



**Agriculture, Forestry, and Waste Management Technical Work Group
Summary List of Draft Priorities for Analysis**

	Policy Option	GHG Reductions (MMtCO ₂ e)			Net Present Value 2007–2020 (Million \$)	Cost-Effectiveness (\$/tCO ₂ e)	Level of Support
		2012	2020	Total 2007-2020			
	AGRICULTURE, FORESTRY, AND WASTE MANAGEMENT						
AFW-1	Agricultural Crop Management						TBD
AFW-2	Manure Management and Energy Utilization						TBD
AFW-3	Reductions in On-Farm Energy Use						TBD
AFW-4	Biodiesel Production						TBD
AFW-5	Ethanol Production						TBD
AFW-6	Preserve Lands with Carbon Storage Value						TBD
AFW-7	Biomass Feedstocks for Energy Production						TBD
AFW-8	Forestry Programs to Enhance GHG Benefits						TBD
AFW-9	Source Reduction, Enhanced Recycling and Composting Programs						TBD
AFW-10	Landfill Methane Energy Programs						TBD
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS						
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)						
	SECTOR TOTAL PLUS RECENT ACTIONS						

AFW-1. Agricultural Crop Management

Policy Description

The amount of carbon stored in the soil can be increased by crop management practices that increase C inputs to soil and/or reduce soil organic matter decomposition rates. Adoption of conservation tillage, in particular no-till, can increase soil C stocks. Reducing mechanical soil disturbance reduces the oxidation of soil carbon compounds and allows more stable aggregates to form. Other benefits of conservation tillage include reduced wind and water erosion, improved soil structure and crop water use, reduced fuel consumption, and improved wildlife habitat. On non-irrigated cropland, increased cropping frequency to reduce or eliminate summer fallow goes hand in hand with adopting no-till practices. Improved nutrient management (i.e. better timing, application rates based on soil test, advanced fertilizer formulations, etc.) of both fertilizer and manure can increase nutrient use efficiency and reduce addition rates, thereby reducing nitrous oxide emissions and potentially fossil fuel use. For some production systems, organic farming practices result in lower net GHG emissions. Application of biochar (i.e. stable organic residues from biomass pyrolysis) to soils is a potential practice to capture and sequester atmospheric CO₂.

Policy Design

Goals:

- **No-Till Goal:** approximately 15% of total annual cropland is currently managed under no-till (most with reduced summer fallow). Achieve 50% no-till by 2020.
- **Nutrient Goal:** Increase nitrogen fertilizer efficiency by 20% through the use of best management practices by 2020.

Timing:

- **No-Till:** 30% no-till on annual croplands by 2012; achieve the full goal by 2020.
- **Nutrient Goal:** Increase fertilizer efficiency by 10% by 2012; achieve the full goal by 2020.

Parties involved: To be determined (TBD).

Other: Current (2005) Colorado cropland: 1,923,000 ha dryland; 924,000 ha CRP; 1,000,000 ha irrigated cropland (~50% as hay).

AFW-2. Manure Management and Energy Programs

Policy Description

The methane emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. Methane and nitrous oxide emissions can occur at several different places in the manure management process. Management techniques can also reduce GHG emissions and, with energy recovery, offset fossil-based energy. This option covers producer incentives to adopt programs to increase the number of methane capture and energy recovery projects or other manure management techniques that reduce methane and nitrous oxide emissions.

Policy Design

Goals: Implement manure management and energy programs (where feasible for adoption by the facility) on 80% of confined animal feeding operations (CAFOs) by 2020.

Timing: Implement programs on 10 CAFOs by 2012; achieve the full goal by 2020.

Parties involved: TBD

Other: Currently one housed commercial swine feeding operation utilizes a methane digester to produce power for facility use and one additional CAFO is developing a manure energy recovery strategy.

AFW-3. Reductions in On-Farm Fossil Energy Use

Policy Description

This option seeks to develop and implement cost effective programs for renewable energy (biofuels, renewable electricity generation) and energy efficiency technologies for farmers and ranchers. Reductions in fossil fuel consumption reduce emissions of carbon dioxide, methane, nitrous oxide, and black carbon.

Policy Design

Goals:

- **Fossil fuel reduction goal:** 20% reduction in petro-diesel use by 2020.
- **Electricity reduction goal:** 40% includes reductions from electricity efficiency and on-site generation using renewable energy (solar, wind, hydro).

Timing:

- **Fossil fuel reduction goal:** Achieve 5% reduce consumption by 2012. Achieve the full policy goal by 2020.
- **Electricity reduction goal:** Achieve 10% reduce consumption by 2012. Achieve the full policy goal by 2020.

Parties involved: Colorado Rural Electric Associations, State Agriculture Organizations, Governors Office of Energy Management and Conservation, Colorado Department of Agriculture, Businesses providing energy efficiency and renewable energy equipment.

Other: As needed, identify incentives that encourage the growing and supply of feedstocks, and the utilization of ethanol in transportation markets across the state.

AFW-4. Biodiesel Production

Policy Description

Provide incentives for the production of biodiesel from oilseed crops, waste vegetable oil, or other sources. Biodiesel use will offset diesel fuel derived from petroleum and will lead to decreased fossil fuel-based CO₂ emissions.

Policy Design

Goals: Produce enough biodiesel fuel to offset 20% of the state diesel fuel demand by 2020 using GHG-superior feedstocks.

Timing: Produce enough in-state biodiesel to offset 2% of Colorado's petro-diesel consumption by 2012 and 20% by 2020.

Parties involved: Governor's Office of Energy Management and Conservation, Colorado Dept. of Agriculture, Rocky Mountain Farmers Union, Colorado Farm Bureau, Colorado Livestock Association.

Other: Colorado's distillate fuel usage in 2002 was 0.73 billion gallons and is projected to be 1.25 billion gallons by 2020 (transportation diesel use was 0.56 billion gallons in 2002; 1.0 billion gallons by 2020).

AFW-5. Ethanol Production

Policy Description

Trees, crops and other plants convert atmospheric carbon to carbohydrate or fiber stocks that can be converted to liquid fuels, such ethanol. The use of these renewable, biological fuels can offset fossil fuel use and reduce associated net carbon dioxide emissions. Production incentives for the conversion of crops, forest sources, animal waste and other sources to ethanol through existing or new technologies can increase the level of ethanol use in future markets. In-state production of ethanol using GHG-superior feedstocks and processes (e.g. cellulosic technologies) offer the highest GHG benefits and complement policies to increase ethanol consumption (e.g. TLU-5).

Policy Design

Goals: Increase in-state ethanol production using GHG-superior feedstocks and production methods to 400 million gallons per year above BAU by 2020.

Timing: Add additional ethanol production capacity of 50 million gallons/yr by 2012 and achieve the full policy goal by 2020.

Parties Involved: Suppliers of feedstocks, ethanol producers and distributors.

Other: Colorado's gasoline consumption was 1.9 billion gallons in 2002 and is projected to be 2.4 billion gallons by 2020.

AFW-6. Preserve Lands with Carbon Storage Value

Policy Description

Reduce the rate at which existing crop/pasture and forested lands are converted to developed uses. The carbon stored in soils and aboveground biomass is typically higher in these lands than in developed land uses. Each year, developed areas also typically sequester less carbon dioxide than forested areas. Policies are needed to protect working farms and forests from unwise and unplanned development. Indirectly, this option also supports important policies in the transportation and land use sector by promoting more efficient development patterns (e.g. TLU-1).

Policy Design

Goals: Protect 3,500,000 acres of lands in natural cover that would have been converted by 2030.

Timing: By 2015, protect 2,000,000 acres of lands that would have been converted (protect 1,500,000 by 2012); achieve the full goal by 2030.

Parties involved: TBD

Other: Data from the Natural Resources Conservation Service (NRCS) National Resources Inventory (NRI) show the following losses of lands between 1982 and 1997 to the “urban built-up” and “rural transportation” categories¹:

Land Cover/Use	10 ³ Acres Lost 1982-1997	Annual Average Loss (10 ³ acres)
Cultivated cropland	89.9	6.0
Non-cultivated cropland	36.1	2.4
Pastureland	46.9	3.1
Rangeland	176.9	11.8
Forest land	66.6	4.4
Totals	416	27.7

¹ See this table: <http://www.co.nrcs.usda.gov/technical/nri/tables/table5.pdf> for conversion rates between 1982 and 1997. The NRI annual acreage lost to development can be compared to an estimate from David Theobald of CSU of 33,700 acres/yr on average from 2000-2030.

AFW-7. Biomass Feedstocks for Energy Production

Policy Description

The goals of this option are to increase the use of low value wood material (including logging and mill residues), agricultural residues, and municipal solid waste fiber by appropriate processing centers for energy purposes (electricity, heating, liquid fuels). Offsetting fossil fuel use with biomass for energy, in applications such as distributed generation, combined heat and power and community energy systems will yield additional GHG emissions reduction benefits.

Policy Design

Goals: Increase production and use of biomass energy feedstocks by a factor of 10 by 2020 through sustainable harvesting and recovery practices.

Timing: Achieve an increase in consumption of biomass energy feedstocks of a factor of 3 by 2012; achieve the full goal by 2020.

Parties involved: TBD

Other: Not applicable

AFW-8. Forestry Programs to Enhance GHG Benefits

Policy Description

Carbon dioxide is captured and stored in trees, soil and other forest biomass. Any forest management activity that promotes forest productivity will increase carbon dioxide sequestration rates and enhance GHG benefits. Retaining forest management where it is being done and expanding the area covered by management plans would stimulate the rate of carbon sequestration. Use of biomass waste from forestry programs for energy purposes is covered under AFW-7. This option also seeks to develop management methods that decrease the potential for catastrophic wildfires that result in large carbon losses and losses of near-term sequestration potential.

Policy Design

Goals: Treat 10% of Lower Montaine forests to reduce the risk of stand replacement fires and increase productivity by 2020.

Timing: Increase productivity by 2% by 2012 and achieve the full goal by 2020.

Parties involved: TBD

Other: Focus is on the lower elevation forest systems in the state.

AFW-9. Source Reduction, Enhanced Recycling and Composting Programs

Policy Description

Solid waste that is normally buried in landfills generates methane through decomposition processes. By preventing this source of methane, GHG emissions are reduced. Waste can be diverted through a variety of actions including composting, source reduction, recycling, and re-use. Alternatives to landfilling unprocessed organic material (food wastes, agricultural wastes, biosolids, lawn & garden wastes, or other organic materials) include composting and anaerobic digestion. Both alternatives reduce net GHG emissions and anaerobic digestion can also provide a source of renewable energy (methane). Source reduction and recycling also reduce product life cycle GHG emissions, including extraction and processing of raw materials, product manufacture, transport, and final disposal.

Policy Design

Goals: Divert 75% of wastes from landfilling by source reduction, recycling and composting.

Timing: Divert 25% by 2012; achieve the full goal by 2020.

Parties involved: TBD

Other: Not applicable.

AFW-10. Landfill Methane Energy Programs

Policy Description

Provide incentives that will result in an increase in the recovery of landfill methane for use as an energy source. Increasing the recovery of landfill methane will reduce emissions of this GHG and will offset the use of fossil fuels for commercial/industrial heat/steam generation or electricity production.

Policy Design

Goals: Implement controls or waste management options at municipal solid waste landfills such that 50% of the methane emissions that would be generated under business as usual conditions are avoided by 2020. This can be done through development of additional landfill gas to energy (LFGTE) projects, flaring, reducing the amount of biodegradable waste being landfilled, or possibly other methods.

Timing: By 2012, implement controls or management strategies at 12 sites not currently using these technologies; by 2020, achieve full implementation of the policy (50% coverage of generated methane).

Parties involved: TBD

Other: This policy is meant to cover sites that would not be expected to trigger the Federal New Source Performance Standards/Emission Guidelines for landfills (and would be required to capture and control methane). Per the Colorado GHG Inventory & Forecast, the following landfills currently employ LFG controls:

Site Name	County	Control
County Line LF	Arapahoe	Flare
Fountain LF	El Paso	Flare
Foothills LF	Jefferson	Flare
Denver Regional North LF	Weld	Flare
Denver Regional South LF	Weld	Flare
Tower LF	Adams	Flare
Denver – Arapahoe	Arapahoe	LFGTE
Boulder LF	Boulder	LFGTE