt Fuels Colorado programs and must continue to do so as the adoption of EVs grows statewide. Particular emphasis must be placed on filling gaps on the state highway network to allow for longer-distance travel and addressing the greater charging requirements needs of medium and heavy duty vehicles. In addition, installing chargers at multi-family housing will remove a significant barrier to EV access and allow renters and some lower-income individuals to more easily transition to EVs. Increasing the number of public DC fast-charging stations will provide those without access to home charging the ability to purchase an EV.

- Local Government EV Planning: While state regulatory and policy efforts to plan for and deploy zero emission vehicles and infrastructure are vital, local action by counties and municipalities is also needed. Some Colorado communities have taken the lead in developing vehicle electrification plans and investing in implementing those plans. However, many local governments lack the roadmap needed to begin making progress. State agencies can help local governments in taking this critical first step by providing grants, tools, and technical assistance for transportation electrification planning.

- Public Investment in Clean Vehicles and Infrastructure: Significant public investment will be needed to support electrification of medium and heavy duty vehicles. These include investment in infrastructure as well as vehicle purchase incentives. In addition, investment will be needed to both accelerate light duty vehicle electrification and to

make it equitable, through mechanisms that could allow lower-income Coloradans with old and inefficient cars and small businesses with older trucks to upgrade to electric vehicles or other zero emission vehicles. The level of funding that will be required to achieve the transition to high levels of zero emissions vehicles is unlikely to be available through the state general fund, and instead would need bondable and sustained long term revenue mechanisms that could be considered either as a standalone clean transportation measure or as part of a broader transportation funding package.

Clean Trucking Strategy and Fleet Rules

In July 2020, Colorado joined a multistate memorandum of understanding on zero emissions trucks. The Department of Transportation, along with CDPHE and CEO, announced plans to develop an all-of-the-above strategy to reduce pollution from medium and heavy duty transportation. With transportation now the largest source of air pollution in Colorado— and with our economy increasingly reliant on freight, as exemplified during the COVID-19 crisis— it is critical that we develop a thoughtful and balanced approach that provides a pathway for emissions reductions from medium and heavy duty vehicles. The draft strategy includes a suite of ideas that will be evaluated comprehensively, including through stakeholder input and in-depth technical evaluation, to determine the most impactful and reasonable actions. Possible actions include:

- Getting older vehicles off the road, especially replacing them with electric vehicles
- Providing incentives for cleaner trucks
- Planning for the fueling needs of zero emission trucks
- Building partnerships with fleets for short- and long-term planning
- Training people to maintain and repair new transport technologies
- Leading by example and working with other states to explore possibilities together
- Considering potential regulatory strategies such as fleet rules or the Advanced Clean Truck rule

As motor carriers have noted, decades-old diesel trucks, manufactured prior to the enactment of more recent federal emissions standards for medium and heavy duty trucks, play an outsized role in current fleet emissions of particulates and nitrogen oxides. The federal government strengthened vehicle standards beginning with Model Year 2014, and a second, stronger set of federal standards was scheduled to take effect in Model Years 2018 or 2021, depending on the class of vehicles. **Accelerating opportunities for fleet turnover within the conventional truck fleet, including diesel emissions reduction strategies, and continuing to pursue a variety of strategies to ensure that the diesel fleet is as clean as possible, should be an important component of a clean truck strategy.** Colorado is exploring a number of opportunities to design and support a public-private partnership program that focuses on displacing high emitting diesel trucks with cleaner models, especially emissions free. This should be structured to increasingly reward models that meet the most rigorous emissions standards, with the major focus on advancing zero emissions vehicle adoption.

As zero emission vehicle truck technologies, including electrification and hydrogen fuel cells proliferate, their success will depend on a robust network of charging and fueling infrastructure. Developing infrastructure to support zero emission vehicles in medium and heavy duty fleets is critical to

their success and the state is working with utilities and other industry partners to identify a strategy for supporting this sector with charging and fueling infrastructure.

Infrastructure improvements include incorporating clean technologies into key freight corridors and highway projects and developing a strategy for medium/heavy duty ZEV fueling infrastructure along these critical routes. These strategies include features such as runaway truck ramps and signage to designate steep grades and other safety concerns, and it should also incorporate improvements that facilitate cleaner trucking— be it fueling infrastructure or elements that can help reduce pollution along those corridors, including a careful look at the siting for charging and hydrogen fueling infrastructure, working with impacted communities, utilities, and industry partners. Considering that many of Colorado's freight corridors and industrial centers are located in close proximity to lower-income and disproportionately impacted communities such as Commerce City and North Denver, careful attention must also be paid to ensuring that these communities are early beneficiaries of cleaner and quieter medium and heavy duty electric vehicles.

State agencies are exploring opportunities for cleaner fleets by engaging with major fleet owners to discuss how best to support large scale transition to ZEV fleets, including identifying what vehicle classes work best for early adoption and what complementary policies can support fleet transition. The state is also working with shippers and carriers to explore acquisition of refrigerated trailers with electric standby units as well as having the necessary charging system to support those units at distribution or receiving sites. While major fleet operators control the purchase decisions for a large portion of the medium and heavy duty vehicles in operation in Colorado, the trucking industry is dominated by very small companies, 91.3% of which operate six or fewer trucks.[xxxii] These small companies often purchase used vehicles and the state will need to closely consider their needs

when designing purchase incentives to ensure that small fleets can also benefit from the efficiency and lower maintenance costs of electric vehicles.

Reducing emissions from last mile freight delivery and pickup will be an important part of meeting transportation emissions reduction targets. Both locally and on the internet, home and business deliveries have increased substantially, a trend that has only increased since the coronavirus pandemic, and downtown business areas have been particularly affected. As we seek to reduce emissions in our downtowns, diminish congestion and make these areas more multimodal and pedestrian-friendly, it is important to work with logistics companies and businesses on a series of strategies to achieve those objectives. These include the greater adoption of cleaner and zero emission vehicles, use of routing optimization software, providing advanced parking solutions for deliveries, establishing freight consolidation centers, encouraging off-peak deliveries, and creating strategies to reduce dwell time and idling. As in other elements of the Clean Trucking strategy, particular emphasis should be taken to ensure that disproportionately impacted neighborhoods surrounding freight hubs are prioritized for early adoption of EVs and charging infrastructure.

As manufacturers introduce new ZEV technologies into the medium and heavy duty market, we must explore all options to ensure that Colorado truck consumers have access to innovations that are being made available elsewhere in the country. Thus, as other states explore Advanced Clean Truck regulations, **Colorado is beginning an analysis of its own to evaluate the benefits and any drawbacks of joining the program, as well as potential regulatory flexibilities that may be allowable under the Clean Air Act should Colorado pursue rulemaking**.

CDOT, in collaboration with CDPHE and CEO, will engage in stakeholder discussions and have contracted with M.J. Bradley & Associates, a leading national consulting firm, to do a technical and economic analysis of the

potential for ZEV adoption in Colorado. The M.J. Bradley study, in conjunction with stakeholder input, will be used to inform a decision on what regulatory proposals will be submitted to the AQCC. The study should be completed in summer of 2021, with regulatory consideration at the AQCC in 2022. Any formal rulemaking proposal could include potential fleet rules requiring fleets above certain size thresholds to transition to ZEVs. In addition, Indirect Source rules, as described later in this section, could support ZEV adoption as a mechanism for mitigating emissions associated with some types of development.

Moving toward ZEV vehicles will require investments on the part of truck dealers, private repair shops, and fleets with their own on-site maintenance. These groups will need to retrofit or upgrade their facilities to perform maintenance on newer vehicle technologies and train mechanics and other personnel to service them. The state must begin working with and assisting truck dealerships and private maintenance shops in supporting workforce development that will be necessary for successful ZEV implementation. This could be part of a larger workforce development effort targeted at increasing the number of mechanics and technicians and supporting curriculum development at our vocation and technical schools. It is critical that the state work with these different maintenance operations on how we can better support the movement toward more ZEV trucks.

In addition to ZEV efforts, there are a number of existing strategies to improve the fuel economy of traditional diesel trucks that will also improve the efficiency and range of electric vehicles. The state can encourage private fleets to become involved in the SmartWay Transport Partnership, a collaborative program among logistics companies and the EPA. The program helps companies to adopt and implement technologies and strategies that will reduce emissions and improve fuel efficiency, including methods like aerodynamic packages and low rolling resistance tires.

The state is committed to "walking the talk" and will take a leading role toward reducing emissions from medium and heavy duty trucks, both in its own fleet and with those private fleets with which it conducts business through green procurement practices. The state is already working to turn over its light duty fleet to ZEVs and more efficient fleet vehicles—including reducing the footprint of vehicles, where possible, to categories that are available in more efficient models. As more ZEV and hybrid options become available in the medium and heavy duty market, state procurement targets should look to these vehicle classes as well. Further, the state will explore whether there are options to improve air quality performance on its projects during construction.

VMT Reduction Strategies

In addition to transitioning the fleet toward zero emissions vehicles, reducing the growth in vehicle miles traveled is a critical element of reducing pollution from the transportation sector. For 2030, the HB 1261 Targets Scenario models a 10% VMT reduction below the levels in the Reference Scenario. Land use decisions and providing more options to travelers is important to reducing the emissions impacts of driving. This includes both increasing access to clean transit vehicles but also providing more choices to manage demand, and associated pollution, on the roadways over time. Notably, VMT during the "Stay at Home" period of the COVID-19 pandemic was significantly lower compared to pre-COVID-19 levels. It is notable that VMT reductions hovered close to 10% during the summer of 2020 and were maintained for an additional period of months even though there was an uptick in economic activity during that time period. The state has embedded this 10% reduction in its projections based on the assumption that shifts in behavior over a meaningful period of time may make this reduced level of VMT sustainable, especially when coupled with supportive policies to help manage driving demand such as affordable housing close to job locations and ensuring that Colorado's economy remains in the top tier of the nation. This will likely require a suite of policy solutions, such as:

- Transportation Demand Management (TDM): Utilizing incentives, marketing, and other tools to encourage non-Single Occupancy Vehicle travel, is a core strategy in reducing VMT. Traditionally, this has meant working with employers to provide transit passes, encourage carpooling, and making multimodal options more appealing. In light of COVID-19, a specialized focus on making teleworking more permanent will be essential in promoting a longer-term shift toward alternatives to driving. This must be a concerted effort to support and encourage employees, employers, and local communities in reshaping the work commute. One strategy is trip reduction planning for large employers, which would ensure that employers over an employee size threshold develop TDM programs for their employees. The state intends to submit this proposal to the AQCC in 2021 for consideration in the transportation GHG rulemaking. TDM requirements can save companies money, save employees time, and are likely necessary to help achieve tight 70 and 75 ppb standards for ground level ozone. If the Denver/North Front Range Nonattainment Area is re-designated as Severe for ozone, TDM requirements will likely be required under the federal Clean Air Act.

- Land use planning and land use incentives: VMT is driven in part by the land use planning decisions made at local and regional levels. Designing and building communities that allow for and encourage the use of biking, walking, transit, and other low-carbon modes of transportation will decrease emissions. Local governments often make decisions that have the effect of separating housing at long distances from employment, as well as often placing major trip destinations,

such as grocery stores, schools, colleges and hospitals, far away from where people live, often far from public transit access, and often using exclusionary zoning to limit the ability to increase housing supply within communities. In many cases, limited state transportation funds are then used to try to address the high levels of traffic that come from these land use decisions. These land use patterns negatively impact the state budget and often lead to racial and social inequities as lower-income workers are forced into very long commutes, and worsen GHG and other air pollution. State agencies must work with local governments and metropolitan planning organizations to develop strategies to promote more sustainable land use planning. As part of this effort, the state will explore options for how best to incentivize smart land use decisions. It should also be noted that land use planning strategies can have a beneficial multiplier effect on other transportation policies. For example, pairing land use planning policies or incentives with vehicle electrification will result in higher GHG reductions than doing either policy in isolation. It is important to recognize the challenges in addressing this issue, particularly given the long history of local control of land use decisions in Colorado. State agencies will lead a study and stakeholder engagement process in 2021 that can develop detailed proposals for agency action and potential legislation in 2022.

- Integrate State GHG Pollution Standards and Analysis in Regional, and Statewide Plans: The transportation planning process in Colorado does not fully account for the impacts of GHG emissions when identifying and selecting projects for funding and construction. The Statewide Transportation Plan, Regional Transportation Plans, and Statewide Transportation Improvement Program are key documents that establish funding priorities for future years and decades, but do not meaningfully factor estimated increases or decreases in GHG emissions

into cost-benefit analyses of specific projects or entire funding programs. Establishing GHG budgets for projects, programs, and future plans and requiring the inclusion of the social cost of carbon in benefit-cost analyses will more accurately reflect the trade-offs between projects and allow for planners, decision-makers, and the public to evaluate them accordingly. For regional and state plans, a possible model is the existing air quality conformity process, in which CDOT would work with the AQCC to establish emissions budgets, as is done today for ozone and other criteria pollutants. The state can also more fully incorporate GHG emissions in project level environmental review. The specifics of such policies must be developed through close collaboration between CDPHE, CDOT and major metropolitan planning areas— especially those that are currently situated in nonattainment areas, which is where policies should be most focused, in order to maximize the co-benefits of reduced ozone pollution. This will be submitted to the AQCC for consideration in a summer 2021 transportation GHG rulemaking. Note that while this is listed under VMT reduction strategies, it will also support planning decisions and mitigation activities that support ZEV adoption.

- Enhanced multimodal options: Increased transit and active transportation options are critical to reducing VMT. This could include more investment in physical infrastructure such as mobility hubs or light or commuter rail (e.g., the proposed Front Range Passenger Rail project along I-25). It could also include more regular and reliable service along existing routes, such as more frequent and expansive bus rapid transit along congested corridors. Increased investment in transit and multimodal infrastructure can yield the behavior change required to get people out of their cars, as evidenced in Seattle, where a large ballot measure to fund light rail, enhanced bus services, and congestion mitigation, all contributed to a drop in VMT.[xxxiii] This will

require incorporating such elements into future transportation funding packages, and prioritizing multimodal options in programming existing revenue streams. For example, the Governor's FY 2021-22 budget request includes $70M for CDOTs Safer Main Streets and Revitalizing Main Streets programs which provides communities with funds for projects that encourage safe, multimodal and active transportation options for Colorado's downtowns and rural main streets.

Indirect Source Rulemaking

Indirect sources are recognized by the federal Clean Air Act as emissions sources that generate or attract motor vehicle activity, such as shopping malls, developments, office buildings, warehouses, or industrial sites. In California, regulation has been used to mitigate the impacts of these sources' vehicular activity on air quality more directly than motor vehicle emissions standards. This can be done through the NEPA process for some federally-funded or approved projects. For all or some categories of projects, indirect source rules could supplement local land use authority to ensure the impacts from large attractors of mobile sources are evaluated and mitigated. Implementation of this type of regulation could help encourage more sustainable, multimodal and transit-oriented development, and could generate mitigation measures that support electrification. In developing proposed standards, state agencies will work with disproportionately impacted communities to prioritize emissions reductions that will have direct public health benefits to these communities in addition to reducing GHG pollution. The intent is to develop a proposal for submission to the AQCC for consideration in a 2022 transportation rulemaking.

Clean Fuels Standard

A Clean Fuel Standard ("CFS") is designed to decrease the carbon intensity of the state's transportation fuels and provide an increasing range of low-carbon and renewable fuel alternatives. A CFS functions by establishing carbon intensity ratings for different fuel types based on their lifecycle

emissions impact and then establishing carbon intensity benchmarks that increase in stringency over time. Fuels that are below the carbon intensity benchmark generate credits while those above the benchmark generate deficits, and thereby a market is created that encourages greater investment in low carbon fuels and discourages continued production and use of high-carbon alternatives. A CFS could serve as a mechanism for continued progress toward reducing the emissions generated by the transportation system. The CEO conducted a feasibility study in 2020 that examined a range of clean fuel standard scenarios that would achieve reductions in carbon intensity of 10%, 15%, and 20% over 10 years.[xxxiv] While the study concluded that a CFS is feasible, a number of questions remain unanswered, including potential double counting between emissions reductions from other light and heavy duty electrification efforts and from a CFS. A more significant issue is that the modeling indicated that, at least for the first decade, the bulk of emissions reductions would come through replacement of gasoline and diesel fuel with conventional biofuels. The state has not had a comprehensive analysis or public process examining the tradeoffs involved with large scale use of conventional biofuels, so it is premature to move forward with a CFS. In addition, the compliance cost for a CFS would likely be passed along to consumers of high carbon fuels such as gasoline and diesel, potentially making the policy regressive for consumers who are unable to purchase lower emitting vehicles. It may be more appropriate in the near term to look at revenue mechanisms that directly support adoption of zero emissions vehicles. Thus, we are not recommending that a CFS be part of the near term action agenda for the state but instead should be further evaluated.

The state did receive substantial comment from many segments of the biofuels industry on this topic, as well as from companies involved in carbon capture and sequestration, urging the state to consider adopting a clean fuels standard. The state also received comments from stakeholders concerned about the indirect land use impacts of biofuels production. We are not

recommending that a CFS be part of the near term action agenda for the state but instead that it should be evaluated further, with full discussion of the appropriate role for biofuels and how CFS program design would best support the state's policy objectives.

Aviation

While not as large a contributor to greenhouse gases as surface transportation, aviation will become increasingly important between now and 2050. Emissions from the sector are estimated at 4 million tons in 2015 and 5 million tons annually from 2020 to 2030. Emissions from aviation are more difficult to manage due to extensive federal control of the sector and expectations for long-term growth in demand. Industry, technology and supply chain changes will be important for long-term sustainability of aviation greenhouse gas emissions.

Fortunately, airlines are committing to investments and approaches to reduce long-term emissions from aviation. For example, United Airlines, which has a large hub in Denver, pledged in December 2020 to reduce its net greenhouse gas (GHG) emissions by 100% by 2050. In 2018, United became the first U.S. airline to commit to reducing its GHG emissions by 50% by 2050. United recently committed to a multimillion-dollar investment in atmospheric carbon capture technology known as direct air capture, and is continuing to invest in the development and use of sustainable aviation fuel (SAF), with 80 percent lower lifecycle emissions. Other airlines are expected to undertake similar commitments and make changes to reduce emissions over time, and we expect additional international efforts to reduce aviation emissions.

Technology will also play a critical role. In addition to approaches like direct air capture and biofuels like SAF, manufacturers, researchers and airlines are exploring use of electricity and hydrogen in some aviation contexts to reduce emissions. Ground operations can also be electrified.

Residential, Commercial and Industrial Fuel Use

The Roadmap analysis shows that the use of fossil methane in buildings and industry is one of the four major sources of GHG pollution in Colorado. Emissions from burning of fossil methane for space heating, water heating, and cooking not only contribute to GHG pollution but worsen indoor air quality.

Meeting the state's GHG targets will require reducing pollution from buildings and industry. The state's Near Term Action Plan includes new requirements for gas utilities to reduce carbon emissions. To ensure that utilities are making progress toward these goals, the Roadmap calls for increasing utility investments in energy efficiency, the use of lower carbon fuels such as biogas or hydrogen, benchmarking energy use and setting energy and emissions performance standards for large commercial buildings, requiring investor owned electric utilities to develop beneficial electrification programs to support customer adoption of technologies like electric heat pumps, transitioning certain appliances from fossil methane to electricity, moving to advanced building codes, enhancing financing opportunities for customers who want to invest in lower-carbon technologies, and requiring industrial and energy emissions audits and use of best available control technologies by industrial operations.

Colorado's Gas Utilities

The 1261 Targets Scenario for 2030 includes emissions reductions of 37% below 2005 levels from fossil methane end uses (exclusive of electricity generation). However, Colorado does not have requirements for the state's gas distribution utilities to reduce GHG pollution. In the development of the near term actions, the state agency team concluded that a 20% reduction from 2005 levels (4.75 million tons from residential, commercial and industrial fuel use) was achievable by 2030.

The Public Utilities Commission has taken an important step in looking at the role of gas utilities in meeting the state GHG goals. In fall 2020, the PUC opened a proceeding to investigate whether changes in fossil methane utilities could help meet the state's GHG pollution reduction goals and the impacts that those changes might have on utilities and their customers.[xxxv] At the time this report was published, the investigation was still on-going. However, PUC commissioners have stated that they intend to investigate steps the PUC can take now to reduce pollution from gas utilities while long-term regulatory changes are being implemented, including gathering information about:

- Historic gas utility customer GHG emissions and associated system and upstream emissions
- Expectations for reduction of GHG emissions from the retail fossil methane sector or customers
- Options to decarbonize retail fossil methane utilities and the costs and benefits of those actions
- Impacts on customers who participate in income-qualified programs
- Potential for electrification of current fossil methane loads

In addition to the planning actions taken at the PUC, we are recommending legislation in 2021 to set statutory goals for the reduction of emissions by gas distribution utilities. The emissions reduction trajectory will be more gradual than in the electric sector, in part because there are fewer lower-cost technologies available and because many of the actions needed require action by utility customers, not just the utility company. Legislation could allow a utility flexibility in the measures used to achieve the emissions reduction goals and could include direction to the PUC to consider both the emissions reduction achieved and the cost of the plan. By setting a technology neutral emissions standard, the legislation would enable utilities to cost effectively achieve needed emissions reductions through a number of strategies, including, providing incentives for building energy efficiency

improvements; lowering the carbon intensity of gas that is used through some combination of use of biogas and hydrogen produced from renewable resources rather than fossil methane; the electrification of some end uses in buildings and industrial processes; increasing usage of electric and induction stoves; and reducing methane leaks from utility gas distribution systems.

Biogas Portfolio Standard and Leak Standards for Gas Utilities

As the state considers options for reducing the carbon intensity of fossil methane delivered to Colorado homes and businesses, it may look at a program that would require certain gas utilities to meet a GHG intensity standard across their portfolio. As part of a program like this, biogas and hydrogen from renewable energy resources could be used to replace a portion of the fossil methane currently sold to residential, commercial, or industrial customers. Biogas refers to methane that is captured from sources such as sewage treatment plants, landfills and dairy farms and otherwise is emitted directly into the atmosphere. Biogas could also be used to generate electric power or in the transportation sector to reduce emissions there.

In addition to requiring the use of lower-carbon fuels, the state could also set enhanced leak detection and repair requirements that apply to the gas distribution system. This could be structured as a standalone requirement for utilities without GHG targets or could be one measure that gas utilities could take as part of a suite of measures to achieve GHG reduction targets in a gas clean energy plan. It will be important to have a process at the PUC to evaluate costs for this transition and the impacts on customers, especially lower-income customers. One important note is that the potential supply of biogas from waste is relatively constrained, probably topping out at 5-10% of current gas use in the state, based on the 2019 renewable natural gas study conducted for the Colorado Energy Office.[xxxvi] However, because much of this is currently emitted directly to the atmosphere, and since the global warming potential of methane is so high compared to carbon dioxide, if biogas use by

utilities stimulates a market that captures this methane, the reduction in emissions could be quite high.

Modernizing Gas Energy Efficiency Programs

Colorado adopted its initial gas demand-side management program in 2007. Under those programs, the state's regulated gas utilities are required to provide rebates and incentives to customers that help those customers purchase more efficient appliances that reduce gas use and save money. While recent statutory changes extended those programs, the investment and savings have been very modest compared to the level of efficiency improvements that are achieved by leading utility programs. Modernizing the state's statutory requirements for gas efficiency programs will create one pathway to reducing emissions from the gas utilities. Modernizing gas efficiency could include requiring the PUC to set savings-based targets to achieve all cost effective and achievable energy savings, incorporating the social cost of greenhouse gas emissions in cost benefit analysis (as is done for electric sector DSM), and better aligning gas DSM with the state's goal of improving building shells and increasing electrification in buildings.

In order to ensure that these strategies promote equity and avoid potential unintended consequences, programs need to prioritize accessibility to efficiency improvements and electrification for lower-income households and provide special consideration and compliance flexibility for affordable housing. Efforts should be made to create education and outreach initiatives that provide clear and credible information to people about the benefits of energy efficiency and of transitioning to electric appliances. It is also important to ensure that utility investments help to develop workforce skills and provide good jobs. To achieve these goals, legislative action should ensure appropriate apprenticeship opportunities and labor standards for large projects included in utility funded programs.

Commercial Building Benchmarking and Performance Standards

While state and local governments and utilities are seeking to decarbonize their building stock, it is challenging to set energy or emissions reduction targets without an understanding of how buildings are performing currently.

The Colorado Energy Office is in the process of launching a commercial building benchmarking program. The program, when fully developed, will enable building owners to report energy use data to a statewide database. The program will work to modernize utility data protocols to improve customer access to building level energy data. Making whole building energy use data more transparent will help identify cost-effective opportunities for energy efficiency and beneficial electrification upgrades. After establishing baselines for buildings, the program will require less efficient buildings to make improvements that will reduce energy consumption, save money for owners, and lower GHG emissions. Once the program requirements are in place, fee for service or fines for non-compliance could fund this program and provide additional dollars for education and technical assistance to further building decarbonization work.

The Colorado Housing and Finance Authority ("CHFA") will require affordable housing projects that receive tax credits to annually assess and report their building energy performance using the free ENERGY STAR Portfolio Manager tool. Benchmarking building energy use will help CHFA and other partners understand energy savings and costs in publicly-funded affordable housing, leading to better design of energy efficiency standards and incentives.

Building Electrification Requirements for Utilities

A Colorado Energy Office study of beneficial electrification potential estimated the technical, economic, and achievable potentials for beneficial electrification in buildings in Colorado over the next ten years. As shown below, the report concluded that electrification in Colorado provides

substantial opportunities to reduce GHG emissions in the built environment. The research identified key technologies and sectors that can benefit from this transition. The report found a high potential adoption of residential space and water heating, concluding that with the right policy support nearly 200,000 homes could have electric heat pumps by 2030. The report also found that switching from propane to electrified end-uses is cost effective currently and recommended the state consider prioritizing efforts that can help transition customers from propane to electrification.

Figure 19: GHG Reduction Potential from CEO's Electrification Report

TABLE 1-2 CO2E REDUCTION POTENTIAL UNDER BENEFICIAL ELECTRIFICATION SCENARIOS

Potential Scenario	2030 Cumulative CO2e Reduction (short tons)
Technical Potential	31,147,459
Economic Potential	20,797,877
High Electrification	3,499,843
Moderate Electrification	2,085,315

The report analyzed market barriers that will impede electrification efforts and provides policy and program recommendations to accelerate the adoption of BE technologies noting that the BE market in Colorado is nascent—the next five years will be a critical market preparation period to develop policies, programs, outreach, awareness, contractor training and the supply chain to drive higher adoption rates over the long-term.

Consistent with the administration's efforts to build a Colorado for all, growth in BE adoption must occur equitably and include Colorado's most vulnerable residents. Successful BE adoption must address current barriers and ensure that affordable technologies are available and financially accessible to all customers and that vulnerable customers do not shoulder a disproportionate share of the cost for this transition.

Based on the analysis in the Roadmap, the state is advancing policies that will cultivate market transformation including adoption of a requirement for investor-owned utilities to file plans to support beneficial building electrification by providing rebates and incentives for customers to switch to electric heat-pump water heaters and heat-pump space heating. As with Senate Bill 19-077 and the resulting consideration of transportation electrification plans at the PUC, it will be important to require that utility beneficial electrification plans have a particular focus on enabling electrification by lower-income customers and in disproportionately impacted communities. The state is also intending to pursue expansion of finance programs that support building improvements, including electrification. Currently, the RENU loan program supports the installation of eligible heat pump technology in the residential sector and the Colorado C-PACE program recently enacted a program change to further accommodate the deployment of BE technologies in the commercial sector. The state will also look for opportunities to expand beneficial electrification for lower-income residents through the Weatherization Assistance Program. It is also important to ensure that utility investments help to develop workforce skills and provide good jobs. In order to achieve this, legislative action should ensure appropriate apprenticeship opportunities and labor standards for large projects included in utility funded programs.

Advanced Building Codes

Strong building energy codes require new construction or major renovation projects to improve energy performance and lower emissions. But building energy codes do more than reduce energy use in buildings, they ensure the safety, health, durability, sustainability, and affordability of buildings. The state, through the work of the Colorado Energy Office, is committed to continuing to support building energy code training and technical assistance to enable local governments to more easily adopt current and advanced building energy codes on a regular cycle, and to get them on a path to zero energy or zero carbon standards. CEO engages with stakeholders

and jurisdictions through the Colorado Energy Code Compliance Collaborative and other networks to ensure that local governments have the latest information they need to make informed building code decisions through training, resources, and technical assistance. The state may explore regulatory or legislative avenues to strengthen building codes statewide and make the built environment more resilient to the effects of climate change.

Financing

Achieving Colorado's GHG pollution reduction goals will require innovative financing mechanisms and products to help deliver the capital needed to transform the built environment. As noted earlier in the report, the state has deployed several programs including Energy Performance Contracting, C-PACE, and RENU, which have realized significant results to date and demonstrate how public-private partnerships can be used to leverage public money to generate considerable private sector capital investment. The state also worked with the U.S. Department of Energy and the Coalition for Green Capital to create the Colorado Clean Energy Fund, intended as a green bank for the state that could fund clean energy and energy efficiency investments. There is tremendous opportunity to continue to scale these programs to ensure that residential, commercial, and public sectors have access to low-cost financing for clean energy projects. The state supports developing and expanding other innovative financing models including utility on-bill financing or on-bill repayment options to reduce a barrier to upgrading inefficient buildings, reach new markets, and ensure equitable and universal access to clean energy technologies. These low-risk models have the potential to increase adoption of energy efficient appliances, beneficial electrification technologies such as heat pumps, heat pump water heaters and induction cooktops, as well as on-site renewable energy systems or EV chargers for all sectors, but especially for income-qualified households.

One particular near term opportunity is to expand RENU and C-PACE, and to capitalize the CCEF. As outlined in further detail below, Governor Polis has requested $40 million in supplemental stimulus funding in FY 2020-21 for clean energy finance as part of his budget request to the legislature.

Industrial Energy and Emissions Audit Requirements

As part of addressing GHG pollution from Colorado's energy-intensive trade exposed industries, HB 19-1261 directs the AQCC to require such industries to undertake energy and emissions audits. These audit requirements may also be extended to other industrial sectors as a mechanism to assess potential for GHG reduction strategies. APCD is beginning a stakeholder process in late fall 2020 to develop the requirements for conducting and reporting these audits. It is expected that the energy and emissions audit program will be part of a broader GHG rulemaking package scheduled on the AQCC long-term calendar for Summer 2021. It is anticipated, as called for in HB 19-1261, that sources undertaking energy and emission audits will be required to implement best available control technologies and efficiency practices to reduce GHG emissions or achieve comparable reductions through other measures. The audits will also give state agencies a greater understanding of the potential for emissions reductions in diverse industrial operations and may be used to inform future programs or rulemakings.

Oil and Gas

Implementation of SB 19-181 & Minimizing Sector Emissions

AQCC rulemakings to implement SB 19-181 have already commenced and will be an iterative process over the next few years. The AQCC completed a rulemaking that included combustion emissions from stationary engines used in this sector, mandatory monitoring for new wells, pre-production emissions controls and other measures in September 2020. Additional rulemakings are included in the AQCC long term planning calendar for 2021 and 2022 and are expected to focus on reducing methane pollution throughout the sector.

To achieve the state's 2025 and 2030 emissions goals, methane emissions from the oil and gas sector as a whole will need to be reduced by at least 33% by 2025 and over 50% by 2030. The state is targeting 12 million tons of emission reductions from the oil and gas sector by 2030, compared to the 2005 baseline. This level of emissions reductions is deeper than modeled in the HB 1261 Targets Scenario. The decision to pursue deeper reductions in the oil and gas sector reflects the fact that low cost technological solutions are available to get these reductions and that getting deeper reductions from oil and gas will reduce the need to seek reductions from other sectors that may be harder to decarbonize. The specific requirements of the rule are expected to be informed through a stakeholder process, including a review of technological and operational changes that can be implemented to reduce methane releases. The APCD initiated the stakeholder process for this rule on November 5, 2020, and the AQCC long-term calendar plans a hearing in the fourth quarter of 2021.

Reducing the release of methane also reduces the VOCs and other emissions that are co-pollutants with the methane gas stream being controlled. These reductions will further the state's progress in attaining ozone standards and minimizing emissions of the co-pollutants which disproportionately impact the health of Colorado communities.

In addition to the ongoing activities to implement the SB 19-181 requirements, SB 20-204 allocated additional funding to the APCD and created a new Air Quality Enterprise for Colorado. The additional resources allocated to APCD are expected to be applied toward the increased need for permitting, inspection, and enforcement activities associated with the high number of oil and gas facilities operating under permit requirements that are classified as serious nonattainment for ozone. For the first time, the Air Quality Enterprise creates a mechanism for planning and funding collaborative research through educational institutions with public and private sector involvement. Some of this research is expected to focus on

gaining a better understanding and reconciling the differences between top-down monitoring and bottom-up inventory methodologies for the oil and gas sector. Understanding these measurement dynamics is critical to ensuring that the projected emissions reductions are realized through the implementation of the SB 19-181 requirements.

COGCC Flaring Restrictions and Comprehensive Planning

On November 23, 2020, the COGCC completed a series of comprehensive rule changes to implement the updated priorities of the COGCC under SB 19-181. This rulemaking included revisions to regulations to strengthen flaring restrictions, comprehensive planning, reducing emissions, and other increased protections for public health and environment. The rulemaking also requires evaluating and addressing the cumulative impacts of oil and gas development, and includes specific cumulative impact regulatory requirements directed at reducing air emissions. In addition, the COGCC rules:

- Prohibit routine flaring of natural gas from pre-production and operations at oil and gas sites. There is a limited one-year exception for existing facilities to come into compliance. By itself, this measure is expected to improve local air quality and reduce significant CO2e emissions by 2025.
- Require all new oil and gas development plans to provide detailed information regarding greenhouse gas emissions associated with proposed oil and gas development as well as cumulative impact plans detailing how these emissions will be avoided and minimized. The COGCC will be responsible for determining if permit applications avoid and minimize impacts to public health and the environment.
- Create extensive public comment and consultation provisions to consider the effects of proposed oil and gas development.

- Require ongoing consideration of the cumulative effects of greenhouse gas emissions through an annual report that includes an assessment of whether actual emissions reductions are on track with the trajectory identified in this Roadmap for achieving statewide reduction targets, the identification of technologies to achieve further emissions reductions, and recommendations of additional steps that may be needed to improve the implementation of regulatory requirements.

Natural and Working Lands Greenhouse Gas Inventory

A comprehensive natural and working lands emissions inventory is essential for monitoring and verifying changes in GHG pollution and carbon sequestration from land-based activities and is a critical priority for the Natural and Working Lands Task Force over the next one to three years. While Colorado's existing GHG inventory includes metrics such as emissions from agricultural fertilizer applications, methane associated with livestock production, forest carbon, and certain emissions from wildfires, it is not comprehensive. For example, it does not fully quantify the effects of land use conversion on the total carbon balance of Colorado's natural and working lands. Accounting for the impact of land use change, including when natural and working lands are developed, will allow the state to track and measure the critical roles land conservation, agricultural stewardship, and ecosystem restoration play in reducing GHG pollution. This will also help support policies and programs to improve land use planning. An agricultural GHG inventory will also measure voluntary reductions in emissions from implementation of CDA's Soil Health Program and Farm Bill conservation practices through the Natural Resources Conservation Service ("NRCS").

In addition, the state must determine whether the federal forest carbon flux estimates used in Colorado's GHG inventory accurately estimate Colorado's forest carbon flux given the large wildfires Colorado has experienced since 2000. In 2020, Colorado experienced the three largest

wildfires ever recorded. Research indicates that forests may not naturally reestablish post-fire in some areas as quickly as they have in the past, meaning that without reforestation, wildfires may not be carbon neutral within the 21st century. Colorado should establish a baseline estimate for GHG emissions associated with natural fire regimes prior to 20th century fire suppression to compare with recent wildfire emissions. The state also does not have an accurate estimate of the amount of forest carbon sequestered in sustainable wood products each year (e.g., in construction materials). The state aims to resolve some of these questions by working with the research community. In spite of these research needs, Colorado is moving forward with no-regrets strategies to mitigate climate change through improved conservation, restoration, and management of our natural and working lands.

Natural and Working Lands Strategic Plan

The NWL Task Force, in partnership with The Nature Conservancy, is currently conducting a technical analysis funded by the U.S. Climate Alliance to quantify the potential of Colorado's natural and working lands (forests, rangelands, grasslands, croplands, riparian areas and wetlands, and urban landscapes) to contribute to the state's ambitious greenhouse gas reduction goals by 2050. This effort will result in a *Natural and Working Lands Strategic Plan* in 2021 that will identify priority pathways for carbon-smart land management, set quantifiable emissions and sequestration goals for this sector, and inform strategic NWL research, program, and policy development. The NWL Strategic Plan will also evaluate ways to align state grant programs to promote natural climate solutions and will support and leverage other state and local planning processes, including, but not limited to the Colorado Water Plan,[xxxvii] Colorado Resiliency Framework,[xxxviii] State Wildlife Action Plan,[xxxix] Drought Mitigation Plan,[xl] Forest Action Plan,[xli] and sustainable land-use planning efforts led by the Department of Transportation.

While this technical work is underway, state agencies are implementing carbon-smart policies and programs. The Colorado State Forest

Service, in partnership with the U.S. Forest Service, Natural Resources Conservation Service, and other federal, state and local partners, carry out forest restoration work that reduces the risk of high-severity wildfire and improves forest health. While reducing woody fuels through thinning and prescribed fire may initially reduce the carbon stored in Colorado's forests, these treatments can increase the resilience of forests to wildfires, insects, and disease, thereby ensuring forest carbon stocks are more stable over time. Dozens of existing forest collaboratives, as well as the new Rocky Mountain Restoration Initiative and state-level Shared Stewardship initiative, are working to increase the pace and scale of this work. These partnerships are also seeking solutions to expand Colorado's limited forestry workforce and markets for woody biomass utilization, which pose one of the biggest barriers to cost-effective forest management in Colorado.

Colorado Parks and Wildlife, the Colorado State Forest Service, the State Land Board and other agencies, conserve several million acres of natural lands in Colorado that are important carbon sinks. These conservation efforts include the acquisition of Fisher's Peak in 2020, Colorado's second largest state park. As these efforts continue, state staff are exploring a variety of opportunities and policy actions to further support this work.

Soil Health Program

Starting in 2020, the Colorado Department of Agriculture has been participating in a soil health initiative in coordination with individual stakeholders, the Colorado Collaborative for Healthy Soils, the U.S. Department of Agriculture's Natural Resources Conservation Service, conservation districts, the Colorado Department of Natural Resources, and the Natural and Working Lands Task Force. The goal of this initiative, which is voluntary and incentive-based, is to provide technical assistance and grants to producers to implement soil health practices that benefit the environment and the state's climate goals while supporting the financial stability of Colorado's farmers and ranchers. This effort aligns with a growing number of

public and private efforts throughout the United States and other parts of the world to mitigate climate change through the voluntary implementation of improved agricultural stewardship practices that simultaneously help mitigate risk and expand revenue opportunities for producers.

Through increased access to private market opportunities that support producers who wish to transition to practices that regenerate the soil and help meet climate goals, Colorado agricultural producers will be able to take advantage of national programs such as Field to Market, Soil Health Partnership, and the Ecosystem Services Market Consortium in a way that works for their business. CDA is aligning these tools through traditional pathways, such as conservation districts, and new routes, such as improved market incentives. In addition, CDA's soil health initiative is building toward the development of an inventory framework to aggregate and measure climate mitigation activities within the agricultural sector.

In 2021, CDA will launch a new Soil Health Program built from its current Soil Health Initiative to support and encourage farmers and ranchers to adopt voluntary practices that sequester carbon, reduce GHG emissions, increase drought resilience, conserve energy resources, and promote sustainable agriculture in Colorado. While many farmers and ranchers have been practicing various soil conservation practices over the last 20 years, creating a Soil Health Program will provide research, technical assistance, and incentives to support producers looking to map and quantify biological benefits for agricultural operations transitioning from conventional tillage programs to more biologically beneficial methods. Encouraging and potentially creating incentives for voluntary participation in these practices will enhance resilience to extreme weather and natural catastrophes, such as drought, flood and wildfire events. The program may also create a pathway for Colorado farmers and ranchers to participate in emerging environmental services and carbon markets.

Agricultural Climate Resilience Office

CDA is pursuing creation of an Agricultural Climate Resilience Office that would expand and advance CDA's capacity to provide direct support and resources to producers, conservation districts, and other agricultural entities to reduce GHG emissions, enhance carbon sequestration and cycling, and engage in emerging marketplaces that support producers' bottom lines while incentivizing regenerative or climate-friendly practices. ACRO will be located within the Conservation Services Division to administer programs that help absorb risk by providing technical and grant support for Colorado agriculture facing significant climate-related threats, and by creating the administrative framework to help address and measure the agricultural greenhouse gas reduction targets in the Colorado Greenhouse Gas Pollution Reduction Roadmap through voluntary, farmer and rancher led stewardship practices.

As CDA advances its work on climate change from the agricultural perspective a number of administrative barriers have been identified that limit its ability to continue existing programs, to implement new programs, and to administer programs effectively. The ACRE3 Program and Soil Health Initiative operate under authority from two separate boards housed within two separate divisions at CDA. ACRO would align those programs under one umbrella while allowing the department to develop and deploy more resources that support Colorado agriculture in advancing climate solutions.

Natural/Working Lands Strategies in Rural/Urban Communities

The economic strength of many rural communities depends on natural and working lands, whether through agricultural production, outdoor recreation and tourism, or other natural resource industries. These communities are particularly vulnerable to increasing climate-related natural hazards, such as drought, pests, floods, wildfires, storms and tornadoes. Natural climate solutions present a critical opportunity for equitable climate change adaptation and mitigation in Colorado. Industries that are dependent on healthy natural and working lands are vital to providing jobs and sustaining

local businesses, as well as funding infrastructure and services like schools, government programs, and hospitals.

Farm workers and equipment operators play essential roles in farm, ranch, and forestry operations and require adequate housing, access to healthcare and other services, and safe and healthy working conditions. In many instances, workers, such as migrant laborers, may not be eligible for Medicaid, and social isolation can increase mental health challenges across all rural economic levels. In rural areas, people of color, lower-income residents, and linguistically isolated individuals are often the hardest hit when climate change-related natural hazards occur. These individuals may experience direct financial losses and have fewer financial resources and social connections for them to adequately prepare for and recover from natural disasters.

Considering equity in natural and working lands policy is also important in urban areas. Long-term disinvestment in urban canopy cover in lower-income communities and communities of color contributes to disparities in urban heat impacts. Insufficient access to greenspace further amplifies inequalities in mental and physical health. Therefore, in addition to helping to address climate change, expanding urban canopy cover and greenspace has multiple social co-benefits, particularly when paired with affordable housing, energy, and transportation policies. Prioritizing land for urban agriculture programs can also address disparities in education and food security.

Natural climate solutions must be informed by principles of environmental justice, as well as enhanced outreach and engagement with these important stakeholder groups. The state can enhance equity considerations in natural climate solutions through various strategies, including modifying grant making requirements for rural communities and those with fewer economic resources, providing targeted technical support, developing resources to communicate with linguistically-diverse audiences,

and consulting with and learning from impacted groups. This work will be developed and strengthened as state agencies continue to build an equity, diversity, and inclusion framework into programs and services.

ACRE3

Going forward, the Advancing Colorado's Renewable Energy and Energy Efficiency Program has identified three strategic priorities: (i) agricultural energy efficiency and photovoltaics, which focuses on reducing energy costs in energy-intensive operations, such as dairies, pumped irrigation, and greenhouses; (ii) agricultural hydropower, which focuses on energy-recovery hydropower and water resources conservation in irrigated fields and irrigation canals and ditches; and (iii) renewable thermal technologies, which focuses on solar water heating, solar space heating, and ground-source heat pumps in agricultural applications. The ACRE3 program is evaluating criteria for agrivoltaic projects as an emerging fourth priority.

Other Sectors

Coal Mine Methane Regulations

Coal mine emissions in Colorado are already declining significantly with the transition away from coal-fired electricity generation, as demonstrated in the 2019 Colorado GHG Inventory. The overall trend of declining emissions is expected to continue as additional mines reduce production or close between 2020 and 2030. The analysis underpinning the state strategy for achieving the 2030 economy wide targets includes an expected reduction of 7 million tons CO2e in annual emissions from coal mines due to mine closures by 2030. Monitoring of production levels and the number of active mines in operation will be performed as part of the tracking of critical metrics that are reported

annually to the AQCC and will be used in emissions projections for future GHG inventory reports. Should these metrics indicate significant increases in production or if new mines are opened, permit requirements may be implemented or regulations addressing methane venting may be proposed for future consideration at the AQCC. CDPHE and the Department of Natural Resources will also work with land managers and other parties to explore opportunities for using or flaring emissions from abandoned mines.

Methane from Landfills and Wastewater & Waste Diversion

In recent years, a number of new legislative efforts have provided an influx of additional funds and resources towards improving Colorado's waste diversion rate. In 2019, the legislature created the Front Range Waste Diversion Enterprise Fund that will spur economic development and advance the state's circular economy efforts with the goal of increasing the Front Range waste diversion rate to 51% by 2036. The Enterprise Fund is financed by an increase in user fees at Front Range landfills. Collection of these fees began in January 2020 and will increase by 50 cents per ton per year for four years, then annually by inflation, ultimately providing an estimated $15 million per year for waste diversion projects. The program announced the first set of nine grant awards in November 2020 that will divert an additional 18,000 tons of waste from landfills.

CDPHE and CDA are collaborating on a 2021-22 fiscal year study and plan to manage agricultural organic waste and promote compost use. The study will conduct a gap analysis of the state’s current capacity to manage organic waste, identify and prioritize key locations within the state that need additional processing infrastructure, and examine a cost-benefit analysis and net GHG implications of both infrastructure expansion and increased compost use including agricultural healthy soil initiatives.

Waste management currently makes up a small but growing fraction of Colorado’s GHG inventory. Colorado will continue accelerating waste diversion efforts through funding under the Front Range Waste Diversion

Enterprise, Recycling Resources Economic Opportunity Program and other recycling end use market development. Based on the statutory goal for the Front Range Waste Diversion Enterprise of a 51% diversion rate by 2035, the state is aiming for 32% and 39% rates by 2025 and 2030, respectively. The state will continue to look for other opportunities to accelerate diversion rates, especially for organic materials that can form methane.

Methane capture from landfills and wastewater treatment facilities offers an opportunity to slow and ultimately reverse the emissions growth in this sector. Capital investments and new infrastructure are required to capture methane from these sources and these investments would benefit from legislative action on a biogas standard to create a market for the captured methane. In addition, future regulations may be considered for adoption by the AQCC to address methane emissions from these sources. A biogas standard will also spur investment in methane capture from agricultural operations unlikely to be addressed by regulations, such as dairy farms. As noted above, the emissions reductions associated with these policies are shown in the residential, commercial and industrial fuel use category, to avoid double counting.

HFC Regulation

In May 2020, Colorado became the first state to adopt the Climate Alliance States' Model Framework for the phasing out of hydrofluorocarbons. The Model Framework, adopted by AQCC as part of Air Regulation Number 22, establishes phase out dates for the use of these potent greenhouse gases in foams, aerosols, air conditioning, and refrigeration. The phase out of HFCs in these products in Colorado is projected to reduce cumulative GHG pollution by 6.34 MMT CO2e by 2030. Additional measures to reduce HFC emissions are also being explored at the state and federal level. Potential measures include bolstering maintenance and repair requirements for products in service that use HFCs, such as air conditioners, and expanding the scope of the phase out to additional end uses.

Carbon Capture, Use and Sequestration

The state received comment from multiple stakeholders that the draft Roadmap did not sufficiently address the potential for carbon capture utilization and storage to play a role in reducing GHG emissions in the next decade and did not speak to any actions the state would take to enable or support CCUS. We agree with this critique given the need for rapid reductions in net emissions, the fact that there is serious consideration by the private sector of carbon capture at some Colorado facilities, such as the Holcim/LaFarge cement plant in Florence, and the existence of significant federal incentives in the form of the 45(Q) tax credits. A further example is United Airlines' December 2020 commitment to completely eliminate greenhouse gas emissions through strategies such as direct air capture and sequestration of carbon dioxide.

At the same time, because this is not an area where the state government has existing experience or expertise, many questions remain unanswered: How can the state encourage carbon capture and sequestration while also advancing reductions in localized air pollution? How should the state treat carbon capture that is used for enhanced oil recovery as compared to long term sequestration without enhanced oil recovery? Are there existing state regulations or permitting processes that need to be modified to enable CCUS? Should the state seek primacy over the EPA for permitting CCUS operations? Are there requirements or incentives that should be enacted for CCUS? Are there opportunities to provide jobs and economic development in areas that are impacted by the move away from fossil fuels? How can policies be designed to ensure benefits to diverse and disproportionately impacted communities?

In order to address these questions and develop an action plan, the state will convene a task force on CCUS starting in mid-2021, which will report back to the Governor within a year with a recommended framework,

including policies and actions steps for pursuing CCUS that are aligned with Colorado's emissions reduction targets.

Governor's FY 2021-22 Budget

The Governor's FY 2021-22 Budget advances a number of innovative funding proposals that will help protect Coloradans from the existential threat of climate change, improve air quality, and position Colorado to seize on the economic benefits of a renewable energy economy. Although forecasted revenues have improved, the economic forecast continues to project an operating deficit. That is why this budget proposes stimulus and strategic investments to help Colorado climb out faster and better. These proposals include:

- $78M for wildfire relief, mitigation and prevention in light of the extraordinarily destructive recent wildfire season, driven by a changing climate and declining forest health.
- $40M for clean energy finance programs in FY 2020-21 to ensure that we build our economy back better and position Colorado to seize on the economic benefits of the clean energy economy.
    - Funding will be distributed among multiple existing programs supported by the Colorado Energy Office, including the Colorado Clean Energy Fund, the Colorado New Energy Improvement District, CEO's RENU loan program, and the Charge Ahead Colorado program. The funding to these private-public partnership programs will deploy limited state dollars to leverage greater private capital for investments in clean energy retrofits and construction.
- $5M in FY 2020-21 to further supplement the DOLA Renewable and Clean Energy Challenge that supports local government investment in renewable energy, energy efficiency, and energy conservation.
    - Investment will provide grants to local governments for a variety of renewable and clean energy projects. Examples of projects in the pipeline include micro-hydro systems, energy performance contracting with solar photovoltaic components, community solar gardens, charging stations for electric vehicles, and solar/EV bus charging canopies with microgrid potential.
- The creation of an innovative new Agricultural Climate Resilience Office at the Department of Agriculture.

    - The new office will provide technical support for Colorado agricultural producers facing significant climate-related threats, set up an inventory framework, and create the administrative framework to help address agricultural GHG reduction and carbon sequestration targets.
- $0.3M to build the capacity of Colorado's Office of Just Transition to ensure a just and equitable transition from a coal based economy.

- $70M in additional funding for CDOT's Safer Main Streets and Revitalizing Main Streets programs to be distributed directly to local communities through grants. These programs directly help communities reimagine public spaces in dramatic fashion, implementing necessary COVID-19 mitigations, increasing multimodal transportation access, and making it safer and easier for pedestrians and cyclists to navigate Colorado main streets— actions that reduce VMT.

The Governor's FY 2021-22 Budget protects funding for high priority programs and services, including:

- the Air Pollution Control Division ($28.9M) at CDPHE
    - provides air monitoring, researches pollution, and permits and inspects air pollutant emitters.
- the Public Utilities Commission ($16.8M) at DORA
    - regulates utilities and facilities so that the people of Colorado receive safe, reliable and reasonably priced services consistent with the economic, environmental and social values of our state.
- the Oil & Gas Conservation Commission ($20.2M) at DNR
    - regulates the development of Colorado's oil and gas natural resources in a manner consistent with the protection of public health, safety, the environment, and wildlife.
- Program Administration ($6.3M) at the Colorado Energy Office
    - supports the Executive Director's Office, the CEO Policy Team, a portion of the Transportation & Fuels Technology Team, and a portion of the Building Innovation & Energy Finance Team.

<u>Resource and Funding Considerations</u>

Even beyond this upcoming year's budget, additional funding, staff, and resources will be necessary to develop rules, administer programs, and make the investments needed to transform Colorado's economy. House Bill 19-1261 provided $188,588 per year for 2 full-time equivalent positions at the

Air Pollution Control Division to develop and implement climate programs. Senate Bill 19-096 provided $265,589 annually for 3.1 full time equivalent positions to administer greenhouse gas inventories and other efforts under that bill. Over the coming decades, the funding and staffing needed to develop the rules, programs, incentives and other tools to transform Colorado's economy will be considered as part of the annual budget process.

For high level illustrative context, the table below compares the resources available to the Division to California's Air Resources Board program for climate regulations, as well as funding believed necessary for economy wide cap-and-trade programs for legislation in Washington and Oregon. This comparison focuses on staffing and administrative capacity and does not include the substantially larger amounts that will likely be needed for incentives, infrastructure investment, and other tools to achieve necessary progress to implement change. While these comparisons are not indicative of specific resource needs for Colorado, the table illustrates funding and resource capacity in other states leading on climate action.

	California Air Resources Board Climate Program	Washington Proposed Bill SB 5981	Oregon Proposed Bill SB 1530B	Colorado Air Pollution Control Division
Annual Budget[xlii]	**$148M**	**$8.5M**	**$9.9M**	**$454,177**
Staff	**211.4**[xliii]	**38**	**26.5**	**5.1**

NOTE: The CARB spending is only for certain administrative expenses and does not include incentives and other program costs which range to billions of dollars.

Under Colorado's constitution and laws, the General Assembly must approve any departmental or agency spending, as well as provide new fee authority. The voters must approve any new or increased taxes. The state is working to maximize the use of existing funds and evaluate additional, targeted resource needs and revenue sources moving forward to fully implement the Roadmap as part of the annual budget process.

Carbon Pricing Mechanisms

The Roadmap focuses on a sector based approach to meeting the state's GHG pollution reduction goals with an emphasis on near term actions that can help the state make progress toward the 2025 and 2030 goals and ensure that the state remains on a path toward meeting the 2050 goals. These sector based policies, based on standards and investment, are the fastest pathways towards near and mid-term emissions reductions. As part of the Roadmap process, the state has begun to evaluate the merits of shifting tax burdens from income to GHG pollution. However, the work to develop the sophisticated tax and economic modeling that would be necessary to further explore this policy approach is outside the scope of this Roadmap. It would require further evaluation for such an approach to be considered in the future.

While the state received feedback about consideration of an economy-wide or individual sector cap and trade programs, the Roadmap is not recommending pursuing an economy-wide cap. Colorado is taking an approach that draws upon strong collaboration between the public and private sectors— as opposed to focusing on a singular state rule that would be costly to administer, does not guarantee the critical emissions reductions needed, and risks shifting even more pollution to lower-wealth communities and communities of color that are already bearing the brunt of poor environmental quality. As outlined throughout the Roadmap, we have identified a variety of opportunities to achieve near term, lasting emissions reductions through a number of sector based policies spanning standards, investment, innovation, and partnerships with key industries, local governments, and other diverse stakeholders. It should be noted that in the two sectors that are best suited to emissions regulation— electricity generation and oil and gas development— the state's policies will achieve sector wide emissions reductions of 80% and over 50%, respectively, with a high degree of enforceability.

Reporting, Tracking and Management of Progress Adaptation

Consistent with the resolution passed by the AQCC in October 2020, the Air Pollution Control Division of the Department of Public Health and Environment will report annually to the AQCC on current and projected GHG inventories, will provide a complete assessment every two years, and will provide assessments of the most dynamic sectors (e.g., oil and gas, transportation, etc.) and areas of major change every other year. The reports will compare current and projected emissions against subsector targets from the Roadmap and identify proposed measures to return to a trajectory to meet House Bill 19-1261 targets, if necessary. As part of its reporting, APCD will also develop a dashboard of vital metrics that can be tracked monthly or quarterly, such as oil and gas production, rig counts, VMT, and gas deliveries. The intent is to allow regular periodic evaluation of whether the state is making progress toward the targets set by HB 19-1261.

In an October Resolution, the AQCC provisionally adopted the following sectoral targets to guide rulemakings. The AQCC intends to revisit these targets and amend the Resolution as necessary following publication of the final Roadmap.

Table 7: Emissions Reductions by Sector

Sector	Revised 2005 Baseline (MMT CO2e)	2025 Target (MMT CO2e)	2030 Target (MMT CO2e)
Electricity	40.28	21	8
Oil and Gas	20.17	13	8
Transportation	30.71	23	18
Residential, Commercial, Industrial Energy Use	24.65	26	20
Other	23.42	19.9	15.6
Total	139.22	102.9	69.6
Percent Reduction	--	26%	50%

In the October Resolution the AQCC also resolved to hold a public meeting each September, starting in 2022, to assess whether the state is on track to meet these targets. If not, the AQCC will take actions required to get back on track to meet the emissions targets.

E3 SCENARIO ANALYSIS

Identifying pathways to make progress toward Colorado's GHG pollution reduction goals requires a comprehensive analysis of potential GHG reduction measures across all sectors of the state's economy. The state hired Energy + Environmental Economics to conduct this evaluation of the emission trajectory of the state and to model emissions reductions from policies and actions taken since 2019. E3 also modeled potential emissions reductions from additional measures Colorado could adopt to meet the pollution reduction targets in the *Colorado Climate Action Plan*. This analysis provides an initial foundation for Colorado to assess various decarbonization options, identify areas for additional analysis, and consider concrete next steps in making progress towards its 2025, 2030 and 2050 targets.

Colorado's Emissions

E3 benchmarked its analysis to Colorado's emission in 2015, the last year that the state released a comprehensive GHG inventory. Colorado's GHG emissions in 2015 were dominated by electricity generation, transportation, and the oil and gas sector. Electricity generation emissions are predominantly attributed to coal combustion with a lesser portion from fossil methane generators. Emissions from the oil and gas sector include fugitive methane emissions from upstream and downstream operations in Colorado as well as on-site combustion of fossil fuels in industrial operations. Passenger vehicles are the largest contributor to transportation emissions in the state, followed by large trucks and air travel. Remaining direct emissions come from manufacturing and other industries, building energy use (especially space

heating and water heating), agriculture, waste, refrigerants, and coal mining.[xliv]

Figure 20: 2020 CO GHG Emissions (MMT CO2e, AR5 100-yr GWP)

Model Framework

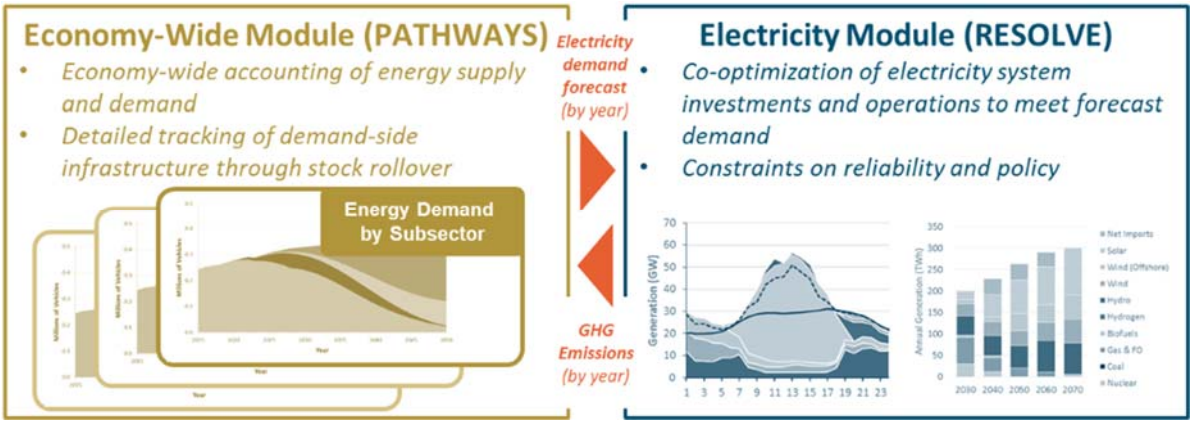
This analysis uses E3's PATHWAYS model to create distinct scenarios of future energy demand and GHG pollution in Colorado. The model is built using a "bottom-up" accounting of all energy-consuming devices and their pollution for key sectors of the economy along with a more general accounting of all energy demand and pollution for sectors where device-level data are not readily available. Scenarios are designed to test "what if" questions and to provide a comparison of emissions reductions under a range of mitigation measures.

PATHWAYS also captures interactions between demand and supply-side variables (e.g., electrification of space heating leads to a reduction in fossil methane demand and its related emissions, while causing an increase in electricity demand and any related emissions), with constraints and assumptions informed by existing analyses of resource availability, technology performance, and cost.

For key sectors like buildings and transportation, PATHWAYS uses a bottom-up stock rollover approach primarily based on data from the federal Energy Information Administration's National Energy Modeling System that is validated through benchmarking to historical "top-down" energy consumption data for Colorado. For certain sectors like industry or off-road transportation where equipment stock data are not readily available, we benchmark directly to historical energy consumption data. Non-combustion emissions from sources like agricultural methane, industrial processes, and oil and gas extraction are benchmarked to a combination of federal and state data sources.

The E3 modeling approach also incorporates a detailed representation of the electric sector using E3's RESOLVE model. RESOLVE is used to develop least-cost electricity generation portfolios that achieve Colorado's policy goals, including an 80% by 2030 emissions reduction, while maintaining reliability. Finally, we calculate potential bioenergy supply from a variety of feedstocks as well as emissions reduction potential for a variety of negative emissions technologies, including CCUS for industrial process emissions and the direct air capture of CO2. Figure 20 illustrates the relationship between the different modules of the analysis.

Figure 21: E3 Modeling Framework



More detail on modeling approach and assumptions is available in a technical appendix that is available on the Roadmap website.

SCOPE OF GREENHOUSE GAS INVENTORY

UNDER HB 19-1261, COLORADO IS RESPONSIBLE FOR ADDRESSING AND REDUCING "STATEWIDE GREENHOUSE GAS POLLUTION." STATEWIDE GREENHOUSE GAS POLLUTION INVENTORIED IN THIS ROADMAP AND IN AIR POLLUTION CONTROL DIVISION ANALYSIS INCLUDES POINTS OF EMISSIONS WITHIN THE STATE OF COLORADO, SUCH AS VEHICLE TAILPIPES, FUGITIVE EMISSIONS FROM OIL AND GAS, OR SMOKESTACKS FROM INDUSTRY AND POWER PLANTS. THIS IS CONSISTENT WITH INVENTORY ACCOUNTING FOR OTHER STATE AND NATIONAL GREENHOUSE GAS INVENTORY AND REDUCTION PROGRAMS, INCLUDING THE PARIS ACCORDS, AND AVOIDS DOUBLE COUNTING PROBLEMS BETWEEN JURISDICTIONS.

THIS MEANS THAT SOME EMISSIONS THAT ARE RELATED TO COLORADO, BUT THAT DO NOT OCCUR IN THE STATE, ARE NOT INCLUDED IN THE INVENTORIES FOR COMPLIANCE WITH HB 19-1261. FOR EXAMPLE, EMISSIONS FROM OTHER STATES OR COUNTRIES TO PRODUCE GOODS AND PRODUCTS CONSUMED IN COLORADO (E.G., CARS FROM MICHIGAN, FOOD FROM THE MIDWEST, ELECTRICITY GENERATED IN WYOMING, OR APPLIANCES MADE IN ASIA) ARE NOT INCLUDED. SIMILARLY, EMISSIONS OUTSIDE OF THE STATE FROM COLORADO-PRODUCED FOSSIL FUELS (COAL, OIL AND GAS) ARE NOT INCLUDED.

HOWEVER, LIFE-CYCLE EMISSIONS ARE IMPORTANT AND USEFUL FOR MANY POLICY DISCUSSIONS. UNDER SB 19-096, SB 19-236, AND HB 19-1261, CDPHE AND PUC CONSIDER THE TOTAL EMISSIONS ASSOCIATED WITH ELECTRICITY CONSUMED IN COLORADO, AND CLEAN ENERGY PLANS ARE TIED TO 80 PERCENT REDUCTIONS IN EMISSIONS ASSOCIATED WITH ELECTRICITY CONSUMED IN COLORADO, EVEN IF SOME OF THE GENERATION TAKES PLACE OUT OF STATE. SIMILARLY, UNDERSTANDING THE EMISSIONS ASSOCIATED WITH BURNING OIL AND GAS THAT IS PRODUCED IN COLORADO CAN BE USEFUL FOR UNDERSTANDING THE TOTAL IMPACTS OF FUEL PRODUCTION IN COLORADO. THESE ARE ESTIMATED IN APPENDIX TK. UNDERSTANDING NET GLOBAL EMISSIONS FROM FOSSIL FUELS CONSUMED IN OTHER STATES IS COMPLICATED, BECAUSE CONSUMERS MIGHT SUBSTITUTE FUELS PRODUCED IN TEXAS OR NORTH DAKOTA FROM FUELS PRODUCED IN COLORADO. IN ADDITION, LIFECYCLE EMISSIONS CAN BE VERY HELPFUL FOR WASTE REDUCTION AND DIVERSION POLICY DEVELOPMENT, EVEN IF NOT ALL EMISSIONS "CREDIT" OCCURS IN THE STATE.

HOW ARE METHANE AND OTHER GHGS COMPARED TO CARBON DIOXIDE?

THE ROADMAP INVENTORIES USE 100-YEAR GREENHOUSE GAS GLOBAL WARMING POTENTIAL VALUES TO TRANSLATE METHANE AND OTHER GASES TO CO_2E, BASED ON THE MOST RECENT IPCC AR5 METHODOLOGY. FOR EXAMPLE, ONE TON OF METHANE IS EQUIVALENT TO 28 TONS OF CO_2 OR ONE TON OF NITROUS OXIDE IS EQUIVALENT TO 265 TONS OF CO_2.

BECAUSE DIFFERENT GASES WILL PERSIST IN THE ATMOSPHERE FOR DIFFERENT PERIODS (E.G., SHORTER FOR METHANE AND LONGER FOR CO_2), USING DIFFERENT TIME PERIODS CAN RESULT IN DIFFERENT GLOBAL WARMING POTENTIALS. FOR EXAMPLE, BECAUSE IT IS VERY POTENT ON A SHORTER-TIME FRAME, THE GLOBAL WARMING POTENTIAL FOR 20 YEARS FOR ONE TON OF METHANE IS 84 [TK CHECK] TONS OF CARBON DIOXIDE. LIKE OTHER STATE AND NATIONAL INVENTORIES, COLORADO IS USING 100-YEAR GLOBAL WARMING POTENTIAL VALUES TO CAPTURE THE LONG-TERM RISKS OF CLIMATE POLLUTANTS AND ENSURE THAT EARLY INVESTMENTS ARE MADE IN CO_2 EMISSIONS REDUCTIONS. HOWEVER, PROPOSED EARLY REDUCTIONS IN METHANE AND HYDROFLUOROCARBONS WILL CREATE EVEN GREATER SHORT-TERM (20 YEAR) BENEFITS.

Scenario Development

For this analysis, E3 developed three distinct scenarios: a Reference Scenario that reflects a "business-as-usual" projection of energy consumption and emissions under policies adopted prior to 2019, a 2019 Action Scenario that includes the impacts of both legislative and regulatory policies and measures adopted in 2019, and a HB-1261 Targets Scenario that is designed to meet the state's goals in 2025, 2030, and 2050.

- **Reference Scenario:** Includes existing sector-specific policies adopted before the 2019 legislative session, including the Renewable Portfolio Standard (RPS) for electricity and federal CAFE standards for passenger vehicles.
- **2019 Action Scenario:** Includes the impact of key policies adopted during 2019, such as electric sector GHG emissions targets (HB19-1261), the incorporation of the social cost of carbon in electric sector planning, (SB19-236), increased efficiency standards for certain appliances (HB10-1231), and the creation of a Zero Emission Vehicle (ZEV) program (EO B 2019 002). Since a number of the pieces of legislation passed in 2019 require regulatory implementation, this scenario includes what we believe are reasonable assumptions about implementation.
- **HB-1261 Targets Scenario:** Includes one illustrative scenario of sectoral changes and the impacts of additional measures needed to reach the 2025 target of reducing greenhouse gas emissions by 26%, reducing 2030 by 50%, and 2050 emissions by 90% from 2005 levels.

Table 8: Key Strategies by Sector in E3 Scenarios

Strategy	Reference	2019 Action	HB19-1261 Targets
Clean Electricity	Existing RPS, announced coal retirements	80% reduction in pollution from Colorado generation by 2030, 95% by 2050 Includes Xcel & Tri-State commitments and HB 1261	Same as 2019 Action
Building Efficiency	**Utility efficiency programs, existing appliance standards**	**Appliance efficiency standards covered under HB 1231**	**Appliance efficiency standards for all end-uses, efficient building shell requirements**
Building Electrification	None	Same as Reference	High electrification for all end-uses
Transportation Efficiency	CAFE Standards	Same as Reference	CAFE Standards, LDV VMT reductions
Transportation Electrification	EIA AEO 2019 Reference Forecast	ZEV Standard for LDV, state EV Plan target of 940,000 EVs by 2030	Aggressive ZEV sales for all vehicle types
Low-Carbon Fuels	Existing ethanol and biodiesel blends	Same as Reference	Advanced biofuels and hydrogen production
Oil & Gas	Projected oil and gas production	2019 Updates to AQCC Reg. 7	SB19-181, significant reductions in methane emissions
Agriculture	ACRE3	Same as Reference	Soil Health Program

Sensitivity Analysis for Impacts of COVID-19 on the Economy

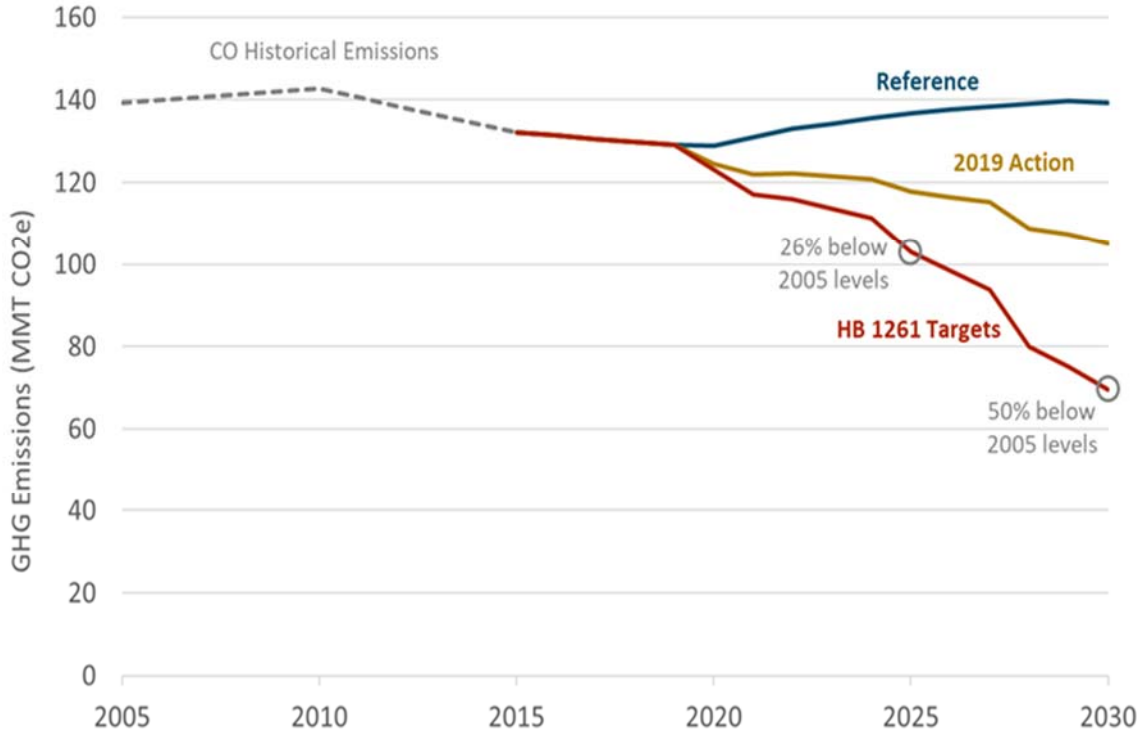
The three core scenarios (Reference, 2019 Action, HB-1261 Targets) modeled in this study are based on pre-COVID-19 conditions and do not take into account impacts from the recent COVID-19 pandemic. To reflect some of the potential impacts from COVID-19, E3 ran sensitivities on the 2019 Action and HB-1261 Target that included:

- A lower population and household growth rate from 2020 through 2025 to reflect lower migration to Colorado.
- A reduction in vehicle miles traveled (VMT) in 2020 consistent with what has been observed through the first half of this year. Annual VMT slowly increases back to pre-COVID-19 levels by 2027.
- Flat oil and gas production levels from 2020 through 2030, in comparison to the production increase seen over the same period in the three core scenarios.

Scenario Results for 2025 and 2030

E3's analysis finds that achieving Colorado's 2025 and 2030 GHG emissions targets is feasible with existing technologies. However, as shown in Figure 21 below, **this will require additional measures and policies beyond those that are included in the 2019 Action Scenario**. The changes needed to achieve the 2030 goals rely primarily on existing mature technologies. Achieving the 2050 goals likely requires innovation to drive costs down and enable large scale deployment of technologies that are less mature. More information on the key transformations needed by 2050 is available later in the report.

Figure 22: E3 GHG Emissions Projections by Scenario Through 2030

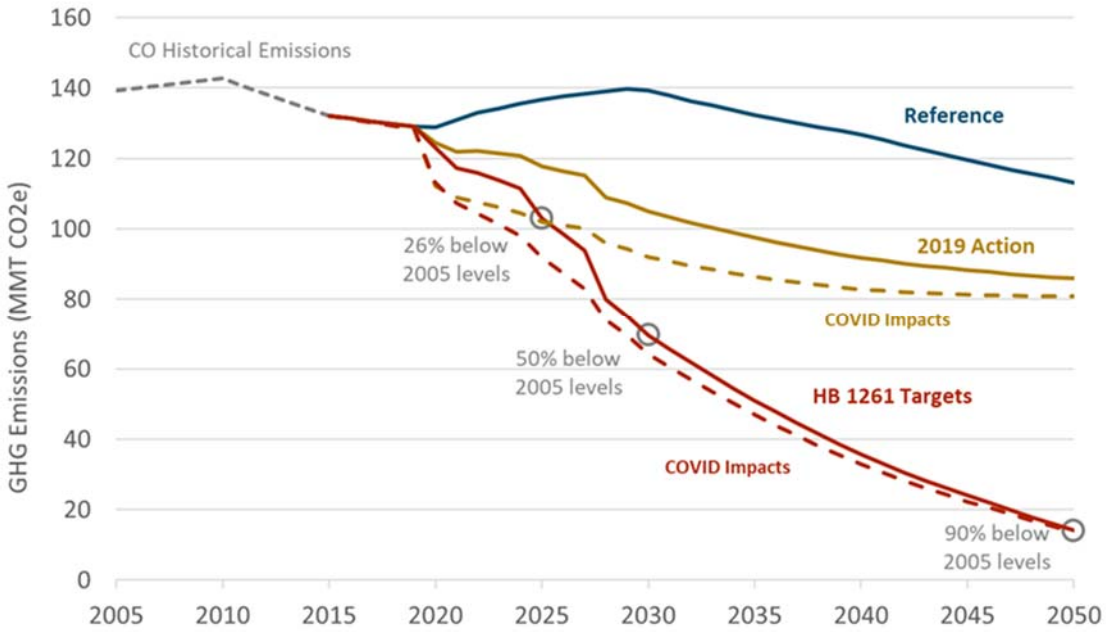


Making progress towards the 2025 and 2030 goals primarily will rely on continuing the transition to renewable electricity generation, reducing methane emissions from oil and gas development and operations, accelerating the transition to electric cars, trucks and buses, making changes to transportation planning and infrastructure to reduce the growth in driving, accelerating improvements to building efficiency and electrification of buildings, reducing methane emissions from landfills, sewage plants and agriculture, and investing in natural and working lands and the people who steward them to help mitigate the impacts of climate change and build greater resilience.

Impacts of COVID-19 on pollution may be large in the near term, but long term effects are unknown. The modeled COVID-19 sensitivities show significantly lower emissions in 2025, although this difference is modeled conservatively as smaller by 2030 and essentially gone by 2050. The emissions

impact of lower population growth, reduced VMT, and flat oil and gas production is larger in the 2019 Action scenario because of the higher rates of building and vehicle electrification and lower oil and gas methane leak rate in the HB-1261 Targets Scenario. It is uncertain what long-standing effects will be felt after 2030 with respect to how Coloradans live, work, and travel, but these sensitivities indicate that the impacts in 2025 and 2030 may be substantial. And while the state is not relying on COVID-19 sensitivity assumptions for purposes of achieving emission reduction targets, it will continue to evaluate how they impact actual emissions trajectories over time and update relevant modeling accordingly.

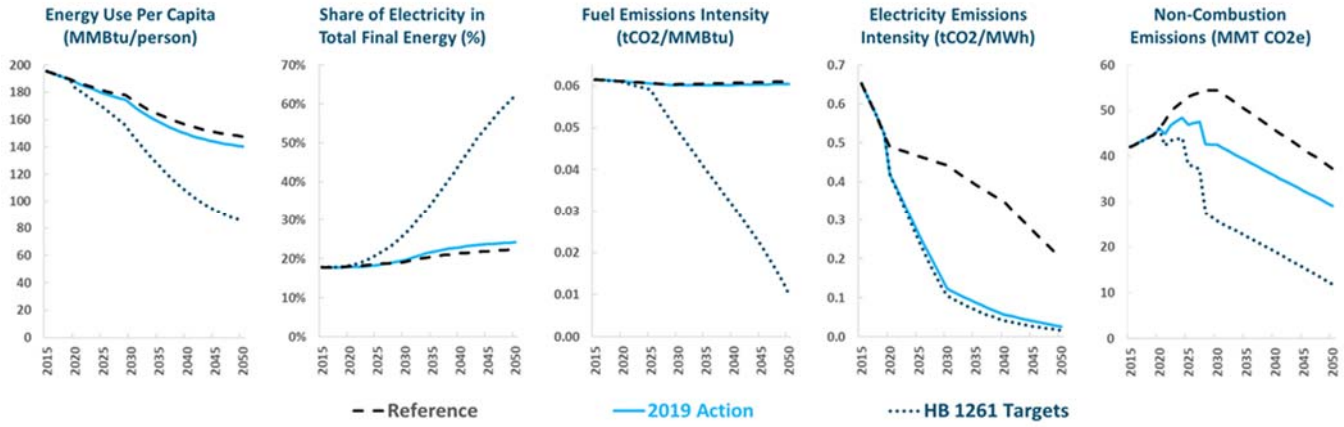
Figure 23: E3 GHG Emission Projections by Scenario Through 2050



Any deep decarbonization pathway to 2030 and 2050 will require a transformation in energy infrastructure and consumption patterns. **The deep decarbonization transition in Colorado will be supported by five pillars: energy efficiency, electrification, low-carbon fuels, decarbonizing electricity supply, and reducing non-combustion emissions.** The scale of

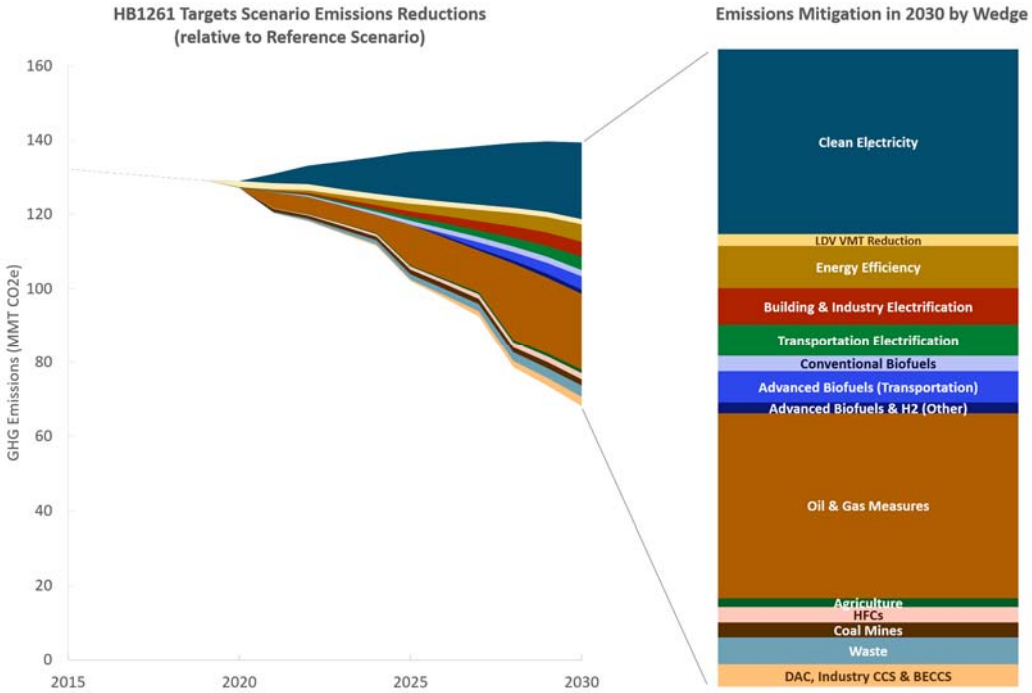
transformational change needed in each of these categories for the 2050 targets is illustrated in the figure below.

Figure 24: Five Pillars of Decarbonization in Colorado by Scenario



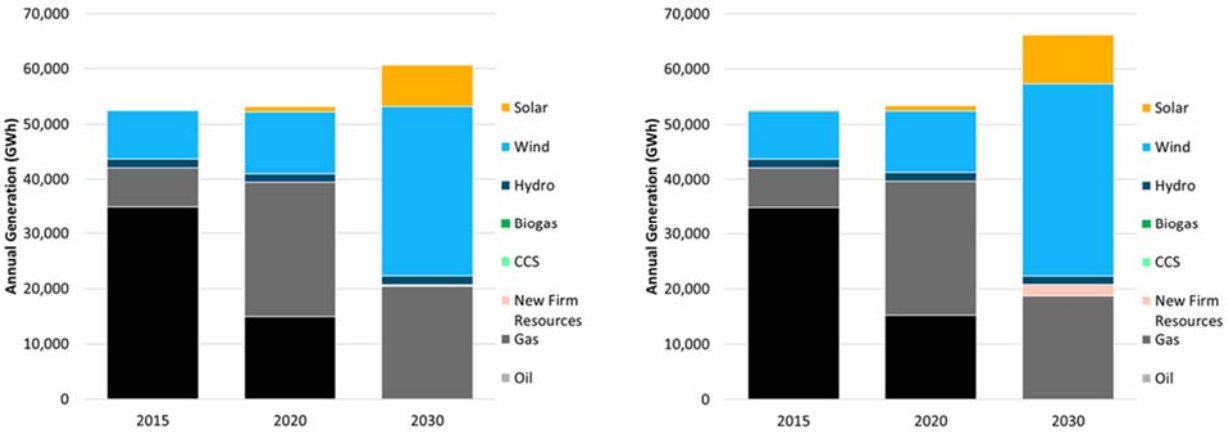
To meet 2025 and 2030 targets, emissions reductions are needed across many sectors. Figure 25 below shows the breakdown of emissions reduction by distinct sets of measures or "wedges" in 2030. The largest near term gains can be made in electricity generation and oil and gas, but early effort is also needed in buildings, transportation, industry, refrigerants, waste reduction, and reducing methane emissions from landfills, sewage treatment plants, and agricultural operations, waste, and coal mine methane.

Figure 25: Emissions Reduction by Measure in 2030



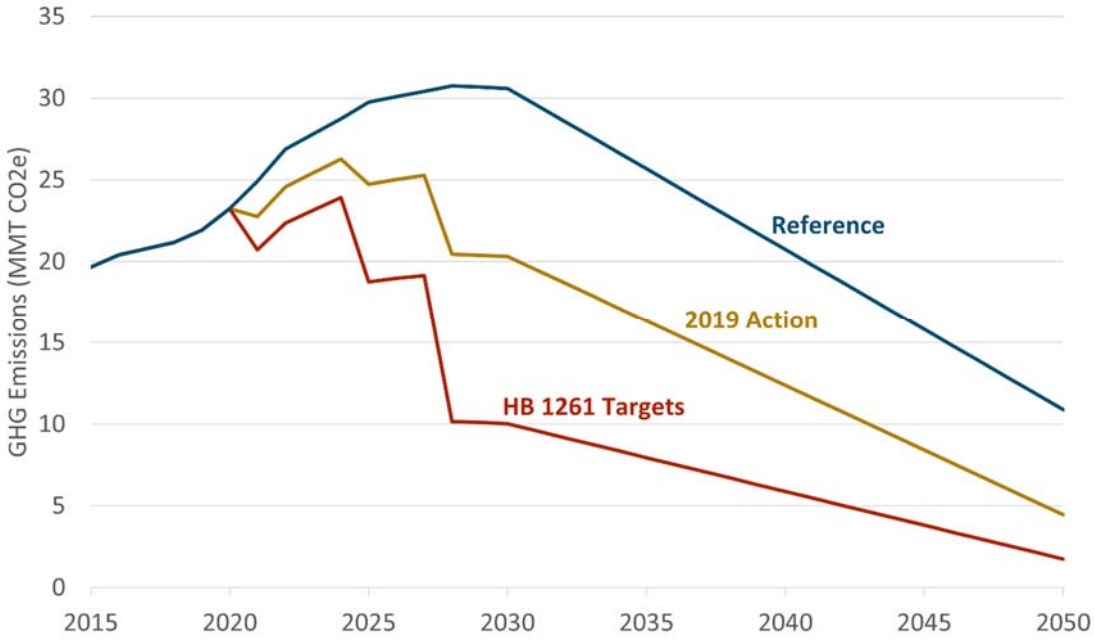
The clean electricity targets set in 2019 as part of HB 19-1261, along with additional commitments from Colorado utilities, form the backbone of deep decarbonization by directly reducing electricity generation emissions and indirectly enabling greater emission reductions elsewhere through the electrification of buildings, transportation, and industry. The clean electricity targets modeled by E3 assume that Xcel Energy and Tri-State's share of load is met with carbon-free resources by 2050, while other utilities must meet an emissions reduction of 80% below 2005 levels by 2050. This is likely a conservative assumption; other utilities will also be transitioning towards zero carbon generation. In fact, Platte River Power Authority already has adopted a resource plan to achieve a 90% reduction by 2030, and Holy Cross Energy has committed to zero carbon emissions by 2030.

Figure 26: Electricity Generation through 2030 in 2019 Action Scenario (left) and HB19-1261 Targets Scenario (right)



Minimizing the release of methane from the oil and gas industry is essential to achieving the state's goals, as these make up the largest source of non-combustion emissions in the state. Oil and gas production is assumed to be the same between the three scenarios, with emission reductions coming from reducing methane emissions leaks in upstream operations and the downstream distribution system. The forecasts of production emissions and leak rates were set on the high side of potential outcomes for planning purposes. Greater leak rate reductions or less production would drive deeper reductions. Methane is a short-lived but potent climate pollutant, making it a priority for the state to mitigate impacts in the next ten years. Oil and gas emission reduction measures are estimated to be low cost, approximately $4/tonne CO2e relative to the Reference scenario (for comparison, the social cost of damages caused by carbon emissions is over $50/ton). In the near term action recommendations developed by the state agencies, a rulemaking is proposed in 2021 to achieve deeper emissions reductions from the oil and gas sector than are contained in this illustrative scenario.

Figure 27: Methane Emissions in Colorado's Oil and Gas Sector by Scenario



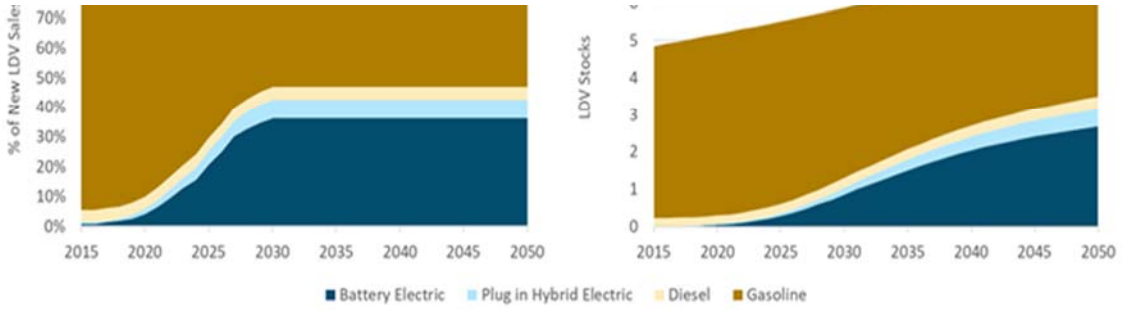
Energy efficiency in residential and commercial buildings is a no-regrets action in the near term. E3's analysis assumes a transition to 100% sales of high efficiency appliances and technologies in buildings, which in turn reduce pollution and costs. Widespread adoption of energy efficiency improvements in the buildings sector, however, is contingent on continued advancement of building energy codes, utility incentive and technical assistance programs, building performance standards, consumer education, and other actions. Building efficiency measures are estimated to save $54/tonne CO2e (i.e., cost savings) relative to the Reference scenario in 2030. Because of the challenges in achieving widespread changes to buildings over relatively short timeframes, the near term action recommendations assume smaller emissions reductions from the building sector between now and 2030 than are shown in the illustrative HB-1261 Targets Scenario.

Vehicle and building electrification are very effective at reducing pollution, but their adoption will take time to ramp up. Electric passenger vehicles and trucks are more efficient at converting energy to miles traveled,

and the electricity they use is increasingly clean, so they reduce pollution relative to internal combustion engine vehicles. In the illustrative scenario that achieves the HB 19-1261 targets, E3 assumes a ramp up in the sales of zero emission vehicles to 70% by 2030, which is a significant departure from adoption today. This level of transformation will require continued effort from the state to remove barriers to consumer adoption, install robust EV charging infrastructure, and plan the electricity grid to accommodate new levels of electrification. Light duty vehicle electrification is expected to be very affordable by 2030, E3 estimates cost savings of $172/tonne CO2e in 2030 relative to the Reference scenario. Medium and heavy duty electrification may take additional time to ramp up— E3's analysis assumes a 40% sales share of zero-emission trucks by 2030.

One criticism that was raised by a number of stakeholders during the public process has been a concern that the 2019 Action Scenario assumes a higher level of light duty EV adoption under current policy than is required by state ZEV regulations, and that the HB-1261 Targets Scenario assumes a perhaps too aggressive increase in EV uptake over the next decade. The numbers included in the 2019 Action Scenario were not arbitrary— they are normalized to the goals in the state EV plan, and are very similar to market projections that were developed for the Energy Office by Navigant Consulting as part of the ZEV rulemaking at the AQCC in 2019. However, in order to respond to this concern, for the purposes of the near term action recommendations, the state agency analysis assumes much lower adoption of EVs by 2030 under current policy, and then proposes additional actions to achieve emissions reductions from transportation.

Figure 28: Vehicle Stock Rollover



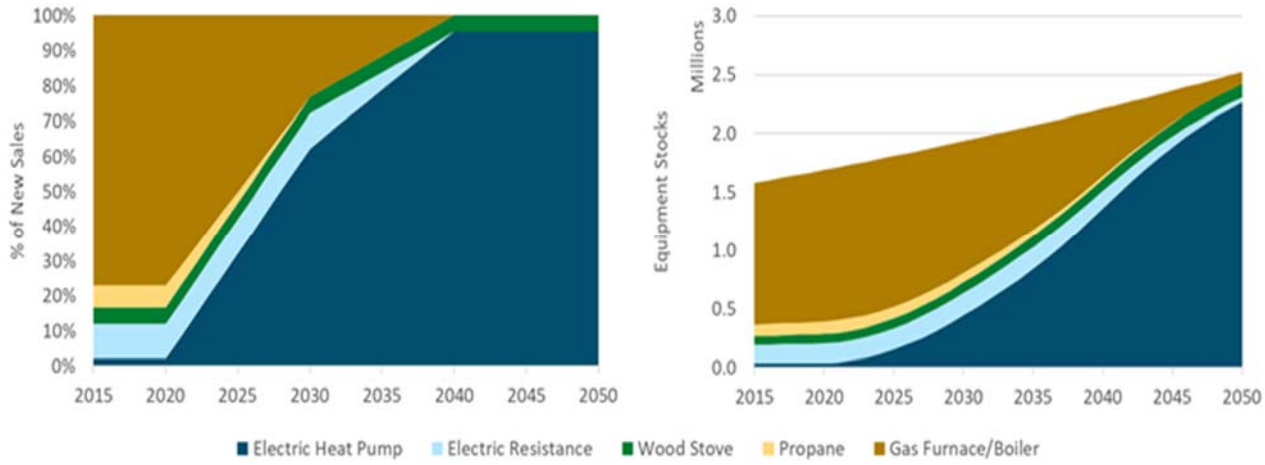
MDV and HDV electrification is currently estimated in the E3 model to be more expensive ($114/tonne CO2e in 2030), which indicates that technology costs may need to continue to decline- and in some cases or operating conditions may need to be changed- to maximize benefits of truck and bus electrification. However, given the trends that we are seeing of declining battery costs, and lifecycle cost savings already possible in certain segments of the medium and heavy duty vehicle market, this is likely too conservative, as these vehicles will be initially deployed in those industry segments where they are most cost effective.

Electric water heaters and space heating can provide an efficient alternative to fossil devices, but are less widespread in Colorado. E3 assumes a 60% sales share of electric heat pumps in space heating and water heating by 2030, which will require moving quickly to identify least-cost early adopters and investments in heat pump technology to bring down costs for a diverse set of buildings. Building electrification is estimated to cost $55/tonne CO2e relative to the Reference scenario.

It is important to emphasize that there are still substantial uncertainties about the ultimate pathway towards building decarbonization. While the HB-1261 Targets Scenario focused on electrification, there is some potential for other technology pathways to achieve the 2050 targets— such as mixing green hydrogen into the natural gas distribution system, or the

potential for air capture of carbon dioxide as a feedstock for synthetic methane. While studies in California have found that electrification is likely the lowest cost option, there are still questions about the lowest cost pathways in a cold weather state such as Colorado, as well as about the scalability and costs of the other technology pathways. For this reason, we recommend that the Roadmap support a broad suite of near term no-regrets strategies (including building efficiency, electrification, use of bio methane and hydrogen, and reduction of methane leaks), and that further stakeholder engagement and analytical work is needed to explore longer term pathways. We also note that the near term action recommendations assume a smaller reduction in emissions from the buildings sector (20% rather than 37%) than are shown in the illustrative HB-1261 Targets Scenario, to reflect the long lead times necessary to achieve significant changes in the building stock.

Figure 29: Heating Appliance Rollover in HB 1261 Targets Scenario



It will be important to slow the growth of vehicle miles traveled by providing better alternatives to driving, by encouraging telecommuting, by factoring GHG pollution into the transportation planning process, and by making wiser land use decisions. Even with the adoption of zero emissions vehicles, there will be at least three decades to come with internal

combustion engines still on the road, and there are many other co-benefits associated with lower levels of vehicle miles traveled.

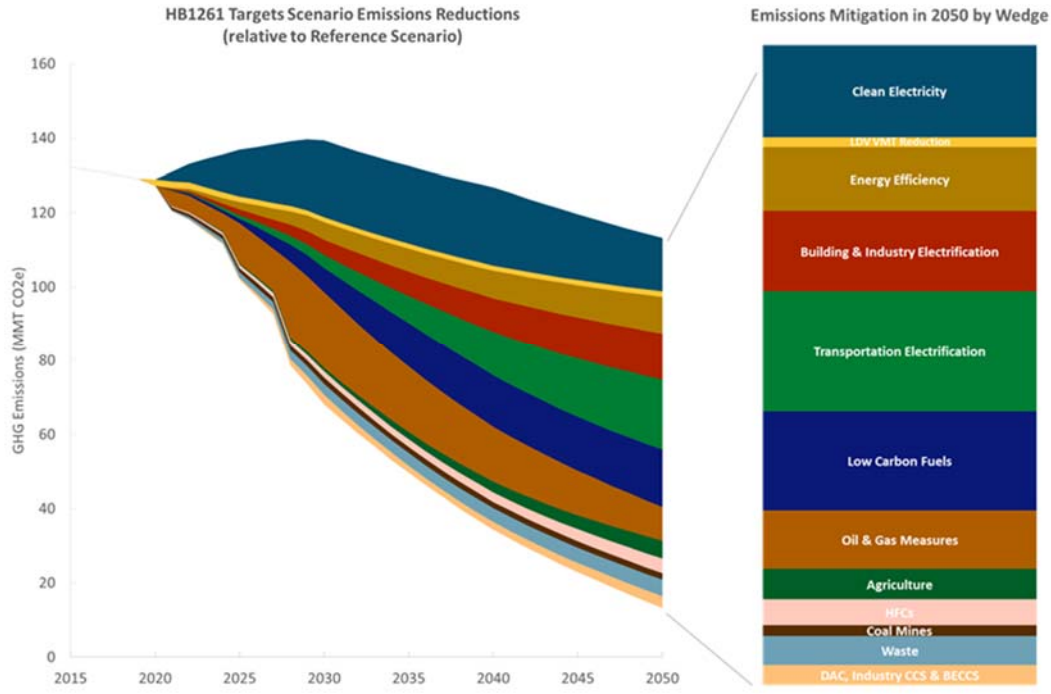
Low carbon fuels will likely play a role as biofuels and hydrogen are shown to be necessary to reduce emissions in sectors that are difficult to decarbonize, such as some industrial processes and some portions of the heavy duty vehicle sector. E3's analysis finds that low-carbon fuels are essential after 2030, but that the role of ethanol, biodiesel, biogas, advanced biofuels, and hydrogen, will need to start ramping up between 2025 and 2030. Promising near term opportunities in Colorado include biogas from waste sources in Colorado, ethanol with carbon capture and storage, and renewable diesel for transportation. Low-carbon fuels range in costs ($168 - $395/tonne CO2e) based on feedstock, conversion process, and delivery of fuel. There are unaddressed questions in a number of areas about the indirect land use impacts of some types of biofuels, and about policy tradeoffs between investments in ZEV infrastructure and incentives and investments in biofuels, which need additional stakeholder and analytical work.

Natural and working lands play a crucial role in the state's low-carbon future. The total carbon flux between the atmosphere and Colorado's natural and working lands sector is currently unquantified. As a result, with the exception of specific agricultural emissions identified in the technical appendix available on the State of Colorado website, the natural and working lands sector is not explicitly modeled in PATHWAYS. **However, natural and working lands have an important role to play in achieving the state's emission targets, in addition to the fundamental value they provide in support of the lives and collective resilience of all Coloradoans**. In addition to identifying near term emission reduction strategies, developing a comprehensive natural and working lands carbon inventory is a key near term priority for Colorado, because it is critical for monitoring and verifying land management activities, policies, and programs that may increase or decrease carbon sequestration over time.

LEADERSHIP AND INNOVATION REQUIRED TO MEET 2050 GHG GOAL

All sectors have an important role to play in emissions reductions if the state is to reach 90% reductions by 2050. There are clear early priorities for the state to make progress towards 2025 and 2030 targets, but achieving the state's science-based 2050 goals will require effort across all sectors of the economy. Figure 29 below shows a potential breakdown of emissions reduction by sector. E3's modeling is only one possible path that Colorado can take to meet the 2050 goal.

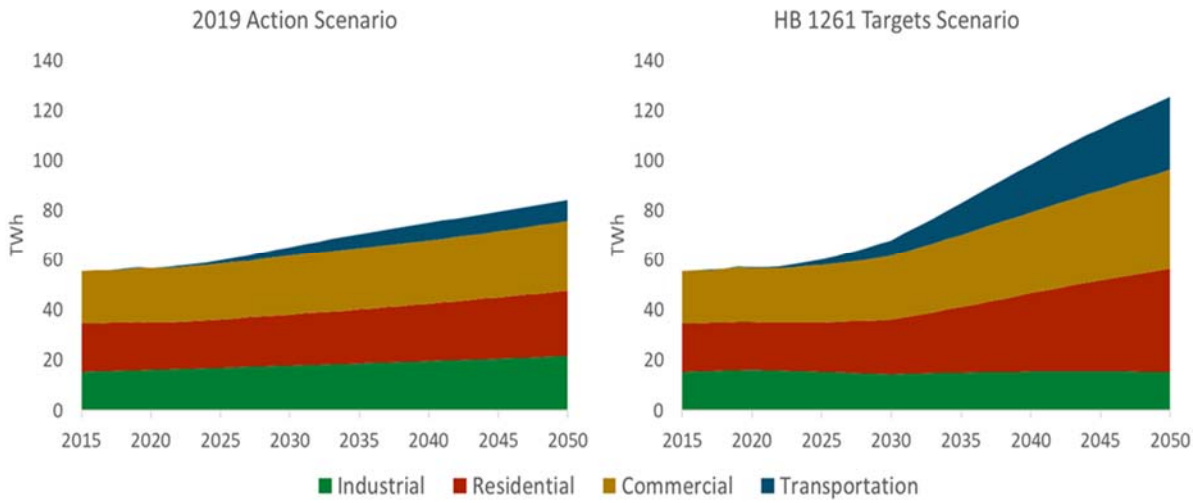
Figure 30: GHG Emissions Reductions by Measure in the HB19-1261 Targets Scenario



Electrification is the largest driver of demand-side emissions reductions by 2050. Widespread electrification in buildings and transportation, along with some electrification in the industrial sector, leads to total electric load more than doubling by 2050 in the HB-1261 Targets

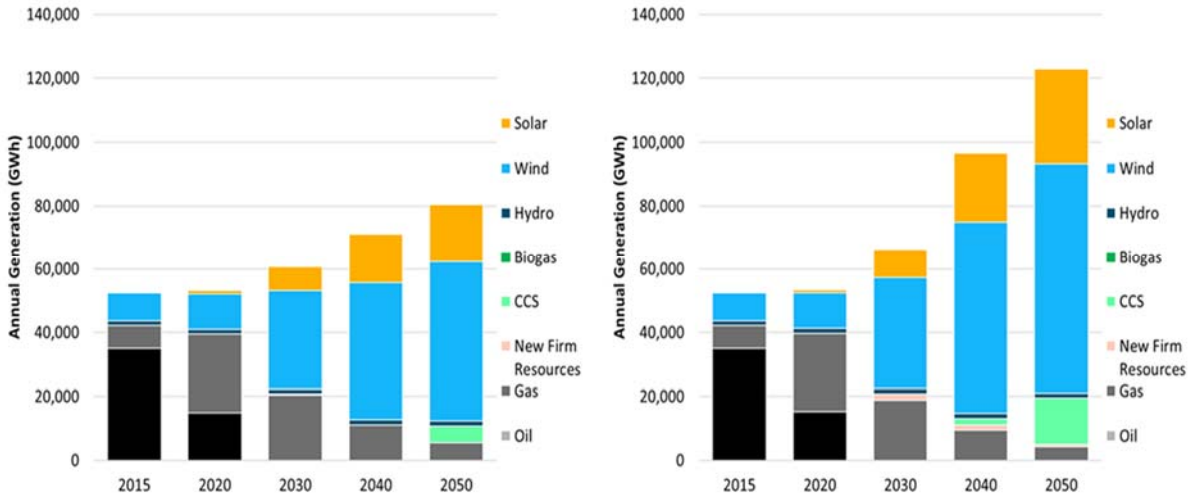
Scenario. Electrification, along with energy efficiency, is crucial to reducing emissions as Colorado's population is projected to grow at more than twice the national rate over the next 30 years. Consumers, influenced by state and federal policy, will drive the pace of adoption for new passenger vehicles and appliances, which in turn determines a large share of the emissions from buildings and transportation.

Figure 31: Total Electricity Demand by Sector and Scenario



The vision for a decarbonized future in Colorado requires two key transformations in the electricity sector: (1) a need to serve increasing electricity demands due to population growth and electrification of fossil devices, and (2) a need to significantly reduce emissions from coal and natural gas generation by developing new renewable resources. This two-fold challenge will require significant wind and solar resource development in the state. This level of development offers opportunities to reduce pollution and create local jobs, but will also require careful land-use planning across the state.

Figure 32: Electricity Generation in 2019 Action (left) and HB19 1261 Targets Scenario (right)



Firm dispatchable capacity is crucial to a reliable electricity system at high levels of renewables. At high levels of wind and solar deployment, it becomes increasingly important to have sufficient electric generating capacity that can be dispatched when winds are not blowing and the sun is not shining. Current battery storage can help by moving this power within the day, but as we approach 2050, the electricity system will also need to be able to function for multi-day periods without significant renewable output. While the vast majority of generation is projected to come from wind and solar, these infrequent periods will require firm dispatchable electric resources, which could include fossil methane (with or without CCUS), bioenergy, use of renewables to produce hydrogen combined with hydrogen combustion, nuclear power, or a future long-duration energy storage technology. It is unclear what the best technological solution will be for this challenge, so Colorado will work with electric utilities to ensure that a full suite of low or zero-carbon technologies can compete to fill that role.

Supplying reliable energy to heat homes in winter is essential and requires careful planning, especially after 2030.

To reduce emissions in Colorado's buildings, a significant effort will be required to achieve greater efficiency in new appliances and building envelopes, in addition to strategic electrification of appliances like stoves (including induction), space heaters and water heaters. A subset of homes and businesses are cost effective to electrify today, but with consumer adoption and innovation building electrification is expected to become increasingly cost competitive by 2030 and beyond.

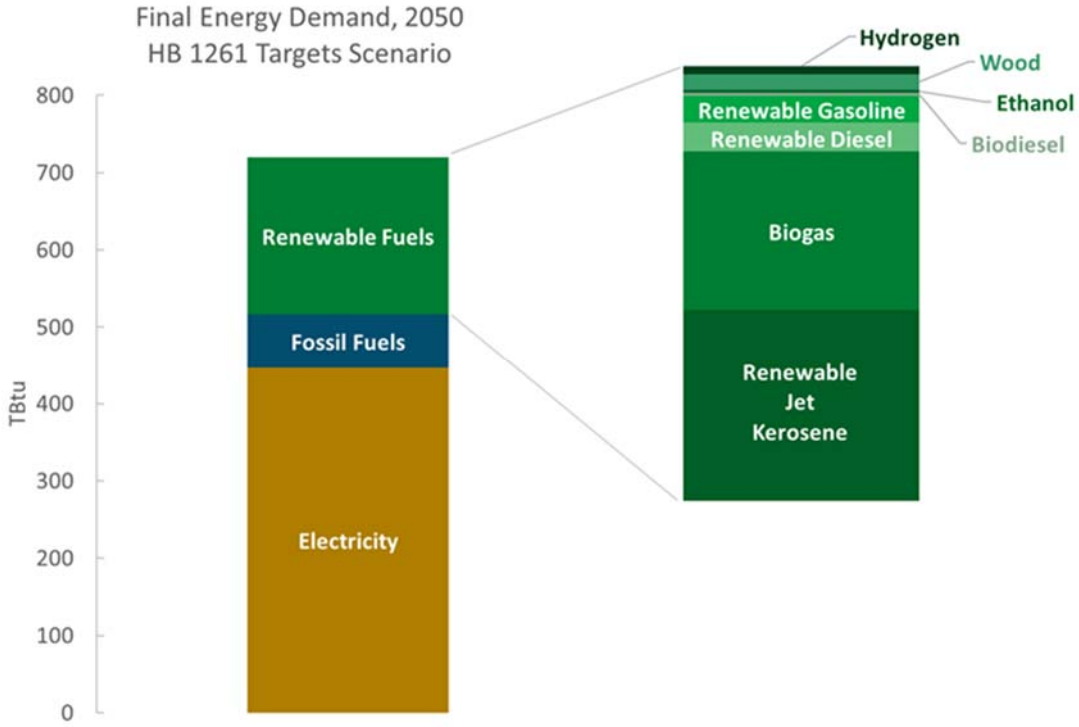
One key consideration for building electrification is the need to reliably heat homes in the winter in Colorado, which requires careful electric sector planning if we shift to primarily electric space heating. E3's analysis indicates that Colorado could shift from a summer peaking to a winter peaking system with the levels of adoption in the HB-1261 Targets Scenario. Continued research into cold climate air source electric heat pumps and barriers to electrification in Colorado's buildings will be essential to the transition. Winter peak heat impacts can be further mitigated through load flexibility in space heating and a balanced mix of technologies (such as ground source heat pumps and combustible fuel backup).

Low-carbon fuels will be necessary to decarbonize sectors that are difficult to electrify

E3's analysis finds the most optimal uses for low-carbon fuels in 2050 are in decarbonizing aviation fuel, remaining diesel consumption in transportation, and remaining natural gas use in industry. While some low-carbon fuels are used to decarbonize the remaining non-electric fuel demand in buildings and passenger vehicles, these constitute a small fraction of energy demand in those sectors. Low-carbon fuels can be sourced from sustainable biofuels (e.g., methane captured from landfills, agricultural wastes, forest thinnings) or can be produced by improving current processes (e.g., ethanol production with CCUS). Low-carbon fuels can also be produced through electricity for fuels like hydrogen and synthetic fuels. A significant

advanced biofuels or electrolytic fuels market will take time to develop in Colorado and neighboring regions, so it will be essential for Colorado to invest in research and development towards furthering these different low-carbon fuel options. New technologies, including electric aircraft, also have the potential to revolutionize this area.

Figure 33: Total Final Energy Demand in 2050 by Fuel in the HB19-1261 Targets Scenario



Reaching 90% GHG reductions will require significant transformation of the oil and gas sector, mainly by reducing upstream and downstream operation leak rates.

The oil and gas sector is a significant source of pollution in Colorado and production has been growing since 2005 (at least until the industry downturn starting in early 2020). A key strategy will be identifying and reducing leak rates in both upstream operations and downstream distribution of oil and gas. E3's HB-1261 Targets Scenario assumed a reduction in upstream leak rate from 4% in 2005 to 0.25% in 2050 and a downstream leak

rate reduction from 0.5% in 2005 to 0.15% in 2050. These reductions reflect realistic targets consistent with SB 19-181 and the goals of leading oil and gas companies.

Strategic deployment of carbon capture utilization and sequestration can reduce pollution in key sectors.

Carbon capture technology is not new, but large scale deployment has been slow especially without an aggressive mandate to reduce emissions or economic incentive. Carbon capture is most cost-effective and appropriate in applications with a pure and concentrated stream of CO2 or significant non-combustion process emissions that would not be avoided from fuel switching. Prime candidates for CCUS in Colorado include ethanol production facilities, central gas processing operations, and cement manufacturing. This is in addition to the carbon sequestration potential of Natural and Working Lands.

An example of a CCUS project in development is a joint venture between Lafarge-Holcim and Oxy Low Carbon venture to capture CO2 from the Holcim cement plant in Florence, Colorado. The project just received a $1.5 million federal grant to complete feasibility work for a project that would remove two million tons of CO2 per year from the cement manufacturing and natural gas fired steam generator. The CO2 would then be placed into a nearby pipeline and then injected underground to sequester the carbon.

Continued engagement with these industries will be needed to determine the appropriate sites and timing of CCUS deployment, in addition to the proximity to appropriate carbon sequestration and utilization opportunities. Further work will also be necessary to assess and address any regulatory barriers to capture and sequester carbon in the state. It is anticipated that a CCUS Task Force will be established to assist the state to evaluate the legal and technical steps toward implementation of CCUS.

Strategic efforts in the natural and working lands sector will be necessary to further reduce associated GHG pollution, and protect and enhance the ability for Colorado's lands to sequester carbon from the atmosphere.

Long-term priority actions include enhancing land conservation and reducing the conversion of native grassland, forests, and pastureland to cropland, energy development, or urban and suburban development. Land conservation should complement sustainable land use planning efforts to reduce transportation and other emissions associated with development. Additional key strategies include reforestation and afforestation of wildfire burn scars, urban and suburban areas, and wind breaks in agricultural landscapes, while acknowledging that these practices must be equitable and adaptive to ongoing climate change and the availability of water resources. Additionally, increases in place-appropriate practices such as cover cropping and cropland nutrient management will achieve substantial emissions reductions from the agricultural sector, and the pace and scale of forest management must be increased substantially to maintain forest health and reduce wildfire severity.

PRIOR ACTIONS TO REDUCE GHG POLLUTION

Because of early actions and commitments to addressing the climate crisis, Colorado has made significant progress on a transition to renewable energy, electric vehicles, and reducing GHG pollution. This work would not have been possible without a strong partnership among the General Assembly, public interest groups, private sector leaders, local governments and the public.

Earlier Climate Plans

In 2007 Governor Bill Ritter, Jr., released the *Colorado Climate Action Plan: A Strategy to Address Global Warming*. The plan concluded that the scientific evidence for human-caused climate was clear. Governor Ritter called global warming, "Our generation's greatest environmental challenge."[xlv] The plan also described three principal roles for state government: enacting bridge strategies that immediately reduce greenhouse gas pollution while we pursue technologies to generate cleaner energy; providing leadership to ensure that long-term solutions, such as renewable energy, are fully developed and broadly implemented; and preparing the state to adapt to those climate changes that cannot be avoided.

The plan established a goal of an 80% reduction in greenhouse gas pollution by 2050 from 2005 levels. To make progress towards this goal, the 2007 plan established a goal of increasing renewable energy and reducing GHG pollution from electric utilities by 20% by 2020. The plan also called on state agencies to partner with research institutions and industry to develop ways to prevent methane leakage from oil and gas drilling; established goals for diverting waste from landfills; directed state government to reduce energy consumption in state buildings and vehicles; and sought to develop a

workforce that would make Colorado a leader in the emerging new energy economy.

In 2014, Governor Hickenlooper released a *Colorado Climate Plan* that identified a number of opportunities to reduce greenhouse gas emissions at the agency level and recommended a number of actions to help improve Colorado's ability to adapt to future climate change impacts and to increase the levels of preparedness of Colorado's state agencies. In 2017, Governor Hickenlooper signed an executive order committing the state to further climate action, including reducing statewide greenhouse gas emissions 26% by 2025 from 2005 levels. Governor Hickenlooper issued an updated Climate Plan in 2018, which identified opportunities to mitigate greenhouse gas emissions and promoted state policy recommendations and actions that increase Colorado's level of preparedness for impacts of a changing climate.

Clean Energy & Efficiency Legislation & Regulatory Actions

Colorado has taken significant legislative and regulatory action to reduce GHG pollution. In 2004, Colorado voters passed Amendment 37, which set a renewable energy target of 10% by 2020 for investor-owned utilities. The legislature has amended the RPS several times, including adopting changes that expanded the requirement for behind the meter generation, increasing the renewable energy target to 30% by 2020 for investor-owned utilities, and establishing renewable energy targets for rural electric cooperatives and municipal utilities.[xlvi]

Colorado adopted legislation in 2007 that created an energy efficiency resource standard by requiring the Public Utilities Commission to establish energy and demand savings goals for regulated gas and electric utilities. In 2017 the law was extended to require regulated utilities to offer electric efficiency programs through 2028. As part of the update to the EERS, the PUC is required to set goals of at least 5% peak demand reduction and 5% energy savings by 2028.

In 2010, the state adopted the Clean Air Clean Jobs Act, which required regulated utilities to file with the PUC plans to reduce emissions from coal-fired power plants. Xcel Energy filed a plan addressing 900 megawatts (MW) of coal-fired generation and the PUC ultimately approved a plan to retire 597 MW of coal-fired generation.[xlvii]

In 2014, Colorado became the first state to adopt regulations to reduce methane emissions from both new and existing oil and gas well operations. The regulations have served as a model for subsequent federal and state regulations in the sector. In 2018, the Colorado Air Pollution Control Division determined that in the intervening years following the implementation of the regulations (2015-2017) the number of methane leaks had fallen by 52%.

In 2014, as part of the settlement of litigation around a State Implementation Plan to reduce Regional Haze, the owners of the Nucla coal-fired power plant agreed to accelerate the retirement date for the plant to 2022. The agreement was later amended to include the early retirement of a second coal-fired plant, Craig 1 in 2025. The updated plan was approved by the state Air Quality Control Commission on December 15, 2016, and approved by the Environmental Protection Agency on July 5, 2018. Ultimately, the Nucla plant was retired more than two years earlier than the date set out in the settlement.

In 2016, Xcel Energy filed an electric resource plan with the PUC. During the proceeding, Xcel and more than 20 different groups joined together to present the PUC with the Colorado Energy Plan- an agreement that proposed to retire two coal-fired power plants and replace them with 1,100 MW of new wind generation and 700 MW of solar, while saving customers a projected $200 million. The Colorado Energy Plan proposed to retire Comanche unit 1 (325 MW) in 2022, 11 years ahead of schedule, and to retire Comanche unit 2 (335 MW) in 2025, a decade ahead of schedule. According to analysis submitted with the plan, Xcel Energy will cut its carbon

emissions from electricity generation 60% by late 2025 from 2005 levels. The plan was projected to create nearly 2,000 jobs and add $203.6 million in GDP statewide. The PUC approved the plan in 2018.

In 2018, the AQCC adopted the Colorado Low Emission Automobile Regulation (CLEAR) in response to efforts at the federal level to roll back vehicle emission standards. CLEAR established low-emission vehicle standards for light-duty and medium-duty vehicles in Colorado beginning with the 2022 model year. CLEAR is projected to reduce GHG pollution by more than 30 million tons cumulatively between 2022 and 2031, compared to a scenario in which federal standards are relaxed, and to provide net savings to Colorado drivers through reduced fuel costs due to greater vehicle efficiency.

PROGRESS UNDER POLIS ADMINISTRATION

Renewables Roadmap

In June of 2019, Governor Polis released the *Roadmap to 100% Renewable Energy by 2040 and Bold Climate Action*, which included a number of key priorities and strategies, including growing green jobs and saving consumers money; modernizing the Public Utilities Commission; promoting Energy Efficiency; putting more zero emission vehicles and commuting options on Colorado roads; moving toward zero emission buildings; supporting local commitment to 100% renewable energy; and ensuring a just and equitable transition for all of Colorado. Since the release of the 2019 Roadmap, the state has taken a number of important steps towards the identified priorities. This Roadmap builds on that work.

Recent Legislation

In 2019, the General Assembly passed and Governor Polis signed into law 14 pieces of clean energy and climate legislation, including the Climate Action Plan, which established GHG pollution reduction goals. Other legislation required local jurisdictions to adopt one of the three most recent versions of the International Energy Conservation Code (IECC); created pathways for electric utilities to invest in clean energy; modernized the Public Utilities Commission; adopted new energy efficiency standards for appliances; and required investor-owned utilities to invest in electrifying transportation.

While COVID-19 impacted many climate and clean energy priorities for the 2020 legislative session, Colorado continued pushing forward by creating a new Air Quality Enterprise (SB20-204) to protect air quality and advance air

monitoring research, adding staff to the Air Pollution Control Division to address stationary source emissions, increasing fines and reporting requirements for air quality violations (HB 20-1143 and HB 20-1265), increasing the availability of new all-electric cars and trucks in Colorado, and supporting greater consumer choice in the future (SB20-167).

Electricity

Electricity has historically been the largest single source of greenhouse gas pollution in Colorado, driven primarily by emissions from coal-fired power plants. A lesser portion of emissions come from natural gas power plants. However, pollution from electricity has been trending downwards for the last 15 years, driven by public policy and by changes in technology and economics. As wind and solar have been deployed on a large scale, their cost has come down dramatically through a combination of technical improvements, economies of scale, and advances in forecasting and the ability to cost effectively integrate renewable energy into the grid. This has led to new wind and solar generation often being less expensive than continuing to operate existing coal-fired power plants.

In the last two years, the clean energy transition has accelerated. The administration's strategy for the electricity sector has been to focus on achieving deep reductions in pollution (at least 80% by 2030) enabled by the declining cost of wind, solar, and storage, while using the expertise of utility boards and the PUC to ensure this transition is accomplished in a way that maintains reasonably priced electricity and the reliability of the system. While many of these plans were voluntarily developed by the utilities, a variety of state regulatory structures will allow these plans to be made enforceable, including placing announced coal plant retirements into enforceable State Implementation Plans (SIPs) for reducing regional haze or through the Clean Energy Plan approval processes.

Xcel Energy, the largest utility in the state, made a voluntary commitment to reduce GHG pollution by 80% below 2005 levels by 2030; SB 19-236 built on this voluntary commitment by requiring Xcel Energy to submit a Clean Energy Plan to the PUC that will achieve an 80% carbon reduction by 2030. Xcel is required to file its Clean Energy Plan in March 2021. This plan will build on an approved plan that will retire the Comanche 1 and 2 coal units (totaling 660 MW) in Pueblo roughly a decade early and replace them with a combination of wind, solar, and storage. As part of its transition to clean electricity generation, Xcel Energy agreed with the Evraz steel mill to construct a 250 MW solar plant on the mill's grounds—the largest behind the meter project in the country. This project will provide low cost, clean electricity at a reliable price, which enabled Evraz to announce a $480 million improvement to the Pueblo mill, including a guarantee of 1,000 jobs.[xlviii]

Xcel Energy also signed a settlement agreement with the City of Boulder to end a 10-year dispute over whether Boulder will form a municipal electric utility. Boulder voters approved the agreement in the 2020 election, which sets pre-2030 GHG emissions targets, committing Xcel Energy to greenhouse gas pollution reductions of 52% by 2022, 61% by 2024 and 67% by 2027. In January, 2021, Xcel Energy announced plans for the early retirement of two additional coal plants, Hayden Unit 1 in 2028 and Hayden Unit 2 in 2027.

The combination of SB 19-236 and HB 19-1261 creates strong incentives for other utilities to reduce their pollution. Under part of SB 19-236, any utility is permitted to file a Clean Energy Plan that reduces carbon emissions by 80% by 2030 with the PUC. If a utility's CEP meets this reduction target and is approved by the PUC, the AQCC grants the utility a "safe harbor" from additional regulation of carbon emissions through 2030. The administration has encouraged utilities to voluntarily adopt energy plans that will achieve these goals and to file CEPs as a mechanism to achieve deep pollution

reductions and a quick transition to renewables. The state will continue to coordinate with utilities and report annually to the AQCC regarding their intent to file and implement CEPs.

The state's other electric utilities with coal plants have announced plans to retire coal-fired generation and replace it with renewable energy and storage. The state's second largest utility, Tri-State Generation and Transmission, historically has been reliant on coal-fired generation including the Nucla plant and three coal-fired units located in Craig, Colorado. The three Craig Station units total 1,285 MW. Prior to 2019, Tri-State did not submit its resource plans to the PUC for approval. With the passage and signing of SB 19-236, Tri-State must now get approval of its Electric Resource Plan from the PUC. While Craig Unit 1 (427 MW) was scheduled for retirement in 2025, Craig unit 2 (410 MW) was anticipated to stay in operation through 2039 and Craig unit 3 (448 MW) was projected to run through 2044.[xlix] In 2019, new leadership at Tri-State worked with the administration and a variety of stakeholders to develop a new "Responsible Energy Plan," which commits to closing all Colorado coal-fired generation by 2030, and commits to closing the mines associated with those plants. As a result of these closures, the plan reduces emissions from generation located in Colorado by 90% and emissions from generation serving Colorado load by 70% (this reflects the fact that some electricity used in Colorado comes from coal generation in Wyoming). At the time the plan was announced, Tri-State's CEO described the "green dividend," in which low cost solar and wind would allow the company to make these changes without negatively impacting ratepayers — in fact, they project an 8% decrease in wholesale electricity prices over the next three years. Tri-State also selected developers to add 1,000 MW of wind and solar in five locations across the state. More recently, Tri-State submitted a resource plan to the PUC in December 2020 that targets an 80% reduction in emissions from the generation that serves load in Colorado.

Colorado Springs Utilities, the state's third largest utility, which serves Colorado Springs and is governed by the city, is also making voluntary efforts to reduce its reliance on coal-fired generation. In June 2020, the City Council, acting as the utility board, voted to retire the Drake coal-fired unit by 2023, roughly 12 years ahead of schedule, and to retire the Ray Nixon plant by 2030. The plan presented to the board calls for 500 MW of wind power generation capacity, 150 MW of solar, and more than 400 MW of battery storage, reducing GHG pollution by 80% by 2030. Colorado Springs Utilities has announced that it will submit this as a clean energy plan to the PUC.

The Platte River Power Authority (PRPA), the fourth largest utility in the state, provides power to the municipal utilities serving Estes Park, Longmont, Loveland, and Fort Collins. In fall of 2020, the PRPA board voted to approve an electric resource plan that includes retiring the Rawhide coal plant by 2030, years ahead of schedule, and adding 400 megawatts of renewable generation. PRPA's analysis shows that the plan will reduce greenhouse gas pollution by 90% by 2030. PRPA has committed to submitting this as a clean energy plan to the PUC.

Holy Cross Energy, one of the largest rural cooperatives that is not a wholesale customer of Tri-State, announced in December of 2020 that it is committing to 100% carbon free generation by 2030. This builds upon its previous adopted plan to achieve 70% by 2030, which it now anticipates achieving in 2021, and represents a new bar for utility ambition in decarbonization. Holy Cross has also announced its intent to file its plan as a clean energy plan with the PUC.

In the fall of 2019, Black Hills Energy filed voluntarily with the PUC to amend its current electric resource plan. In its filing, Black Hills stated that its goal was to add up to 200 MW of new renewable resources while saving money for its customers by avoiding burning fossil methane. At the time this

Roadmap was developed the case was still before the PUC. In January 2021 Black Hills announced its intent to file a clean energy plan that will achieve an 80% pollution reduction by 2030.

In addition to the work the state is doing with utilities to reach deep pollution reduction, the State Land Board is providing opportunities for renewable energy development on state lands. The State Land Board has signed renewable energy leases for projects that will increase installed production capacity on State Trust Land to 520 MW, enough energy to power 150,000 homes in Colorado, and generate revenue for Colorado's public schools.

One important benefit flowing from the rapid transition towards clean electricity is that it magnifies the pollution reduction, public health, and other benefits of electrification in other sectors, such as cars and buildings.

Transportation

In 2020, transportation overtook electricity generation as the largest source of greenhouse gas pollution in Colorado, consistent with the trend nationwide. That is why the state is working to develop policies and strategies that will reduce emissions in this sector by making cars, trucks, and buses cleaner, by reducing the number of miles traveled, and by helping local governments invest in infrastructure to reduce the need to drive.

Colorado's EV Plan

In 2020, the Colorado Energy Office updated the state's EV plan. The plan presents a framework for transitioning vehicles in Colorado, setting a goal of increasing the number of light-duty cars and trucks to 940,000 by 2030. In support of the goal, the plan also calls for transitioning medium-duty (MDV) and heavy-duty (HDV) vehicles to zero emission vehicles; undertaking a gap analysis to identify the type and number of charging stations needed across the state to meet the state's vehicle electrification goals; and for state government agencies lead by example.

Shortly after taking office, one of Governor Polis' first executive orders, Executive Order B 2019-002, "Supporting a Transition to Zero-Emission Vehicles," committed the state to a large-scale transition to zero emission vehicles and identified several key initiatives in support of this goal. The order directed CDPHE to develop a rule to establish a zero emission vehicle program under Section 177 of the Clean Air Act, including proposing adoption of the rule to the AQCC by May 2019, and requiring consideration of adoption by October 30, 2019. It also required CDPHE and its partner agencies to revise the state's Volkswagen Settlement Beneficiary Mitigation Plan to direct all remaining funds to transportation electrification projects, a process that was completed by September of 2019. Finally, Executive Order B 2019-002 laid the foundation for a number of subsequent bills and initiatives over the course of 2019 and 2020 in support of greater transportation electrification.

The AQCC adopted Low Emission Vehicle Standards on November 16, 2018. In August 2019, the AQCC subsequently adopted Zero Emission Vehicle

Standards. With that decision, Colorado became the first state in nearly a decade to adopt a ZEV regulation and the first ever to do so with support of automakers. State agencies negotiated an approach that created incentives for early deployment of ZEVs, which resulted in the associations representing 99% of auto sales supporting the proposed rule. These regulations start with model years 2022 and 2023 vehicles, respectively, and will allow Colorado to continue making progress on improving the sustainability of its transportation system despite federal government inaction and the roll back of nationwide emissions standards. In particular, the ZEV standard will require auto manufacturers to make a greater number and variety of clean vehicles available to Colorado consumers. Colorado's program also contains a provision that allows manufacturers to earn early action credit against their requirement by making EVs available as early as the 2021 model year. The early action credit could result in Colorado being one of the first states to receive electrified SUVs and trucks. Finally, Colorado's ZEV program also establishes a process for tracking and increasing the percentage of ZEVs on the road in the years to come.

A ZEV program is just one strategy needed to help the state reach its goal of 940,000 EVs by 2030. A 2019 analysis conducted by Navigant for the Colorado Energy Office looked at three different EV growth scenarios and found that while the ZEV program is critical to ensuring increased model availability, achievement of the state's goal will also require a significant and long term utility investment in charging infrastructure and a multi-year consumer education and awareness campaign. The analysis also stated that continuation of the state Innovative Motor Vehicle Credit, albeit at a lower level, would be needed through at least 2025 to achieve the State's 2030 goal.

The Colorado Legislature passed several new laws in 2019 that support transportation electrification. The actions taken under these statutes will reinforce one another and the goals and strategies of the Colorado

Department of Transportation's Clean Transportation Plan and the updated *Colorado Electric Vehicle Plan 202*0. CDOT has enhanced its focus on electrification of transit fleets and is supporting zero emission vehicle adoption throughout the state through consumer education, investment in charging infrastructure programs, and additional measures to reduce emissions. CDOT is working to expand multimodal options through its intercity bus service, Bustang, as well as the continued development and construction of mobility hubs – transportation centers that emphasize multimodal options. In addition, CDOT continues to support local transit agencies across the state, which provide critical transportation services and driving alternatives to diverse populations throughout the state.

SB 19-077, one of the bills passed in the 2019 legislative session, supports vehicle electrification for Colorado homes and business, including vehicle and transportation fleets. The statute requires Colorado's two investor-owned electric utilities, Black Hills and Xcel Energy, to file plans with the Public Utilities Commission for how they will invest in vehicle electrification and requires utilities to include in those plans investments that serve historically disadvantaged communities. The statute authorizes the utilities to provide electric vehicle charging as a service to customers, allows the utilities to provide incentives to customers, and to support customers' investments in charging infrastructure. To ensure that there is competition in the EV charging marketplace, the law requires the utilities to apply to the Public Utilities Commission to build facilities to support EVs.

In May 2020, Xcel Energy and Black Hills Energy submitted their first Transportation Electrification Plans to the PUC. Xcel Energy's 3-year $130 million proposal included a wide range of programs for residential customers in single-family and multi-family homes as well as programs for small and

Equity in Xcel's TEP

In the PUC case addressing Xcel's TEP, the state advocated for using the Equity Framework as a key tool for identifying impacted communities and for how utilities should engage with identified communities to better understand their goals and interests in vehicle electrification. CEO also advocated that the framework and outreach should be used to help determine how funds should be allocated.

large businesses. Xcel's plan proposed funding for advisory services and research and innovation for projects such as electrification of shared mobility, optimization solutions for fleets, and electrification of school buses. In December 2020, the PUC voted to approve a $110 transportation electrification plan for Xcel that includes investment in new electric vehicle infrastructure, residential home charging, and programs to support electrification of vehicle fleets and multi-family homes. The Commission provided emphasis on support for programs that benefit lower income households and communities impacted by transportation pollution, including $2.2 million to support electrification of buses and $5million for rebates for customers who qualify based on income to purchase electric vehicles. to ensure that the benefits of electrification are broadly shared.

The Black Hills Energy Ready EV plan would offer rebates for installation of charging stations to single and multifamily residences, businesses, governments, and nonprofits. Black Hills Energy also proposes customer and auto dealership outreach and education. Both Xcel Energy and Black Hills Energy have proposed expanded offerings for lower-income customers, in order to support an equitable transition to electrified transportation.

Other supporting measures passed in 2019 included HB 19-1159, which extended existing income tax credits for the purchase or lease of alternative fuel vehicles (including EVs) through 2025, while ratcheting them down over time. HB 19-1159 also allows Transportation Network Companies, like Lyft and Uber, that offer leased EVs to their drivers under short term rental programs to claim the full tax credit. This last provision helped Lyft deploy 200 Kia Niro EVs in Denver in November 2019, the single largest EV deployment made by a TNC to date. Concurrently, HB 19-1198 modified the

statute governing the electric vehicle grant fund to allow fees collected on EV registrations to be used for administrative costs associated with making charging station grants and to offset charging station operating costs. HB 19-1298 established signage procedures and penalties for non-charging vehicles parked in designated EV charging spots to safeguard access to public charging infrastructure, including those EV stations funded using the grant funds addressed above.

Finally, SB 19-239 directed CDOT to examine the environmental, congestion, and social impacts of technological and business model changes related to commercial vehicles and convene a stakeholder working group to develop recommendations on how best to mitigate these impacts, including via a potential fee structure. CDOT released its findings in fall 2019, setting the stage for future efforts aimed at electrifying these emerging commercial vehicle types before they worsen air quality and increase GHG emissions over the longer-term.

In 2020, the General Assembly passed SB 20-167, which allows EV manufacturers to sell directly to customers if they only make EVs and have no franchised dealers. This will help to increase the availability of new all-electric cars and trucks in Colorado and will support greater consumer choice.

In July 2020 the state announced the launch of a Colorado Clean Trucking Strategy aimed at formulating a cohesive and comprehensive plan to reduce the air quality and GHG impacts of the medium and heavy duty vehicle sector. Reducing pollution from M/HD vehicles is particularly important because M/HD vehicles are major sources of nitrogen oxide pollution, which contributes to ozone formation. The particulate emissions from diesel vehicles have serious health impacts, especially in disproportionately impacted communities. Transitioning to much cleaner and zero emissions trucks in one of the most important strategies to simultaneously address GHG pollution and local air pollution.

To advance the Clean Trucking Strategy, Colorado is working in partnership with the Colorado Motor Carriers Association and vehicle manufacturers, electric utilities, environmental advocacy groups, environmental justice communities, and local governments. The state held three public meetings between August and October 2020, bringing more than 200 attendees from across the state into the Clean Truck conversation. The state is pursuing a wide-ranging strategy that will include evaluating a potential ZEV regulation for medium and heavy duty vehicles, potential new regulations of nitrogen oxide emissions from trucks, voluntary vehicle efficiency improvements, utility infrastructure investments, integration of electrification considerations in highway infrastructure improvements, incentives for cleaner trucks, ZEV workforce development, and state government leadership by example.

At the same time that Colorado launched this internal state effort, it also signed on to a Memorandum of Understanding with 14 other states and the District of Columbia committing to work collaboratively to advance and accelerate the market for electric M/HD vehicles, including large pickup trucks and vans, delivery trucks, box trucks, school and transit buses, and big-rig long-haul delivery trucks. The goal of the multistate MOU is to ensure that 100 percent of all new M/HD vehicle sales will be zero emission vehicles by 2050 with an interim target of 30 percent zero emission vehicle sales by 2030.

The state has made progress in ensuring Coloradans can drive anywhere in Colorado in an EV and find a place to “fill-up” their battery. In April 2019, CEO issued a $10.33 million grant to ChargePoint to build high-speed charging stations in 34 communities along Colorado’s interstate as well as state and US highways. ChargePoint has partnered with a variety of public and private site hosts all over Colorado, with each location selected for its proximity to amenities and ability to ensure quick, convenient charging. Each site will allow two-to-four cars to charge at a time, and each site will be built

so that as more EVs begin driving on Colorado's roads, the number of vehicles that can charge and the charging speed can be expanded in a cost-effective way. In 2020, stations will open in Dinosaur, Salida, and Pagosa Springs as well as nine other locations. Twenty-two more stations are projected to come online by spring 2021. In addition, through the Charge Ahead Colorado grant program, the state has made awards for installation of more than one thousand community-based Level 2 and DC fast-charging stations at workplaces, multi-family housing, commercial facilities, and public parking lots and garages.

Outside of the vehicle electrification space, the state is also moving towards a strategy of better accounting and mitigation for the pollution impacts of infrastructure, and towards an approach that focuses on providing more mobility options to travelers, including transit and active mobility options like walking or biking. For example, as the state begins its community input process for the reconstruction of I-270, a highly trafficked thoroughfare that traverses Commerce City— an important environmental justice community —CDOT is pursuing a range of new strategies, previously unprecedented in the agency's approach, to better measure air quality impacts at the outset as a baseline for mitigation, and to work with the community to identify advanced mitigation options to incorporate into the project. This builds on lessons learned from evaluation of the Central I-70 project through Denver, and CDOT intends to carry these practices into other capacity projects moving forward.

CDOT and the Denver Regional Council of Governments have collaborated on a new model for making funding available to make urban arterial roadways into "safer main streets" for all modes of transportation including walking, transit, and biking— including through an allocation of more than $75 million dollars of current road and multimodal funds that are

in the process of being awarded competitively through this program. This is one of the highest priorities included in CDOT's 10-year infrastructure plan, "Your Transportation Plan," and will provide safety and multimodal transportation benefits to all Coloradans.

Importantly, CDOT is also working closely with the Front Range Rail Commission to accelerate completion of program options and a surface development plan for Front Range Rail, in conjunction with work to build demand and make anchor investments in transit along the I-25 corridor through a network of multimodal hubs along the corridor. Several of these mobility hubs are already funded and others would be funded as part of CDOT's 10-year plan, which will provide transit corridor rapid bus service as planning for Front Range Rail continues. Additionally, the administration is working to ensure that RTD funds completion of Northwest rail, consistent with the Fastracks plan adopted by voters in 2004. The project is projected to have ridership of 8,600-10,100 people daily on rail by 2025 according to the binding plan adopted by voters.

Buildings

While Colorado's electricity and transportation sectors are the top two sources of climate warming pollution, fuel use in residential, commercial, and industrial buildings is not far behind. Achieving the state's pollution reduction goals will require significant reductions in this sector. Integrating more energy efficiency with the expanded use of clean electricity as an alternative to burning fossil fuels in buildings could bring consumer cost savings, enhance electric grid operations, reduce GHG pollution, and improve indoor air quality. The state has taken a number of steps to advance building efficiency and is engaging in a variety of programs and strategies to decarbonize the built environment. It is also important to note that energy costs can be a significant burden for lower-income Coloradans; while the average household

spends approximately 2% of its income on energy, many low income households may spend more than 10% of their income on energy costs. It is important that building sector programs, including energy efficiency and solar programs that can reduce household energy costs, be designed to benefit these energy burdened households.

The Weatherization Assistance Program serves approximately 2,000 low income households per year out of roughly 500,000 eligible households. Participation in the program is based on income; the household income threshold for WAP qualification is approximately $35,000 per year. However, WAP-served households have a median income of about $13,000 per year. WAP served homes save an average of $350 per year, but savings can range from less than $100 to more than $800 depending on the energy efficiency and renewable energy measures installed in the home.[l] In addition to energy savings, weatherized homes reduce GHG pollution by 3,500 pounds of carbon-dioxide emissions each year. WAP installed measures go beyond energy savings and produce improved indoor environmental quality through air sealing and reduction of carbon-monoxide.

The state passed legislation in 2019 to expand the number of products covered under appliance efficiency standards (HB 19-1231) and updated the building energy code statute (HB 19-1260) to require local building codes to be at least as strong as one of the three most recent versions of the International Energy Conservation Code. The state supports local governments in adopting these codes by providing no-cost technical assistance and training to county and municipal building departments. In addition, to increase education and awareness of the benefits of newer energy codes, the CEO created an Energy Code Adoption Toolkit that details significant changes and provides a cost comparison between code editions, has examples of advanced codes, and includes code compliance checklists.

The state also supported the adoption of the 2021 IECC, which achieves an estimated 10% greater efficiency than the prior code. The 2021 IECC will be the first code in several cycles that has achieved this level of energy savings and puts codes on a path toward increasing efficiency and performance standards, setting the stage for future codes to enable new buildings to produce net zero emissions. Requirements in the draft 2021 IECC that buildings be pre-wired for future installation of electric appliances and EV charging infrastructure were unfortunately removed by the International Code Council board before publication despite the overwhelming support from state and local governmental voting members for these requirements. The state will still encourage local governments to adopt these requirements.

The Colorado Energy Office and the Division of Housing within the Colorado Department of Local Affairs worked with the Colorado Housing and Finance Authority to modify the 2020 Qualified Allocation Plan, which outlines criteria for awarding tax credits to developers and investors for affordable housing projects in Colorado. The updated criteria encourage developers to design housing that meets higher efficiency standards such as the U.S. Department of Energy's Zero Energy Ready Home or Passive House certifications. The update also includes electric vehicle ready parking space requirements, mandates energy-use intensity reporting, and adds criteria to assess the future retrofit needs of the building, ongoing utility costs, and housing density.

In 2020, the Colorado Energy Office funded a beneficial electrification potential study that estimates the technical, economic, and achievable potentials for BE in buildings in Colorado over the next ten years. The research identifies key technologies and sectors that can benefit from this transition. The report also analyzes market barriers that will impede electrification efforts and provides policy and program recommendations to accelerate the adoption of BE technologies. The report is available on the Colorado Energy Office website.

The Colorado Energy Office is also in the process of launching a commercial building benchmarking program. The program, when fully developed, will enable building owners to report energy use data to a statewide database. The program will work to modernize utility data protocols to improve customer access to building level energy data. Making whole building energy use data more transparent will also help identify cost-effective opportunities for energy efficiency and beneficial electrification upgrades.

CEO provides a number of commercial and residential financing programs that support Coloradans investing in energy efficiency and renewable energy to reduce pollution from the built environment and help customers save money. CEO manages a statewide residential energy upgrade loan program, called RENU, that provides low-interest financing to residential homeowners for energy efficiency and renewable energy improvements. With extended loan terms and the ability for borrowers with lower credit scores to qualify, RENU makes investing in energy upgrades more accessible to Coloradans. Eligible measures include insulation, air sealing, energy-efficient windows, efficient space conditioning and water heating equipment, heat pumps and heat pump water heaters, and solar PV systems. RENU has approximately 140 authorized contractors statewide that are qualified to offer this loan.

The state also has a Commercial Property Assessed Clean Energy financing tool that enables owners of eligible commercial and industrial buildings to finance up to 100% of energy efficiency, renewable energy and water conservation improvements. Financing is provided by private capital providers at competitive rates with repayment terms up to 25 years. Repayment of the financing occurs through a voluntary assessment on their property tax bill. Pending federal reforms, PACE for residential also can provide increased low-cost financing opportunities for investments like home solar.

The Energy Performance Contracting Program is an innovative financing model that enables state and local governments, school districts, special districts, and higher education institutions to make comprehensive energy and water efficiency facility improvements by using guaranteed utility savings to repay the costs of the upgrades over time. Colorado's energy performance contracting program provides the framework and technical assistance to help public facilities lower their annual utility and operations and maintenance costs and improve building performance.

In addition to providing direct access to funding, and in partnership with the Department of Energy and the Coalition for Green Capital, CEO supported the formation of the Colorado Clean Energy Fund to identify strategies for accelerating clean energy investment in Colorado. CCEF is a non-profit financial institution that seeks to increase clean energy deployment and investment in Colorado and operates on the "Green Bank" model pioneered successfully in other states. CCEF has identified a strong pipeline of projects that need investment and has developed the infrastructure to support these projects, but is in the process of raising capital to be able to fund these investments. As described in the near term action section, the administration is seeking $30 million in supplemental stimulus funding in the 2021 legislative session to capitalize the CCEF. The state is also seeking zero interest financing from the U.S. Department of Agriculture to support CCEF loans to support energy efficiency retrofits for low and moderate income households and C-PACE loans for small businesses in rural areas and just transition communities.

Colorado first adopted gas and electric energy efficiency requirements for investor owned utilities in 2007. An independent analysis concluded that Colorado home and business owners will save over $1.5 billion as a result of the efficiency investments made by Black Hills and Xcel Energy, or about $4 on their utility bill for every $1 spent by the utility. In addition to reducing

energy use and costs to consumers, the programs from the two utilities have reduced cumulative CO2 emissions during 2009-18 by 13 million metric tons.[li]

Oil and Gas

Colorado has a significant amount of oil and fossil methane production and has experienced sustained growth in production in the last decade. Despite the substantial growth in production, methane emissions from oil and gas operations are estimated to have generally remained flat between 2005 and 2015 due to increased regulatory requirements adopted by the AQCC that have led to a declining leak rate from the sector. Colorado has been a leader in developing environmental regulations for the oil and gas sector dating back to 2005 when the first system-wide tank regulations were enacted. Since adoption of that first set of regulatory requirements, Colorado has engaged in a series of rulemakings to reduce emissions from the oil and gas sector. With rulemakings in 2006, 2008, 2014, 2016 and 2017, Colorado has adopted increasingly more stringent requirements on the oil and gas sector aimed at a wide range of sources including: oil storage tanks, glycol dehydrators, engines, gas-driven pneumatic devices, component leaks, and well-unloadings. In 2014, Colorado became the first state in the nation to directly regulate methane from oil and gas operations. During that same 2014 rulemaking, Colorado developed a new leak detection and repair program using optical gas imaging technology, which has since formed the basis for federal LDAR requirements for the oil and gas industry.

In 2019, the Colorado General Assembly passed SB 19-181, which strengthened the state's commitment to regulating emissions from the oil and gas industry by creating a statutory requirement for the AQCC to obtain emissions data from oil and gas operators and to minimize emissions in the sector. The AQCC promulgated the first in a planned series of regulations in December 2019, which included a requirement for annual GHG emissions reporting from the sector. The AQCC promulgated further regulations in September 2020 to require monitoring at all new wells and tighten emissions requirements for pre-production activities. Regulations stemming from additional AQCC rulemakings are expected to result in lower leak rates and declining emissions from the sector.

SB 19-181 also changed the mission of the Colorado Oil and Gas Conservation Commission. The statutory mission, as modified, directs the COGCC to regulate the development and production of oil and gas in a manner that protects public health, safety, and welfare, including protection of the environment and wildlife resources. The legislation also directed COGCC to update specific rule topics. On November 23, 2020, the COGCC completed a series of comprehensive rule changes to implement the agency's change in mission, address and evaluate cumulative emissions, including air emissions, and updated numerous rule provisions. These changes improve protection for people, wildlife, and the environment, and will also enhance AQCC and COGCC coordination to pursue emissions reductions moving forward.

Waste Diversion and Methane from Waste

The state, local governments, and the private sector have taken steps to reduce greenhouse emissions associated with waste generation in Colorado. Waste diversion can save energy and emissions and composting can reduce the formation and release of methane in landfills. Organic waste, including food waste and yard waste, is the largest contributor to landfills in Colorado and also produces methane when it decomposes in the landfills. As

the largest waste stream and a key contributor to GHG emissions, CDPHE has put an emphasis on reducing organic waste and finding beneficial methods to utilize these discarded materials.

While Colorado's municipal solid waste and industrial waste diversion rates remain lower than other states at 15.9% and 50.0% respectively, Colorado's waste diversion industry continues to reduce greenhouse gases. In 2019, recycling and composting in Colorado reduced greenhouse gas emissions by 1.92 million metric tons of CO2e, which is equivalent to removing 407,000 cars from the road for a year in Colorado or the energy use and emissions savings equivalent to 148,000 homes being removed from the grid for the year or conserving 2.34 million barrels of oil or 113 million gallons of gasoline. Because Colorado's recycling and waste diversion rates have been below the average of other states, recycling and waste diversion provide critical opportunities to reduce emissions.

In July 2020, the legislature adopted a key piece of legislation to advance recycling end markets in the state. SB 20-055 will support and grow recycling programs by addressing the lack of local end markets for recyclable materials. The bill directs CDPHE to:

- convene stakeholders to help shape the structure and governing guidance for a possible Recycling Market Development Center in the state;
- complete a literature review regarding producer responsibility programs and submit policy recommendations to legislature; and
- administer a statewide education campaign on recycling.

Expanding in-state recycling end markets further reduces GHG emissions by keeping materials here in Colorado, reducing transportation-related emissions.

Similarly, capture of methane associated with waste management in wastewater treatment plants, agriculture and other areas can create biogas that can be captured for use for heat, electricity generation or vehicle fuel. Twenty Colorado wastewater treatment plants put biogas to beneficial use, including Metro Wastewater District (electricity generation), South Platte Water Renewal Partners (injection into Xcel Energy gas pipelines), Grand Junction (biogas for vehicles), City of Longmont (biogas for vehicles), and City of Boulder (electricity generation). There is considerable opportunity remaining in the state to put biogas to beneficial use to reduce greenhouse gas emissions.

Natural and Working Lands

Colorado's natural and working lands include forests, grasslands, agricultural croplands and rangelands, wetlands, riparian areas and urban greenspaces. Natural and working lands are both sources of GHG pollution, including emissions from wildfires, agricultural equipment and fertilizer use, and serve as carbon sinks by holding or sequestering carbon in plants and soils. Natural and working lands, and agricultural producers in particular, are often the first to experience the impacts of climate change. Natural climate solutions aim to conserve, restore and improve lands and land management actions to avoid GHG emissions and increase carbon storage. Natural climate solutions present a unique opportunity to jointly address climate change mitigation and adaptation, and generate ecosystem benefits, while also sustaining working farms, forests and ranches. The generation of ecosystem market and supply-chain opportunities is another increasingly relevant tool to help accomplish agricultural emissions reductions and adaptations.

Vega State Park; Photo credit: Colorado Parks and Wildlife/Dustin Doskocil.

In 2018 Colorado signed on to the U.S. Climate Alliance's Natural and Working Lands Challenge, committing to managing natural and working lands to be resilient carbon sinks and to protect the communities, economies and ecosystems that depend on them.[lii] In 2020 state staff established an interagency Natural and Working Lands Task Force to address Colorado's commitment to improving inventory methods for land-based carbon flux; identify opportunities to reduce GHG pollution and increase resilient carbon sequestration; and advance programs, policies, and incentives to promote natural climate solutions. In partnership with The Nature Conservancy, state staff from the Colorado Department of Natural Resources, Colorado Department of Agriculture, and Governor's Office, are currently conducting a technical analysis to quantify the potential for specific strategies to contribute to the state's GHG reduction goals by 2050. This effort will be completed in 2021 and will identify priority pathways for land management

and inform strategic development of NWL policies, programs, and research agendas. This work complements ongoing and completed work by individual state agencies and partners.

In 2020 the Colorado State Forest Service published the Colorado Forest Action Plan, which is a strategic framework to address the conditions and trends in Colorado's forests[liii]. The Plan identifies priority natural climate solutions, including reducing the conversion of forests to other land cover types, particularly in the wildland-urban interface; improving forest management and productivity through climate-adaptive silviculture; sequestering carbon in sustainable wood products; enhancing equitable urban canopy cover; reducing the risk of uncharacteristic wildfires; and promoting the natural role of fire in ecological processes. The Forest Action Plan will be integrated into ongoing research, policy development and strategic planning for natural and working lands in Colorado.

Since 2015, Colorado Energy Office's Agricultural Energy Efficiency program has provided dedicated technical resources and services to agricultural producers across the state to identify and realize energy efficiency and renewable energy opportunities in their operations. These no-cost, turn-key services include preliminary renewable energy assessments and Type-II energy audits, evaluating energy efficiency opportunities, project cost estimates, payback periods, and a variety of funding mechanisms available to provide significant project cost coverage. The AgEE program also offers support services to help producers successfully complete the funding application process for each funding source. This soup-to-nuts approach removes the guesswork and many of the risks of deploying energy efficiency & renewable energy projects in agricultural operations. The AgEE program provides the necessary information, materials, and technical support, and simplifies the process for producers to capitalize on a variety of project cost coverage options, such as CDA's ACRE3 grants.

The ACRE3 program has been providing grant funding and technical assistance since 2007 to help Colorado agricultural producers reduce or offset their on-farm energy costs by installing high efficiency or renewable energy equipment within their operations. ACRE3 program services include detailed feasibility studies, engineering assistance, and technical support for project construction and commissioning. The program collaborates extensively with the CEO and the USDA-NRCS in providing these services to agricultural producers throughout the state. In addition to partnering with the CEO on the AgEE program, the ACRE3 program also provides services through a second initiative, the Irrigation Hydropower Partnership.

Through the AgEE program, ACRE3 provides funding and additional technical services for qualifying energy efficiency projects recommended through CEO's Type-II energy audit reports, along with technical services and project funding for solar electric, solar thermal, and geo-exchange projects. These projects significantly reduce the burden of energy costs for energy-intensive agricultural operations, such as dairies. The Irrigation Hydropower Partnership is an innovative initiative and partnership with the USDA-NRCS to modernize on-farm irrigation infrastructure, incorporating energy-recovery hydropower. The hydropower initiative prioritizes water-use efficiency improvements and water quality improvements in each of its projects. The hydropower initiative also allows farmers to install center pivot irrigation systems in remote, off-grid applications when the right combination of resources is available.

The ACRE3 program is also evaluating criteria to develop a new agrivoltaics initiative. These large-scale solar projects are designed to allow continued agricultural production underneath and around the solar arrays. Among the new criteria, CDA is reviewing strategies to promote social equity in agrivoltaics by incentivizing community solar gardens with allocations for lower-income subscribers.

While a meaningful proportion of Colorado's landscape is under various levels of local, state and federal protection, and more opportunities exist for public land conservation to address population and climate stressors, privately-owned natural and working lands present a significant conservation opportunity for services such as carbon storage, water quality, soil health, wildlife habitat protection, and safeguarding of local farming and ranching economies. Voluntary, private land protections such as conservation easements may help achieve regional climate and land use goals by preventing mass releases of GHGs through development activities. Research conducted as part of the Greener Fields project indicates that cutting farmland loss in California by 75 percent by 2050, or by 700,000 acres, would reduce GHG emissions the equivalent of taking 1.9 million cars off the road each year.[liv] Colorado's Conservation Easement and Great Outdoors Colorado programs offer financial and tax incentives for restricting development on private lands. In 2017, Colorado State University and the Colorado Natural Heritage Program reported that there are more than 2.5 million private acres protected under conservation easement.

Water Planning

The Colorado Water Plan is the state's framework for identifying solutions to water challenges. After completing the 2015 Water Plan, the Colorado Water Conservation Board began implementing actions and updating the underlying technical data that ultimately supports the next Water Plan (anticipated for completion in 2022). In 2019, the state released the *Analysis and Technical Update to the Water Plan* — a state of the art study of water supply and needs through 2050. As the first statewide supply analysis completed within the context of the Water Plan, the Technical Update estimates future supply gaps under five planning scenarios that incorporate the effects of climate change, population growth, and variable economic futures and societal values. The Technical Update generated a rich dataset that produced insights to statewide and regional impacts to agriculture, municipalities and the environment. The results support regional stakeholder groups in each of Colorado's eight major river basins and others to plan for near- and long-term adaptation actions. Recognizing that climate impacts deeply affect hydrology, water use, water quality, and related disasters such as flood, drought, and wildfire, the 2022 Water Plan update will continue to elevate climate science to the forefront of the state water planning.

Just Transition

Coal has played an important role in Colorado's economy, but with price declines among market competitors, technological advances, and environmental and public health imperatives, the move away from coal toward cleaner energy resources is already taking place and will only accelerate. While the transition to cleaner, lower-cost resources brings economic benefits to the state, the transition away from coal carries significant implications for Coloradans who work in the coal industry and the communities supported by the mines and power plants and those who work in them. As the state embraces the renewable-energy future, Colorado must

remain committed to partnering with and supporting these workers and communities. They powered Colorado's growth in the past and they should continue to share in its future prosperity.

In 2019, Colorado established the nation's first State Office of Just Transition (OJT) and a Just Transition Advisory Committee (JTAC) focused on providing support and resources to both communities and workers impacted by the energy system's transition away from coal.

The JTAC— composed of a diverse set of representatives ranging from impacted workers and communities, disproportionately impacted communities, economic development experts, elected officials, electric utilities, and state officials— is tasked with developing a Just Transition Plan for the state. In August 2020, the JTAC submitted a Draft Plan. Following evaluation of the draft plan and an extensive public input process, executive leadership from the Department of Labor and Employment and the Department of Local Affairs will submit a final Just Transition Plan to the Governor and General Assembly by December 31, 2020.

Climate Equity Framework

In addition to helping workers and communities affected by the clean energy transition, the state is developing a Climate Equity Framework to help ensure that Colorado's response to climate change is guided by principles of racial equity and economic justice. The framework outlines the state's plan to identify and meaningfully engage with communities who are disproportionately impacted by climate change, including people of color, Tribes, indigenous persons, lower-income people, historically

underrepresented groups, like rural and linguistically isolated communities, and those experiencing multiple environmental burdens. The framework lays out data mapping strategies to identify disproportionately impacted communities and provides best practices for equitable and authentic community engagement. It also outlines key opportunities for evaluating potential impacts of policies on disproportionately impacted communities, striving to reduce burdens and maximize benefits.

Informed by an advisory committee made up of equity, environmental justice, and community engagement experts and focus groups with members of disproportionately impacted communities, the Climate Equity Framework will inform long-term state outreach programs and shape how the state, with community input, develops and implements specific greenhouse gas reduction policies, rules, and regulations. The success of the framework depends, in part, on strong partnerships with community leaders and organizations across the state. The state recognizes that these important steps to help rebuild a more just and inclusive system will take time. This change requires a lasting commitment to constantly reexamine policies and processes, connect with and listen to community input and ideas, and elevate voices that have been underrepresented for far too long.

Greening Government

In December 2019, Governor Polis signed an executive order (Executive Order D 2019 016) focused on the state's commitment to reducing greenhouse gas pollution and making government operations more energy efficient and sustainable. This executive order builds on the state's prior greening government efforts and establishes new goals and directives for all State agencies and departments that will save taxpayer money and reduce the impact of state operations on the environment and public health. The executive order's goals center on reducing greenhouse gas emissions across state government by at least ten percent below 2014-15 levels by 2022-23. The executive order also highlights directives in several areas including utility

and fleet fuels management; energy efficiency and renewable energy; state fleet vehicle fuel efficiency and zero emission fleet vehicles; agency and department staffing and training directives; and leased facilities. To accomplish these goals, it establishes more targeted efforts in energy efficiency and energy conservation, increased telecommuting, renewable energy, and fleet management, including:

- Reducing energy consumption per square foot by 15 percent by the end of FY 2022-2023
- Increasing the percentage of renewable electricity consumed or purchased by state facilities to five percent by the end of FY 2022-2023
- Reducing greenhouse gas emissions from state fleet vehicles by 15 percent by the end of FY 2022-2023

Local Government Activities

In addition to state actions, numerous local governments throughout Colorado are implementing strategies to address climate change and its adverse impacts in their communities or are initiating planning to address the climate crisis. These communities range from the largest metropolitan centers to small mountain counties and represent the diverse economic and geographic aspects of Colorado. While the individual programs vary in size and scope, collectively they form a foundation that can be built on through continued collaboration and dedication to a common goal.

The City of Fort Collins Climate Action Plan tracks annual GHG emissions using 2005 as its baseline year. The community aims to reduce carbon dioxide emissions by 20% below 2005 levels by 2020 and 80% by 2030 with the goal of being carbon neutral by 2050. As of 2018, the community had reduced emissions 14%.

In 2018 Boulder County completed a *Greenhouse Gas Inventory and Emissions Reductions Strategies Report* with an updated inventory and new long-term emission reduction goals to reduce community GHG emissions 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050. On January 1,

2020, the County began collecting a voter approved 0.125% sales tax, which will generate approximately $7.5 million per year for sustainability programs. The City of Boulder set a 100% renewable energy goal by 2030, and 100 megawatts of renewable energy generation by the same year. They have also set the target of reaching 80% community greenhouse gas emission reduction by 2050, and have a climate action plan tax on electricity consumption that funds climate programs.

The City and County of Denver adopted the *80X50 Climate Action Plan* with a goal of reducing greenhouse gas emissions 45% by 2030 and 80% by 2050 through the decarbonization of transportation, buildings, and the electricity grid. To reach those goals, the plan calls for reducing total community-wide greenhouse gas emissions 30 percent by 2025, making all new buildings net-zero by 2035 and achieving 100 percent renewable electricity in municipal facilities by 2025 and community-wide by 2030. In November, 2020 Denver voters approved measure 2A, which increases the Denver sales tax rate by 0.25% and is projected to generate approximately $36 million annually to invest in implementing the city climate plan.

Summit County has a plan to reduce community wide emissions 50% by 2030 and 80% by 2050. Many cities and counties throughout the state including Carbondale, Adams County, and Gunnison County have adopted similar plans with substantive goals on energy efficiency and renewable energy, sustainability measures, multi-modal transportation programs, energy efficient building codes, and waste reduction.

A $12 million Renewable and Clean Energy Challenge was launched in 2019 by the Department of Local Affairs to help spark efforts to reach Colorado's 2040 100% renewable energy goal. That challenge resulted in $1,175,456 in renewable planning projects and another $4,416,704 in renewable implementation awards across Colorado. Funds that remain from the Challenge are specifically earmarked for ongoing renewable and clean

energy projects. Projects must include renewable energy, energy efficiency, and energy conservation efforts, support innovations in renewable energy, achieve multiple objectives and/or serve those with the greatest need, develop plans, studies, and policies that further long-term, large-scale renewable energy generation and energy conservation. The governor's supplemental stimulus request to the legislature for the 2021 session would add $5 million to this fund.

Federal Government Activities

The November 2020 election significantly changes climate leadership at the federal level. While the composition of the United States Senate is still unclear at the time of this writing, the incoming Biden Administration has elevated climate action, environmental justice, and clean energy infrastructure investment as top priorities to build a more resilient and sustainable economy, and put the United States on a path to achieve net-zero emissions no later than 2050.

Colorado and a growing coalition of other states have taken significant steps over the past four years to reduce GHGs and other pollution while swiftly transitioning to renewable energy, despite not only lack of leadership at the federal level but in many cases active obstruction and rollback of critical environmental protections. While Colorado is not relying on or assuming specific federal activity to reach its state-based renewable energy and emissions reduction goals, the state welcomes partnership with the federal government to advance and broaden state momentum on climate action and re-engage the United States as a global leader on this critical issue. While not exhaustive, below are a few examples of opportunities to further partner with the federal government in the coming years:

Federal Stimulus Investment

Top of mind for all Coloradans is COVID-19's dire impact on our health and safety, our well-being, our economy and our economic security. Colorado

urges the federal government to prioritize immediate relief and public health protection measures. Looking toward future fiscal stimulus, the incoming Administration shares Colorado's perspective that fueling a strong economic recovery provides a significant opportunity to invest in clean energy infrastructure, innovation, and technology. This will ensure a more resilient, equitable and sustainable economy as the state progresses toward science-based emission reduction targets. In May 2020, Governor Polis issued a letter to the Colorado Congressional Delegation in which he outlined a number of opportunities for federal funding to support robust, long-term recovery through investments in key areas. Immediate areas for funding include transportation infrastructure, clean transportation technology, broadband, water infrastructure, energy efficiency, renewable energy, and lower-income weatherization. We will continue to engage the federal government to secure critical resources for Colorado.

Transportation Policy

The transportation sector is the top emitter of greenhouse gases both nationally and in Colorado, and is also a significant contributor to local air pollution that disproportionately impacts lower-wealth communities and communities of color. Regulations requiring improvements in vehicle efficiency or ZEV adoption are largely controlled at the federal level or through California's vehicle standards under Section 177 of the Federal Clean Air Act. While Colorado has already adopted both Low Emission Vehicle and Zero Emission Vehicle standards that increase each year through 2025 through California's waiver, the Trump administration engaged in a rulemaking (SAFE 1) to revoke California's waiver, as well as a rulemaking (SAFE 2) to roll back federal standards. Colorado is one of many states engaged in litigation to overturn the waiver revocation and restore state authority. President-elect Biden has committed to strengthening federal standards, and is expected to restore the California waiver in 2021. In addition, the Biden administration is likely to propose new car and new clean truck standards. As described in the

section on near term actions (page 58), the state intends to actively engage to provide input on the development of both the federal and California standards, and evaluate which standards are appropriate for Colorado.

HFC Transition

Phasing out HFCs is an important step toward meeting climate objectives. HFCs have a very high global warming potential and their use is projected to grow substantially without action to phase them out in products such as foams, refrigerants and aerosols. The state has led in this area through the AQCC's passage of HFC phase-out rules in May 2020. Further opportunities for phase out and capture of HFCs exist in the residential sector and in the maintenance and replacement of products using these substances. The state supports further efforts at the national level to achieve HFC phase-out and will evaluate opportunities to address remaining gaps.

Natural and Working Lands

The NRCS has partnered with CDA to financially support (75% match) up to six soil health and urban agricultural specialists over the next five years. NRCS also operates the Agricultural Conservation Easement Program, which partners with local land trusts and local governments to protect wetlands, grasslands and working farms and ranches.

President-elect Biden has indicated support for limiting greenhouse gas emissions both domestically and internationally from land use change, forests, and agriculture, as well as strengthening land conservation efforts. The Colorado Department of Natural Resources and Department of Agriculture will pursue federal partnerships on natural and working lands through federal funding opportunities such as the Regional Conservation Partnership Program (RCPP), Emergency Watershed Protection (EWP), and State and Private Forestry funding. In seeking to form the Agricultural Climate Resilience Office, CDA would create a structure to facilitate new opportunities and partnerships. President-elect Biden supports investing in agricultural

conservation programs for cover crops and other climate-smart practices, so there may be further opportunities for CDA to expand their programming with support from federal partners in the coming years.

ENDNOTES

1. The implementing rules may take into account other relevant laws and rules, as well as voluntary actions taken by local communities and the private sector, to enhance efficiency and cost-effectiveness, and shall be revised as necessary over time to ensure timely progress toward the 2025, 2030, and 2050 goals."
2. The Roadmap discusses emissions reduction in agriculture in the broader context of natural and working lands.
3. This resolution is available from the CDPHE website.
4. Technical appendices available on the Roadmap webpage describe the methodology that the state agencies used to model the emissions reductions associated with these actions.
5. https://www3.drcog.org/documents/archive/2004_FasTracks_Plan.pdf
6. Emissions reduction from the use of biogas in the residential, commercial, and industrial sector is included here and not reflected in the reductions in the Waste sector.
7. State staff set a minimum goal of sequestering 1MMT CO2e through agricultural soil health practices by 2030. Land use, land use change and forestry are not included in this analysis and current data is insufficient to inform broader emissions reduction goals across all natural and working lands. This number will be revised pending ongoing inventory improvements detailed in the Recommended Near Term Action Plan.
8. The emissions reductions associated with biogas use are shown in the residential. commercial, industrial category.
9. Fuel use from the industrial sector is included in the residential, commercial fuel use category.
10. In most cases, it is the utility, not the state, that initiates actions at the PUC.
11. Other major greenhouse gases include: Nitrous Oxide (N_2O) and fluorinated gases such as hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride.
12. Source: https://climate.nasa.gov/vital-signs/carbon-dioxide/
13. National Oceanic and Atmospheric Administration State Climate Series. Accessed at https://statesummaries.ncics.org/chapter/co/
14. National Oceanic and Atmospheric Administration State Climate Series. Accessed at https://statesummaries.ncics.org/chapter/co/
15. National Oceanic and Atmospheric Administration State Climate Series. Accessed at https://statesummaries.ncics.org/chapter/co/
16. Colorado Climate Plan: State Level Policies and Strategies to Mitigate and Adapt. State of Colorado, 2015. Page 49.
17. https://statesummaries.ncics.org/chapter/co/
18. The Economic Contribution of Agriculture to Colorado's Economy. Colorado Department of Agriculture. https://drive.google.com/file/d/1ZJm_G8ng_1csUQvZw_iiMsn6DYSDjm_X/view
19. Colorado Climate Plan: State Level Policies and Strategies to Mitigate and Adopt. State of Colorado, 2015. Page 49.
20. Colorado Climate Plan: State Level Policies and Strategies to Mitigate and Adopt. State of Colorado, 2015. Page 49
21. The 2017 Economic Contributions of Outdoor Recreation in Colorado. Southwick and Associates. July 23, 2018.
22. U.S. EPA, 2019, Section 12.5.4.
23. USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018
24. House Bill 2019-1261. https://leg.colorado.gov/bills/hb19-1261

25. Senate Bill 19-96, https://leg.colorado.gov/bills/sb19-096
26. Heald, Sarah. Colorado 2015 Greenhouse Gas Inventory Update Including Projections to 2020 & 2030. State of Colorado, December 2019.
27. The modeling inputs and assumptions developed by E3 are available to download from the Roadmap webpage. The state modeling assumptions and data is available from the Roadmap webpage and the Colorado Department of Public Health and Environment website.
28. Emissions reduction from the use of biogas in the residential, commercial, and industrial sector is included here and not reflected in the reductions in the Waste sector.
29. State staff set a minimum goal of sequestering 1MMT CO2e through agricultural soil health practices by 2030. Land use, land use change and forestry are not included in this analysis and current data is insufficient to inform broader emissions reduction goals across all natural and working lands. This number will be revised pending ongoing inventory improvements detailed in the Recommended Near Term Action Plan on page 33.
30. The emissions reductions associated with biogas use are shown in the residential. commercial, industrial category.
31. Fuel use from the industrial sector is included in the residential, commercial fuel use category.
32. Source: https://www.trucking.org/economics-and-industry-data
33. https://usa.streetsblog.org/2019/02/08/minneapolis-and-seattle-have-achieved-the-holy-grail-for-sustainable-transportation/
34. The study is available from the Colorado Energy Office website, https://drive.google.com/file/d/11zczj8ieUzNbxMvlob9HJCctyzJGVYF3/view
35. See Decision No. C20-0770, Proceeding No. 20M-0439G
36. RNG in Transportation: Colorado Market Study, June 2019, available at https://drive.google.com/file/d/1oewEgxtchUJS60djChqQF8jsJxRETnNJ/view
37. https://www.colorado.gov/cowaterplan
38. https://www.coresiliency.com/
39. https://cpw.state.co.us/aboutus/Pages/StateWildlifeActionPlan.aspx
40. https://cwcb.colorado.gov/drought
41. https://csfs.colostate.edu/forest-action-plan/
42. Note: Washington SB 5981 and Oregon SB 1530 would have directed economy-wide cap-and-trade programs for those states. Costs are based on administrative costs and not the value of proceeds of actions, etc.
43. This number only includes CARB staff assigned to programs implementing California Assembly Bill 32, the Global Warming Solutions Act of 2006, and CA Health & Safety Code section 38566 (setting GHG reduction targets), and sections 39710-39723 (the Greenhouse Gas Reduction Fund). CARB has, along with other California agencies, hundreds of additional staff working on other aspects of climate change
44. GHG emissions in 2015 were estimated in the EPA's State Inventory Tool that uses national, regional, and state energy and activity data to calculate a greenhouse gas emissions inventory in a given year. This was supplemented with a detailed analysis of oil and gas fugitive emissions from the Colorado Air Pollution Control Division of the Department of Public Health and Environment.
45. *Colorado Climate Action Plan: A Strategy to Address Global Warming*, Governor Bill Ritter, Jr., November 2007.
46. Section 40-2-124(1)(c)(I)(E), C.R.S.
47. Decision No. C10-1328, Proceeding No. 10M-245E
48. https://www.chieftain.com/news/20200807/evraz-on-solid-ground-in-pueblo-with-new-rail-mill-project.
49. Source Tri-State filings PUC proceeding 20M-0218E.
50. Examples of measures include attic insulation, air infiltration sealing, high efficiency appliances, LED light bulbs, and rooftop solar photovoltaic systems; measure installation

is based on energy modeling and cost effectiveness. These installed measures produce a typical combined reduction of 20% in electricity and heating fuel bills for WAP homes.
51. Data taken from *Colorado Electric Utility Energy Efficiency Programs: A Success Stor*y. Southwest Energy Efficiency Project, 2019. https://www.swenergy.org/Data/Sites/1/media/aaa-documents-2019/fact-sheets/co-dsm-fact-sheet-2019.pdf
52. http://www.usclimatealliance.org/nwlchallenge
53. Colorado Forest Action Plan. Colorado State Forest Service, 2020.
54. https://www.google.com/url?q=https://farmlandinfo.org/publications/greener-fields-california-communities-combating-climate-change/&sa=D&ust=1608062215896000&usg=AOvVaw0VLHH75GFZfY8BiTKqTcnp

[x] In most cases, it is the utility, not the state, that initiates actions at the PUC.