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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.

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.

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.

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.

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.

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.

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:

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.

References

http://bioenergy.ornl.gov/
http://www.eere.energy.gov/biomass/biomass_feedstocks.html

1. **PROCESSING COST ANALYSIS FOR BIOMASS FEEDSTOCKS,** Phillip C. Badger**,** General Bioenergy, Inc., Florence, Alabama, Date Published: October 2002, Prepared for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Biomass Program, Budget Activity Number EB 24 04 00 0, Prepared by OAK RIDGE NATIONAL LABORATORY, Oak Ridge, Tennessee 37831, managed by UT-BATTELLE, LLC for the U.S. DEPARTMENT OF ENERGY under contract DE-AC05-00OR22725, ORNL/TM-2002/199
2. **A GEOGRAPHIC PERSPECTIVE ON THE CURRENT BIOMASS RESOURCE AVAILABILITY IN THE UNITED STATES,** A. Milbrandt, Technical Report NREL/TP-560-39181, December 2005, Prepared under Task No. HY55.2200.
3. **BIOMASS AS FEEDSTOCK FOR A BIOENERGY AND BIOPRODUCTS INDUSTRY: THE TECHNICAL FEASIBILITY OF A BILLION-TON ANNUAL SUPPLY;** Robert D. Perlack, Lynn L. Wright, Anthony F. Turhollow, Robin L. Graham. Environmental Sciences Division, Oak Ridge National Laboratory; Bryce J. Stokes,

Forest Service, U.S. Department of Agriculture; Donald C. Erbach, Agricultural Research Service, U.S. Department of Agriculture; A Joint Study Sponsored by U.S. Department of Energy, U.S. Department of Agriculture; Prepared by: Oak Ridge National Laboratory; Managed by: UT-Battelle, LLC for the U.S. Department of Energy under contract DE-AC05-00OR22725, DOE/GO-102005-2135, ORNL/TM-2005/66

4. ORNL 1999 database: http://bioenergy.ornl.gov/resourcedata/
5. NREL GIS database, updated with new sources of data: mill residue data are from the 2002 Timber Products Output Database by the USDA Forest Service; agricultural residue data are from the National Agricultural Statistics Service at USDA (http://www.nass.usda.gov:81/ipedb/)
6. ILSR 1997 database: http://www.carbohydrateeconomy.org/library/admin/uploadedfiles/Survey_of_Minnesotas_Agricultural_Residues_and.html
7. **MINNESOTA BIOMASS-HYDROGEN AND ELECTRICITY GENERATION POTENTIAL**, A study by the National Renewable Energy Laboratory Golden, Colorado, Provided with financial assistance from the U.S. Department of Energy for The Minnesota Department of Commerce and The Minnesota Office of Environmental Assistance, February 2005
8. A Report To The Minnesota Legislature, Minnesota Department Of Commerce, State Energy Office, January, 2006
9. Center for Energy & Environment Report, 2007, on Biopower (theoretical, technical, economically available biomass for power production).

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:

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.

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:

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.

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%.

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.

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.

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.

Barriers to Consensus

TBD – [blank until final vote by the MCCAG]