Catalog of State Actions
Agriculture, Forestry, and Waste Management (AFW) Policy Working Group

A catalog of state-level, GHG-reducing actions and policy options prepared by the Center for Climate Strategies (CCS) and the Rocky Mountain Climate Organization based on actions undertaken or considered by Colorado and other states, including regional, state, local and private actions.

Key to Future Rankings of Options in the Tables that Follow:

Potential GHG Emission Reductions 1/	Potential Cost or Cost Savings 1/ 2/
High (H): At least 1.0 million metric tons (MMt) carbon dioxide equivalent (CO_2e) per year by 2020 (~1% of current Colorado emissions)	**High (H)**: $50 per metric ton CO_2e (tCO_2e) or above
Medium (M): From 0.1 to 1.0 $MMtCO_2e$ per year by 2020	**Medium (M):** \$5-50/tCO_2e
Low (L): Less than 0.1 $MMtCO_2e$ per year by 2020, or 1 MMtCO2e by 2050	**Low (L):** Less than \$5/tCO_2e
Uncertain (U): Not able to estimate at this time	**Uncertain (U):** Not able to estimate at this time
1/ Several measures may overlap in terms of emissions reductions and/or cost impacts. Estimates assume measures would be implemented independently from other measures. 2/ Costs are denoted by a positive number. Cost savings (i.e., "negative costs") are denoted by a negative number.	

Definition of "Priorities for Analysis":

- **High:** High priority options will be analyzed first.
- **Medium:** Medium priority options will be analyzed next, time and resources permitting.
- **Low**: Low priority options will be analyzed last, time and resources permitting.

Notation of Options:
Options marked with an asterisk (*) indicate options that are at least partially "base case" policies, i.e., that have been considered or undertaken at some level in Colorado. Distinctions are made between statewide (S) and local (L) policies where appropriate.
Options marked with two asterisks (**) indicate options that have been proposed for consideration.

Agriculture, Forestry, Waste Management (AFW)

Option No.	GHG Reduction Policy Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
AFW-1	**AGRICULTURE – PRODUCTION OF FUELS AND ELECTRICITY**					
1.1	Manure Digesters/Other Waste Energy Utilization *(L)		M	L - M	• Linked with Option AFW2.2 below • Costs dependent on livestock type and manure management methods	Included in Arizona (AZ) and New Mexico (NM) climate action plans, abbreviated as AZ or NM in other catalog options below. Montana priority for analysis listed as MT below.
1.2	Biodiesel Production (incentives for feedstocks and production plants)		M - H	L - M	• Production from both virgin and waste vegetable oils	NM MT
1.3	Biomass Feedstocks for Electricity or Steam Production		M	Neg - L	• Need to identify viable feedstocks and volumes [e.g., crop residue (wheat straw, corn stover) or energy crops (switchgrass)	AZ, NM
1.4	Ethanol Production *		M - H	M - H	• Starch- (e.g. corn-) and cellulosic production processes.	AZ, NM MT
AFW-2	**AGRICULTURE – FERTILIZER AND MANURE MANAGEMENT**					
2.1	Nutrient Management (improve efficiency of fertilizer use)		L	L	• Significant opportunities beyond current practice?	•

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2.2	Manure Management (improve application methods) *(S)		L - M	U	• Linked with Option AFW1.1 above and 2.1, 2.3 below. • Co-benefits include reduction of ammonia and VOC emissions.	• Application improvement includes incorporation into soil, instead of surface spray/spreading.
2.3	Manure Composting		L	U	• Potentially most feasible in the poultry, dairy or beef cattle sectors.	• Potential for reduction in CH4 emissions; impacts to N2O emissions unclear.
2.4	Change Feedstocks (optimize nitrogen for N_2O reduction)		L - M	M	• Co-benefits include reduction in ammonia emissions.	• Option includes supplements to reduce CH4 from enteric fermentation, as well as nitrogen efficiency to reduce downstream N20.
2.5	Reduce Non-Farm (Residential and Commercial) Fertilizer Use		L	U	• Emissions from non-farm application are not currently in the inventory; unclear what the reductions and costs would be.	• Additional research needed on the levels of N20 emissions from lawns, golf courses, etc.
AFW-3	**AGRICULTURE – SOIL CARBON MANAGEMENT**					
3.1	Conservation Tillage/No-Till (carbon sequestration and reduced energy use)		M	L	• Significant opportunities beyond current practice?	NM, MT • Need estimates on current practices/potential for increased acreage.
3.2	Reduce Summer Fallow (increase soil C content, reduce N_2O emissions)		L	U	• Significant opportunities beyond current practice?	•
3.3	Increase Winter Cover Crops (increase soil C content, increase soil N content)		L	U	• Significant opportunities beyond current practice?	•

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3.4	Improve Water and Nutrient Use (to minimize soil C loss) *(S)		L	L	• Significant opportunities beyond current practice?	
3.5	Rotational Grazing/Improve Grazing Crops and/or Management		L	L	•	
AFW-4	**AGRICULTURE – LAND USE CHANGE**					
4.1	Convert Land to Grassland or Forest		M	?		AZ, NM • Need estimates of marginal agricultural land with the potential for conversion.
4.2	Preserve Open Space/Agricultural Land *(S,L)		M	?	• Reductions occur both from higher retention of carbon in soil and lower transportation activity.	AZ, NM MT
4.3	Promote "No Net Loss" of Agricultural Land		M	?	• Reductions occur both from higher retention of carbon in soil and lower transportation activity.	
AFW-5	**AGRICULTURE – FARMING PRACTICES**					
5.1	Convert Diesel Farm Equipment to LNG/CNG or Hybrid Technology		L	M - H	• LNG/CNG engines or engine conversions reduce BC emissions • Availability of diesel hybrid equipment for farm applications?	•
5.2	Organic Farming *(S)		M	L	• Reductions occur via lower intensity agricultural practices (nutrient/pesticide application, reduced tillage) and higher soil carbon	NM MT

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5.3	Programs to Support Local Farming/Buy Local *(S)		L - M	U	• Reductions occur through lower transport related emissions.	NM, MT
AFW-6	**FORESTRY – BIOMASS PROTECTION AND MANAGEMENT**					
6.1	Forest Protection – Reduced Clearing And Conversion to Nonforest Cover		M - H	M - H	Reductions depend on current rates of clearing; Relatively large amount of carbon can be protected per acre	AZ, NM MT
6.2	Increase Maintenance of Urban and Residential Trees *(L)		L	L - M	Cost savings are possible if thinnings directed to products and energy	AZ ("Forest Ecosystem Management – Residential Lands") NM ("Forest Health and Restoration – Residential lands")
6.3	Afforestation and/or Restoration of Nonforested Lands		M	M - H	Reductions depend on available land; Relatively high rate of c-sequestration/acre	MT – priority option covers 6.3/6.4
6.4	Reforestation/Restoration of Managed Stands *(S,L,Fed)		M	M - H	Reductions depend on available land and initial stand conditions (highly degraded stands have higher potential);	AZ
6.5	Increased Stocking of Poorly Stocked Lands		L - M	M - H	Reductions are greatest if applied to lands that are very poorly stocked; poor sites may be more expensive to treat	*AZ & NM have general forest management options that essentially encompass specific practices in the rows below:* AZ ("Forest Ecosystem Management – Other Lands") NM ("Forest Health and Restoration – Other lands") MT – similar priority option

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6.6	Age Extension of Managed Stands		L	M	Relatively low c-sequestration per acre; age-extension increases standing carbon stocks, however sequestration rates are slows in older stands	
6.7	Thinning and Density Management of Managed Stands *(S,L,Fed)		M - H	L - M	Costs and benefits depend on whether the practice is combined with energy recovery; thinning encourages growth of bigger trees in the long run but may not change net c balance; potential benefits of more biomass going to wood products (because of larger stems for harvest)	
6.8	Fertilization and Waste Recycling		L	U	Reductions depend on full life cycle analysis to consider impacts of nitrogen based fertilizers	
6.9	Expand Short Rotation Woody Crops (for fiber and energy)		M	M - H	Reductions depend on available land and whether practice is combined with energy capture	
6.10	Expanded Use of Genetically Preferred Species		L	U	Depends on opportunities for seeding; may be only a marginal increase in c-sequestration	
6.11	Modified Biomass Removal Practices (reduced decay and energy use)		L - M	U	Reductions depend on available acreage, current practice, and energy production	

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6.12	Fire Management and Risk Reduction Programs *(S,L,Fed)		L	U	Depends on flexibility to modify programs; Reductions may be relatively low because primary objective of programs is not carbon sequestration	
6.13	Ecosystem Health Risk Reduction Programs (pest/disease, invasive species) *(S,L,Fed)		L	U	Ditto	
6.14	Drought Management Programs (tree selection, placement, protection) *(S,L)		L	U	Ditto	
6.15	Flood and Riparian Management Programs (tree selection, placement, protection) *(S,L)		L	U	Ditto	
6.16	Watershed Management Programs (stand retention, enhancement and management) *(S,L,Fed)		L	U	Ditto	
6.17	Habitat Management Programs (stand retention, enhancement and management) *(S,L, Fed)		L	U	Ditto	
AFW-7	**FORESTRY - WOOD PRODUCTS AND WASTE**					
7.1	Improved Mill Waste Recovery		L	L	Reductions depend on current levels of efficiency, which tend to be high	

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7.2	Improved Logging Residue Recovery		L - M	U	Reductions depend on energy recovery and current levels of efficiency	
7.3	Expanded Use of Wood Products for Building Materials		M	U	Cost depends on relative costs of materials	
7.4	Expanded Use of State and Locally-Grown Wood Products		U	U	Reductions depend on current levels of wood product imports and potential for reducing transportation emissions	
AFW-8	**FORESTRY – ENERGY PRODUCTION**					
8.1	Expanded Use of Forest Biomass Feedstocks for Electricity (fuel switching)		M - H	L - M		MT priority option covers 8.1/8.2
8.2	Expanded Use of Forest Biomass Feedstocks for Residential, Commercial/Institutional, or Industrial Heating		M - H	L - M		
8.3	Improved Efficiency of Wood Burning Stoves and Direct Heat *(S)		L	U		
8.4	Improved Energy Capture from Wood Waste Combustion *(L)		L - M	U		
8.5	Expanded Landfill Methane Recapture (wood products waste)		L - M	L - M	Reductions depend on existing sites that capture gas	

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8.6	Improved Commercialization of Biomass Gasification and Combined Cycle		U	U		AZ
AFW-9	**WASTE MANAGEMENT – WASTE MANAGEMENT STRATEGIES**					
9.1	Advanced Recycling and Composting *(L)		L - M	L	•	AZ and NM (as one of the RCI options in both states) MT
9.2	Advanced Municipal Solid Waste Management Practices (e.g., bioreactors)		L - M	Neg - L	•	•
9.3	Source Reduction Strategies *(S,L)		L - M	L	•	•
9.4	Resource Management Contracting		U	U	•	• Programs that compensate waste contractors based on performance in achieving waste reduction goals rather than the volume of waste disposed
9.5	Manure Digesters *(L)		M	Neg - L	•	• Also under Agriculture (Option AFW1.1)
9.6	Waste Coal Recapture		?	?	• Applicable to CO?	•
AFW-10	**WASTE MANAGEMENT – LANDFILL GAS STRATEGIES**					
10.1	Flare Landfill Methane at non-NSPS (smaller) sites		M – H	M - H	• Federal New Source Performance Standards and Emissions Guidelines require methane capture at larger landfills.	• Should be limited to consideration at sites where energy can not be recovered feasibly; • Need to consider energy required to collect CH4.

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10.2	Methane & Biogas Energy Programs		L	U	• Significant opportunities for digesters/energy utilization outside of the municipal solid waste sector?	•
10.3	Landfill Methane Energy Programs *(L)		M	Neg - M	• Methane conversion to motor fuels (LNG), electricity, steam, or space heat are examples	• Also included under option 8.5.
AFW-11	**WASTE MANAGEMENT – WASTEWATER ACTIVITIES**					
11.1	Energy Efficiency Improvements		L	Neg - L	•	•
11.2	Lower Waste Processing Needs (lower water consumption, waste production) *(L)		L	U	•	•
11.3	Install Digesters and Turbines or Fuel Cells		L - M	U	• Reductions occur via methane control and offsetting fossil energy use	•