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Agriculture, Forestry, and Waste Management Technical Work Group

Summary List of Pending Policy Options for Analysis

	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2025 (Million $)	Cost-Effectiveness ($/tCO_2e)	Status of Option
		2010	2025	Total 2007-2025			
AFW-1	Agricultural Crop Management	*Not Quantified*					Pending
AFW-2	Land Use Management Approaches for Protection and Enrichment of Soil Carbon *(TLU-1)*	*Not Quantified*					Pending
AFW-3	In-State Liquid Biofuels Production *(TLU-3)*	*Not Quantified*					Pending
AFW-4	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production *(ES-2)*	*Not Quantified*					Pending
AFW-5	Forestry Management Programs to Enhance GHG Benefits	*Not Quantified*					Pending
AFW-6	Forest Protection – Reduced Clearing and Conversion to Nonforest Cover	*Not Quantified*					Pending
AFW-7	Integrated Waste Management	*Not Quantified*					Pending
AFW-8	End of Use Waste Management Practices	*Not Quantified*					Pending

AFW-1. Agricultural Crop Management

Policy Description

This option addresses both agricultural soil carbon management as well as nutrient management to achieve greenhouse gas (GHG) benefits. For soil carbon management, conservation-oriented management of agricultural lands, cropping systems, crop management, and agricultural practices can regulate the net flux of carbon dioxide (CO_2) from soil. Each farm operation and each field management unit has unique traits that allow management practices to influence nutrient, water and carbon cycling and sequestration. Defining GHG outcomes based upon management indices will allow farmers to incorporate management practices within their specific operational needs to meet desired GHG goals. Providing cropping and management flexibility within each field or tract management unit allows both production goals and [carbon] resource management goals to be transparent and readily-valued.

The efficient use of agricultural fertilizer, both commercial and animal-based, can be improved through certain management practices and systems. An example is over application of nitrogen that can result in nitrogen not being fully metabolized by plants. This is important because free nitrogen can leach into groundwater and/or be emitted to the atmosphere as nitrous oxide (N2O). Better nutrient utilization can lead to lower nitrous oxide emissions from run-off. An example is tile drainage systems that use the latest technology and design models to reduce nitrates leaching into surface water and groundwater.

Policy Design

Goals: *Soil Carbon Management:* No-till, strip till, other conservation farming practices, or other cropping management practices that achieve similar soil carbon benefits will account for 33% of all annual crop production in Minnesota.

Nutrient Management: 100% of all commercial- and animal-based fertilizer will be applied by use of global positioning system-based (GPS-based), variable rate technology to reduce nitrogen application emissions or other methods and processes that obtain similar GHG benefits. One example is the product N-Serve added to anhydrous ammonia to stabilize fall and spring applied nitrogen.

Timing: *Soil Carbon Management:* By 2012, no-till, strip till or other conservation farming practices that reduce GHG emissions and increase soil carbon sequestration will account for 15% of all annual crop production in Minnesota or manage cropping systems to achieve similar outcomes. By 2025, the full goal will be achieved.

Nutrient Management: By 2012, 60% of all commercial- and animal-based fertilizer will be applied by use of GPS-based, variable rate technology to reduce GHG emissions or other methods and processes that obtain similar outcomes. By 2025, the full goal will be achieved.

Parties Involved: SWCD, NRCS, MDA, U of MN, FSA, and Agriculture Organizations

Other: Research and incentives will be needed to help farmers convert current farming practices over to no-till, strip till or other conservation farming practices. These practices will reduce GHG

emissions and increase soil carbon sequestration. Research will be used to develop methods to efficiently and effectively determine outcomes.
Research and incentives will be needed to speed adoption of GPS based technologies and to develop outcome-based and performance-based methods. Research will be needed to determine the best management practices of animal and commercial based fertilizer. Encouraging incorporation of livestock manure to reduce GHG emissions and possible run-off issues is an example of best management practices for livestock produces.

Implementation Mechanisms

- Develop GHG outcome-based indices to identify the greatest sequestration capacity by individual management field or tract.
- Fund research and development of farming practices and cropping systems that increase carbon input (e.g., reversion to native vegetation, setting agricultural land aside as grassland, improved crop rotations, yield enhancement measures, organic amendments, cover crops, improved irrigation practice) or decrease carbon output (e.g., proper tillage methods) while maintaining crop yield so that GHG emissions are reduced.
- Evaluate and implement economical agricultural practices that maintain a primary income source from crop production or that might become a primary income source from land set-asides.
- Evaluate and implement economical mechanisms that might affect crop choice (support payments, crop insurance, disaster relief) and farmland preservation (conservation easement, use value taxation, agricultural zoning) as incentives to increase carbon stock of agricultural soil.
- Document environmental co-benefits of carbon sequestration practices such as soil fertility, soil buffering capacity, pesticide immobilization, reduced energy for field operation, enhanced water infiltration, prevention of wind and water erosion, and improved fertilizer management.

TWG comments: Flexible outcome-based measures will give farmers the ability to use various management methods and practices.
Recommend a strong research and development component.
Suggestion from TWG: Management outcomes could be used with indices rather than practice-based approaches (i.e. energy consumption indices and nutrient indices related to carbon).

Related Policies/Programs in Place

Blue Earth River Basin Initiative ran a project called the Third Crop Initiative. This initiative aims to replace annual crops with perennial crops.

Types(s) of GHG Reductions

- N_2O: reductions occur when nitrogen run-off and leaching are reduced, which leads to the formation and emission of N_2O.

- CO_2: reductions occur as soil carbon levels in crop soils are increased above business as usual levels. Increasing the levels of carbon in soils indirectly sequesters carbon from the atmosphere.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]

  1.1 Reference Abstract: Tristram O. West and Gregg Marland, *Net carbon flux from agriculture: Carbon emissions, carbon sequestration, crop yield, and land-use change,* Biogeochemistry, Volume 63, Number 1, April, 2003.

  1.2 Reference: Draft Document; The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and Implications for the Global Carbon Cycle, Synthesis and Assessment Product 2.2, Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Edited by the Scientific Coordination Team: Anthony W. King (Lead), Lisa Dilling (Co-Lead), Gregory P. Zimmerman (Project Coordinator), David M. Fairman, Richard A. Houghton, Gregg H. Marland, Adam Z. Rose, and Thomas J. Wilbanks, March 2007

  1.3 1.3 Minnesota Draft Inventory and Forecast. Appendix F. Agriculture, Minnesota Pollution Control Agency and Center for Climate Strategies, July 2007.

- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

TWG Suggestion: IPCC prioritizes N_2O management as high, with important water quality benefits.

Feasibility Issues

1.1 If changes in management result in decreased crop yields, the net carbon flux can be greater under the new system, assuming that crop demand remains the same and additional lands are brought into production. Conversely, if increasing crop yields lead to land abandonment, the overall carbon savings from changes in management will be greater than when soil carbon sequestration alone is considered.

1.2 Options to increase carbon can be implemented in the short-term, but the amount of carbon sequestered typically is low initially then rising for a number of years before tapering off again as the total potential is achieved. There is also a significant risk that the carbon sequestered may be released again by natural phenomena or human activities.

Practices for conserving carbon affect emissions of other greenhouse gases. Of particular importance is the interaction of carbon sequestration with N2O emission because N2O is such a potent greenhouse gas. In some environs, carbon-sequestration practices, such as reduced tillage, can stimulate N2O emissions thereby offsetting part of the benefit. Elsewhere, carbon-conserving practices may suppress N2O emissions, amplifying the net benefit. Similarly, carbon-sequestration practices might affect emissions of methane (CH_4) if the practice, such as increased use of forages in rotations, leads to higher livestock numbers. Policies designed to suppress emission of one greenhouse gas need to also consider complex interactions to ensure that net emissions of total greenhouse gases are reduced.

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

AFW-2. Land Use Management Approaches for Protection and Enrichment of Soil Carbon

Policy Description

Convert marginal or sensitive agricultural land with an immediate history of use for annual crop production to permanent cover such as grassland/rangeland, orchard, or forest on land that was formerly forested, where the soil carbon and/or carbon in biomass is substantially higher under the new land use. Includes opportunities to keep CRP, CREP and RIM lands in well-managed, continual cover, while also providing opportunities for working lands to increase carbon sequestration through biomass production that can provide feedstocks for in-state bioenergy production.

Incentives need to be created to convert annual row crop acres to perennial crops that prevent these acres from either returning to conventionally-tilled production or to suburban/urban development. Incentives also need to be created for promoting carbon sequestration goals on public lands and lands enrolled in existing conservation programs. Finally, research should be conducted and programs adopted to identify and eliminate threats to the vast carbon pools currently stored in lands that hold high levels of soil organic carbon, such as peatlands and wetlands.

Finally, research and increased management of the vast carbon pools stored in wetlands and peatlands is critical. A high percentage of all carbon stored in Minnesota is in wetlands and peatlands. Efforts are needed to protect these carbon reservoirs from the impacts of warmer and drier conditions and increased fire risk. Efforts should include identification of wetlands and peatlands at risk of re-emitting sequestered carbon dioxide and methane. Additional study is needed to understand greenhouse gas dynamics in the full range of wetland types in Minnesota and to apply this understanding to the state's wetlands conservation policies.

Policy Design

Goals: *Agricultural Land Protection*- Protect X acres of lands in natural cover and/or existing conservation programs that would have been converted to intensive agricultural production or urban/suburban development.

Perennial Production on Working Lands- By 2025, expand the Reinvest in Minnesota – Clean Energy (RIM-CE) program land to 200,000 acres.

Protection of Peatlands & Wetlands- Protect or restore northern peatlands and other wetlands to prevent releases of greenhouse gases and fire. The TWG is not comfortable presenting numeric goals at this time. Please see alternative goals under "Protection of Peatlands & Wetlands" below.

Timing:

- *Agricultural Land Protection*- Protect X acres of lands in natural cover and/or existing conservation programs that would have been converted to intensive agricultural production by 2015. Achieve the full goal by 2025. The goal could be met in whole or in part by: increasing the amount of privately held high carbon value lands in land protection programs by 10% by 2015, and by 25% by 2025; and making carbon sequestration an additional management priority for 25% of publicly held and managed lands in Minnesota by 2025.

  Perennial Production on Working Lands- By 2015, 20,000 acres of land should be established and/or producing low-carbon perennial energy crops in Minnesota. Achieve the full goal by 2025.

  Protection of Peatlands & Wetlands- By 2012, identify peatlands at risk of releasing greenhouse gases because of lowered water tables, fire potential, or industrial uses (horticulture, sod-farming, or mining). By 2012, initiate research program on fire potential and management in peatlands. By 2012, develop carbon management standards for wetlands and peatlands. By 2025, raise water table elevations as high as practicable on degraded peatlands and/or plant with appropriate forest species.

Parties Involved: Board of Soil and Water Resources, Department of Natural Resources, University researchers, Rural Advantage, AURI, Minnesota Waterfowl Association, Delta Waterfowl, Ducks Unlimited, Izaak Walton League of America, Institute for Agriculture and Trade Policy, Land Stewardship Project, Minnesota Project, Farmers Union..

Other: ***Agricultural Land Protection:*** This policy would create a program to provide additional tax incentives for landowners donating development rights as part of an easement transaction for the carbon storage value of their land. These programs need to be assessed for their carbon sequestration benefit. Management strategies need to assure that the original goals and public values (water quality, soil conservation, and wildlife habitat) are not diminished as carbon sequestration goals are met.

This option can assist with the promotion of the goals of AFW-3 and AFW-4, by providing some incidental biomass for bioenergy and biofuel production, but these lands should not be viewed as primary biomass sources. Federal and state managed and contracted lands (including federal wildlife refuges, DNR wildlife management areas, state forest lands, national and state park areas, BLM lands, national forests and grasslands, and CRP, CREP and RIM acres) are managed for a variety of purposes and under many state and federal laws, and in many instances these purposes could include carbon sequestration. Most public lands, and all CRP, CREP, and RIM lands, are managed at least in part to preserve the public's interest in their non-commodity values, mainly water quality improvement, soil conservation, and wildlife habitat.

At present, the carbon storage value of lands protected is an uncompensated additional benefit that comes with the open space and wildlife habitat protection values of protecting lands. Moreover, there are clear examples of public lands being managed in ways that are counterproductive or simply squander natural carbon sequestration and detention potentials of the land. Additional incentives that monetize stored carbon and changes in carbon storage on the land, over and above existing compensation for retiring development and production rights, would increase acreage of high carbon value lands that are managed for carbon sequestration, and compensate landowners for the additional societal benefit of avoided carbon emissions.

Perennial Production on Working Lands: While protection of existing perennial production on conservation and public lands is necessary, the vast majority of agricultural land is currently used intensively to produce annual crops that have minimal ability to sequester carbon over the long term. Programs to encourage production of perennial crops on acres currently in agricultural production must be funded and expanded quickly.

The RIM-CE program should be fully funded in 2008. This program is a working lands program for bioenergy production that was established in the 2007 Minnesota legislative session. It provides long-terms easements and training to farmers who want to begin growing next generation energy crops, such as diverse native prairie or monocultures of native species such as switchgrass, for sale to facilities needing the crops for heat, power and transportation fuel production. Tiered payments are made based on increased levels of public benefits, specifically carbon sequestration in the deep root systems of diverse native perennial grassland plantings, improvements to water quality, and improved wildlife habitat. After a short lead time for establishment of the crops, we will begin reaping the benefits as each acre sequesters carbon below ground while producing harvestable biomass fuels above ground. This will jumpstart the production of energy crops in the state, providing some of the feedstocks to meet the goals outlined in AFW-3 and AFW-4.

Protection of Peatlands & Wetlands: Wetlands have among the highest potential carbon sequestration capacities for any type of land use in Minnesota. Peatlands are likely Minnesota's largest single carbon sink containing 37% of all carbon stored in the state compared to 3% stored in the state's forests. Protecting these enormous carbon reservoirs from the impacts of warmer and drier conditions and increased fire risk is critical. Early attention should be given to identifying degraded peatlands at risk of re-emitting sequestered carbon dioxide and methane. Additional study is needed to understand greenhouse gas dynamics in the full range of wetland types in Minnesota and management options to reduce the risk of catastrophic releases of stored greenhouse gases from these systems.

Policies need to be designed that assure protection of peatland and wetlands from drainage and other carbon-releasing land uses. Additional research must be done to evaluate their contribution to carbon sequestration and long-term storage. In particular, policies should:

1. Identify areas where significant peatland carbon stocks are in danger of being oxidized by drainage infrastructure. Evaluate and conduct hydrologic or vegetation management, including afforestation with appropriate forest species.
2. Evaluate GHG impacts of horticulture, sod farming, and energy production on peatlands and develop standards to protect carbon stocks.
3. Protect carbon stocks in freshwater mineral wetlands. Support development of scientific understanding and management options for GHGs associated with mineral wetlands.
4. Initiate serious research program of the fire potential and management in peatlands.

Implementation Mechanisms

TBD – [CCS drafts based on TWG inputs; this can be developed as they go along, and can start early or late as they prefer; the level of detail can vary on TWG approval]

Related Policies/Programs in Place

Minnesota has invested significantly in preservation and restoration of significant conservation lands -including forests, prairies, and wetlands. The Minnesota DNR owns and manages over 1.1 million acres of public conservation lands in addition to the state forestland. In addition, the State of Minnesota holds long term conservation easements on nearly 200,000 acres of privately owned lands. Restoration and management strategies for these lands focus on restoring diverse native plant communities, which are shown to be very productive in the sequestration of carbon.

In 1991, Minnesota established one of the most sweeping wetlands protection laws in the country: the Wetland Conservation act. With a goal of no-net-loss of wetlands, the Wetland Conservation Act requires anyone proposing to drain, fill, or excavate a wetland first try to avoid disturbing the wetland; second, to try to minimize any impact on the wetland; and, finally, to replace any lost wetland acres, functions, and values.

Types(s) of GHG Reductions

- **CO_2:** Conservation of agricultural lands retains the ability of the land to sequester carbon in soil and biomass. Also, emissions are indirectly reduced to the extent that development patterns are influenced and vehicle miles traveled (VMT) are reduced (see TLU Option 1).

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

AFW-3. In-State Liquid Biofuels Production

Policy Description

Promote sustainable in-state production and consumption of transportation biofuels from agriculture and/or agroforestry feedstocks to displace the use of gasoline and diesel. Decrease the use of fossil fuel in the production of these biofuels, which will improve the GHG profile of in-state liquid biofuels production and consumption. Sustainability standards also need to be developed for low-carbon biofuels, so that producers are rewarded accordingly.

Promote the in-state development of feedstocks, such as cellulosic material and perennials that are able to be utilized. Realize that conversion technologies, such as thermo-chemical Fischer Tropsch processes and enzymatic conversion, are developing fast in this sector, so facilitate their development but not be prescriptive.

Promote multiple biofuel (ethanol, biodiesel, biobutanol) production systems that improve the embedded energy content, life cycle, and carbon profile of biofuels. Focus on plant material feedstocks that favor energy production and are carbon neutral or negative and have multiple other positive environmental benefits, such as maintaining carbon sequestration potential and soil productivity, and decreasing water and fossil fuel inputs in their production.

It is understood that promoting biofuel production must be coupled with strong policies to reduce overall transportation fuel consumption if true gains in reducing greenhouse gases is to be achieved. Upon successful implementation of this policy, MN consumption of biofuels produced in-state will produce better GHG benefits than these same fuels obtained from a national market due to lower embedded CO_2 (due to out of state fuels produced using feedstocks/production methods with lower GHG benefits; and transportation of biodiesel, ethanol, other fuels, or their feedstocks from distant sources).

Note: This option is linked with TLU Option 3 on Biofuels and the ES Option 2 on a Low Carbon Fuels Standard. This option seeks to achieve incremental GHG benefits beyond the TLU option by promoting in-state production of biofuels using feedstocks with greater GHG benefits than the likely business as usual national production methods.

Policy Design

Goal: *Lower the carbon content of ethanol produced from existing plants:* Produce 80% of thermal heat consumed by ethanol facilities by biomass or other renewable energy sources. Also, 80% of electricity consumed by ethanol facilities should come from biomass or other renewable sources. The goal of this policy design is to decrease the use of fossil fuel in the production of Minnesota biofuels by using biomass for the heat and power inputs into biofuel production facilities. A technology that could achieve both goals is biomass gasification, which is currently available.

Gasoline displacement goals: By 2025, 50% of the gasoline consumed in the state will be replaced by biofuels using GHG superior feedstocks and conversion processes.*

Fossil diesel displacement goals: By 2025, 10% of the fossil diesel consumed in the state will by replaced by biodiesel produced using feedstocks and conversion processes that are superior to today's conventional sources.

Timing: *Lower the carbon content of ethanol produced from existing plants:* By 2012, 100% of the thermal heat used in ethanol facilities will be produced from biomass or other renewable energy; by 2017, 100% the electrical power consumed by ethanol facilities will produced from biomass or other renewable energy.

Ethanol production goals:

Biodiesel production goals:

Parties Involved: Ethanol facilities, Department of Commerce, Department of Agriculture, Next Generation Energy Board, engineering firms, forest products industry, agriculture production groups, sustainable agriculture groups, conservation and renewable energy nonprofits, those currently developing standards (i.e. Forest Resource Council, Board of Water and Soil Resources)

Other: Current State policy for fossil diesel displacement is 2% biodiesel blend. For gasoline displacement, current policy is 20% displacement by 2013. Current petroleum displacement goal is 20% of the liquid fuel sold in the State will come from renewable sources by the year 2015 and 25% by 2025. This new policy would need to be coupled with strong reductions in fossil gasoline/diesel consumption demand out to 2025 and E85 vehicle/infrastructure.

Money related to capital conversion for certain near-term technologies, such as gasifiers, may need to be allotted. A certification process to acknowledge that Minnesota-produced biofuels have lower carbon footprints (i.e. for future Minnesota, California and potentially national LCFS markets) is needed. Incentives for planting crops that have a low carbon profile that can be used as boiler fuel should be enacted (i.e. RIM-CE program).

Note the linkage to the TLU option for establishing a low carbon fuel standard (LCFS) that will stimulate the biofuels production envisioned by this option, as well as innovation and investment in biofuel production technologies. Promote efficiency and low carbon feedstocks/fuel inputs in biofuels production facilities, and increase demand for biofuels blending in transportation fuel production processes. Either within AFW or TLU, policies should address labeling and certification to verify low and zero-carbon biofuel players should be implemented, which will allow for a sound low-carbon fuels market to be developed locally and nationally. Any Minnesota based fuel standard/certification process should be able to easily integrate into the emerging California, federal (EPA) and European LCFS as well as any tax or cap regimes established for Minnesota and the Upper Midwest.

Note the linkage to AFW-2 on funding the Reinvest in Minnesota – Clean Energy (RIM-CE) program (200,000 acres growing low-carbon energy crops by 2025). This program is a working lands program for bioenergy production that was established in the 2007 legislature. It provides long-term easements and training to farmers who want to begin growing next generation energy crops such as switchgrass and other diverse prairie grasses for sale to facilities needing the crops for heat and power (gasifiers). Tiered payments are made based on increased levels of public benefits such as carbon storage in the roots, improvements to water quality/use and wildlife habitat. We need to begin getting these energy crops in the ground and farmers trained on how to grow them, especially since there is a lead time for establishment of the crops. Getting started on that now will set the stage for utilizing the energy crops for biofuels in the coming years as well as link to goals outlined in AFW-1 and AFW-2.

Implementation Mechanisms

TBD – [CCS drafts based on TWG inputs; this can be developed as they go along, and can start early or late as they prefer; the level of detail can vary on TWG approval]

TWG Suggestion: *A low-carbon index or biofuels production should be incorporated, along with feedstock sustainability standards.* By 2012, a life-cycle certification/labeling process for low-carbon fuels should be implemented (either through MN-specific or adoption of regional/national standards) that credits biofuels for varying reductions in their carbon intensity, ranging from 25-100%.

Related Policies/Programs in Place

Ethanol: Minnesota established an ethanol production incentive to provide payment to producers to help develop a new market for Minnesota's agricultural products. On the market side, Minnesota requires that all gasoline sold in the state be blended with a 20% ethanol mix by 2013. Of this, there is a state goal that a quarter of the RFS will come from cellulosic derived biofuel by 2015, or when 60,000,000 gallons comes online, whichever is first. In addition, Minnesota began efforts in 1997 to develop a network of fueling stations for flex fuel vehicles that could run on an 85% ethanol blend.

Biodiesel: According the U.S. Department of Energy, biodiesel has the most favorable energy balance of any currently commercially viable transportation fuel. For every unit of energy needed to produce a gallon of biodiesel, 3.2 units of energy are gained. As of September 29, 2005, Minnesota requires nearly all diesel fuel sold in the state to contain at least a 2 percent biodiesel blend.

Petroleum Replacement Goal: There exists a state goal that 20% of the liquid fuel sold in the state will come from renewable sources by the year 2015, and 25% will by 2025. There are many grants available for bioenergy facilities, through the Department of Commerce and the Department of Agriculture.

RIM-Clean Energy – a reinvest in Minnesota program within the Board of Soil and Water Resources. RIM –CE is a working lands program that allows for growing and harvesting of bioenergy crops with added payments for increased conservation, water quality benefits. The program still needs funds for granting easements for bioenergy crops.

Types(s) of GHG Reductions

- **CO2:** Lifecycle emissions are reduced to the extent that biofuels are produced with lower embedded fossil-based carbon than conventional (fossil) fuel. Feedstocks used for producing biofuels can be made from crops or other biomass, which contain carbon sequestered during photosynthesis (e.g., biogenic or short-term carbon).

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

AFW-4. Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production

Policy Description

Dedicate a sustainable quantity of biomass from agricultural lands, land restoration activity, agricultural industry wastes, wood industry process wastes, and agro forestry resources for efficient conversion to energy and economical production of heat, steam, or electricity. This biomass should be used in an environmentally-acceptable manner considering proper facility siting and feedstock use (e.g., proximity of users to biomass, impact on water supply and quality, control of air emissions, solid waste management, cropping management, nutrient management, soil and non-soil carbon management, and impact on biodiversity and wildlife habitat). The objective is to create concurrent reduction of carbon dioxide due to displacement of fossil fuel considering life cycle GHG emissions associated with viable collection, hauling, energy conversion, and energy distribution systems.

The potential feedstocks associated with this policy are summarized as follows. An estimate of Minnesota biomass resource available for electricity, steam, or heat production is:

Source of Biomass	MN Biomass Resource (tons/year)	%
Forest Residue	874,900	2.6
Mill Residue	903,549	2.7
Agricultural Residue	24,895,287	73.2
Energy Crops	5,783,002	17.0
Urban Wood Waste	1,532,529	4.5
Total	**33,989,267**	**100**

(Ref 7, Minnesota Biomass-Hydrogen and Electricity Generation Potential, 2005.

Expanded biomass resources can be developed from agricultural industry process wastes and agro forestry products as new industrial facilities are built and through conversion of existing facilities. Analyses project that there is theoretically enough residual biomass and energy crops in Minnesota that, if collected and fed to the most efficient conversion technologies available, could produce up to 99% of the total electricity currently used in Minnesota. Actual results are highly dependent on economically attractive methods for collection of materials, hauling, energy conversion and energy distribution systems, as well as sustainable harvest methods. Current research and increasing numbers of demonstration projects occurring nationally are available to determine which system components are most functional and cost effective for given locations.

The policy will address the following needs:

- Provide resources to advance the rate of development of domestic biomass yield through research and development without compromising soil carbon stability and long-term viability of the production area, and to develop standards and methods to measure ecological sustainability and economical aspects of yield and harvest methods.
- Advance energy collection and conversion technologies for a range of applications from farm-scale point of use to larger industrial size units designed for specific use. Collection and conversion processes should be designed to maximize overall GHG reductions through life cycle analysis.
- Provide market incentives to develop a Minnesota biomass to energy conversion equipment industry and to enhance market infusion of biomass conversion products.

Policy Design

Goals: *Energy Crop Utilization:* produce bioenergy crops in an environmentally-acceptable manner on 1,000,000 acres of crop land.
Residue Utilization: Divert all available biomass into energy conversion. The following amounts of biomass and end use are envisioned (based on 2005 biomass resource estimates):

Biomass Energy Use	Year	Fraction of Available Biomass
Heat/Steam – Commercial and Residential Sector	2025	30
Conventional Electricity Generation	2025 2050	10 30
Biomass Gasification Combined Cycle Electricity Generation	2050	40

Timing: *Energy Crop Utilization*: By 2012, establish criteria for harvest and utilization of bioenergy crops in a sustainable manner. By 2012 create a demonstration plot of 10,000-50,000 acres of bioenergy crops in place (e.g. via a RIM-CE type program). By 2025, achieve the full goal.

Residue Utilization: See timing under Goals above.

Parties Involved: Review and analysis of power sector industry restructuring issues must consult with affected and interested parties, including representatives of: area land planners, rural and other energy consumers; commercial energy consumers; industrial energy consumers; small business energy consumers; investor-owned utilities; cooperative electric associations; municipal utilities; local units of government; Minnesota Pollution Control agency and local environmental agencies; renewable energy developers and providers; natural gas distribution utilities; community action agencies; and the public utilities commission; Agro-industries with waste products, Forest-product industries with waste products, conservation groups, Forest Resource Council, Board of Water and Soil Resources, Department of Natural Resources, Department of Agriculture.

Other:

Implementation Mechanisms

TBD: *TWG Suggestion: Focus on high potential, low cost actions that do not adversely effect existing agriculture and forestry practices.*

Guarantee dedicated bioenergy crops and biomass wastes and residues as feedstock for biomass power facilities. Increase the supply of bioenergy crops and biomass wastes and residues that are ecologically sustainable and economically viable.

Commercialize advanced and high-efficiency biomass energy conversion technologies integrated with dedicated feedstock supply. Increase the demand for bioenergy crops and biomass wastes and residues that are ecologically sustainable and economically viable.

Affirm financial investment security to promote the research and development of biomass yield improvement and variable scale energy conversion technologies.

By 2012, establish criteria/standards for sustainable harvest and utilization of agricultural and forest residues. Build on FSC guidelines and other FRC, RIM-CE, Department of Ag guidelines for residue removal to ensure soil health and soil carbon storage.

Related Policies/Programs in Place

The Minnesota legislature overwhelmingly passed a bill on February 2007 requiring the state's utilities to generate at least 25 percent of their electricity from renewables by 2025. Under the new law, Minnesota will add between 5,000 to 6,000 MW of new renewable energy.

RIM-Clean Energy – a reinvest in Minnesota program within the Board of Soil and Water Resources. RIM –CE is a working lands program that allows for growing and harvesting of bioenergy crops with added payments for increased conservation, water quality benefits. The program still needs funds for granting easements for bioenergy crops.

WOOD AND CROP WASTE. A gasification plant that is planned for the University of Minnesota at Morris will use crop waste (corn stover) to produce heat, electricity, syngas and/or hydrogen. The University of Minnesota Duluth's Coleraine Lab has obtained a grant to develop a gasification project that will convert wood waste to hydrogen. (8)

BIOMASS DENSIFICATION. The Center for BioRefining at the University of Minnesota has developed a biomass/hydrolysis process that converts waste biomass, such as corn stover, into bio-oil which can be used to make polymers for products and hydrogen-rich gas. (8)

St. Paul District Energy – provides over 80% of power for downtown from woody biomass. Also, MN Power in Duluth has a large biomass to energy plant.

The Laurentian Energy Authority Biomass Energy Project has provided $150,000 to the Minnesota Forest Resources Council (MFRC) to establish guidelines for sustainable removal of woody biomass from forests for energy, and to the MN DNR to develop similar guidelines for brushlands and open lands. This project has produced a partnership between public utilities in the

Cities of Virginia and Hibbing. Public utilities in these cities have converted formerly coal-fired power plants to power plants that re now 75% fueled by woody biomass.

Numerous other projects for reference such as: Koda Energy, CMEC, CVEC, municipal energy projects.

Types(s) of GHG Reductions

CO_2, N_2O, CH_4: Displaces emissions from fossil fuel combustion.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods:** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

1. Any action to expand use of biomass for energy conversion must consider ecological sustainability and standards for harvesting. In addition, actions must consider land use limitations and resource needs for relatively scaled heat/power facilities.
2. Feedstock has certain inherent physical and chemical characteristics. The fuel preparation steps must change the characteristics inherent in the feedstock into the characteristics needed for the conversion device, thus the feedstock requirements for the conversion device must be known. (1)
3. Various wood sources can have different physical and chemical characteristics, which can greatly influence its conversion to energy. Feeding of these materials with differing characteristics as slugs into the conversion device can cause rapid changes in operating conditions, and make control difficult. Even wood sources differing only in moisture content can cause significant variations in operating conditions and cause control problems. (1)
4. Environmental factors associated with processing wood include noise, solid waste disposal, air emissions, water pollution, and facility aesthetics. (1)
5. The ability to cost-effectively collect, store, and transport biomass feedstock presents many challenges. A biobased industry will require a safe and sustainable supply system. Research and Development in this area is designed to overcome the engineering systems barriers of collection, delivery, and storage of agricultural residues. (US Department of Energy, Energy Efficiency and Renewable Energy)

6. Among the plant growth factors that pose barriers to yield increase, soil moisture is the most limiting factor. Thus, continued selection for stress tolerance, including tolerance to moisture deficits, will be critically important to achieving a crop's potential yield. (3)
7. Additional analyses would be required to discern the potential impact that large-scale forest and crop residue collection and production of perennial crops could have on traditional markets for agricultural and forest products.

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

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Appendix

Definitions

Crop Residues. (2) Crops included in this reference are: corn, wheat, soybeans, cotton, sorghum, barley, oats, rice, rye, canola, beans, peas, peanuts, potatoes, safflower, sunflower, sugarcane, and flaxseed. The quantities of crop residues that can be available were estimated using total grain production, crop to residue ratio, moisture content, and taking into consideration the amount of residue left on the field for soil protection, grazing, and other agricultural activities. Estimates were developed using total grain production by county for 2002 reported to the U.S. Department of Agriculture. Quantities that must remain on the field for erosion control differ by crop type, soil type, weather conditions, and the tillage system used. It was assumed that 30% residue cover is reasonable for soil protection. Animals seldom consume more than 20%-25% of the stover in grazing, and it is presumed about 10%-15% of the crop residue is used for other purposes: bedding, silage, etc. Therefore, it was assumed that about 35% of the total residue could be collected as biomass. (2)

Forest Residues. (3) Forestlands have considerable potential to provide biomass from two primary sources: residues associated with the harvesting and management of commercial timberlands for the extraction of sawlogs, pulpwood, veneer logs, and other conventional products; and non-merchantable biomass associated with the standing forest inventory. These two categories of forest resources constitute the primary source of forest residue biomass.

Forestry biomass as feed stock for energy conversion also needs to consider utilization of unused residues generated by the forest products industry; urban wood residues discarded from construction and demolition activities; and residues from the disposal of tree trimmings, packaging residues, and wood-based consumer durables to expand the existing forest biomass available energy conversion.

Biomass Availability. Biomass availability can be obtained through a combination of technology changes focused on conventional crops only and further through technology changes in both conventional crops and new perennial crops together with significant land use change. Technology change comes from research driven increase in crop yield, increase in residue-to-grain or residue-to seed ratio, residue collection technology for annual crops, cropland tillage management practices, and allocation of cropland to perennial crops. Forest growth and increase in the demand for forest products, in the long term, could increase the potential contribution of forest biomass. (3)

Technologies

Direct combustion systems. Direct combustion systems commonly used for combustion of biomass fuels can be classified into pile, suspension, and fluidized bed combustion (FBC) systems. *Pile combustion systems* burn the wood fuel in either a heaped pile supported on a grate (used for smaller scale systems) which are horizontal or inclined, or in a thinly spread pile spread across a grate which may be traveling or stationary. These burners are sometimes referred to as Dutch oven or wet cell burners. Combustion air is provided both under the grate and above the fuel pile. The spreader-stokers fuel-feed and distribution systems used with "thin-pile" combustion units are generally quite reliable, with any problems most often traced to poor fuel distribution, which results from either oversize fuel or high moisture fuel particles. (1)

Gasification systems. Thermochemical gasification of biomass fuels involves the use of heat to decompose a feedstock under oxygen-limiting conditions. Gasification removes ash, including most alkali metals, and with gas-cleanup, removes particulates from the fuel stream. The gaseous form facilitates its use in a wider range of energy applications than solid fuels. (1)

Pyrolysis. Fast pyrolysis is a thermal decomposition process that occurs at moderate temperatures with a high heat transfer rate to the biomass particles and a short hot vapor residence time in the reaction zone. Reactor configurations include bubbling fluid beds, circulating and transported beds, cyclonic reactors, and ablative reactors.

Direct Hydrothermal Liquefaction. Direct hydrothermal liquefaction involves converting biomass to an oily liquid by contacting the biomass with water at elevated temperatures (300-350°C) with sufficient pressure to maintain the water primarily in the liquid phase (12-20 MPa) for residence times up to 30 minutes. The primary product is an organic liquid with reduced oxygen content (about 10%) and the primary byproduct is water containing soluble organic compounds.

*Biomass Integrated Gasification Combined Cycle (BIGCC).*Biomass is uniquely used as fuel in combined heat and power applications.

<u>Data</u>

Farmland Use 2002 vs. 1997 (not including land in house lots, ponds, roads, wasteland)

Farm Land Use	2002 acres	1997 acres
Harvested Cropland	19,398,309	19,794,078
Cropland Pasture Grazing	728,593	1,033,959
Other Cropland	2,602,256	1,755,394
Woodland	1,975,495	2,217,052
Pasture Rangeland	1,187,082	1,035,159
Total Acres	25,891,735	25,835,642

Agricultural Crop Residues in Minnesota (2)

Source of Biomass	Crop Residues (Thousand Dry Tonnes	
Estimated Crop Residues	14,231	
Estimated Forest Residues	2,242	
Estimated Primary Mill Residues	985 total	65 unused
Estimated Secondary Mill Residues	59	
Estimated Urban Wood Residues	496	

Biomass Resources in Minnesota (7)

Source of Biomass	Biomass Resources from ORNL database	Biomass Resources from NREL GIS Group	Biomass Resource from 1997 ILSR Inventory	Average of all biomass resource data
	tons/year at <$50/ton	tons/year	tons/year	tons/year
Forest Residue	874,900	-	-	874,900
Mill Residue	1,121,000	1,017,688	571,960	903,549
Agricultural Residue	11,935,896	40,709,527	22,040,438	24,895,287
Energy Crops	5,783,002	-	-	5,783,002
Urban Wood Waste	1,532,529	-	-	1,532,529
Total	21,247,327	41,727,215	22,612,398	33,989,267

Power Potential from the Use of Direct-Fired Biomass Power Plants in MN
(Based on Average of Biomass Resource Data) (7)

Source of Biomass	Electricity	potential % of MN electricity use that could be met with biomass power	Equivalent capacity	Direct CO_2 reductions for this biomass power	Life-cycle GHG reductions for biomass power
	MWh/year	%	MW	tons CO_2/year	tons CO_2-equiv/year
Forest Residue	1,233,609	2%	176	935,138	965,030
Mill Residue	1,274,005	2%	182	965,760	996,631
Agricultural Residue	35,102,355	58%	5,009	26,609,365	27,459,935
Energy Crops	8,154,033	14%	1,164	6,181,170	6,378,752
Urban Wood Waste	2,160,866	4%	308	1,638,046	1,690,406
Total	47,924,867	80%	6,839	36,329,479	37,490,754

Table 8: Electricity Results Based on Functional Amounts of Biomass Resources used in Direct fired Biomass Power Plants
(Based on Average of Biomass Resource Data) (7)

Biomass resource base	Electricity potential	% of MN electricity use that could be met with biomass power	Equivalent capacity	Direct CO_2 reductions for this biomass power	Life-cycle GHG reductions for biomass power
tons/year	MWh/year	%	MW	tons CO_2/year	tons CO_2-equiv/year
1	1	0%	0	1	1
100	141	0%	0	107	110
1,000	1,410	0%	0	1,069	1,103
100,000	141,000	0%	20	106,885	110,302
1,000,000	1,410,000	2%	201	1,068,852	1,103,017
10,000,000	14,100,000	23%	2,012	10,688,515	11,030,174

Table 9: Electricity Results Based on Functional Amounts of Biomass Resources used in IGCC Power Plants

Biomass resource base	Electricity potential	% of MN electricity use that could be met with biomass power	Equivalent capacity	Direct CO_2 reductions for this biomass power	Life-cycle GHG reductions for biomass power
tons/year	MWh/year	%	MW	tons CO_2/year	tons CO_2-equiv/year
1	2	0%	0	1	1
100	176	0%	0	133	138
1,000	1,760	0%	0	1,334	1,377
100,000	176,000	0%	25	133,417	137,682
1,000,000	1,760,000	3%	251	1,334,169	1,376,816
10,000,000	17,600,000	29%	2,511	13,341,692	13,768,161

AFW-5. Forestry Management Programs to Enhance GHG Benefits

Policy Description

Forests – public, private, urban, managed, and wild - provide many GHG benefits. The following actions are recommended:

1. Protect and enhance the carbon stored in tree biomass by maintaining and improving the health, longevity, and number of trees in urban and residential areas. Emissions reductions from reduced heating and cooling as a result of planting shade trees are a significant co-benefit.

2. Promote forest cover and associated carbon stocks by establishing forests on former forestland. Additional benefits include public recreation, water quality, wildlife habitat and enhanced biodiversity. Implement practices such as soil preparation, erosion control, and stand stocking to ensure conditions that support forest growth.

3. Encourage activities that promote forest productivity and increase the rate of carbon dioxide sequestration in forest biomass and soils, and in harvested wood products. Practices may include: adjusting rotation ages to increase carbon sequestration; increased stocking of poorly stocked lands; thinning and density management; increasing the acreage of short rotation woody crops (for fiber and energy) on agricultural lands; fire management and risk reduction, and management of detrimental insects and disease.

4. Reduce the severity of wildfires to reduce GHG emissions by lowering the forest carbon lost during fire and by maintaining carbon sequestration potential. Similarly, reducing damage from insects, disease, and invasive plants reduces GHG emissions by maintaining the carbon sequestration potential of healthy forests.

Policy Design

Goals: *Forestation:* Increase amount of permanent forestland in the state by 1 million acres by planting trees on converted forestland.

Urban Forestry: Increase the canopy cover of urban forest in Minnesota communities by 25%.

Forest Health: Fully stock all under-stocked stands; conduct fuel reduction on all areas requiring these treatments (direct biomass to beneficial use); increase sustainable harvests by X% above current levels.

Timing: *Forestation:* Identify lands appropriate for re-establishing forest by 2008. Achieve the goal by 2025.

Urban Forestry: Achieve the goal by 2025.

Forest Health: Identify under-stocked stands on state and county lands by 2010. Where appropriate, fully stock half of identified stands by 2012 and all such stands by 2025; Identify areas in need of wildfire fuel reduction, principally to avoid stand- replacing fires by 2010. Conduct fuel reduction on 50% of identified areas by 2012 and 100% by 2025. Direct any biomass to beneficial use wherever possible (energy use or wood products). Increase sustainable harvest consistent with greenhouse gas reduction and other environmental objectives by X% above current levels by 2025.

Parties Involved: TBD.

Other:

Implementation Mechanisms

TBD – [CCS drafts based on TWG inputs; this can be developed as they go along, and can start early or late as they prefer; the level of detail can vary on TWG approval]

TWG Note: Many funding sources can help implement these multi-faceted options.

Develop scientific foundation of carbon sequestration practices in Minnesota forests, including stocking, rotations (lengthened and shortened rotation), harvest methods, and tree species. Evaluate CO_2 impacts of fire management and fire-fighting activities. Evaluate the impacts of increasing annual timber harvest on greenhouse gases and production of wood fiber products and other forest values. Analyze GHG impacts of different end uses of MN timber harvest (e.g., engineered products, pulp and paper, energy, solid wood products).

Use scientific information to develop Minnesota forest protocols for carbon sequestration by 2010. Incorporate carbon protocols into forest management plans for all publicly administered forests by 2012.

By 2012, establish monitoring program to document long-term impacts of carbon management practices and climate change on Minnesota forests.

Evaluate and provide incentives, such as tax benefits or government purchasing programs, to support investments into wood products that store carbon for long periods of times.

Increase the number of communities implementing inventory-based forest management plans from 50 to 150 by 2025.

Related Policies/Programs in Place

The Board of Soil and Water Resources (BSWR) has been directed by the 2007 MN legislature to administer $500k in grants to conduct site level ecological research and assessments, a clean energy program, and technical teams for native seed harvesting and working lands initiatives.

State has spent many millions of dollars since 1990 on a nationally recognized program called Minnesota ReLeaf, a cost-share program designed to plant trees in urban and rural areas to sequester carbon, promote energy conservation, and provide an array of other co-benefits. The MN DNR Division of Forestry may have cost per ton figures available.

Types(s) of GHG Reductions

CO_2: Promotion of forestry management programs serves to increase the sequestration of carbon in forested lands, as well as preventing carbon currently stored in Minnesota's forests from being released.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

TWG Note: Tree mortality has doubled since 1977, from 123 to 250 million cubic feet. Mortality rate could continue to increase, increasing susceptibility to wildfires and large releases of CO_2

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

TWG Suggestion: Management for carbon sequestration will also benefit production of high quality wood products for the construction industry keeping the carbon out of the cycle for a greatly increased time period.

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

AFW-6. Forest Protection – Reduced Clearing and Conversion to Nonforest Cover

Policy Description

Reduce conversion of forested lands to land uses with lower carbon sequestration potential. Forestland captures and stores carbon dioxide in trees, soil and other forest biomass at a much higher rate than developed areas and other areas without forest cover.

Policy Design

Goals: Adopt a policy of no net loss of carbon stocks on forested land and implement it through local land use planning, conservation easements, technical and financial assistance, education, revised tax policy, and other appropriate mechanisms.

Timing: Achieve the policy goal by 2012.

Parties Involved: TBD

Other:

Implementation Mechanisms

TBD – [CCS drafts based on TWG inputs; this can be developed as they go along, and can start early or late as they prefer; the level of detail can vary on TWG approval]

Related Policies/Programs in Place

The Minnesota Forest Legacy Partnership is a group of public and private business and non-profit interests engaged in promoting large-scale forest conservation easements in northern and central Minnesota. A 51,000 acre forest easement in Koochiching and Itasca County is being actively pursued, and two additional easements comprising a total of 76,000 acres have been proposed in Koochiching County (located on the Ontario border in north central MN). Most of the funding for purchasing the 51,000 easement has been obtained from private foundation, other private, and state sources, and funding for the additional easements is being sought.

Types(s) of GHG Reductions

CO_2: Avoided emissions from forest clearing and maintenance of annual carbon sequestration from forest growth.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

AFW-7. Integrated Waste Management

Policy Description

Integrated waste management promotes the reduction of the sheer volume of waste produced as well as a reduction in consumption through incentives, awareness and increased efficiency. Three major areas of focus in Minnesota are source reduction, organic waste management and advanced recycling.

Reduce the volume of wastes from residential, commercial, and government sectors through programs that reduce overall disposal. Reduction of waste generation at the source – of production (including packaging) and of consumption – reduces both landfill and waste to energy (WTE) combustion emissions as well as upstream production emissions.

Reduce methane emissions associated with landfilling by reducing the biodegradable fraction of waste emplaced and also remove the wet and dense fraction that reduces the BTU potential of the combustible components of the waste stream. Recently, an area of focus in the solid waste industry has been in increased recycling of organic wastes (lawn & garden, food waste, wood, paper, etc.) through the use of various methods including food to people (food recovery), food to animals, and composting methods.

Increase reuse and recycling in order to limit greenhouse gas emissions associated with landfill methane generation, waste combustion, waste-to-energy combustion processes, and the extraction of raw materials and energy consumption during the manufacturing process. Expand existing re-use and recycling programs, create new recycling programs, provide incentives for the reuse/recycling of construction materials, develop markets for recycled materials, and increase average participation/recovery rates for all existing recycling programs.

Policy Design

Goals:

- Minnesota will achieve a combined recycling and composting rate of 65% by the year 2020.

Timing:

- Minnesota will achieve a combined recycling and composting rate of 65% by the year 2020.
- Recycling rate of 45% by 2012 and 50% by 2020. Composting rate of 10% by 2012 and 15% by 2020 (for a total diversion rate of 65%).

Parties Involved: TBD

Other: In 2005, the state of Minnesota had a recycling rate of 41%, a composting rate of 5% (although mostly yard waste, 0.02% was source separated compostables which represented a doubling from the prior year) and an estimated source reduction rate of 3%.

Implementation Mechanisms

TBD – [CCS drafts based on TWG inputs; this can be developed as they go along, and can start early or late as they prefer; the level of detail can vary on TWG approval]

Source reduction initiatives identify consumer products and packaging that are neither recyclable nor compostable.

Voluntary initiatives, including increasing consumer education about waste and working with manufacturers and retailers to change packaging type and reduce overall packaging would be developed, prioritized and targeted at products and packaging based on the quantities in the waste stream and the energy intensiveness of their production and the emissions resulting from their ultimate disposal. Depending on the success of these initiatives, other options could include product stewardship and regulations to reduce use of non recyclable and non-compostable materials.

Related Policies/Programs in Place

The Minnesota Pollution Control Agency is undertaking a campaign to "reinvigorate recycling." The state has one of the nation's highest recycling rates, but the MPCA intends to increase that rate. Even a slight increase in the rate has a significant impact on reducing GHG emissions.

Minnesota PCA promotes increased composting of yard waste and source separated organics. By applying it to soils, the compost sequesters carbon by utilizing the short term carbon cycle. In 2005, about 19,000 tons of compost was created and used as soil amendment. That is only capturing about 1% of the organic materials in the solid waste stream. A more aggressive effort could capture5 10 % of the organics in the solid waste stream. This does not include any industrial waste such as vegetable processing wastes, bio-solids, manure composting or digestion. There is a large potential here that is as yet untapped. MPCA is working to increase the amount of composted material.

Types(s) of GHG Reductions

- **CO_2:** Upstream Energy Use Reductions – The energy and GHG intensity of manufacturing a product is generally less using recycled feedstocks than from using virgin feedstocks.
- **CH_4:** Diverting biodegradable wastes from landfills will result in a decrease in methane gas releases from landfills.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]

AFW-8. End of Use Waste Management Practices

Policy Description

Promote activities that reduce greenhouse gas production during end-of-life disposal activities. Encourage and promote the use of energy recovery technologies for waste materials for which more desirable front–end waste management alternatives are not available or feasible. These projects will help reduce greenhouse gas emissions from waste management while producing cleaner energy. These technologies make a two-fold contribution to climate protection: the discharge of methane and other greenhouse gases into the atmosphere is reduced, and the burning of fossil fuels is replaced with recovered energy. For example, the energy created by bioreactor landfills (methane) can be used to make electric power, space heat, or liquefied natural gas.

Policy Design

Goals: *Landfilled waste:* For all waste entering landfills in 2020, 90% of the methane generated over the lifespan of the facility will be captured.

Unprocessed solid waste: by 2020, no methane generating materials will be disposed in Minnesota landfills.

Waste to energy facilities: by 2020, all waste entering waste to energy facilities will be pre-processed to remove recoverable materials and enhance energy recovery.

Timing: By 2012, identify which of the available end-of-use practices are best applied to the: 1) most energy intensive materials to produce, 2) the largest GHG emitting materials, and 3) by type the materials that are found in the greatest quantity in the end-of-use waste stream.

Parties Involved: TBD.

Other: After implementing the upper hierarchy Front-End Waste Management goals (Reduce, Reuse, Recycling, Composting in AFW-7), the best End-of-Use practices should be employed to minimize the release of GHG emissions. The Minnesota Pollution Control Agency shall conduct ongoing evaluation of the success of front end abatement activities and the environmental viability and greenhouse gas reduction feasibility of different waste management technologies to refine and update information on best practices.

Implementation Mechanisms

TBD – [CCS drafts based on TWG inputs; this can be developed as they go along, and can start early or late as they prefer; the level of detail can vary on TWG approval]

Related Policies/Programs in Place

Currently, nine waste-to-energy facilities in Minnesota process 3,800 tons of MSW per day for industrial heat and electrical generation. The total energy reclaimed since 1982, when these facilities first began to come on-line, is the equivalent of 12 million tons of coal. Currently, these facilities produce approximately 100,000 megawatts of electrical energy, or enough energy to power 110,000 homes. The MPCA has a strategic objective to increase the state's waste-to energy capacity by 60% by 2011. In 2005, Minnesota waste-to-energy reduced carbon dioxide and methane gases by an amount equivalent to taking 90,000 cars off the road.

There are twenty-one open mixed municipal landfills in Minnesota. The majority of these facilities are owned and operated by county governments. Two of these facilities (Waste Management's Elk River Facility, and BFI's Pine Bend Facility) currently generate electricity derived from the collection and combustion of the methane gas generated as a result of waste decomposition. Methane is a potent greenhouse gas. A third facility, Three Rivers Landfill in Kanabec County, will be capturing methane for the production of energy in the near future. Lyon County is currently assessing the potential of a landfill gas-to-energy project at their county owned facility. The MPCA has been proactive with landfill owners and operators in promoting and encouraging the capture and utilization of this valuable resource.

Types(s) of GHG Reductions

- **CH_4:** Methane reductions via collection and control (via flaring, or preferentially via energy utilization).
- **CO_2:** Reduction of fossil fuels and associated GHGs through the generation of electricity from landfill methane.

Estimated GHG Reductions and Net Costs or Cost Savings

TBD – [CCS should provide a worksheet and other reference material as needed for transparency]

- **Data Sources: [**TBD by CCS on TWG approval]
- **Quantification Methods: [e.g.** Full life-cycle analysis with supply/demand equilibrium adjustments on TWG approval]
- **Key Assumptions: [**TBD, as needed on TWG approval]

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MCCAG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MCCAG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]