

# Chapter 1

## Background and Overview

### The Creation of the Colorado Climate Project

In June 2005, the Rocky Mountain Climate Organization (RMCO, [www.rockymountainclimate.org](http://www.rockymountainclimate.org)) decided to undertake the Colorado Climate Project, to bring Coloradans together to reduce the state's contribution and vulnerability to climate change.<sup>1</sup> The project was inspired by and patterned after similar efforts undertaken by state governments around the country, including in particular efforts then underway in two western states, Arizona and New Mexico, soon followed by a third such effort in Montana. One key difference between the Colorado Climate Project and these state-government efforts is that this is the first effort of this kind undertaken by a non-profit organization. One key similarity between the Colorado Climate Project and many of the state-government efforts around the country is that this project was carried out as a partnership between RMCO and the Center for Climate Strategies (CCS, [www.climatestrategies.us](http://www.climatestrategies.us)), which helped design the process and provided technical analyses for and facilitation services for this project, as CCS has done for state government advisory panels in several states. This is the first time that CCS has partnered with a nonprofit organization in helping to carry out a process to develop recommendations for state climate action.

Over the next year, RMCO entered into the partnership with CCS, obtained the agreement of key public and private officials to serve as Project Directors of the Colorado Climate Project, and secured initial funding for it. In August 2006, the Project Directors held a news conference to publicly launch the project. They announced that they would appoint a blue-ribbon Climate Action Panel (CAP) to develop recommendations on actions that could be taken by the state government, local governments, water providers, the private sector, and others to address climate change and its effects in Colorado. The Project Directors then appointed the members of the CAP and gave them the following mission:

*The Climate Action Panel is charged to develop recommendations for actions that can be taken in Colorado to reduce the state's contribution and vulnerability to a changed climate. Those recommendations are to include goals that can be adopted consistent with the goal of an efficient, robust Colorado economy for statewide reductions in the amount of greenhouse gases (GHGs) emitted, actions that can be taken that would achieve those goals, and actions that can be taken to prepare for and reduce the possible adverse impacts of climate change in Colorado. The recommendations may also include actions that can be taken by Colorado as part of international, national or regional efforts that would reduce Colorado's contribution and vulnerability to climate change. The panel shall, to the extent reasonably possible with the best information available, consider the feasibility and costs or cost savings of possible goals and actions and develop goals and actions that may achieve additional benefits, including protecting and improving Colorado's economy, public health, and natural resources and avoid adverse economic or environmental impacts. In considering how goals*

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<sup>1</sup> RMCO is a three-year old nonprofit organization whose partners now include 16 local governments, Denver Water, 17 businesses, and 11 nonprofit organizations.

*and actions may affect Colorado's economy, the panel shall take into account the effects of both action and inaction.*

*It is up to the members of the panel to determine which actions it recommends, with no recommendations predetermined. The panel shall work in an open process that allows for Coloradans not on the panel to observe the work of the panel and to submit in an appropriate manner comments for consideration by the members of the panel. A report with the recommendations of the panel is expected before the end of calendar year 2007.*

This report is the culmination of the work of 116 Coloradans who worked as members of and alternates to the CAP and the six Policy Work Groups (PWGs) that supported the CAP.

## **Colorado GHG Emissions Inventory and Reference Case Projections**

In January 2007, CCS prepared a preliminary draft greenhouse gas (GHG) emissions inventory and reference case projection for the Colorado Department of Public Health and Environment (CDPHE) through an effort of the Western Regional Air Partnership.<sup>2</sup> The draft report was separately provided to the CAP and its PWGs to assist them in understanding past, current, and possible future GHG emissions in Colorado, and thereby inform the policy development process. The CAP and the PWGs provided comments for improving the reference case projections. Subsequently, the inventory and reference case projection estimates (hereafter referred to as the *Inventory and Projections*) were revised to incorporate revisions approved by the CAP.<sup>3</sup>

The *Inventory and Projections* included detailed coverage of all economic sectors and GHGs in Colorado, including future emissions trends and assessment issues related to energy, economic, and population growth. The assessment included estimates of total statewide “gross emissions” (leaving aside carbon sequestration<sup>4</sup>) and “net emissions” (in which reductions due to sequestration are subtracted from gross emissions) on a production basis for all sources and a consumption basis for the electricity sector (see prior discussion under “Analysis of Policy Recommendations” in this chapter for an explanation of the production versus consumption approach). Further discussion of the issues involved in developing the inventory and reference case projections is summarized in Chapter 2 (Inventory and Projections of GHG Emissions) and discussed in detailed in the final report for the *Inventory and Projections*.

The *Inventory and Projections* revealed substantial emissions growth rates and related emission reduction (also called mitigation) challenges. Colorado's gross emissions of GHGs grew by 35%

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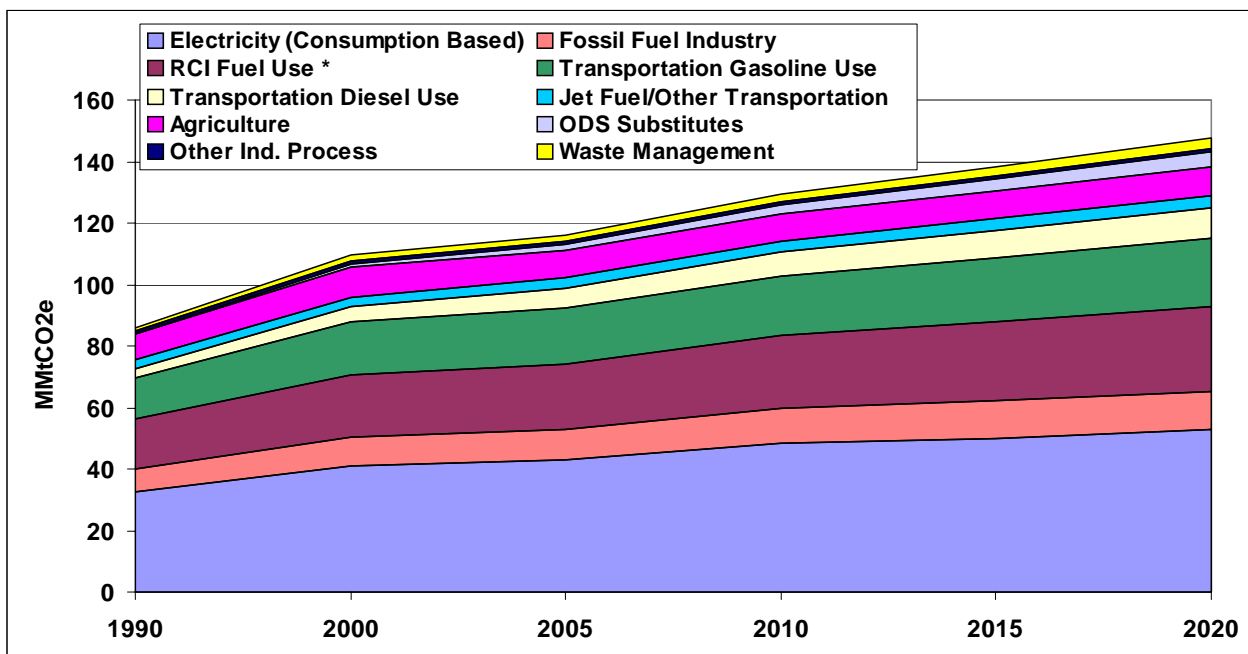
<sup>2</sup> *Draft Colorado Greenhouse Gas Inventory and Reference Case Projections, 1990–2020*, prepared by the Center for Climate Strategies for the Colorado Department of Public Health and Environment (CDPHE) through an effort of the Western Regional Air Partnership, January 2007.

<sup>3</sup> *Final Colorado Greenhouse Gas Inventory and Reference Case Projections, 1990–2020*, prepared by the Center for Climate Strategies for the Climate Action Panel of the Colorado Climate Project, October 2007.

<sup>4</sup> Sequestration refers to the storing of carbon in mines, brine strata, oceans, plants and soil. As trees and other plants grow they remove CO<sub>2</sub>, the principal GHG, from the atmosphere transforming the carbon (C) through photosynthesis into cellulose, starch and sugars, thus sequestering it in their structures and roots. The oxygen (O<sub>2</sub>) is released back into the atmosphere. Colorado's forests and agricultural lands are capable of sequestering much CO<sub>2</sub>, as described in Chapter 6 (Agriculture, Forestry and Waste Management).

between 1990 and 2005, slightly more than twice the national average of 16%. Colorado's emissions growth was driven largely by the growth of Colorado's population, as the state's emissions on a per-capita basis stayed essentially constant between 1990 and 2005. Figure 1-1 shows the reference projections for Colorado's gross GHG emissions (not counting sequestration) as rising fairly steeply to 147.5 million metric tons (MMt) of carbon dioxide equivalent (CO<sub>2</sub>e) by 2020, or 71% over 1990 levels. Figure 1-1 also provides the sectoral breakdown of forecasted GHG emissions. Using a net emissions basis – by accounting for sequestration in Colorado's forests and soil – would decrease the gross estimates by about 27 MMtCO<sub>2</sub>e per year. On a net emissions/consumption-based basis, Colorado's GHG emissions are projected to grow by about 103% over 1990 levels (about 121 MMtCO<sub>2</sub>e in 2020).

**Figure 1-1. Gross GHG Emissions by Sector, 1990-2020: Historical and Projected (Consumption-based Approach) Business as Usual Base Case**



\* RCI = direct fuel use in residential, commercial, and industrial sectors; ODS Substitutes = ozone depleting substances substitutes. Other Industrial Processes include process-related GHG emissions from cement, lime, and soda ash manufacturing; semiconductor manufacture; soda ash, limestone, and dolomite use; electricity transmission and distribution systems; and, Ozone Depleting Substitutes (ODS) substitutes (for hydrofluorocarbons) used in cooling and refrigeration equipment for industrial and commercial applications as well as for vehicle air conditioners.

The inventory and projection of Colorado's GHG emissions provided several critical findings, including:

- As is common in many states, the electricity and transportation sectors are the two sectors with the largest emissions, and are expected to continue to grow faster than other sectors.
- Consumption of electricity is growing faster in Colorado than its population. In addition, there appears to be a trend toward an increasing reliance on natural gas and imported electricity. Vehicle-miles traveled (VMT) are also projected to grow faster than the state's

population. Freight traffic (resulting in increased diesel consumption) and increasing use of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as substitutes for ozone-depleting substances (ODS) in refrigeration, air conditioning, and other applications is also increasing more rapidly than population.

While Colorado's emissions estimated growth rate (71% from 1990 to 2020 on a gross emissions/consumption basis) presents challenges, it also provides major opportunities. It is usually easier and cheaper to reduce emissions resulting from future population growth, by making initial choices on the technologies and infrastructure to support that growth, than it is to reduce emissions from an existing population, which can require revising technologies and infrastructure that are already in use. The CAP's recommendations document the opportunities for the state to reduce its GHG emissions while continuing its strong economic growth by being more energy efficient, using more renewable energy sources, and increasing the use of cleaner transportation modes, technologies, and fuels. The inventory and reference case projections are discussed in more detail in Chapter 2 of this report and the entire study appears in the final report for the *Inventory and Projections*.<sup>5</sup>

## CAP Policy Recommendations

The CAP recommends 70 policy actions. Among those CAP members present and voting, sixty-one actions were approved unanimously; seven were approved by a super majority, with fewer than five votes against them; and two were approved by a simple majority. For each of 10 recommendations (four of which were among the recommendations not approved unanimously), at least one CAP member expressed qualifications but did not object to it. These expressions of qualifications, which CAP members called "yes but" votes, allowed members to express an objection or concern to some of the specific details of a policy recommendation or the supporting analysis considered by the CAP while supporting the overall concept of the policy. Explanations of both individual objections and qualifications are in the appendices to this report, in the detailed accounts of CAP recommendation (except that the explanation for the one objection to a water adaptation recommendation is in Chapter 8, where those recommendations are detailed).

Figure 1-2 below presents a summary of some of the recommendations. Table 1-1 provides the numeric estimates underlying Figure 1-2. In Figure 1-2:

- Actual (for 1990, 2000, and 2005) and projected (for 2012 and 2020) levels of Colorado's gross GHG emissions on a consumption basis are shown by the blue line. (The consumption-based approach accounts for emissions associated with the generation of electricity in-state and imported from out-of-state to meet Colorado's demand for electricity.)
- Projected emissions if all of the CAP's 33 recommendations that were analyzed quantitatively with respect to its GHG reduction potential are completely implemented and the estimated reductions are fully achieved are shown by the green line. (Note that other CAP

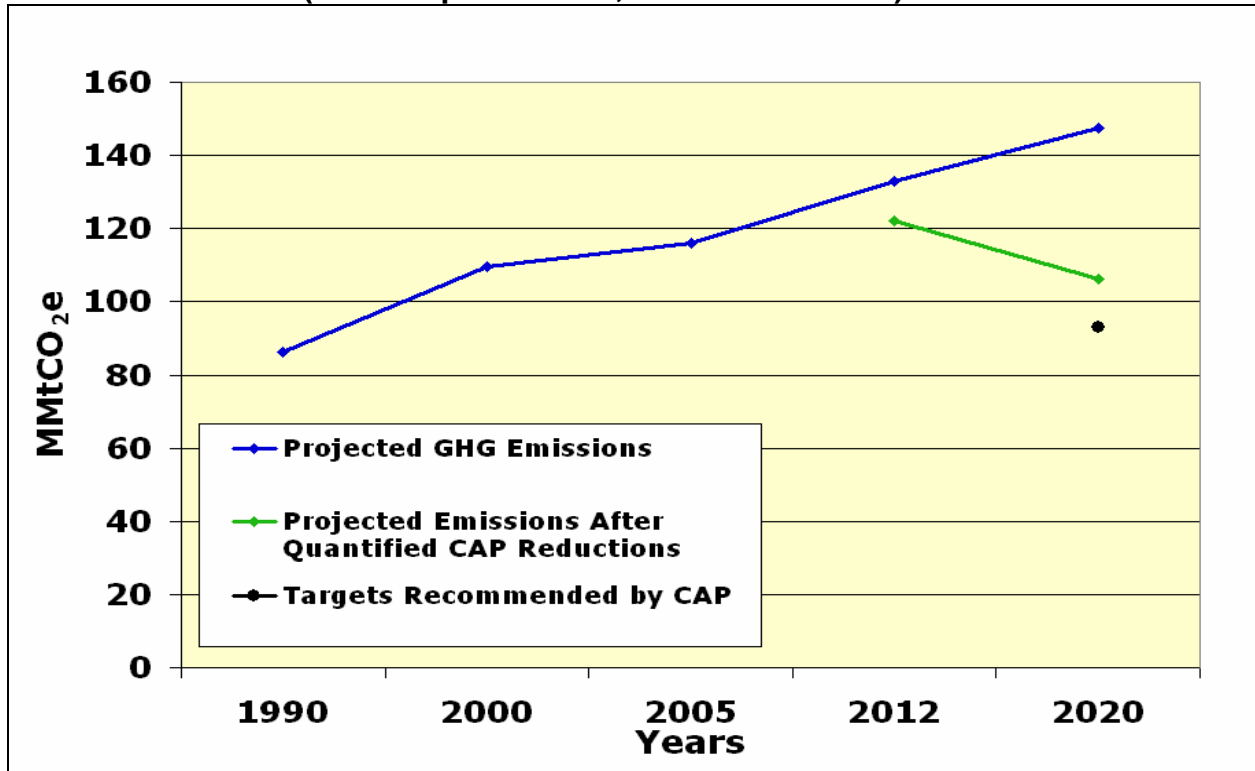
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<sup>5</sup> *Final Colorado Greenhouse Gas Inventory and Reference Case Projections, 1990–2020*, prepared by the Center for Climate Strategies for the Climate Action Panel of the Colorado Climate Project, October 2007, <http://www.coloradoclimate.org/>.

recommendations would have the effects of reducing emissions, but those reductions were not analyzed quantitatively and they are not reflected in the green line.)

- Projected emissions associated with the CAP’s recommendation that Colorado set a target to reduce its GHG emissions economy-wide in the vicinity of 20% below 2005 levels by 2020 are shown by the black dot.

**Figure 1-2. Annual GHG Emissions: Reference Case Projections and CAP Recommendations (Consumption-Basis, Gross Emissions)**



**Table 1-1. Annual Emissions: Reference Case Projections, and Impact of CAP Recommendations (Consumption-Basis, Gross Emissions)**

Greenhouse Gas (GHG) Emissions (millions metric tons of CO <sub>2</sub> equivalent)					
	1990	2000	2005	2012	2020
Actual/projected GHG emissions	86.1	109.6	116.1	132.8	147.5
Projected emissions compared to 2005				+14%	+27%
Total GHG reductions from 33 analyzed CAP recommendations				-10.6	-41.3
Projected emissions after above reductions				122.2	106.2
2020 target recommended by CAP					92.9
2020 target compared to actual/forecast			-20%	-30%	-37%

The CAP approved 55 recommendations to reduce emissions, of which 33 were analyzed quantitatively to estimate their effects on emissions. The analyzed measures were estimated to have a cumulative effect of reducing emissions by about 41.3 MMtCO<sub>2</sub>e in 2020, enough by themselves to achieve over three quarters of the reductions necessary to meet the 2020 goal. The 26 measures analyzed in terms of their cost effectiveness were estimated to have a total net savings of about \$2.6 billion between now and 2020. That is because the most effective way to reduce emissions often is to improve energy efficiency, which both cuts emissions and saves money.

The statewide goals and targets recommendation (CC-4) is an over-arching CAP recommendation. The Cross-Cutting (CC) PWG waited until the last stages of the project to develop the recommendation, which it proposed to the CAP and which the CAP approved, in order to be able to consider the GHG reduction policies that emerged from the other PWGs. Once the emissions reductions potentials and cost-effectiveness of the policies were quantified by the other groups, the CC PWG and in turn the CAP were able to gain a perspective on the scope of the overall reductions that are realistically attainable by 2020.

The CAP chose to recommend goals for emission reductions to be achieved by 2020 and 2050, mindful of scientists' conclusions that global GHG emissions have to be reduced substantially by 2050, compared to 2000 levels, in order to stabilize global temperatures, and that emission reductions in the next two to three decades will have a large impact on opportunities to achieve that kind of stabilization. Accordingly, the CAP recommends that the Governor of Colorado set goals for reducing GHG emissions in Colorado in the vicinity of a 20% reduction in GHG emissions by 2020 and an 80% reduction by 2050, both compared to 2005 levels on a gross emissions/consumption basis. The CAP believes the goals should guide actions in the state, but should not be a firm cap.

If the 2020 goal were achieved, Colorado's emissions in 2020 would be reduced 37% to 92.9 million metric tons of GHGs, compared to 147.5 MMtCO<sub>2</sub>e projected under current law. The Colorado target would fall within the range of statewide emission goals already set by other western states, including Arizona (45% below projected emissions in 2020), Oregon (44%), New Mexico (33%), California (28%), and Washington (28%). Table 1-2 shows how the goals recommended by the CAP compare with the goals set by other states across the country.

If adopted, the 33 recommendations for emission reductions that were analyzed quantitatively could achieve 75 percent of the 2020 goal chosen by the CAP. While the CAP's 22 other GHG mitigation recommendations were not readily quantifiable, many of them would likely achieve additional reductions. In addition, the CAP believes other reasonable measures to reduce emissions beyond those recommended by the panel are available now, and emerging technologies hold the potential to substantially reduce emissions even more.

It should be noted that the CAP recommended that statewide goals be established to reduce gross emissions on a consumption basis to be consistent with the levels and framework of goals set by other states, including those in the West, that are implementing GHG reduction strategies. Since Colorado is a net importer of electricity, goals established on a consumption-based accounting approach provides Colorado with the opportunity to reach beyond its borders to reduce

**Table 1-2. US State, Canadian Province, and Regional GHG Reduction Goals and Timelines**

State, Province, or Region	GHG Reduction Goals and Timelines
Arizona	2000 level by 2020; 50% below 2000 level by 2040; WCI goal
British Columbia	See WCI goal
California	2000 level by 2010; 1990 level by 2020; 80% below 1990 level by 2050; WCI goal
Colorado - CAP Recommendations	20% below 2005 level by 2020; 80% below 2005 level by 2050
Connecticut	1990 level by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2050
Florida	2000 level by 2017; 1990 level by 2025; 80% below 1990 by 2050
Maine	1990 level by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2050
Manitoba	See WCI goal
Maryland	1990 level by 2020; 80% below 2006 level by 2050
Massachusetts	1990 level by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2050
Minnesota	15% below 2005 level by 2015; 30% below 2005 level by 2025; 80% below 2005 level by 2050
Montana	1990 level by 2020; 80% below 1990 level by 2050 (consumption & production basis)
NEG/ECP <sup>6</sup>	1990 level by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2050
New Jersey	1990 level by 2020; 80% below 2006 level by 2050
New Mexico	2000 level by 2012; 10% below 2000 level by 2020; 75% below 2000 level by 2050; WCI goal
New York	5% below 1990 level by 2010
Ontario	6% below 1990 level by 2014
Oregon	10% below 1990 level by 2020; 75% below 1990 level by 2050; WCI goal
Rhode Island	1990 by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2050
Vermont	25% below 1990 level by 2012; 50% below 1990 level by 2028; 75% below 1990 level by 2050
Puget Sound, WA	1990 level by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2100
Rhode Island	1990 level by 2010; 10% below 1990 level by 2020; 75% below 1990 level by 2050
Vermont	25% below 1990 level by 2012; 50% below 1990 level by 2028; 75% below 1990 level by 2050
Utah	See WCI goal
Washington State	1990 level by 2020; 25% below 1990 level by 2035; 50% below 1990 level by 2050; WCI goal
WCI <sup>7</sup>	15% below 2005 level by 2020 (applies to AZ, CA, NM, OR, UT, WA, British Columbia, Manitoba)

emissions associated with the generation of electricity by managing its own demand for electricity. It should be noted that Colorado could also consider establishing goals on a net emissions basis; however, as noted in Chapter 2, there are significant uncertainties associated

<sup>6</sup> New England Governors/Eastern Canadian Premiers

<sup>7</sup> Western Climate Initiative

with forest carbon sink estimates that should be addressed before setting goals based on a net emissions basis.<sup>8</sup>

In addition to the 55 policy recommendations to reduce GHG emissions, the CAP adopted 15 recommendations for adaptation to future climate changes. They include 14 policies that together outline a road map for dealing with the projected effects of climate change on the state's water supplies. This may well be Colorado's greatest vulnerability to climate change. Another recommendation is that the state government assess Colorado's particular vulnerabilities to climate change and develop specific adaptation plans.

Table 1-3 provides a summary by sector of the estimated cumulative impacts of implementing all of the CAP's recommendations. Table 1-4 shows the estimated GHG reductions, costs or savings from each policy recommendation and, its cost effectiveness (cost or savings per ton of reduction) upon which the cumulative impacts in Table 1-3 are based. Note that the cumulative impacts shown in Table 1-3 account for overlaps between policies by eliminating potential double counting of emission reductions and costs or cost savings. Chapters 3 through 7 and the Appendices provide detailed descriptions and analysis of GHG reductions, costs or cost savings, additional impacts, feasibility, etc. for each policy developed by the six PWGs for each sector.

In order for the CAP recommended policies to yield the levels of estimated emission reductions and cost savings shown in Table 1-3, the policies must be implemented in a timely, aggressive, and thorough manner. In some cases, the actions recommended by the CAP are precise, concrete steps. In other cases, the recommendations are more general, and work must be done to develop precise, concrete steps to achieve goals recommended by the CAP. In the latter case, the additional work to identify precise, concrete actions is needed before they can be implemented. While there are considerable benefits to both the environment and to consumers from implementation of the policy recommendations, careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if these benefits are to be achieved. It should be noted that the CAP's policy recommendations complement the numerous other climate-related efforts underway in Colorado outlined at the end of this chapter, underscoring the potential co-benefits of their implementation.

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<sup>8</sup> The standing forest carbon sink estimates in states like Colorado with a large amount of unproductive forest area (e.g. Pinyon-Juniper forests) are highly uncertain (with potential for over-estimation of the sink). This is because these types of forest were not well represented in earlier US Forest Service surveys. Since they are now being inventoried, it is anticipated that future inventories will reduce the amount of uncertainty. See Appendix H of the separate report Final Colorado Greenhouse Gas Inventory and Reference Case Projections, 1990–2020, for a discussion of uncertainties associated with the estimates for this sector.

**Table 1-3. Summary by Sector of Estimated Impacts of Implementing All of the CAP Recommendations**

Cumulative Reductions and Costs/Savings	2012 GHG Reductions (MMtCO <sub>2</sub> e)	2020 GHG Reductions (MMtCO <sub>2</sub> e)	2007-2020 GHG Reductions (MMtCO <sub>2</sub> e)	2007–2020 Costs (Savings) (Net Present Value Million \$)	2007-2020 Cost-Effectiveness (\$/tCO <sub>2</sub> e)
	<i>From 33 recommendations analyzed for GHG reductions:</i>			<i>From 26 recommendations analyzed for costs &amp; cost savings:</i>	
Residential Commercial and Industrial (RCI) Sector Total Adjusted for Overlaps	3.7 <sup>9</sup>	15.1 <sup>9</sup>	86.0 <sup>9</sup>	-\$ 153 <sup>10</sup>	-\$ 2/ton <sup>10</sup>
Energy Supply (ES) Sector Total Adjusted for Overlaps	3.0 <sup>11</sup>	9.1 <sup>11</sup>	58.8 <sup>11</sup>	\$ 526 <sup>12</sup>	\$ 10/ton <sup>12</sup>
<i>Adjustments for Overlaps Between RCI and ES Recommendations</i>	<i>[-0.3]</i>	<i>[-2.0]</i>	<i>[-8.6]</i>	<i>[-\$ 10.0]</i>	
Transportation and Land Use (TLU) Sector Total Adjusted for Overlaps	2.1 <sup>13</sup>	7.8 <sup>13</sup>	46.7 <sup>13</sup>	-\$ 3,185 <sup>14</sup>	-\$ 141/ton <sup>14</sup>
Agriculture, Forestry, and Waste Management (AFW) Sector Total Adjusted for Overlaps	2.2	11.5	66.0	\$ 252	\$ 4/ton
<i>Adjustments for Overlaps Between AFW and ES Recommendations</i>	<i>[-0.04]</i>	<i>[-0.21]</i>	<i>[-1.40]</i>	<i>[-\$ 0]</i>	<i>[-\$ 0/ton]</i>
Cross-Cutting (CC) Sector Total	N/A	N/A	N/A	N/A	N/A
Water Adaptation (WA) Sector Total	N/A	N/A	N/A	N/A	N/A
<b>TOTALS</b>	<i>From 33 recommendations analyzed for GHG reduction:</i>			<i>From 26 recommendations analyzed For costs &amp; cost savings:</i>	
	<b>10.7</b>	<b>41.3</b>	<b>247.5</b>	<b>-\$ 2,570</b>	<b>Not estimated</b>

Notes: Negative numbers indicate cost savings. N/A = Not available.

<sup>9</sup> Totals from all 9 RCI recommendations with estimated GHG reductions.

<sup>10</sup> Totals from only those 7 RCI recommendations with estimated costs/cost savings.

<sup>11</sup> Totals from all 6 ES recommendations with estimated GHG reductions.

<sup>12</sup> Totals from only those 5 ES recommendations with estimated costs/cost savings.

<sup>13</sup> Totals from all 8 TLU recommendations with estimated GHG reductions.

<sup>14</sup> Totals from only those 4 TLU recommendations with estimated costs/cost savings.

**Table 1-4. Summary of CAP’s 70 policy recommendations by sector**

Notes: Negative numbers indicate cost savings. The cost (savings) shown are calculated in terms of net present value in constant 2005 dollars using a 5% annual real discount rate for the period 2008 through 2020. Capital investments are represented in terms of levelized or amortized costs through 2020.

**Residential, Commercial, and Industrial Policy Recommendations**

	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Costs (Savings) 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Climate Action Panel Action
		2012	2020	Total 2007–2020			
RCI-1	Expand demand side management programs of all electric and gas utilities, ramped up to reduce energy use by 1% per year by 2013.	0.6	5.2	24	–\$853	–\$32/ton	Unanimous Consent (Several qualified approvals)
RCI-2	Revolving loans to reduce energy use in state and local government buildings.	0.2	0.5	3.7	–\$67	–\$18/ton	Super Majority (1 objection)
RCI-3	Upgrade the state’s energy requirements for local building codes every 3 years, and improve enforcement of building codes.	0.3	2.7	13.0	N/A	N/A	Unanimous Consent
RCI-4 (total)	Targets and programs for beyond-code reductions in energy use in new government, residential, and commercial buildings.	1.0	2.4	20.4	\$1,550	\$76/ton	Unanimous Consent
	<i>Government subtotal:</i>	<i>0.4</i>	<i>0.6</i>	<i>6.0</i>	<i>\$348</i>	<i>\$58/ton</i>	
	<i>Commercial subtotal:</i>	<i>0.5</i>	<i>1.4</i>	<i>11.2</i>	<i>\$1,219</i>	<i>\$109/ton</i>	
	<i>Residential subtotal:</i>	<i>0.2</i>	<i>0.4</i>	<i>3.2</i>	<i>–\$17</i>	<i>–\$5/ton</i>	
RCI-5	Inverted electricity block rates for all residential and commercial consumers to fund utility energy efficiency programs.	1.6	6.7	38.2	–\$1,135	–\$30/ton	Majority (7 objections)
RCI-6	Low interest loans to fund energy efficiency retrofits for commercial and industrial buildings.	0.5	1.8	11.7	–\$334	–\$28/ton	Unanimous Consent (2 qualified approvals)
RCI-7	Electricity smart metering with time-of-use rates and in-home or in-office displays for all residential, commercial, and industrial consumers.	2.0	2.6	25.4	–\$844	–\$33/ton	Unanimous Consent
RCI-8	Tax credits for renewable energy systems in new and existing residential, commercial, and industrial buildings.	N/A	N/A	N/A	N/A	N/A	Unanimous Consent
RCI-9	Promote commercial and industrial combined heat and power (CHP) systems.	0.3	1.4	8.3	–\$25	–\$3/ton	Unanimous Consent
RCI-10	Statewide program for voluntary GHG reductions by businesses.	0.6	1.0	4.5	N/A	N/A	Unanimous Consent
RCI-11	Inverted electricity block rates for all residential and commercial consumers, recovering only cost of service.	N/A	N/A	N/A	N/A	N/A	Unanimous Consent
	<b>RCI Sector GHG reduction total of 9 analyzed policies</b> after adjusting for overlaps among policies	<b>3.7</b>	<b>15</b>	<b>86</b>	<b>N/A</b>	<b>N/A</b>	
	<b>RCI Sector cost-effectiveness total of 7 analyzed policies with cost analysis</b> after adjusting for overlaps among policies				<b>–\$153</b>	<b>–\$2/ton</b>	

## Energy Supply Policy Recommendations

	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Costs (Savings) 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Climate Action Panel Action
		2012	2020	Total 2007-2020			
ES-1	Tax credits and incentives to finance renewable energy generation facilities.	Benefits are quantified in policy ES-2					Unanimous Consent
ES-2	Increase renewable portfolio standards to 30% for investor-owned electric utilities and 15% for municipal and co-op utilities, with no more than 85% of renewable energy from centralized wind power.	1.9	4.9	34	\$524	\$16/ton	Super Majority (3 objections) (1 qualified approval)
ES-3	Consider adoption of Xcel's clean energy portfolio standard on a state, regional, or national basis.	Non-specific policy was not quantified					Majority (9 objections)
ES-4	Require all electric utilities to plan cooperatively for electricity transmission infrastructure investments that support renewable resources.	Non-quantitative policy proposal analyzed					Unanimous Consent
ES-5	Consider applying a price to CO <sub>2</sub> emissions (such as cap and trade or tax) on a state, regional, or national basis.	Non-specific policy not quantified					Super Majority (1 objection) (1 qualified approval)
ES-6	Assess a public benefit charge on all electric utility bills to fund renewable energy programs.	Policy not quantified					Super Majority (3 objections) (1 qualified approval)
ES-7	Adopt structural changes to facilitate large businesses and universities to invest in combined heat and power (CHP) and distributed generation (DG) systems.	0.4	1.1	7.3	\$110	\$15/ton	Unanimous Consent
ES-8	Work with neighboring states to form a regional CO <sub>2</sub> transportation and sequestration collaborative.	Non-quantitative proposal not quantified					Unanimous Consent
ES-9	Low interest loans to Colorado companies and universities for research and development of carbon emissions reduction technology, funded at \$100M/yr through surcharge on all electricity bills.	R&D benefits not quantified					Unanimous Consent
ES-10	Evaluate and, if appropriate, seek funding for advanced fossil fuel generation with carbon capture demonstration project.	Non-specific policy not quantified					Unanimous Consent
ES-11	Statewide mapping and development of small hydro-power, geothermal, and biomass renewable power sources.	0.0	0.8	3.1	\$123	\$40/ton	Unanimous Consent
ES-12	Review costs and emission reduction potential of nuclear power.	Non-specific policy not quantified					Unanimous Consent
ES-13	Adopt policies to promote a 2% increase in efficiency of existing power generators by 2020.	Costs not quantified—savings ca. 1 MMtCO <sub>2</sub> /yr by 2020					Unanimous Consent
ES-14	Reduce GHG emissions from oil and gas operations 35% by 2020.	0.8	2.6	16	\$12	\$0.8/ton	Unanimous Consent
ES-15	Establish a CO <sub>2</sub> emissions performance standard of no more than 1,100 lbsCO <sub>2</sub> /MWh for new non-peaking power plants and those older than 60 years.	0.5	2.3	13	-\$14	-\$1/ton	Super Majority (5 objections)

	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Costs (Savings) 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Climate Action Panel Action
		2012	2020	Total 2007–2020			
	Energy Supply Sector totals of <b>6 analyzed policies</b> (including ES-13) after adjusting for overlaps among policies	3	9	59	N/A	N/A	
	Energy Supply Sector totals of <b>5 policies with cost estimates</b> (not including ES-13) after adjusting for overlaps				\$526	\$10/ton	

### Transportation and Land Use Policy Recommendations

	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Costs (Savings) 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Climate Action Panel Action
		2012	2020	Total 2007–2020			
TLU-1	Reduce light-duty vehicle miles traveled 2% by 2020 by promoting “smart growth” land use planning and development. Require that GHG emissions be considered in long-range transportation plans by 2010.	0.08	0.47	2.43	Less than \$0	Less than \$0/ton	Unanimous Consent
TLU-2	Incentives for the purchase of low-GHG vehicles. [An alternative if the TLU-6 clean car standards are not implemented.]	Quantified as part of TLU-6					Unanimous Consent
TLU-3	Reduce light-duty vehicle miles traveled 6% by 2020 by improving transit service quality and funding expansion of transit infrastructure.	0.17	0.97	5.09	N/A	N/A	Unanimous Consent
TLU-4	Reduce heavy-duty vehicle idling.	0.07	0.11	0.91	–\$123	–\$134/ton	Unanimous Consent
TLU-5	Adopt a low carbon fuels standard that will reduce carbon intensity of passenger vehicle fuels by 10% by 2020.	0.38	2.21	16.1	N/A	N/A	Unanimous Consent
TLU-6	Adopt California GHG emission standards for cars and trucks.	0.70	3.40	18.8	–\$1,880	–\$100/ton	Unanimous Consent
TLU-7	Expand transit use marketing and employer-sponsored transit fare programs.	Quantified as part of TLU–3					Unanimous Consent
TLU-8	Move toward basing motor vehicle insurance on the distances vehicles are driven.	0.32	0.94	7.19	Less than \$0	Less than \$0/ton	Unanimous Consent
TLU-9	Local parking management programs to encourage alternative travel choices and transit-oriented development.	0.03	0.03	0.34	–\$37	–\$110	Unanimous Consent
TLU-10	Require employers with more than 100 employees to offer commuter benefits programs.	0.42	0.45	4.77	–\$1,145	–\$240/ton	Unanimous Consent
TLU-11	Incorporate vehicle maintenance, operation, and transportation choice GHG reduction information in driver training and education.	Not quantified					Unanimous Consent
	TLU Sector GHG reduction total of <b>8 analyzed policies</b> after adjusting for overlaps among policies	2.14	7.84	46.7	N/A	N/A	
	TLU Sector cost-effectiveness total of <b>4 analyzed policies with cost estimates</b> after adjusting for overlaps among policies				–\$3,185	–\$141/ton	

## Agriculture, Forestry, and Waste Management Policy Recommendations

	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Costs (Savings) 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Climate Action Panel Action
		2012	2020	Total 2007–2020			
AFW-1	Achieve no-till operation of half of croplands by 2020 and increase nitrogen fertilizer efficiency by 20%.	0.57	0.78	7.7	–\$57	–\$7/ton	Unanimous Consent
AFW-2	Implement methane capture and energy recovery on manure management projects on 80% of animal feeding operations by 2020.	0.01	0.32	1.8	\$66	\$36/ton	Unanimous Consent (1 qualified approval)
AFW-3	Reduce on-farm petro-diesel use 20% by 2020, and reduce electricity use from fossil fuels 40% through energy efficiency and on-site renewable sources generation.	0.14	0.64	3.8	–\$150	–\$40/ton	Unanimous Consent
AFW-4	Incentives for the production of biodiesel fuel from oilseed crops, waste vegetable oil, or other sources to offset 40% of fossil diesel fuel use by 2020.	0.02	0.22	1.1	\$13	\$12/ton	Unanimous Consent (3 qualified approvals)
AFW-5	Increase in-state ethanol production, using GHG-superior feedstocks and production methods, to 400 million gallons per year above BAU by 2020.	0.39	3.1	15	\$58	\$3/ton	Unanimous Consent (3 qualified approvals)
AFW-6	Preserve forest lands (line 1) and grasslands (line 2) to reduce the rate of conversion to developed uses by 25% by 2020.	0.10 0.05	0.24 0.14	1.7 1.0	\$44 \$31	\$26/ton \$32/ton	Unanimous Consent
AFW-7	Increase the use of biomass from forest health and fire risk treatment for energy production, using 20% of harvested wood by 2020.	0.08	0.20	1.4	–\$104	–\$75/ton	Unanimous Consent
AFW-8	Divert 75% of wastes from landfills by 2020 through source reduction, enhanced recycling, and composting programs.	0.48	4.6	24	\$311	\$13/ton	Unanimous Consent
AFW-9	Control or capture landfill methane to achieve 50% reduction from BAU by 2020.	0.33	1.2	7.5	–\$0.1	–\$0.02/ton	Unanimous Consent
AFW-10	Plant 3.4 million new trees statewide by 2020 through expanded urban forestry programs.	0.03	0.08	0.59	\$40	\$79/ton	Unanimous Consent (1 qualified approval)
	<b>AFW Sector Total of Analyzed Policies After Adjusting for Overlaps</b>	<b>2.2</b>	<b>11.5</b>	<b>66</b>	<b>\$252</b>	<b>\$4 /ton</b>	

### Cross-Cutting Issues Policy Recommendations

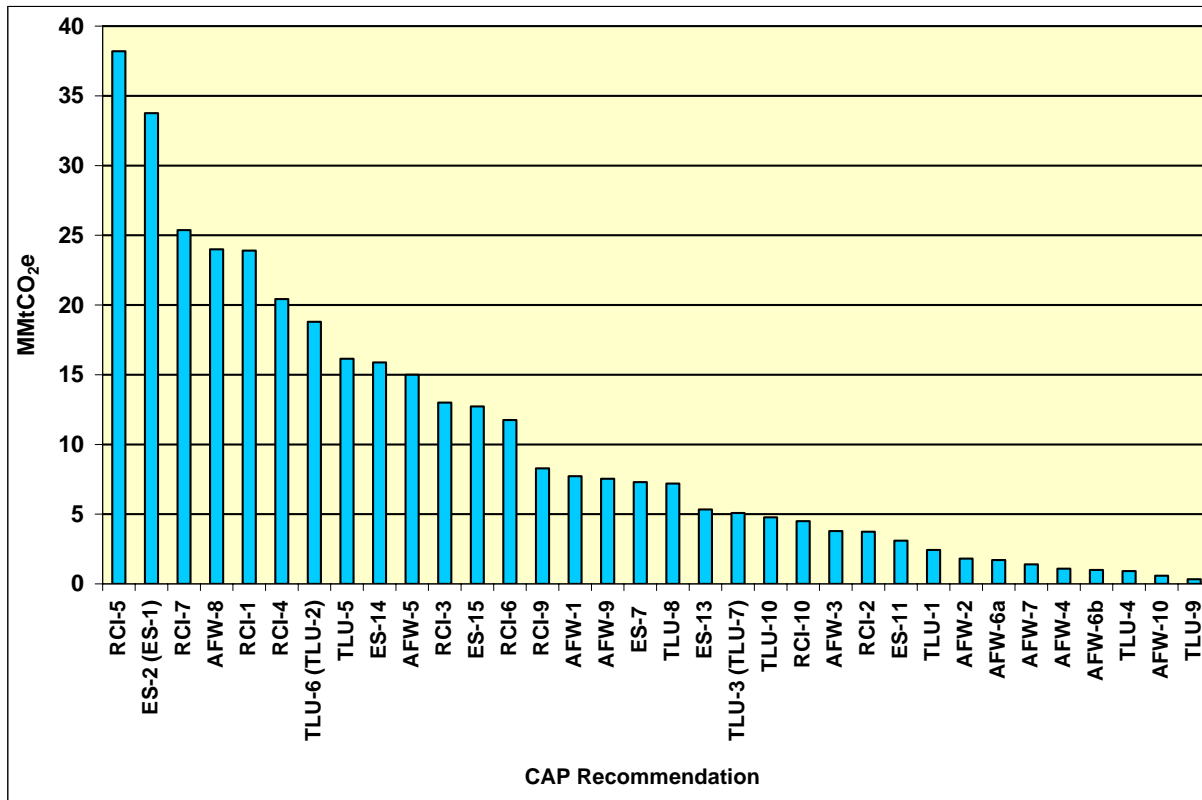
	Policy Recommendation	Analysis	Climate Action Panel Action
CC-1	Periodically update GHG inventories and forecasts.	<i>Not Quantified</i>	Unanimous Consent
CC-2	State development of annual GHG reporting protocols for all sources, including mandatory reporting for significant sources.	<i>Not Quantified</i>	Unanimous Consent
CC-3	State development of capacity to participate in the national <i>Climate Registry</i> to measure, track, and record emissions reductions.	<i>Not Quantified</i>	Unanimous Consent
CC-4	The governor should set statewide GHG reduction goals and targets to achieve in the vicinity of a 20% reduction by 2020 and 80% by 2050, both compared to 2005 levels.	<i>Not Quantified</i>	Super Majority (1 objection) (5 qualified approvals)
CC-5	Set state and local government reduction targets for their own GHG emissions; the state target should be at least an amount consistent with CC-4 levels.	<i>Not Quantified</i>	Unanimous Consent
CC-6	Promote adoption of comprehensive local government climate action plans.	<i>Not Quantified</i>	Unanimous Consent
CC-7	State and local government public education and outreach efforts to support GHG reduction programs, policies, and goals.	<i>Not Quantified</i>	Unanimous Consent
CC-8	A public-private partnership to seek funding for GHG reduction measures and development of a new energy economy in Colorado.	<i>Not Quantified</i>	Unanimous Consent
CC-9	State government assessment of vulnerabilities to climate change and development of adaptation plans.	<i>Not Quantified</i>	Unanimous Consent

### Water Adaptation Policy Recommendations

	Policy Recommendation	Analysis	Climate Action Panel Action
WA-1	Public officials exercise leadership in addressing climate change effects on water supplies.	<i>Not Quantified</i>	Unanimous Consent
WA-2	Water managers consider climate change in all water supply decisions.	<i>Not Quantified</i>	Unanimous Consent
WA-3	Climate change effects considered in the new Colorado Water Conservation Board study of Colorado River water availability.	<i>Not Quantified</i>	Unanimous Consent
WA-4	State government develop mechanisms for compact calls for each major river basin.	<i>Not Quantified</i>	Unanimous Consent
WA-5	Assessment of knowledge about climate change effects on Colorado's water resources. An assessment of data and data systems for understanding climate change.	<i>Not Quantified</i>	Unanimous Consent
WA-6	Cooperative development of information on climate change effects in each major river basin.	<i>Not Quantified</i>	Unanimous Consent
WA-7	Municipal water providers evaluate water conservation savings, best demand management practices, and the best uses of conserved water in their systems.	<i>Not Quantified</i>	Unanimous Consent
WA-8	Minimize effects of water-rights transfers on agricultural economies.	<i>Not Quantified</i>	Unanimous Consent
WA-9	Consider relationships between energy and water use.	<i>Not Quantified</i>	Unanimous Consent
WA-10	Information exchanges on effects of climate change on water resources.	<i>Not Quantified</i>	Unanimous Consent
WA-11	State government consider ways to reduce climate change effects on water-related recreation and tourism.	<i>Not Quantified</i>	Unanimous Consent
WA-12	State government consider ways to reduce climate change effects on the environment.	<i>Not Quantified</i>	Unanimous Consent
WA-13	Reduce use of groundwater for irrigation until recharges match discharges.	<i>Not Quantified</i>	Unanimous Consent
WA-14	Establish new Colorado Water Institute.	<i>Not Quantified</i>	Super Majority (1 objection)

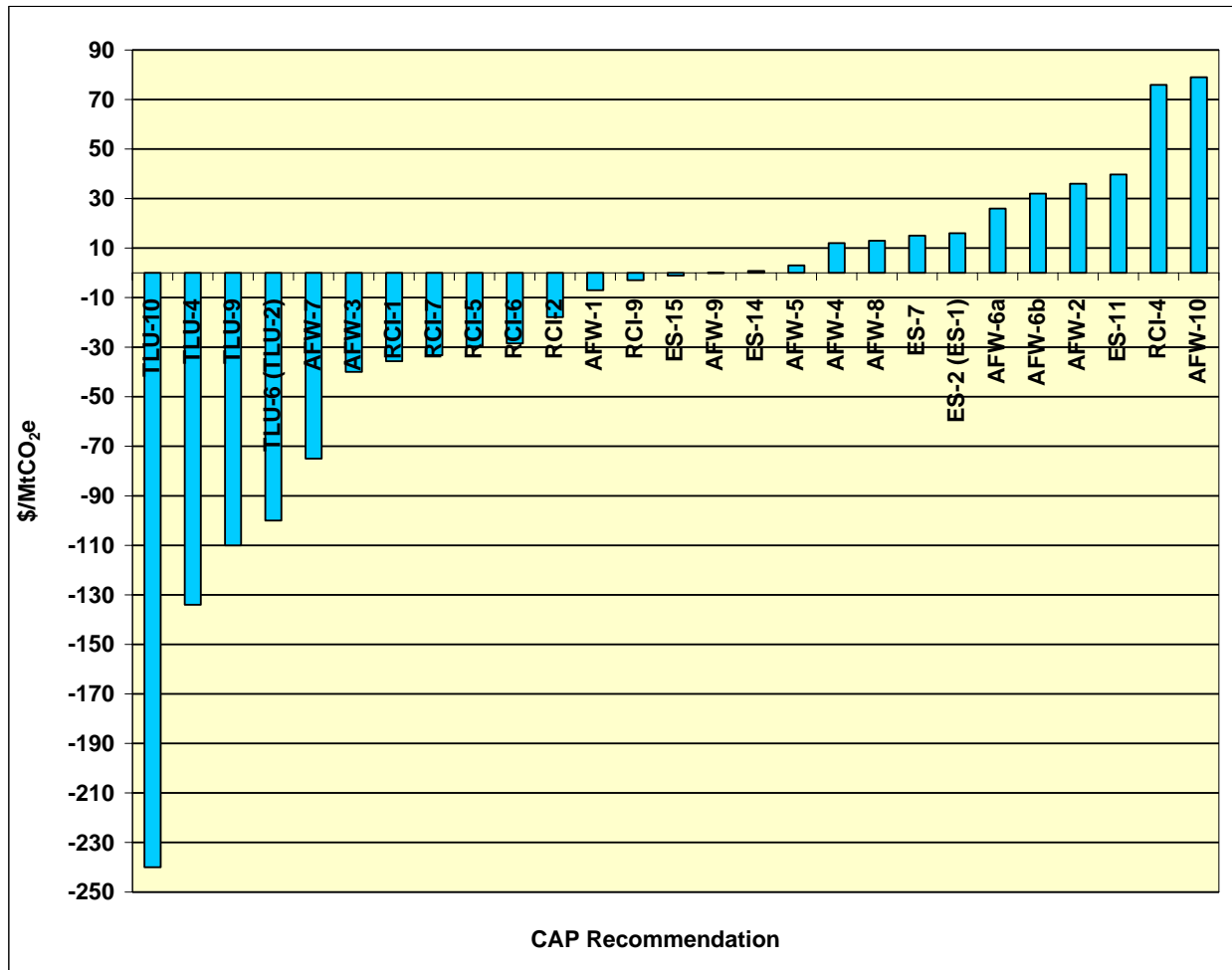
As explained above, the CAP considered the estimates of the GHG reductions that could be achieved by 33 of its recommendations, and the costs (or cost savings) of 26 of those 33. Having these analyses was very helpful to the CAP, but the CAP was mindful that these are estimates. There can be a large imprecision in the GHG reductions associated with various policy recommendations. Figure 1-3 presents the estimated tons of reductions for each policy recommendation for which estimates were available, expressed as a cumulative figure for the period 2007-2020. In addition to the imprecision in GHG reductions achieved by each policy recommendation, there are also uncertainties in the exact cost (or cost savings) per ton of reduction achieved. Figure 1-4 presents the estimated dollars per ton cost (or cost savings, depicted as a negative number) for each policy recommendation for which cost estimates were available. This measure is calculated by dividing the net present value of the cost of the policy recommendation by the cumulative GHG reductions, all for the period 2007-2020. In some cases, there is a wide variation in the cost effectiveness of the policy recommendations depending on the assumptions used in the analysis.

**Figure 1-3. CAP Policy Recommendations Ranked by Cumulative GHG Reductions, 2007-2020**



Note: Emission reductions for TLU-2 are included in the reductions for TLU-6, reductions for TLU-7 are included in the reductions for TLU-3, and reductions for ES-1 are included in the reductions for ES-2. For the purpose of counting the number of options for which emission reductions were quantified, each of the following are counted as one option: TLU-6 & 2; TLU-3 & 7; ES-2 & 1; and AFW-6a & 6b.

**Figure 1-4. CAP Policy Recommendations Ranked by Dollars per Metric Ton**



Note: Negative values represent net cost savings and positive values represent net costs associated with the policy recommendation. Cost savings for TLU-2 are included in the cost savings for TLU-6, and costs for ES-1 are included with the costs for ES-2. For the purpose of counting the number of options for which costs or cost savings were quantified, each of the following are counted as one option: TLU-6 & 2; ES-2 & 1; and AFW-6a & 6b.

## Recent Policy Developments

In the year that the CAP has been working on the development of this report, the Colorado state government, local governments, and others have taken many actions that will make it quicker and easier for the state to reduce its contribution and vulnerability to climate change. These recent actions include the enactment of bills by the Colorado General Assembly in 2007 that:

- Strengthen the state’s renewable portfolio standard, first adopted by the voters of Colorado in 2004, requiring utilities to obtain a certain percentage of their electricity from renewable sources.

- Direct natural gas utilities to implement energy-efficiency programs.
- Direct rural electric cooperatives to enable customers to use net metering.
- Require local governments who have building codes to adopt and update to international energy conservation codes at a minimum.
- Require electric utilities to identify areas where transmission capacity lags behind generating capacity, including renewable sources.
- Created the Renewable Energy and Infrastructure Authority to provide loans and grants for transmission lines to serve renewable energy sources.
- Created a Clean Energy Fund for programs and grants administered by the Governor's Energy Office.
- Establish a pilot grants program for forest restoration projects.

Other significant actions in 2007 include:

- The issuance by Governor Bill Ritter of an executive order to reduce GHGs from state government operations.
- A decision by the Colorado State Government to participate in *The Climate Registry* and to participate as an observer in the development of the Western Climate Initiative.
- Actions by several local governments around the state to reduce local GHG emissions.
- A heightened awareness of potential climate change impacts on the state's water supplies and new efforts by water providers to consider what must be done to meet our water needs in a changed future.

## **The CAP Process**

The CAP first met on November 20, 2006, and met a total of seven times, with the final decisional meeting held on September 12, 2007, and a final meeting for review of this report on October 25, 2007. In all, over 50 meetings and teleconference calls of the CAP and the six supporting PWGs were held to identify and analyze various potential policy actions in advance of the CAP's September 12, 2007, final decisional meeting.

The six PWGs considered information and potential recommendations in the following sectors:

- Energy Supply (ES)
- Residential, Commercial, Industrial (RCI)
- Transportation and Land Use (TLU)
- Agriculture, Forestry, and Waste Management (AFW)
- Cross-Cutting Issues (CC)

- Water Adaptation (WA)

CCS provided facilitation and technical assistance to the first five of those and RMCO played a similar role with respect to the Water Adaptation group. The PWGs consisted of CAP members as well as individuals not on the CAP with interest and expertise in the issues being addressed by each PWG (see Appendix B for a listing of the members of each PWG). The PWGs served as advisors to the CAP and brought forth initial recommendations on priority policy recommendations for analysis, then developed draft proposals on the design characteristics and quantification of the proposed policy recommendations. Where members of a PWG did not fully agree upon recommendations to the CAP, the summary of their efforts was reported to the CAP for their further consideration and actions. The CAP then made its decisions after reviewing the PWGs' proposals.

The CAP process involved a model of informed self-determination through a facilitated, stepwise, consensus-building approach. Under the oversight of RMCO, the process was conducted by CCS, an independent, expert facilitation and technical analysis team. It was based on procedures that CCS consultants have used in a number of other state climate change planning initiatives since 2000, but adapted specifically for Colorado. The CAP process sought, but did not mandate consensus, and it explicitly documented the level of CAP support for some policies and key findings established through a voting process established in advance.

The 70 policy recommendations (out of over 300 potential options considered) adopted by the CAP and presented in this report underwent two levels of screening by the CAP. First, a potential policy recommendation being considered by a PWG was not accepted as a "priority for analysis" and fleshed out for full analysis unless it had a super majority of support from CAP members present at the decisional meetings (with a "super majority" defined as five objections or less by CAP members attending a meeting). Second, after the analyses were conducted, only policy recommendations that received at least majority support (defined as less than half of those present objecting) from CAP members present at the decisional meetings were adopted by the CAP and included in this report.

In total, of the 70 policy recommendations adopted by the CAP, 62 were approved unanimously, six were approved by a super majority, and two were approved by a simple majority of the CAP.

The PWGs' recommendations to the CAP were documented and presented to the CAP at each CAP meeting. All of the CAP and PWG meetings were open to the public and all materials for and summaries of the CAP and PWG meetings were posted on the Colorado Climate Project website.

### ***Analysis of Policy Recommendations***

With CCS providing facilitation and technical analysis, the five PWGs other than the Water Adaptation group submitted recommendations for policies for CAP consideration using a "policy option template" conveying the following key information:

- Policy option description
- Policy option design (goals, timing, parties involved)
- Implementation mechanisms

- Related policies / programs in place
- Type(s) of GHG reductions
- Estimated GHG Savings and Costs per metric ton (Mt) of CO<sub>2</sub>e
- Key uncertainties
- Additional benefits and costs
- Feasibility issues
- Status of group approval
- Level of group support
- Barriers to consensus

In its deliberations, the CAP modified and embraced various policy recommendations. The final versions for each sector, conforming to the policy option templates, appear in Appendices E through I (and Chapter 8 for Water Adaptation) and constitute the most detailed record of decision of the CAP. Appendix D presents a description of the methods used for quantification of the 33 policy recommendations that were analyzed quantitatively. Three key methods are summarized here:

- *Estimates of GHG reductions.* Using the projection of future GHG emissions (see below) as a starting point, 33 policy recommendations were analyzed by CCS to estimate GHG reductions attributable to each policy in the individual years of 2012 and 2020, and cumulative reductions over the time period 2007-2020. The CCS estimates were prepared in accordance with guidance by the appropriate PWG and the CAP, which later reviewed the estimates and in some cases directed that they be revised with respect to such elements as goals, data sources, and methodology. Many policies were estimated to affect the quantity or type of fossil fuel combusted; others affected methane (CH<sub>4</sub>) or CO<sub>2</sub> sequestered. Among the many assumptions involved in this task was selection of the appropriate GHG accounting framework, namely, the choice between taking a “production-based” approach versus a “consumption-based” approach to various sectors of the economy.<sup>15</sup> The CAP took a “production-based” approach in all sectors except the electricity sector, in both forecasting emissions and in estimating the GHG impacts of policies. This issue, along with other GHG estimation issues (e.g., analysis of overlapping or interacting policy impacts), are discussed in detail in Appendix D (Methods for Quantification).
- *Estimates of costs / cost savings.* The analyses of 26 policy recommendations included estimates of the cost of those policies, both in terms of a net costs or cost savings from 2007-

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<sup>15</sup> A production-based approach estimates GHG emissions associated with goods and services produced within the state, and a consumption-based approach estimates GHG emissions associated with goods and services consumed within the state. In some sectors of the economy, these two approaches may not result in significantly different numbers, however, the power sector is notable in that it is responsible for large quantities of GHG emissions, and states often produce more or less electricity than they consume (with the remainder attributable to power exports or imports). Colorado imports electric power and must account for the emissions this consumption creates, even though they are not produced in-state.

2020 and a dollars-per-ton cost (i.e., cost-effectiveness).<sup>16</sup> (The other seven policy recommendations that were analyzed with respect to their GHG reductions were of such a nature that their costs or cost savings could not be readily estimated.) The approach used was similar to a conventional cost-benefit framework but had some important differences:

— *Discounted and “Levelized” Costs.* Fairly standard approaches were taken here. The “net present value” of costs was calculated by applying a real discount rate of 5%. Dollars-per-ton estimates were derived as a “levelized” cost per ton, dividing the “present value cost” by the cumulative GHG reduction measured in tons. As was the case with GHG reductions, the period 2007-2020 was analyzed.

— *Benefits vs. costs.* The principal benefit of the CAP policy recommendations is reduced GHG emissions and these were quantified simply as metric tons. There was no attempt to monetize the benefit of these reductions in atmospheric concentration (e.g., health benefits). Many policies did create easily monetized non-GHG benefits (e.g., fuel savings and electricity savings). In these cases, monetized benefits were subtracted from monetized costs, resulting in net costs. These net costs could be positive or negative; negative costs indicated that the policy saved money or produced “cost savings.”

— *Direct vs. Indirect Effects.* Cost estimates were based on “direct effects” (i.e., those borne by the entities implementing the policy).<sup>17</sup> Implementing entities could be: individuals, companies, and/or government agencies, etc. In contrast, conventional cost-benefit analysis takes the “societal perspective” and tallies every conceivable impact on every entity in society (and quantifies these wherever possible).

*Colorado vs. National/Global perspective.* Cost estimates were based on implementing entities in Colorado, not on a broader societal perspective (national or global). One implication of this is that national taxes or subsidies that affect actions in Colorado were considered as external to the analysis. For example, while the federal Production Tax Credit was taken into account in reducing the cost of renewable resources in Colorado, the cost of this program to taxpayers nationally was not considered.

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<sup>16</sup> The analysis addressed the costs / cost savings of each policy recommendation and, with the exception of a few recommendations that address rate structures, did not attempt to estimate specific price changes or utility rate changes that might result from implementation of a policy.

<sup>17</sup> “Additional benefits and costs” were defined as those borne by entities other than those implementing the policy recommendation. These indirect effects were quantified on a case-by-case basis depending on magnitude, importance, need and availability of data.