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Table x.
Agriculture, Forestry, and Waste Management Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$) 2010	2020	Total 2007-2020	Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
	AGRICULTURE, FORESTRY, AND WASTE MANAGEMENT						
AFW-1	Programs to Support Local Farming/Buy Local						TBD
AFW-2	Agricultural Soil Carbon Management Programs						TBD
AFW-3	Manure Management Methods to Achieve GHG Benefits						TBD
AFW-4	Protect Open Space/Agricultural land						TBD
AFW-5	Forestry Programs to Enhance GHG Benefits						TBD
AFW-6	Increased Forest Biomass Energy Use						TBD
AFW-7	Forest Protection – Reduced Clearing and Conversion to Non-forest Cover						TBD
AFW-8	Expanded Use of Durable Wood Products (especially from VT sources)						TBD
AFW-9	Advanced/Expanded Recycling and Composting						TBD
AFW-10	Programs to Reduce Waste Generation						TBD
AFW-11	Waste Water Treatment – Energy Efficiency Improvements						TBD
AFW-12	In-State Liquid Biofuels Production						TBD
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS						
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)						
	SECTOR TOTAL PLUS RECENT ACTIONS						

AFW–1. Programs to Support Local Farming/Buy Local

Mitigation Option Description

Programs that promote the production, storage, processing, distribution and consumption of locally-grown food products reduce transportation and manufacturing emissions by offsetting the consumption of products with higher embodied energy.

Food products consumed in the U.S. can travel thousands of miles before reaching a grocery or clothing store in the form of a final product (a typical food product can travel over 1,500 miles and change hands dozens of times). Vermont food buyers should focus the majority of their food product purchases from New England and New York markets.

In addition to Vermont production, storage and processing, the percentage of locally grown food consumed in Vermont should also be a priority as it will reduce fossil fuel use and its associated GHG emissions. Establishment and support of creative and effective multi-layered marketing programs including "a virtual marketplace for local farmers markets" (e.g., Local Foods Plymouth) has shown to boost consumption of local foods.

Mitigation Option Design

- **Goals:** To increase the production, storage, and processing of locally grown animal products, grains, vegetables and fruits and their consumption in Vermont *such that 30% of these products purchased by Vermonters are produced in the state.*
- **Timing:** To increase sales *and consumption* of local farm products by 50% and increase storage and processing capacity of locally grown farm products by 20% by 2012 **above current levels**. *Achieve the 30% goal by 2028.*
- **Coverage of parties:** Center for Sustainable Agriculture at UVM, Agency of Agriculture, Vermont farmers and industry associations.
- **Other:** Promote the use waste heat generated from farm or industry practices to increase the levels of year-round vegetable and fruit production.

Implementation Mechanisms

Working together to further define, develop, implement and promote all local foods production, storage, processing and consumption in accordance with sustainable agricultural practices will require several strategies:

- Establish and promote a "virtual farmers market" to help boost sales;
- Explore the barriers and obstacles on the production side;
- Expand meat production and self-sustaining cold and warm weather products;

- Support continued research and data collection to establish a baseline on local farm sales for farmers markets and farm stands.

Related Policies/Programs in Place

Vermont Sustainable Agriculture Council (www.uvm.edu/sustainableagriculture);

VSJF, VFN, NOFA-VT, Intervale, CSA, UVM, Shelburne Farms, North Country Framers, RAFFL, Vital Communities—Sustainable Ag Network (SAN);

UVM efforts to define local products and work with Sadexo Food Services to include greater percentages of local food in campus dining rooms;

Local Foods Plymouth (http://lfp.dacres.org/);

NH Farmers Market Association (www.nhfma.org).

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–2. Agricultural Soil Carbon Management Programs

Mitigation Option Description

Use of conservation practices to increase the incorporation of organic green manures, implement grass based rotations and cover-cropping, which will reduce soil erosion, maintain/increase soil organic matter level, and increase overall soil tilth. In addition, maximize the use of farm organic wastes to improve crop fertility and to lower the importation of oil based synthetic fertilizers. This option is designed to increase the acreage using soil management practices that lead to higher soil carbon content and reduce nitrogen run-off which has the potential to reduce nitrous oxide emissions.

Mitigation Option Design

- **Goals:** Implement Nutrient Management Plans (NMPs) aimed at increasing soil carbon levels and minimizing nitrogen run-off and subsequent N_2O emissions on 75% of farm acreage by 2012 and 90% by 2028. Inject 10% of liquid dairy manure and processed waste water by 2012. Increase acreage managed under cover crop to 25% of annual cropland by 2012 and 50% by 2028.
- **Timing:** see goals above.
- **Coverage of parties:** Vermont Agricultural Agencies, Vermont non-profit farming organizations, Agricultural Coops, eco-agriculture consulting companies, Vermont farmers, USDA, NRCS, Vermont natural resource agencies, environmental organizations, University of Vermont and other Vermont Colleges.
- **Other:** Nutrient Management Plans would cover a wide variety of practices that will increase soil carbon levels and reduce nitrogen run-off. These include: maximizing the use of on farm manure and processed waste water to reduce imported fertilizers; using crop rotation and increasing the use of cover cropping on annual crop land to minimize the loss of organic matter from soil erosion; and increasing the use of manure injector technologies on grass and no-till crop land. Additional practices for increasing soil organic matter include: planned grazing; biological subsoiling (using root crops and deep tap-rooted plants); composting and compost tea; pasture cropping, or double cropping; charcoal soil amendments (e.g. amazon dark earths and the Epridra Process); biodynamic preparations; mineralization schemes, including rock dusts and sea minerals; microbial stimulants (e.g. effective microorganisms, indigenous microorganisms); cover cropping; green manures; mulches; seaweed products; recycled green wastes; biosolids; humic substances; Dung beetle and earthworm re-introduction.

Implementation Mechanisms

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–3. Manure Management Methods to Achieve GHG Benefits

Mitigation Option Description

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

Mitigation Option Design

- **Goals:** Digest half of dairy cattle manure by 2028; Compost 50% of the poultry and livestock manure produced on farms by 2028; Implement nutrient management strategies which meet the NRCS Technical Practice Code 590 on 90% of the land which receives manure or processed wastewater by 2028.
- **Timing:** Increase the anaerobic digestion from five (5) percent (in operation and under construction) to 15 percent of the dairy cattle manure in Vermont over the next five years (2012). By 2028, digest 50 percent of the dairy cattle manure in Vermont; Increase the percent of manure composted on poultry and livestock farms to 25% by 2012 and to 50% by 2028; Implement nutrient management plans on 75% of the lands receiving manure and processed wastewater by 2012 and on 90% of this land base by 2028.
- **Coverage of parties:**
- **Other:** Anaerobic digestion of half of Vermont's dairy manure could produce 15 megawatts of electric generation and 350 billion Btu's of heat energy per year.

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–4. Protect Open Space/Agricultural Land

Mitigation Option Description

Reduce the rate at which existing crop and pasture are converted to developed uses. The carbon sequestered in soils and aboveground biomass can be higher in agricultural lands than in developed land uses. Policies are needed to protect working farms and forests (see AFW-7) from unwise and unplanned development.

Mitigation Option Design

- **Goals:** To reduce the rate at which agricultural lands are converted to development by 50%.
- **Timing:** Reduce the rate of conversion by 25% by 2012; achieve 50% reduction in the rate of conversion by 2020 and maintain this rate of conversion through the policy period.
- **Coverage of parties:**
- **Other:** Vermont has established planning goals to protect the historic pattern of development which favors compact settlement surrounded by open and productive countryside. The state provides incentives to land owners to keep their property in the production of food, fuel and fiber for local consumption, but much more can be done. Vermont's landscape is susceptible to land development that will negatively impact the viability of farm and forestland unless land conservation programs are expanded and fully funded, and rural sprawl is controlled in a responsible manner.

Implementation Mechanisms

(1) Fully fund the Vermont Housing and Conservation Trust Fund according to the formula set in statute.

(2) Expand enrollment in Vermont's Use Value Appraisal (UVA) Program (Current Use). To expand landowner incentives for enrollment in UVA, allow properties to be enrolled for farm and forest management, carbon sequestration and the protection of open space.

(3) Strengthen regional and local land use planning to better protect the viability of farm and forestland from conversion and development.

(4) Reduce and eliminate policies that promote sprawl in rural lands without appropriate environmental review. Options include eliminating Act 250 exemptions for utility lines and long roads that can promote indiscriminate rural development. Act 250 should be strengthened to conserve the integrity of farm and forestland resources.

(5) Strengthen incentives for landowners to pursue conservation easements by adjusting property tax rates for landowners who hold easements to reflect use value or a comparable rate.

Related Policies/Programs in Place

Housing and Conservation Board, Use Value Appraisal Program, Forest Legacy Program, Land Trust activity, Regional Planning, Growth Centers Legislation, Act 200, Act 250, NRCS and other federal programs.

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–5. Forestry Programs to Enhance GHG Benefits

Mitigation Option Description

Carbon dioxide is captured and stored in trees, soil and other forest biomass. Any forest management activity that promotes forest productivity will increase carbon dioxide sequestration rates and enhance GHG benefits. Retaining forest management where it is being done and expanding the area covered by management plans would stimulate the rate of productivity. Increasing production of high quality, high density wood with subsequent use of these products in durable wood products (building materials, furniture, etc.) serves as a long-term method for storing carbon. Use of biomass waste from forestry programs for energy purposes is covered under AFW-6.

Mitigation Option Design

- **Goals:** Increase productivity of high quality, high density wood in Vermont's forests by 40%
- **Timing:** Increase productivity by 20% by 2028 and 40% by 2048.
- **Coverage of parties:**
- **Other:** Increases in productivity will increase carbon sequestration within Vermont's forest ecosystems as a result of improved forest health and enhanced forest growth. In addition, carbon sequestration will increase in durable wood products harvested from the forests—the increased productivity is intended to provide more high quality wood (high density, large diameter wood) for the wood products industry. The impacts of increased productivity on harvested wood products, in terms of GHG benefits and cost/cost savings, will be covered in AFW 8.

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–6. Increased Forest Biomass Energy Use

Mitigation Option Description

The goals of this option are to increase the use of low value wood material, including logging and mill residues, by appropriate processing centers for energy purposes (electricity, heating or liquid fuels). Offsetting fossil fuel use with biomass for energy, in applications such as distributed generation, combined heat and power and community energy systems will yield additional GHG emissions reductions benefits.[1]

Mitigation Option Design

- **Goals:** Increase production and use of forest biomass energy feedstocks in Vermont by 30% through sustainable harvesting practices.
- **Timing:** Achieve 5% increase by 2010 and 30% increase by 2028
- **Coverage of parties:**
- **Other:** Current levels of forest biomass feedstock production and use in Vermont are estimated at about 12.5% of annual forest growth (50% of annual growth is harvested each year, 25% of which goes to biomass energy). A biomass energy resource assessment is in preparation and publication anticipated in June 2007. Preliminary information from the assessment is being sought and may influence the above goal levels.

  Sustainable harvesting practices should ensure sufficient biomass is left after harvest to provide the necessary nutrients to sustain forest growth. The TWG will provide an estimate of the amount of annual growth that should be left in the forest after harvest.

  The goal above focuses on the supply of forest biomass feedstocks. The TWG strongly encourages complimentary goals related to infrastructure development in the ES and RCI sectors. Specifically, the TWG recommends encouraging bioenergy production through retention and expansion of distributed generation sources, combined heat and power, promotion of district energy production, and establishment of forest biomass power plants. Development of small-scale biomass power generation, close to forest resources should be a priority.

Implementation Mechanisms

[1] Howard and Marland, application of GORCAM Model (1998)—will get the specific citation for research and modeling analysis for three Vermont community applications (i.e., combining biomass and district energy—economic and environmental benefits).

- Vermont is currently experiencing a market transition away from providing raw material for paper production. The biomass that would normally be used for paper production should be shifted over to use for energy production. Currently 12-15% of harvested biomass is going to paper production.
- Productivity increases in AFW-5 may also increase feedstock supply
- Other implementation mechanisms might address the retention and use of wood pallets in Vermont.

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–7. Forest Protection – Reduced Clearing and Conversion to Non-forest Cover

Mitigation Option Description

Reduce losses of forested lands and their carbon sequestration potential to development or other non-productive land uses. Forestland captures and stores carbon dioxide in trees, soil and other forest biomass. Developed areas contain lower amounts of biomass and its associated carbon. These developed areas also sequester less carbon dioxide than forested areas.

Mitigation Option Design

- **Goals:** Reduce the rate of forest loss by 50%
- **Timing:** Reduce the rate of forest loss by 7% by 2010 and 50% by 2028.
- **Coverage of parties:**
- **Other:** Chittenden County alone experienced a 4.4% loss in forestland over the past 15 years. [Will add data on current rates of forest loss in VT]

Implementation Mechanisms

- Increased enrollment in the Use Value Appraisal Program (see Related Policies/Programs in Place)
- Incentives to reduce parcelization
- Incentives to maintain forest cover in developed uses
- Encourage forest stewardship and best practices

Related Policies/Programs in Place

Housing and Conservation Board, Use Value Appraisal Program, Forest Legacy Program, Land Trust activity, Regional Planning Commissions, Growth Centers Legislation, Act 200, Act 250, Forest Stewardship Program, Urban & Community Forestry Program; Agency of Natural Resources, Wood Utilization programs; Biomass Energy Resource Center.

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD

- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–8. Expanded Use of Durable Wood Products (especially from VT sources)

Mitigation Option Description

This option covers programs designed to increase the use of durable wood products in VT with an emphasis on wood products produced in VT. Development of markets for high value wood materials promotes the retention of forestland as actively managed, productive forests, thereby enhancing carbon dioxide sequestration. Wood products have lower embodied energy than many types of building materials (e.g. cement, steel). To the extent that wood products displace products with higher embodied energy, GHG emissions can be reduced.

Mitigation Option Design

- **Goals:** Increase the amount of wood from local and out of state production used in materials for residential, institutional and commercial buildings, and in other long lived wood products *by 10% by 2028*. In addition, increase the supply of locally produced durable wood products as a result of increasing forest productivity under AFW 5.
- **Timing:** *By 2012, increase wood products use by 2%; achieve 10% increase by 2028.*
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

Leveraging/expanding the Cornerstone Project and Vermont Sustainable Job Funds (see Related Policies/Programs in Place).

Related Policies/Programs in Place

The Cornerstone Project and Sustainable Jobs Fund: increase the use and production of wood products (e.g., furniture).

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–9. Advanced/Expanded Recycling and Composting

Mitigation Option Description

Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source (e.g., clean wood waste). Reducing the quantify of materials being landfilled reduces future landfill methane emissions potential, while recycling reduces emissions associated with the manufacturing of products from raw materials. Use of waste materials as a fuel source can further reduce emissions by offsetting fossil-based energy sources.

Mitigation Option Design

- **Goals:** Increase per capita diversion to 50% (2005 actual diversion rate is 30%).[2]
- **Timing:** 25% of the goal reached by 2012 (35% diversion rate); 50% diversion by 2028.
- **Coverage of parties:** Federal, state and municipal government, private solid waste and recycling service providers, commercial, industrial and institutional waste generators, Vermont Agency of Natural Resources Solid Waste Division.
- **Other:** Per capita diversion as calculated by ANR Solid Waste Division.

Implementation Mechanisms

Working together in further defining, developing, implementing, and promoting sustainable recycling practices will require an in depth understanding of the cost effectiveness and environmental benefits of recycling.

- Develop advanced recycling infrastructure so that the entire state is able to participate in single stream recycling. Currently only the Chittenden County area is served by single stream recycling.
- Develop an incentive/rewards based recycling infrastructure, coupled with single stream hardware infrastructure, to encourage all Vermont residents and businesses to divert recyclable materials from the waste stream (VT's diversion rate is essentially unchanged

[2] Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Table 2, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm.

in the last several years (2002: 30%, 2003: 31%, 2004: 29%, 2005: 30%[3]) This incentive/reward system could be expanded to include end of life electronics and promote the recovery, reuse and recycling of all obsolete electronic equipment.

- Develop additional processing capacity across the state for processing organic wastes and expand the collection of commercially generated organic waste materials.
- Develop a used clothing recycling program (curb-side and rural drop off model) for used clothing. Approximately 6% of the municipal solid waste stream is used clothing.[4]

Develop an incentive/rewards based recycling infrastructure specifically for construction and demolition material to encourage all Vermont residents and businesses to divert recyclable construction materials from the waste stream (2005 C&D disposed of 99,654 tons).[5]

Related Policies/Programs in Place

- Vermont Environmental Assistance Division – Business Environmental Partnership Program
- Vermont Food Rescue/Waste Division Grants for Organic Diversion
- Vermont Technology and Information Transfer and Exchange Program
- Vermont Construction & Demolition Waste Reduction Assistance Program

Types(s) of GHG Reductions

Net reduction in CO_2 and methane emissions.

CO_2: Upstream Energy Use Reductions – The energy intensity of a manufacturing is generally less using recycled feedstocks than from using virgin feedstocks.

Methane: Diverting organic wastes from landfills will result in a decrease in methane gas releases from landfills.

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

[3] Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Table 2, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm.

[4] U.S. EPA "Waste Wise" retrieved from www.epa.gov/epaoswer/non-hw/reduce/wstewise/pubs/overview.pdf.

[5] Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Summary, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm.

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

- Post consumer organic waste diversion.

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–10. Programs to Reduce Waste Generation

Mitigation Option Description

Institute programs to reduce waste generation at the source to reduce downstream emissions at the waste management site and for transporting these materials to the site. Reducing waste generation can also reduce the emissions associated during manufacturing of the original products.

Mitigation Option Design

- **Goals:** Reduce the rate of municipal solid waste generation to 50% below 2005 actual rate of 5.40 pounds per person per day.[6]
- **Timing:** 25% by 2012; 50% by 2028.
- **Coverage of parties:** Residential, commercial, industrial and institutional waste generators, Vermont Agency of Natural Resources Solid Waste Division
- **Other:**

Implementation Mechanisms

The policy should aim to develop accessible, cost effective and sustainable policies, strategies and educational/media campaigns that will promulgate cultural and behavioral changes across the state with the ultimate goal of reducing the amount of waste generated. The policy should reflect the principles of the waste hierarchy and reduce the generation of all waste.

- Develop prototype residential and commercial waste prevention programs that will validate costs savings realized by the waste prevention.
- Develop a communication portal that will keep all constituents apprised of waste reduction/minimization initiatives and actively promote waste minimization efforts, including the results of prototype programs and specific case studies.
- Develop sector specific waste minimization strategies (schools, hotels, hospitals, restaurants, retail, banks, etc.). Develop these strategies in collaboration with other organizations and the local community.
- Develop an assistance program to provide engineering support to businesses to: 1) reduce product packaging and shipping materials 2) select product packaging and shipping materials that are highly recyclable.

[6] Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Table 2, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm.

- Encourage manufacturers to provide end-of-life management solutions that reduce the environmental impact of waste

Develop and implement a green purchasing program for all state operations, and use that program as a model and encourage adoption of that model by all municipalities and businesses.

Related Policies/Programs in Place

- Vermont Department of Environmental Conservation "Beyond Disposal & Recycling Waste Prevention Stakeholders Forum"
- Vermont Agency of Natural Resources Environmental Assistance Office Partnership

Types(s) of GHG Reductions

Net reduction of CO_2 emissions.

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–11. Water and Wastewater Treatment – Energy Efficiency Improvements

Mitigation Option Description

Energy efficiency programs at water and wastewater treatment plants can reduce GHG emissions by reducing consumption of electricity to run pumps, fans, and other electrical equipment. Included in this option is a review of the potential for installing anaerobic digesters for biosolids and subsequent use of the methane as an energy source for generating electricity (e.g. using internal combustion engines or microturbines).

Mitigation Option Design

- **Goals:** Develop an energy conservation, management and efficiency plan to increase energy efficiency of plant operations by 25%; Use wastewater digester gas to produce energy where feasible.
- **Timing:** 15% by 2012; 25% by 2028.
- **Coverage of parties:** Municipal and private/investor-owned water and wastewater treatment operators, Vermont Agency of Natural Resources Wastewater Treatment Division
- **Other:**

Implementation Mechanisms

An evaluation of the potential for energy efficiency and energy production improvements in municipal and private/investor-owned water and wastewater treatment sector is needed. Energy costs can account for 30% of the total operation and maintenance costs of WWTPs. WWTPs account for 3% in electric load in the United States.[7]

Goals of the assessment are to:

1. Quantify the energy consumed in Vermont's municipal and private/investor-owned water and wastewater treatment sector annually, to establish a baseline for the sector.
2. Assess the potential for energy savings for the sector.
3. Assess the potential for energy production using digester gas (in anaerobic plants).

Near-term opportunities for energy savings:

- Lighting retrofits from T12 systems to T8;

[7] EPA, Wastewater Management Fact Sheet – Energy Conservation, July 2006.

- Heating retrofits from electric heat;
- Installation of high-efficiency influent and effluent pumps, high-efficiency motors and variable frequency drives;
- Evaluate the costs and benefits to second-stage activated sludge mixing and aeration;
- Identify opportunities for peak demand reduction and optimizing load profiles.

Mid-term opportunities for energy savings:

- Co generating electricity and thermal energy on-site; capturing and using anaerobic digester gas.

Related Policies/Programs in Place

Net reduction in CO2 emissions.

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW–12. In-State Liquid Biofuels Production

Mitigation Option Description

This option covers incentives needed to increase biodiesel and ethanol production in Vermont. Use of biodiesel offsets the consumption of diesel fuel produced from petroleum (petrodiesel). Since biodiesel has a lower GHG content than petrodiesel, overall GHG emissions are reduced. By producing biodiesel in the state for consumption within the state, the highest benefits can be achieved, since the fuel is transported over shorter distances to the end user. Also, feedstocks for biodiesel production (e.g. vegetable oils) produced from GHG-superior sources than the current dominant feedstock (soybean oil) can produce additional significant reductions. An example of a superior feedstock would be cultivated algae, which is capable of sequestering considerable quantities of CO_2 in its lifecycle and converting it to oil and protein meal.

This option also seeks to offset fossil fuel use (gasoline) with in-state production of ethanol. Offsetting gasoline use with ethanol can reduce GHGs to the extent that the ethanol is produced with lower GHG content. Incentives are needed for the research and production of ethanol, especially from GHG-superior cellulosic crops, forest sources, animal waste, and municipal solid waste.

This option is linked with TLU Option 5 on Alternative Fuels and Infrastructure. This option seeks to achieve incremental GHG benefits beyond the TLU option by promoting in-state production of biodiesel and ethanol using feedstocks with greater GHG benefits than the likely business as usual national production methods. In addition, VT consumption of biodiesel and ethanol produced in-state will produce better GHG benefits than these same fuels obtained from a national market due to lower embedded CO2 associated with transportation of biodiesel and ethanol or its feedstocks from distant sources.

Mitigation Option Design

Goals: The goal levels and timing for increasing production of biofuels in Vermont are shown in the table below.

Phase	Year	Gallons of biodiesel produced in Vermont	Represents percentage of total distillate used in state (in 2006)	Gallons of cellulosic ethanol produced in Vermont	Represents percentage of total gasoline used in state (in 2006)
1	2010	8,000,000	3%	0	0%
2	2015	14,000,000	6%	10,000,000	3%

3	2028	50,000,000	20%	50,000,000	15%

- **Timing:** see table above.
- **Coverage of parties:** State of Vermont, farmers, biofuels producers, fuel retailers, fuel wholesalers, business owners, and relevant agriculture and trade associations.
- **Other:**

Implementation Mechanisms

- Incentives in the form of grants or tax breaks (sales and/or income) for incurred capital costs for feedstock producers (oil crops, methanol/ethanol).
- Streamlined permitting of production facilities. Technical assistance for new producers.
- Incentives and grants for expanded research for oilseed production and processing (including canola and other crops not typically grown in VT).
- Active solicitation of new producers.
- Expanded consumer education to drive demand.
- Expanded producer education to develop skilled workforce.

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

Vermont uses approximately 234,000,000 gallons of distillates (heating oil and on and off-road diesel) and 328,000,000 gallons of gasoline per year[8].

[8] Source: U.S. Dept of Energy, Energy Information Administration. Report: Adjusted Sales of Distillate Fuel by End Use/Vermont. URL: http://tonto.eia.doe.gov/dnav/pet/pet_cons_821dsta_dcu_SVT_a.htm.

Biocardel Vermont, Inc., located in Swanton is due to begin production of biodiesel from soy oil in early 2007 with 4 mgy (million gallon per year) capacity and increase to 8 mgy by 2010. One commercial biodiesel producer is in operation in Winooski, with an annual capacity of just 50,000 gallons. Several other small producers may be approaching commercial status for an additional 150,000 gallons of capacity in 2007-2008

Eighteen Vermont farms are currently showing interest in growing oilseed crops for biofuel (soy, sunflower, canola) and a few have begun producing biodiesel. The Vermont Biofuels Association (VBA), UVM Extension, UVM Ctr for Sustainable Agriculture and VT Sustainable Jobs Fund (VSJF) are collaborating on several integrated research and demonstration projects with several of these farms to assess the feasibility of increased oilseed production to meet both farm livestock feed and fuel (biodiesel) need. Vermont's farms use a total of 6.4 mgy of petrodiesel and heating oil distillates and the VBA estimates that by 2015 over half of Vermont's farm distillate use plus an additional 6 mgy will be produced in state, on 100,000 acres (or 17% of cropland[9]).

With seed funding from the Vermont Agency of Agriculture, a Montpelier company is working with the VBA and Gund Institute (UVM) researchers to optimize the production of algae in *photobioreactors* to be located on dairy farms. Using a patented, but as yet untested technology, the systems are two to three years from being commercially viable. It is estimated that over 100 VT dairies would provide a suitable location for the commercial units. Once established a single *photobioreactor* may be capable of producing above 500,000 gallons per year of high quality biodiesel feedstock (oil) as well as cellulosic feedstock as a 'by-product'.

* Numerous government studies confirm microalgae organisms' ability to sequester abundant amounts of CO_2 through photosynthesis and other biological processes.[10] This potential should also be examined and evaluated as a component of the Governor's Commission on Climate Change.

There is currently no commercial production of ethanol from cellulosic feedstock in the United States. However, recent announcements by New England based cellulosic biomass-to-ethanol company Mascoma Corp. (a national leader in this technology), point to a 15,000 sq.ft. test facility planned for the Rochester, NY area. The facility, to be constructed over the next 12 to 15 months, is expected to operate using a number of agricultural and/or forest products as biomass, including paper sludge, wood chips, switch grass and corn stover. At the New York demonstration facility the company and its strategic partners "will demonstrate the commercial scale production of ethanol from biomass", according to a statement issued by the company president in December 2006.

Vermont has an opportunity to position itself as a creator of sustainably produced biofuels by focusing on cellulosic ethanol and biodiesel derived from stringent agricultural

[9] Source: U.S. Dept of Agriculture, 2002 Census of Agriculture – Vermont. Table 9. URL: http://www.nass.usda.gov/census/census02/volume1/vt/index1.htm.

[10] Source: U.S. Dept of Energy, National Renewable Energy Laboratory. Report June 2001, Kiran L. Kadam; Microalgae Production From Power Plant Flue Gas: Environmental Implications On A Life Cycle Basis. Contract DE-AC36-99-GO10337

and forestry practices. VSJF, the VBA, the Vermont Alternative Energy Corporation (VAEC), and other organizations have already completed preliminary research on the potential of cellulosic ethanol in Vermont. However, biofuels research and development is still at an early stage in Vermont. Tapping the capacity of these and other organizations, including Vermont's educational institutions and the cellulosic ethanol expertise at Dartmouth College should help to accelerate the development of the cellulosic ethanol sector.

Which cellulosic feedstocks grow best in Vermont? VAEC's cellulosic ethanol feasibility study concludes that wood, lumber, forest residue, and grass straw would make up the most likely ethanol feedstocks in Vermont. VAEC believes that10 million gallons of cellulosic ethanol can be produced, with about 60,000 acres of land devoted to hay. This is equal to 17 percent of the land currently devoted to forage in Vermont (and 4.8 percent of all agricultural land in Vermont). According to the Vermont Division of Forestry, there are over 140 million tons of wood in Vermont's forests. The McNeil Generating Station in Burlington uses 180,000 tons of wood per year (less than one percent of the total). Statistics for 2003 show that less than one percent (1,096,382 tons) of Vermont's total amount of wood was harvested.

- With a yield of 66 gallons of ethanol per bone dry ton of forest residues, 151,515 tons of residue (less than one percent of the total amount of wood in Vermont's forests) would be required to produce 10 million gallons of cellulosic ethanol.

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD