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Catalog of State GHG Reduction Policy Actions
Agriculture, Forestry, and Waste Management (AFW)

A catalog of state-level, greenhouse gas (GHG)–reducing actions and policy options prepared by the Center for Climate Strategies (CCS) and the Kentucky Climate Action Plan Council, based on actions undertaken or considered in state-wide climate change action plans by multi-stakeholder groups in a wide cross-section of U.S. states and by state, local, and private participants.

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	**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 to \$50/tCO_2e
Low (L): Less than 0.1 $MMtCO_2e$ per year by 2020, or 1 $MMtCO_2e$ 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 of 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.

Important Note: The state actions are numbered in this catalog solely for convenience in referencing them. Their numbers do NOT reflect a ranking or prioritization of the actions.

Agriculture, Forestry, and Waste Management (AFW)

Note that this listing will be developed more fully during the AFW Technical Work Group (TWG) process. TWG members are encouraged to provide input on policies and programs in place in Kentucky to assist in defining baselines. The "Notes" column should be used to record recently enacted policies and programs in Kentucky relevant to state actions in the catalog.

Option No.	Greenhouse Gas (GHG) Reduction Policy Option	Potential GHG Emissions Reduction	Cost per Ton	Externalities, Feasibility Considerations	Priority for Analysis	Notes / Related Actions in Kentucky
AFW-1	**AGRICULTURE & FORESTRY—PRODUCTION OF FUELS AND ELECTRICITY**					
1.1	Expanded Use of Biomass Feedstocks for Electricity, Heat, and Steam Production			• Need to identify viable feedstocks and volumes. • Conventional and emerging/advanced technologies. • Considerations should include the sustainability of biomass, the environmental impacts from biomass harvesting, and transportation costs.		KY Energy Strategy – Renewable Energy Strategy. Take into account Governor's Task Force on Biomass and Biofuels: energy,ky.gov/biomass.
1.2	In-state Liquid/Gaseous Biofuels Production for Stationary and Mobile Applications			• Production of biodiesel from both virgin and waste vegetable oils. • Starch (e.g., corn) and cellulosic production processes for ethanol. Includes		KY Energy Strategy – Biofuels Production Strategy (meet 20% of current demand by 2025 or 775 million gallons of use); also Gas Production Strategy.

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				municipal solid waste (MSW) as feedstock. • Bio-oils from biomass. • Considerations should include the sustainability of biomass, the environmental impacts from biomass harvesting, and transportation costs.		
1.3	Improved Energy Capture From Wood Waste and Biomass Combustion					KY Energy Strategy – Renewable Energy Strategy.
1.4	Improved Commercialization of Biomass Conversion Technologies					KY Energy Strategy – Renewable Energy Strategy.
1.5	Integrated Bioenergy Research and Production			Integrates electricity from anaerobic methane (CH_4) digestion of manure, with production of by-products, e.g. biodiesel and ethanol.		KY Energy Strategy – Renewable Energy Strategy.
1.6	Expanded Production/Use of Bio-based Materials and Chemicals			Corn-based plastics, etc.		
1.7	Manure Digesters/Other Waste Energy Utilization			Costs dependent on livestock type and		KY Energy Strategy – Renewable Energy Strategy.

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				manure management methods.		
AFW-2	**AGRICULTURE—LIVESTOCK AND RANGE MANAGEMENT**					
2.1	Manure Management—Manure Utilization			Includes handling, storage, and improved application methods such as manure/ methane capture, biofilters to control CAFO emissions, increase pasturing, lower densities. Application improvements include incorporation into soil, instead of surface spraying/spreading. Co-benefits include reduction of ammonia and VOC emissions.		

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2.2	Changes in Animal Feed			Optimize Nitrogen for N_2O Reduction. Includes supplements to reduce CH_4 from enteric fermentation, and nitrogen efficiency to reduce downstream N_2O. Co-benefits include reduction in ammonia emissions.		.
2.3	Rotational Grazing/Improve Grazing Crops and/or Management			May Include carbon sequestration through increased pasturing.		
2.4	Mitigation of Carbon Sequestration Loss and GHG Emissions From Crop or Grass Wildfires					New.
2.5	Mitigation of Carbon Sequestration Loss and GHG Emissions From Prescribed/Controlled Burning of Crop Residues or Grassland Residues					There is a Prescribed Fire Council in Kentucky.
AFW-3	**AGRICULTURE—CROP PRODUCTION**					
3.1	Soil Carbon Management			Can include: Conservation Tillage/No-Till; Reduced Fallow; Increase Winter Cover; Application of Biochar:		Kentucky may lead the country in no-till agriculture. Kentucky farmers have made a considerable shift to no-till agriculture in the last decade.

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				Crimp/Roll. Potential based on opportunities beyond current practice		Consequently this option may have limited potential in KY compared to other states.
3.2	Nutrient and Water Management			Includes drainage management. Potential based on whether there are significant opportunities beyond current practice.		
3.3	Technology Improvements to Increase Efficiency			Improved soil sampling to optimize fertilizer application, machinery systems, etc.		
3.4	Biotechnology Application for Greenhouse Gas Mitigation			Improved research in and utilization of drought-resistant, flood-resistant, pest-resistant crop varieties, etc.		
3.5	Perennial Crop Production			Save on planting, tillage, etc.		
AFW-4	**AGRICULTURE – LAND USE CHANGE**					
4.1	Land-Use Management That Promotes Grassland Cover			This includes opportunities to keep CRP lands in permanent cover—i.e., convert cropland to grassland or prevent conversion of grassland to croplands. Demand for corn-based		•

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				ethanol can convert grassland to crop production. (Relates to ethanol/biofuel options.) Need estimates of marginal agricultural land with the potential for conversion.		
4.2	Preserve Open Space/Agricultural Land (Promoting "No Net Loss" of Agricultural Land is a stringent application of this option.)			GHG reductions occur both from higher retention of carbon in soil and from lower transportation activity.		
4.3	Prioritize Environmental Remediation Actions for GHG Benefits			A relevant example is the revegetation of disturbed lands (e.g., mining areas) to improve carbon sequestration.		.
4.4	Preserve and Expand Wetlands for Carbon Sequestration			Anaerobic decomposition in wetlands creates methane emissions.		
4.5	Increase Productivity of Reclaimed Lands			Includes previously mined surface mines		
AFW-5	**AGRICULTURE—FARMING PRACTICES**					
5.1	Increase On-Farm Energy Production and Efficiency			Includes installation of solar or wind power; hydro-powered		Demand-side management (DSM) programs coming from KY Energy Strategy Energy

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				generators for irrigation; converting diesel farm equipment to LNG/CNG or hybrid technology; tractors with variable-speed transmissions.		Efficiency Resource Standard (EERS).
5.2	Organic Farming			Reductions occur via lower-intensity agricultural practices (nutrient/pesticide application, reduced tillage) and higher soil carbon. Net GHG benefits are likely to be specific to the particular cropping system and organic practices applied.		Need to consider higher costs of implementation.
5.3	Programs to Support Local Farming/Buy Local Programs			Reductions occur through lower transport-related emissions. Policy focuses on locally sourced foods for residential and institutional use.		
5.4	Promotion of Urban Agriculture			Includes community gardens and green roofs. Note that policies need to be sensitive to		

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				greenbelt taxing issues.		
5.5	Promotion of Farming Practices That Achieve GHG Benefits			Include sustainable agriculture practices, such as conversion of mechanized farm equipment to animal-powered farm equipment, and encourage appropriate-sized equipment.		
AFW-6	**FORESTRY— BIOMASS PROTECTION AND MANAGEMENT**					
6.1	Forest Protection—Reduced Clearing and Conversion to Non-forest Cover			Reductions depend on current rates of clearing. Relatively large amount of carbon can be protected per acre. Include improved markets for timber and non-timber forest products and payments for ecosystem services.		
6.2	Urban Forestry			Cost savings are possible if thinnings are directed to products and energy.		

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6.3	Reforestation of Understocked Forest Land			Can also be found in TLU-6.5.		
6.4	Afforestation and/or Restoration of Non-forested Land			Reductions depend on available land. Relatively high rate of carbon sequestration/ acre. Include previously mined surface mines and unforested riparian areas.		

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6.5	Forestry Management for Carbon Sequestration			Increased Stocking of Poorly Stocked Lands, Age Extension of Managed Stands, Thinning and Density Management of Managed Stands, Fertilization and Waste Recycling, Expanded Short-Rotation Woody Crops (for fiber and energy), Expanded Use of Genetically Preferred Species, Modified Biomass Removal Practices, Fire Management and Risk Reduction, Pest and Disease Management, Reforestation.		
6.6	Mitigation of Forest Carbon Sequestration Loss and Emissions Due to Wildfire			Note that over 90% of Kentucky's wildland fires are human-caused, 50% of which are deliberately set.		

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6.7	Mitigation of Forest Loss Due to Insects and Disease					
6.8	Silvicultural and Technological Improvements			Improving techniques and technologies to save energy and water.		Costs associated with improved harvesting technology may be prohibitive to many Kentucky loggers.
6.9	Wildlife Management to Encourage Vegetative Regeneration and Growth					New.
6.10	Reforestation of Active Mining Operations and Previously Reclaimed Mined Lands					Promote mine reforestation practices that (1) plant more high-value hardwood trees on reclaimed coal-mined lands in Appalachia; (2) increase the survival rates and growth rates of planted trees; and (3) expedite the establishment of forest habitat through natural succession. See Brief Descriptions document.
AFW-7	**FORESTRY—WOOD PRODUCTS AND WASTE**					
7.1	Improved Mill Waste Recovery—Utilization of Sawmill Residues and Emissions			Reductions depend on current levels of efficiency, which tend to be high. (Can be part of biomass-to-energy option TLU-1.1.)		KY Energy Strategy – Renewable Energy Strategy.
7.2	Improved Logging and Other Residue Recovery			Reductions depend on energy recovery and		The State Master Logger Program trains, educates, and

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				current levels of efficiency (e.g., removal of insect-damaged wood from managed areas). Encourage equipment improvements and Master Logger certification; establish markets for insect-damaged and low-quality wood; reduce timber theft.		certifies loggers in best practices.
7.3	Expanded Use of New, Reused, and Recycled Wood Products for Building Materials			Cost depends on relative prices of materials. Expanded use of state and locally grown wood products and GHG reductions depend on current levels of wood product imports and potential for reducing transport emissions.		A key need for implementing this policy is establishing an in-state marketplace that allows producers and buyers to find one another.
7.4	Promotion of In-state Forestry Products			Emphasis on products that come from certified forests and industries.		
AFW-8	**WASTE MANAGEMENT—WASTE MANAGEMENT STRATEGIES**					
8.1	Advanced MSW Reuse, Recycling, and Organic Waste			Use waste oils as energy feedstocks. (Can		

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	Management Programs			overlap with RCI options.) Include agricultural plastic waste (greenhouse plastic). Reuse of waste materials will lead to the highest GHG benefit and should be considered first.		
8.2	Expanded Use of MSW and Yard Waste Biomass Feedstocks for Electricity, Heat, and Steam Production					KY Energy Strategy – Renewable Energy Strategy.
8.3	Promotion of Bioreactor Technology			Bioreactors can be landfills managed to maximize methane generation over a short period of time (e.g., via leachate recycling).		KY Energy Strategy – Renewable Energy Strategy.
8.4	Source Reduction Strategies			Reduction of generation at the source cuts both landfill emissions and upstream production emissions.		

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8.5	Resource Management Contracting			Programs that compensate waste contractors based on performance in achieving waste-reduction goals, rather than the volume of waste disposed of.		
8.6	Waste Coal Recapture			Limited to states with waste coal resources.		KY Energy Strategy – Coal to Liquids Goal (8 CTL facilities by 2025).
8.7	Waste Management Feedstocks for Liquid/Gaseous Fuels Production for Stationary and Mobile Applications			e.g., use of MSW fiber for cellulosic ethanol production.		KY Energy Strategy – Biofuels Production Strategy (meet 20% of current demand by 2025 or 775 million gallons of use); also Gas Supply Strategy.
8.8	Industrial Waste Management Programs			Bourbon industry is an example.		
8.9	Utilization of Closed Landfills for Other Purposes			Use surface of closed landfills for development of greenfields.		
AFW-9	**WASTE MANAGEMENT—LANDFILL GAS STRATEGIES**					
9.1	Flare Landfill Methane at Non-NSPS (Smaller) Sites			Federal New Source Performance Standards (NSPS) and emission guidelines require methane capture at larger landfills. (Need to		

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				consider economics and energy needed to collect CH_4.)		
9.2	Methane and Biogas Energy Programs			Look at opportunities for digesters/energy utilization outside of the MSW sector. (Linked to AFW-1.7 [Manure Digesters] but directed at municipal/industrial waste streams.)		KY Energy Strategy – Renewable Energy Strategy.
9.3	Landfill Methane Energy Programs			Examples include methane conversion to motor fuels (LNG), electricity, steam, or space heat.		KY Energy Strategy – Renewable Energy Strategy. Five of these are already under development in the state; however, regulatory and legal barriers have limited the penetration of this option.
AFW-10	**WASTE MANAGEMENT—WASTEWATER ACTIVITIES**					
10.1	Energy Efficiency/Technology Improvements					DSM programs coming from KY Energy Strategy EERS.
10.2	Lower Wastewater Processing Needs			Lower water use and waste production lead to lower GHG emissions. Includes use of "reclaimed" water from wastewater treatment plants for use in green		

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				space irrigation.		
10.3	Install Digesters and Turbines or Engines			Reductions occur via methane control and offsetting fossil energy use.		KY Energy Strategy – Renewable Energy Strategy.
10.4	Wastewater Treatment Plant Biosolids for Energy Production					KY Energy Strategy – Renewable Energy Strategy.
10.5	Algae in Effluent and Bio-oils as an Energy Source					KY Energy Strategy – Biofuels Production Strategy (meet 20% of current demand by 2025 or 775 million gallons of use).
10.6	Utilization of Biosolids as a Fertilizer Substitute			May not be suitable for food crops. Public perceptions tend to be negative.		
10.7	Utilization of Stormwater Runoff for Green Space Irrigation					

CAFO = concentrated animal feeding operation; CCI = Cross-Cutting Issues; CH_4= methane; CNG = compressed natural gas; CTL = coal to liquid; DSM = demand-side management; EERS = Energy Efficiency Resource Standard; GHG = greenhouse gas; LNG = liquefied natural gas; MSW = municipal solid waste; N_2O = nitrous oxide; NSPS = new source performance standard; RCI = Residential, Commercial, and Industrial; TWG = Technical Work Group; VOC = volatile organic compound.