



**North Carolina**  
**Climate Action Plan Advisory Group**

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**Agriculture, Forestry, and Waste Management (AFW) Technical Work Group  
Catalog of State Climate Mitigation Options**

**Key to Rankings of Options in the Table that Follows:**

<b>Potential Emission Reductions <u>1/</u></b>	<b>Potential Cost or Cost Savings <u>1/ 2/</u></b>
<b>High (H):</b> At least 1 Million Metric Tons (MMT) carbon dioxide equivalent (CO <sub>2</sub> e) per year by 2020 (~1% of current NC emissions)	<b>High (H):</b> \$50 per Metric Ton CO <sub>2</sub> e (MTCO <sub>2</sub> e) or above
<b>Medium (M):</b> From 0.1 to 1 MMT CO <sub>2</sub> e per year by 2020	<b>Medium (M):</b> \$5-50/MTCO <sub>2</sub> e
<b>Low (L):</b> Less than 0.1 MMT CO <sub>2</sub> e per year by 2020, or 1 MMT CO <sub>2</sub> e by 2050	<b>Low (L):</b> Less than \$5/MTCO <sub>2</sub> e
<b>Uncertain (U):</b> Not able to estimate at this time	<b>Uncertain (U):</b> Not able to estimate at this time
<u>1/</u> Several measures may overlap in terms of emissions reductions and/or cost impacts. Estimates assume measures would be implemented independently from other measures.	
<u>2/</u> 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.

\* 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 North Carolina.

\*\* Options marked with a double asterisk (\*\*) indicate options that are included as recommendations in the September 1, 2005 NC DENR Report under the Clean Smokestacks Act of 2002.

**AFW**

Option No.	GHG Reduction Policy Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
<b>AFW-1 Agriculture – Production of Fuels and Electricity</b>						
1.1	Manure Digesters/Other Waste Energy Utilization		Medium	Neg to Low	<ul style="list-style-type: none"> <li>• Linked with Option AFW2.2 below</li> </ul>	<ul style="list-style-type: none"> <li>• Hog farms a likely focus in NC; Poultry also important.</li> <li>• Recent proposed projects to incorporate this option with ethanol production (e.g. beef feedlots) in other states.</li> <li>• Includes manure combustion for energy recovery</li> </ul>
1.2	Biodiesel Production (incentives for feedstocks and production plants)		Medium	Med to High	<ul style="list-style-type: none"> <li>• Production from both virgin and waste vegetable oils</li> </ul>	
1.3	Biomass Feedstocks for Electricity or Steam Production		Medium	Neg to Low	<ul style="list-style-type: none"> <li>• Need to identify viable feedstocks and volumes [e.g., crop residue (wheat straw, corn stover) or energy crops (switchgrass)]</li> </ul>	<ul style="list-style-type: none"> <li>• Linkage to Energy Supply TWG to determine availability of biomass plants</li> <li>• Linkage to RCI TWG to identify available capacity for biomass generated steam</li> </ul>

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1.4	Ethanol Production (incentives for production plants)		Medium	Med to High	<ul style="list-style-type: none"> <li>Starch- (e.g. corn-) and cellulosic production processes.</li> </ul>	<ul style="list-style-type: none"> <li>Starch-based ethanol has small GHG benefits, while cellulosic ethanol has much higher benefits due to the energy required for ethanol production</li> </ul>
1.5	Algaculture Incentives (production of biodiesel from algae)		?	?	<ul style="list-style-type: none"> <li>No commercial-scale facilities currently exist.</li> </ul>	<ul style="list-style-type: none"> <li>Lab and field studies have estimated high energy return on investment yields</li> <li>Potentially could be used in conjunction with power plants to reduce CO<sub>2</sub> and NO<sub>x</sub>; or with water treatment facilities where waste is used as algal nutrients</li> </ul>
<b>AFW-2 Agriculture – Fertilizer and Manure Management</b>						
2.1	Nutrient Management (improve efficiency of fertilizer use)		Medium	Low	<ul style="list-style-type: none"> <li>Significant opportunities beyond current practice?</li> </ul>	
2.2	Manure Management (improve application methods)		Medium	?	<ul style="list-style-type: none"> <li>Linked with Option AFW1.1 above and 2.1, 2.3 below.</li> <li>Co-benefits include reduction of ammonia and VOC emissions.</li> </ul>	<ul style="list-style-type: none"> <li>Application improvement includes incorporation into soil, instead of surface spray/spreading.</li> </ul>
2.3	Manure Composting		Low	?	<ul style="list-style-type: none"> <li>Potentially most feasible in the poultry, dairy or beef cattle sectors.</li> </ul>	<ul style="list-style-type: none"> <li>Potential for reduction in CH<sub>4</sub> emissions.</li> </ul>
2.4	Change Feedstocks (optimize nitrogen for N <sub>2</sub> O reduction)		Low to Medium	Low	<ul style="list-style-type: none"> <li>Co-benefits include reduction in ammonia emissions.</li> </ul>	<ul style="list-style-type: none"> <li>Option includes supplements to reduce CH<sub>4</sub> from enteric fermentation, as well as nitrogen efficiency to reduce downstream N<sub>2</sub>O.</li> </ul>

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2.5	Reduce Non-Farm (Residential and Commercial) Fertilizer Use		Low	?	<ul style="list-style-type: none"> <li>Emissions from non-farm application are not currently in the inventory; unclear what the reductions and costs would be.</li> </ul>	<ul style="list-style-type: none"> <li>Additional research needed on the levels of N2O emissions from lawns, golf courses, etc.</li> </ul>
2.6	Using Bio-char as Soil Amendment		?	?	<ul style="list-style-type: none"> <li>Increase soil productivity and soil carbon storage</li> </ul>	<ul style="list-style-type: none"> <li>Need information on the sources of bio-char and its impacts.</li> </ul>
<b>AFW-3 Agriculture – Soil Carbon Management</b>						
3.1	Conservation Tillage/No-Till (carbon sequestration and reduced energy use)		Medium	Low	<ul style="list-style-type: none"> <li>Significant opportunities beyond current practice?</li> </ul>	<ul style="list-style-type: none"> <li>Need estimates on current practices/potential for increased acreage.</li> </ul>
3.2	Reduce Summer Fallow (increase soil C content, reduce N <sub>2</sub> O emissions)		?	?	<ul style="list-style-type: none"> <li>Significant opportunities beyond current practice?</li> </ul>	<ul style="list-style-type: none"> <li>Need estimates of fallow summer acreage</li> </ul>
3.3	Increase Winter Cover Crops (increase soil C content, increase soil N content)		?	?	<ul style="list-style-type: none"> <li>Significant opportunities beyond current practice?</li> </ul>	<ul style="list-style-type: none"> <li>Need estimates of winter acreage available for cover crops</li> </ul>
3.4	Improve Water and Nutrient Use (to minimize soil C loss)		Low	Low	<ul style="list-style-type: none"> <li>Significant opportunities beyond current practice?</li> </ul>	
3.5	Rotational Grazing/Improve Grazing Crops and/or Management		Low	Low	<ul style="list-style-type: none"> <li>Is impaired rangeland an issue in NC?</li> </ul>	
3.6	(Additional option, if/as suggested)					
<b>AFW-4 Agriculture – Land Use Change</b>						
4.1	Convert Land to Grassland or Forest		Medium	?		<ul style="list-style-type: none"> <li>Need estimates of marginal agricultural land with the potential for conversion.</li> <li>“Current Use Valuation” Law</li> </ul>
4.2	Preserve Open Space/Agricultural Land		High	?	<ul style="list-style-type: none"> <li>Reductions occur both from higher retention of carbon in soil and lower transportation activity.</li> </ul>	

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4.3	Promote "No Net Loss" of Agricultural Land		High	?	<ul style="list-style-type: none"> <li>Reductions occur both from higher retention of carbon in soil and lower transportation activity.</li> </ul>	<ul style="list-style-type: none"> <li>"Current Use Valuation" Law</li> </ul>
<b>AFW-5 Agriculture – Farming Practices</b>						
5.1	Convert Diesel Farm Equipment to LNG/CNG, Hybrid Technology		Low	Med to High	<ul style="list-style-type: none"> <li>LNG/CNG engines or engine conversions reduce BC emissions</li> <li>Availability of diesel hybrid equipment for farm applications?</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
5.2	Programs to Support Organic Farming		Medium	Low	<ul style="list-style-type: none"> <li>Reductions occur via lower intensity agricultural practices (nutrient/pesticide application, reduced tillage)</li> </ul>	<ul style="list-style-type: none"> <li>Weed management</li> <li>Transgenic crops</li> <li>Integrated pest management</li> <li>Bed/row size or spacing</li> <li>Application efficiencies (low volume sprayers, etc.)</li> </ul>
5.3	Programs to Support Local Farming/Buy Local		Low - Med	?	<ul style="list-style-type: none"> <li>Reductions occur through lower transport related emissions.</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
5.4	Programs to Encourage Local Oilseed Pressing for Bio-diesel Production and Use as Farm Equipment Fuel		Low	?	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
5.5	Policies to Promote On-Farm Bio-diesel Use		Low - Med	?	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Linkage to 5.4</li> </ul>
5.6	Promotion of Less-Centralized Processing and Storage Infrastructure for Ag. Products and Commodities		Low - Med	?	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Linkage to 5.3</li> </ul>
5.7	Policies to Encourage Use of Rail and Water Transportation by Agriculture		Low - Med	?	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Linkage to 5.3</li> </ul>
5.8	Increase Number of Farm Production/Market Facilities Around Population Centers		Low - Med	?	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Linkage to 5.3</li> </ul>

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5.9	Programs to Support Buying Local Agricultural Products		Low-Med	?	<ul style="list-style-type: none"> <li>GHG reductions occur through lower transportation emissions.</li> </ul>	<ul style="list-style-type: none"> <li>Note relationship to Option 5.3 above.</li> </ul>
<b>AFW-6 Forestry – Biomass Protection and Management</b>						
6.1	Forest Protection – Reduced Clearing and Conversion to Nonforest Cover		High	Low	<ul style="list-style-type: none"> <li>Depends on business as usual rates of land clearing and viable alternatives</li> </ul>	<ul style="list-style-type: none"> <li>“Current Use Valuation” Law</li> </ul>
6.2	Increase Maintenance of Urban and Residential Trees		Low	Low to high	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.3	Afforestation and/or Restoration of Nonforested Lands		Low to high	Low	<ul style="list-style-type: none"> <li>depends on available acreage and risk</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.4	Reforestation/Restoration of Managed Stands		Low to high	Low	<ul style="list-style-type: none"> <li>depends on available acreage and risk</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.5	Increased Stocking of Poorly Stocked Lands		Low to high	Low	<ul style="list-style-type: none"> <li>depends on available acreage and risk</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.6	Age Extension of Managed Stands		Low	Low to high	<ul style="list-style-type: none"> <li>involves significant tradeoffs with carbon savings from harvested wood products, as well as ecological risk</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.7	Thinning and Density Management of Managed Stands		High	Low to high	<ul style="list-style-type: none"> <li>cost and technology barriers to market use of harvested biomass may be high; supply potential is high</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.8	Fertilization and Waste Recycling		Low	Low to high	<ul style="list-style-type: none"> <li>site and situation specific</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.9	Expand Short Rotation Woody Crops (for fiber and energy)		Low to medium	Low to high	<ul style="list-style-type: none"> <li>depends on available acreage and market demand</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.10	Expanded Use of Genetically Preferred Species		Low	Low	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>

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6.11	Modified Biomass Removal Practices (reduced decay and energy use)		Low	?	<ul style="list-style-type: none"> <li>may be opportunities to use biofuels for equipment</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.12	Fire Management and Risk Reduction Programs		High	Low to high	<ul style="list-style-type: none"> <li>implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.13	Ecosystem Health Risk Reduction Programs (pest/disease, invasive species)		High	Low to high	<ul style="list-style-type: none"> <li>implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.14	Drought Management Programs (tree selection, placement, protection)		High	Low to high	<ul style="list-style-type: none"> <li>implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.15	Flood and Riparian Management Programs (tree selection, placement, protection)		Low	Low to high	<ul style="list-style-type: none"> <li>depends on available acreage</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.16	Watershed Management Programs (stand retention, enhancement and management)		Low to high	Low to high	<ul style="list-style-type: none"> <li>depends on available acreage and forest health issues</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
6.17	Habitat Management Programs (stand retention, enhancement and management)		Low to high	Low to high	<ul style="list-style-type: none"> <li>depends on available acreage and forest health issues</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>

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6.18	Policies to Promote Forest Soil Carbon Management/Build-up		?	?	• note an element of this option can be the protection of carbon found in wetlands/ marshes (C losses from peat, following drainage)	•
6.19	Application of Waste to Forested Lands		?	?	•	•
6.20	Restoration of Diverse Forest Systems		?	?	• option targets forest systems that are not managed by federal or state agencies.	• Linkage to Option 6.4
<b>AFW-7 Forestry - Wood Products and Waste</b>						
7.1	Improved Mill Waste Recovery		Low to high	Low to high	• technology and market dependent	•
7.2	Improved Logging Residue Recovery		High	Low to high	• technology and market dependent	•
7.3	Expanded Use of Wood Products for Building Materials		Med to High	Low to high	• technology and market dependent	• Supplant use of non-wood products (e.g. steel, cement) with wood products, where possible.
7.4	Expanded Use of State and Locally-Grown Wood Products		Low to high	Low to high	• technology and market dependent	• Reduces transportation-related emissions and embedded energy.
7.5	Promotion of Integrated Biorefinery Processes		?	?	•	•
<b>AFW-8 Forestry – Energy Production</b>						
8.1	Expanded Use of Forest Biomass Feedstocks for Electricity (fuel switching)		High	Low	• technology and market dependent	•
8.2	Expanded Use of Forest Biomass Feedstocks for Residential, Commercial/Institutional, or Industrial Heating		High	Low	•	•

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8.3	Improved Efficiency of Wood Burning Stoves and Direct Heat		Low to Medium	?	•	•
8.4	Improved Energy Capture from Wood Waste Combustion		Low to high	?	• technology and market dependent	•
8.5	Improved Commercialization of Biomass Gasification and Combined Cycle		Low to high	Med to High	• requires improved technology and market incentives	•
8.6	Promote Cellulosic Ethanol Production		Med to High	Med	•	•
<b>AFW-9 Waste Management – Waste Management Strategies</b>						
9.1	Advanced Recycling and Composting		Low	Low	•	•
9.2	Advanced Municipal Solid Waste Management Practices (e.g., bioreactors)		Low to Med	Neg to Low	•	•
9.3	Source Reduction Strategies		Low	Low	•	•
9.4	Resource Management Contracting		?	?	•	•
9.5	Manure Digesters		Med	Neg to Low	•	• Also under Agriculture (Option AFW1.1)
9.6	Increased Collection of Recyclables		?	?	•	•
9.7	Increased Marketing of Recyclable Materials and Products		?	?	•	•
<b>AFW-10 Waste Management – Landfill Gas Strategies</b>						
10.1	Flare Landfill Methane at non-NSPS (smaller) sites		Low	Med to High	• 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 CH <sub>4</sub> .
10.2	Methane and Biogas Energy Programs (Waste Water Processes)		Low to Med	Neg to Med	• Methane conversion to motor fuels, electricity, steam, or space heat are examples	• This option covers methane from waste water treatment, while 10.3 covers landfills.

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10.3	Convert Landfill Methane to Electric Power, Space Heat, or LNG		Low to Med	Neg to Low	•	•
<b>AFW-11 Waste Management – Wastewater Activities</b>						
11.1	Energy Efficiency Improvements		Low	Neg to Low	•	•
11.2	Lower Waste Processing Needs (lower water consumption, waste production)		Low	?	•	•
11.3	Install Digesters and Turbines		Low to Med	?	•	•
11.4	Install Fuel Cells		Low to Med	?	•	•