# Chapter 7
# Agriculture, Forestry, and Waste Management Sectors

## Overview of GHG Emissions

The agriculture, forestry, and waste management (AFW) sectors are responsible for moderately low amounts of Michigan's current greenhouse gas (GHG) emissions. The total AFW contribution to carbon dioxide equivalent ($CO_2e$) gross emissions in 2005 was 14 million metric tons (MMt), or about 6% of the state's total. It is important to note that the AFW sector emissions exclude combustion-related GHGs, such as diesel fuel consumption in the agriculture sector. These fuel combustion emissions are included as part of the industrial fuel combustion sector (and covered in the Residential, Commercial, and Industrial Sectors chapter). The AFW contribution to net emissions in 2005 was less than 1% of the state's total after accounting for the net sequestration of carbon in the forestry sector.

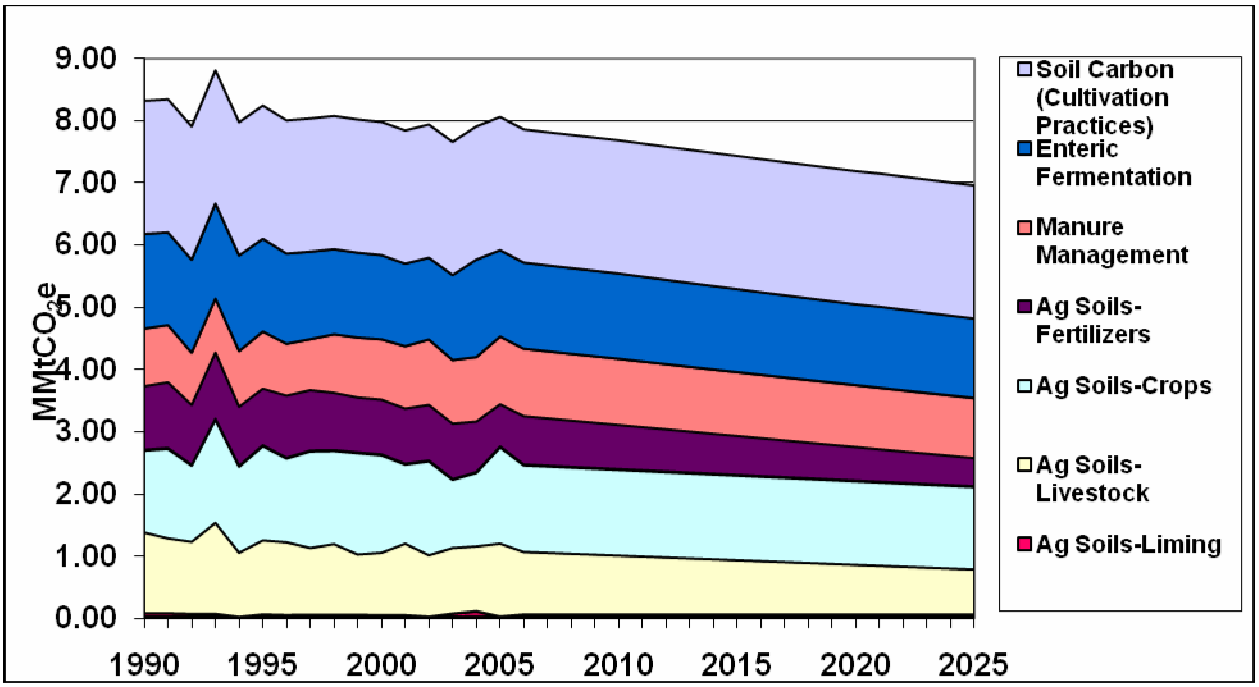
Agricultural emissions include methane ($CH_4$) and nitrous oxide ($N_2O$) emissions from enteric (intestinal) fermentation, manure management, agriculture soils, and agriculture residue burning. As shown in Figure 7-1, emissions from soil carbon losses from agricultural soils, livestock soils, manure management, enteric fermentation, and fertilizer application all make significant contributions to the sector totals. Emissions include $CO_2$ emissions from oxidized soil carbon, application of urea, and application of lime. Sector emissions also include ($N_2O$ emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic and livestock manure) application, production of nitrogen-fixing crops (legumes), and agricultural burning activity.

Note that, in keeping with U.S. Environmental Protection Agency (EPA) methods and international reporting conventions, the Michigan inventory and forecast covers sources of GHGs from human activities. There could be some natural sources of GHGs that are not represented in the inventory and forecast; however these are not addressed in the Michigan Climate Action Council (MCAC) process. In the forestry sector, since all of the state's forests are managed in some way, all emissions are treated as "anthropogenic," or from human activities. GHG reporting conventions treat all managed forests as anthropogenic sources. Sources, such as $CO_2$ from forest fires and decomposing biomass, are captured within the inventory and forecast (as part of the carbon stock modeling performed by the U.S. Forest Service [USFS]). However, $CH_4$ emissions from decomposition of organic matter/biomass in forests are not currently captured due to a lack of data. This methane is from decomposition in oxygen-free (anaerobic) areas, particularly marshes and bogs.

The $CO_2$ emissions occurring from the cultivation of organic soils are a large contributor to the state's total agricultural GHG emissions. By 2025, the contribution from this source is estimated to be about 30% of the total agriculture emissions. The next-highest contributor in 2025 is estimated to be agricultural soils from crop production, at about 19% (including $N_2O$ from decomposition of crop residue). Methane emissions from digestive processes in ruminant animals, known as enteric fermentation, are declining slightly due to lower animal populations; however, they are estimated to be the third-highest contributor to agriculture sector totals in 2025, also at around 19%.

Forestry and land use emissions refer to the net $CO_2$ flux[1] from forested lands in Michigan, which account for about 53% of the state's land area. The inventory is divided into two primary subsectors: the forested landscape and urban forestry and land use. Both subsectors capture net carbon sequestered in forest biomass, urban trees, landfills, and harvested wood products. In addition, other GHG sources, such as $N_2O$ emissions from fertilizer application in urban areas and $CH_4$ and $N_2O$ emissions from prescribed burns and wildfires, are included.

**Figure 7-1. Historical and projected gross GHG emissions from the agriculture sector, Michigan, 1990–2025**




$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

As shown in Table 7-1, USFS data suggest that Michigan's forests sequestered about 12.7 $MMtCO_2e$ per year in 2005 (this excludes estimates of carbon flux from forest soils based on recommendations from the USFS). The negative numbers in Table 7-1 indicate a $CO_2$ sink rather than a source. Even after accounting for the GHG sources from urban soils and prescribed burns/wildfires, the forestry and land use sectors are still estimated to have been a net GHG sink. Hence, during this period, forest carbon losses due to forest conversion, wildfire, and disease were estimated to be smaller than the $CO_2$ sequestered in forest carbon pools, such as live trees, debris on the forest floor, and forest soils, as well as in harvested wood products (e.g., furniture and lumber) and the disposal into landfills of forest products. The forecast for the sector out to 2025 remains a net sequestration of –12.7 $MMtCO_2e$.

[1] "Flux" refers to both emissions of $CO_2$ to the atmosphere and removal (sinks) of $CO_2$ from the atmosphere stored in plant tissue or soils.

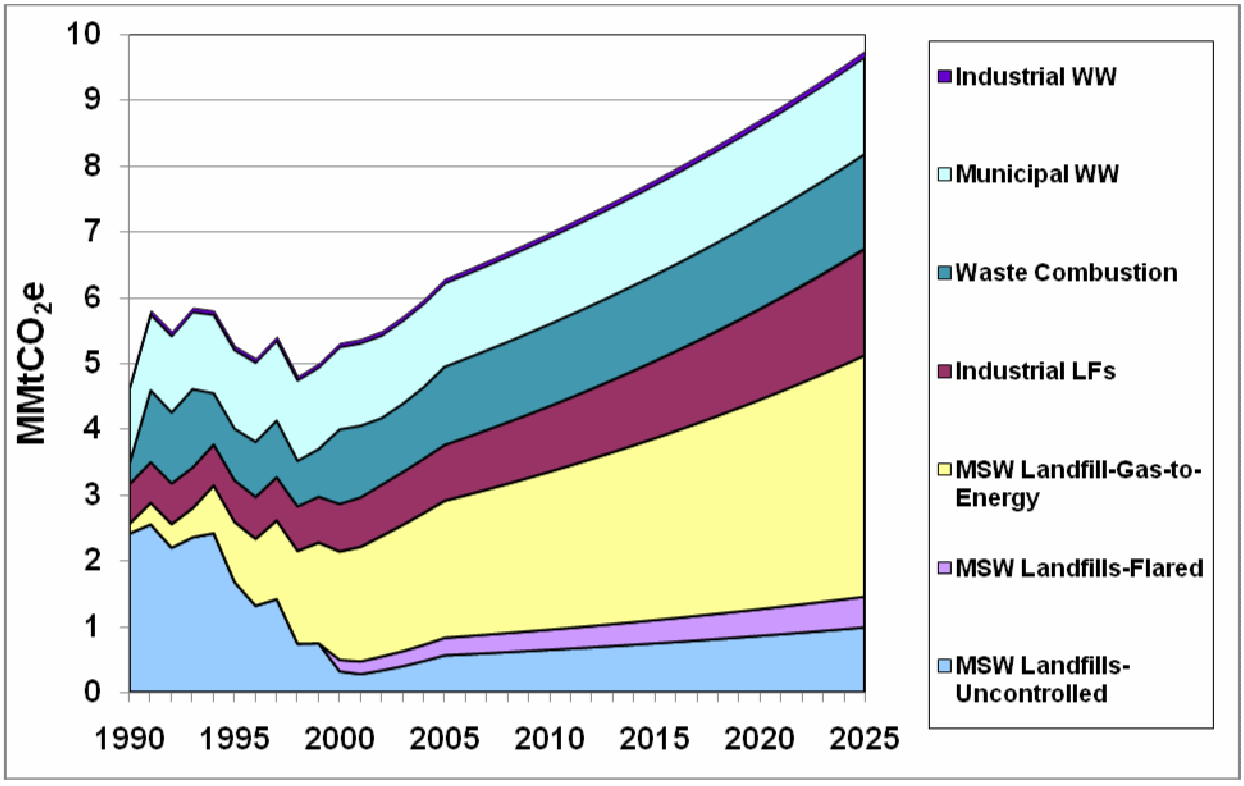
**Table 7-1. Forestry and land use flux and reference case projections ($MMtCO_2e$)**

| Sector | 1990 | 2000 | 2005 | 2010 | 2020 | 2025 |
|---|---|---|---|---|---|---|
| Forested Landscape (excluding soil carbon) | –27.8 | –8.77 | –8.77 | –8.77 | –8.77 | –8.77 |
| Urban Forestry and Land Use | –10.1 | –3.69 | –3.91 | –3.91 | –3.91 | –3.91 |
| Forest Wildfires | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| **Sector Total** | **–37.9** | **–12.4** | **–12.7** | **–12.7** | **–12.7** | **–12.7** |

Note: Positive numbers indicate net emission. Based on USFS input, emissions from soil organic carbon are left out of the forestry sector summary due to a high level of uncertainty.

Figure 7-2 shows estimated historical and projected emissions from the management and treatment of solid waste and wastewater. Emissions from waste management consist largely of $CH_4$ emitted from landfills, while emissions from wastewater treatment include both $CH_4$ and $N_2O$. Emissions are also included for municipal solid waste (MSW) combustion. Overall, the waste management sector accounted for about 3% of Michigan's total gross emissions in 2005. While emissions are expected to grow significantly by 2025, the contribution to the state's total is expected to remain at about 3%.

**Figure 7-2. Estimated historical and projected GHG emissions from waste and wastewater management in Michigan, 1990–2025**




$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MSW = Municipal Solid Waste; LFs = landfills; WW = wastewater.

## Key Challenges and Opportunities

Michigan has substantial opportunities to reduce emissions in the AFW sectors. The principal means to reduce emissions in these areas are:

- Improving methods for managing municipal solid waste,
- Adopting management practices to increase carbon sequestration in both forestlands and urban canopies,
- Improving production and utilization of biomass for use in both solid fuel and liquid fuel applications, and
- Promoting farming practices that result in GHG savings.

Opportunities for GHG mitigation in the AFW sectors involve measures that can reduce emissions within these sectors or reduce emissions in other sectors. Within these sectors, changes in crop cultivation can reduce GHG emissions by building soil carbon (indirectly sequestering carbon from the atmosphere) or through more efficient nutrient application (reducing $N_2O$ emissions and embedded GHG emissions within those nutrients). The implementation of improved farming and harvesting techniques, as well as utilization of biomass for bio-based products, has the potential to reduce future emissions relative to current emissions from this sector and other sectors.

Enhanced management of the state's forests can lead to higher levels of carbon sequestration. These enhancements can be achieved through afforestation projects and enhanced stocking in existing forests. Conversion of land to development results in a loss of current and future carbon sequestration potential. Slowing or stemming conversion rates provides opportunities for carbon sequestration. In the waste management sector, waste reduction measures and landfill gas capture and utilization can reduce landfill $CH_4$ emissions.

Actions taken within the AFW sectors can also lead to GHG reductions outside the sectors: the establishment of short-rotation woody crops (for example, on marginal agricultural lands) for producing biomass energy feedstocks can replace fossil fuel consumption, including transportation fuels and fuels used to produce electricity or steam in the energy supply (ES) sector. Similarly, actions that promote solid waste reduction, recycling, or use of waste sources for energy or bio-based products can reduce emissions within the sector (future landfill $CH_4$ as noted above), as well as emissions associated with the production of products and packaging (recycled products often require less energy to produce than similar products from virgin materials). Finally, urban forestry projects can reduce energy consumption within buildings through shading and wind protection.

## Overview of Policy Recommendations and Estimated Impacts

The MCAC recommends a set of 10 policies for the AFW sector that offer the potential for major economic benefits and emission savings. Implementing these policy recommendations could lead to emission reductions of:

- 17 $MMtCO_2e$ per year by 2025, and

- 147 $MMtCO_2e$ cumulative from 2009 through 2025, after adjusting for overlaps with other sectors.

The weighted-average cost-effectiveness of the recommended policies is about –$11/$tCO_2e$, representing a cost savings. This average value includes policies that have both much lower and much higher likely costs per ton.

The 10 policy recommendations for the AFW sectors address a diverse array of activities capturing emission reductions both within and outside of these sectors (e.g., energy consumption in the ES and Transportation and Land Use [TLU] sectors). The estimated impacts of the individual policies are shown in Table 7-2. The MCAC policy recommendations are described briefly here and in more detail in Appendix J of this report. The recommendations not only result in significant emission reductions, but also offer a host of additional benefits, including protection of biodiversity, reduced local air pollution, and economic development and job growth. To yield the levels of savings described here, the recommended policies need to be implemented in a timely, aggressive, and thorough manner.

The following are primary opportunities for GHG mitigation identified by the MCAC:

- **Agricultural crop production:** Programs can be implemented with growers to utilize cultivation practices that build soil carbon and reduce nutrient consumption. By building soil carbon, $CO_2$ is indirectly sequestered from the atmosphere. New technologies in the area of precision agriculture offer opportunities to reduce nutrient application and fossil fuel consumption. Promotion of local food production could reduce the transportation miles and fossil fuel use associated with importing food products from other areas.
- **Production of liquid biofuels:** Production of renewable fuels, such as ethanol from crop residue, forestry biomass, or municipal solid waste and biodiesel from waste vegetable oils, can produce significant reductions when they are used to offset consumption of fossil fuels (e.g., gasoline and diesel in transportation and other combustion sources). This is particularly true when these fuels are produced using processes and/or feedstocks that have much lower fossil fuel inputs than those from conventional sources (sometimes referred to as "advanced" or "next generation" biofuels). The goals to produce more biofuels in-state are linked to the recommendations under TLU-1, Promote Low Carbon Fuel Use in Transportation. The costs and benefits of liquid biofuels production are combined with the TLU policy on biofuels consumption and presented with the results for that sector.
- **Expanded use of forest, agricultural, and MSW biomass:** Expanded use of renewable energy and bio-based products from biomass removed from forests, crop residues, lawn and garden waste, or MSW can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam) and replacing fossil-based products. Programs to expand sustainably produced biomass fuel production will most likely be needed to supply a portion of the fuel mix for the renewable energy goals of policy recommendation ES-1, Renewable Portfolio Standard.
- **Enhancement/protection of forest carbon sinks:** Through a variety of programs, enhanced levels of $CO_2$ sequestration can be achieved and carbon can be stored in the state's forest

biomass. These include afforestation[2] projects, reforestation programs (restocking of poorly stocked forests), urban tree programs, and wildfire risk reduction. Programs aimed at reducing the conversion of forested lands to non-forest cover will also be important to retain what is currently a net forest $CO_2$ sink in Michigan.

- **Changes in MSW management practices:** By promoting source reduction, advanced MSW recycling practices, improved organics management, and increased collection and utilization of landfill methane, the GHG emissions associated with collecting, transporting, and managing MSW can be reduced. The emissions reduced in this sector would come primarily from waste management but may also provide a reduction in the fossil fuel used to transport waste. When the life-cycle GHG reductions of source reduction/recycling/organics management are considered, the results are substantial: over 35 $MMtCO_2e$/yr could be reduced by 2025.

**Table 7-2. Summary list of AFW policy recommendations**

| Policy No. | Policy Recommendation | | GHG Reductions ($MMtCO_2e$) | | | Net Present Value 2009–2025 (Million 2005$) | Cost-Effectiveness ($/tCO_2e$) | Level of Support |
|---|---|---|---|---|---|---|---|---|
| | | | 2015 | 2025 | Total 2009–2025 | | | |
| AFW-1 | Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production | | 3.3 | 10 | 79 | $1,649 | $21 | Unanimous |
| AFW-2* | In-State Liquid Biofuels Production | | *Included in the Results of TLU-1* | | | | | Unanimous |
| AFW-3 | Methane Capture and Utilization From Manure and Other Biological Waste | | 0.09 | 0.14 | 1.5 | $4.7 | $3 | Unanimous |
| AFW-4 | Expanded Use of Bio-based Materials | A. Use of Bio-based Products | .08 | .21 | 1.7 | –$108 | –$62 | Unanimous |
| | | B. Utilization of Solid Wood Residues | NQ | | | | | Unanimous |
| AFW-5 | Land Use Management That Promotes Permanent Cover | A. Increase in Permanent Cover Area | 0.08 | 0.21 | 1.8 | $63 | $34 | Unanimous |
| | | B. Retention of Lands in Conservation Programs† | 0.05 | 0.11 | 1.1 | $24 | $23 | Unanimous |
| | | C. Retention/ Enhancement of Wetlands | *Not Quantified* | | | | | Unanimous |
| AFW-6 | Forestry and Agricultural Land Protection | A. Agricultural Land Protection | 0.46 | 1.1 | 10 | $864 | $85 | Unanimous |
| | | B. Forested Land Protection | *Not Quantified* | | | | | Unanimous |
| | | C. Peatlands/ Wetlands Protection | *Not Quantified* | | | | | Unanimous |

[2] Afforestation refers to the establishment of forest on lands that have not historically been under forest cover.

| Policy No. | Policy Recommendation | | GHG Reductions ($MMtCO_2e$) 2015 | 2025 | Total 2009–2025 | Net Present Value 2009–2025 (Million 2005$) | Cost-Effectiveness ($/tCO_2e$) | Level of Support |
|---|---|---|---|---|---|---|---|---|
| AFW-7** | Promotion of Farming Practices That Achieve GHG Benefits | A. Soil Carbon Management | 0.7 | 1.7 | 15 | –$200 | –$13 | Unanimous |
| | | B. Nutrient Efficiency | 0.05 | 0.12 | 1.1 | –$27 | –$26 | Unanimous |
| | | C. Energy Efficiency | 0.13 | 0.32 | 2.9 | –$102 | –$35 | Unanimous |
| | | D. Local Food | *Not Quantified* | | | | | Unanimous |
| AFW-8 | Forest Management for Carbon Sequestration and Biodiversity | A. Enhanced Forestland Management | 0.53 | 1.42 | 12.05 | $800 | $66 | Unanimous |
| | | B. Urban Forest Canopy | 1.2 | 2.9 | 26 | –$346 | –$13 | Unanimous |
| | | C. Reduce Wildfire | *Not Quantified* | | | | | Unanimous |
| AFW-9** | Source Reduction, Advanced Recycling, and Organics Management | | | | | | | Unanimous |
| | In-State GHG Reductions | | 1.4 | 3.0 | 28 | –$3,136 | –$112 | |
| | Full Life-Cycle Reductions | | 14.5 | 35.3 | 314 | –$3,136 | –$10 | |
| AFW-10 | Landfill Methane Energy Programs | | 0.91 | 2.7 | 22 | –$35 | –$2 | Unanimous |
| | **Sector Totals†** | | **9** | **23** | **201** | **–$548** | **–$3** | |
| | **Sector Total After Adjusting for Overlaps††** | | **6** | **17** | **147** | **–$1,634** | **–$11** | |
| | **Reductions From Recent Actions** | | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** | |
| | **Sector Total Plus Recent Actions** | | **6** | **17** | **147** | **–$1,634** | **–$11** | |

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; TBD = to be determined; N/A = not applicable

Note that negative costs represent a monetary savings.

* The quantification results for AFW-2 (biofuel production volumes and costs) were used as inputs to the quantification of the results of TLU-1, which covers consumption of biofuels in Michigan.

** The analyses for AFW-5, AFW-7, and AFW-9 include the full life-cycle costs of the policies. In the case of AFW-9, it is estimated that a significant fraction of the reductions will occur out of state. In-state reductions refer only to those occurring from reduced landfilling and waste combustion (these are broken out separately in the table above).

† The reductions from AFW 5B (Retention of Lands in Conservation Programs) have been left out of the sector totals, since they relate to a soil carbon protection measure where the estimated emissions (from conservation acres being returned to active cultivation) are not included in the business as usual (BAU) inventory and forecast (I&F). The costs have been included in the sector totals, since these will be incurred in order to retain the level of emissions in the BAU I&F. For AFW-5, AFW-7, and AFW-9, these include the reductions that are expected to occur within the state.

†† See below for discussion of overlap adjustments.

## Overlap Discussion

The amount of GHG emissions reduced or sequestered and the costs of a policy recommendation within the AFW sectors in some cases overlap with other AFW policies or policies in other sectors. For the MCAC recommendations, overlap occurs between AFW-9 and AFW-10 in the waste management sector. One of the policy elements of AFW-9 covers enhanced management of organic wastes in the MSW sector. To the extent that these wastes are being diverted from landfills to other waste management facilities (e.g., composting facilities), less organic waste is available to generate landfill methane. This effect has been accounted for in the quantification of AFW-10; hence, the values shown for AFW-10 above assume successful implementation of AFW-9.

Overlap also occurs with some of the quantified benefits and costs of policy recommendations within other sectors. Every effort has been made to determine where those overlaps occur and to eliminate double counting. As displayed in the table above, the AFW sector totals have been adjusted accordingly, as follows:

- AFW-1 outlines how biomass may be utilized for energy production. The ES Technical Work Group (TWG) also quantified the use of biomass for energy production (specifically ES-1 and ES-10). AFW-1 utilizes a greater amount of biomass than the ES policies post-2011. The biomass demand requirements for ES (in millions of British thermal units) and the GHG reductions and costs associated with its use were removed from the AFW sector totals in the table above, as these were considered to be accounted for under the ES analyses.
- AFW-2 outlines how biofuels could be produced in-state to offset GHG emissions from fossil-based fuels (primarily in the transportation sector). The TLU TWG also quantified the benefits and costs of increased use of biofuels in TLU-1. To avoid double counting, the goals of biofuel production in AFW-2 and biofuel consumption in TLU-1 were aligned, and then the estimated AFW-2 biofuel production volumes and costs were used as input to the analysis of biofuel consumption under TLU-1. Hence, the benefits and costs of AFW-2 are captured in the overall results of TLU-1. To avoid confusion, those results are left out of the summary table above. The quantification of production volumes and costs is still included in the AFW-2 documentation shown in Appendix J.

## Agriculture, Forestry, and Waste Management Sector Policy Descriptions

The AFW sectors include emission mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and agricultural carbon sinks, control of agricultural $N_2O$ emissions, production of renewable liquid fuels, afforestation and forest management, and lower municipal solid waste management emissions.

### AFW-1. Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production

This policy dedicates a sustainable quantity of biomass from agricultural crop residue, wood industry process residues, unused forestry residues, and MSW biomass resources for efficient conversion to energy and economical production of heat, steam, or electricity. This biomass should be used in an environmentally acceptable and sustainable manner, considering proper facility siting and feedstock use, including co-location of production facilities with heat- and steam-utilizing facilities. The objective is to create concurrent reduction of $CO_2$ due to displacement of fossil fuels, considering life-cycle GHG emissions associated with viable collection, hauling, and energy conversion and distribution systems. This policy includes a recommendation for a complete inventory of the state's biomass resources. The primary goal of this policy is to produce 10% of total in-state electric generation from sustainable biomass feedstock by 2025.

### AFW-2. In-State Liquid Biofuels Production

This recommendation promotes sustainable in-state production and consumption of transportation biofuels from agriculture, forestry, and MSW feedstocks to displace the use of gasoline and diesel. This recommendation also promotes the in-state development of feedstocks, such as cellulosic material, and production facilities to produce either liquid or gaseous biofuels with low carbon content. As with AFW-1, production of biomass for biofuel production must be done in a sustainable manner. Adoption of biofuel production must be done in a way that maintains the sustainability of feedstock, food, and other commodity supplies and natural resources. Upon successful implementation of this policy, Michigan consumption of biofuels produced in-state will result in better GHG benefits than these same fuels obtained from a national or international market due to lower embedded $CO_2$ (resulting from out-of-state fuels produced using feedstocks/production methods with lower GHG benefits, and from transportation of biodiesel, ethanol, other fuels, or their feedstocks from distant sources). Successful implementation of AFW-1 and AFW-2 will also lead to higher levels of in-state energy expenditures remaining in Michigan.

### AFW-3. Methane Capture and Utilization From Manure and Other Biological Waste

This policy seeks to reduce the amount of methane emissions and recapture energy from organic waste materials from livestock, agricultural residues, and solid waste through the promotion of anaerobic digestion, gasification, and other similar technologies. Co-mingling of organic wastes with manure can substantially increase biogas production, while providing a sustainable method for treatment and disposal. In addition, co-products may be created by these technologies, such as stable fertilizer products and building materials. These technologies make a twofold contribution to climate protection: the usual discharge of methane into the atmosphere is prevented, and the burning of fossil fuels is replaced with renewable energy (biogas). The goal of this policy is to reduce GHG emissions from handling, treatment, and storage of livestock manure and organic waste by 15% by 2015 and 25% by 2025 through improved manure management practices and methane utilization.

### AFW-4. Expanded Use of Bio-based Materials

This policy seeks to promote the manufacture, use, recycling, and reuse of materials made from biological products, such as wood, fiber, wheat board, agricultural by-products, biodegradable plastics, and green chemistry applications. These products reduce GHG emissions by sequestering carbon and displacing the production of fossil-based products. Additional GHG reductions can be achieved by promoting the use of Michigan-produced materials, which results in lower transport-associated emissions. This policy does not refer to energy uses, such as electricity or ethanol production, which are covered in AFW-1 and AFW-2. The goals associated with this policy are to utilize 100,000 tons of bio-based products annually by 2025, and to reclaim 150,000 tons of solid wood residues from manufacturing processes, deconstruction sites, and urban/suburban trees annually by 2025.

### AFW-5. Promote Continuous Vegetative Cover

This recommendation is the maintenance and promotion of continuous vegetative cover, such as wind breaks and winter cover crops to prevent soil erosion, increase carbon sequestration, and provide new biomass sources. It also promotes the planting of cover crops with higher carbon content than current cover on marginal lands, including buffer strips, roadsides, on-off ramp areas, and transportation medians. GHG savings occur from carbon sequestration in the vegetative cover, indirect sequestration via carbon accumulation in soil, and reduced fertilizer application. The goals associated with this policy are to increase the acreage of lands with permanent cover by 10% by 2025 (existing land that is not under forest cover); retain 90% of lands coming out of the federal Conservation Reserve Program by 2025 in some type of permanent cover; and reduce rates of carbon loss by restoring or enhancing the maximum feasible percentage of wetlands by 2025.

### AFW-6. Forestry and Agricultural Land Protection

This policy seeks to reduce the rate at which agricultural and forestlands and wetlands are converted to developed uses. The protection of these lands through conservation tools, such as land grants and easements and tax benefits, will retain the above- and below-ground carbon on these lands, as well as the future carbon sequestration potential of these lands. Markets for natural products from agriculture, forests, and wetlands also serve as incentives to keep these lands in their current state rather than convert them to development. GHG reductions come from the prevention of release of carbon from conversion of these lands. Additionally, indirect benefits occur through the reduction of urban sprawl, thus avoiding additional emissions from vehicle miles traveled. The goals associated with this policy are to reduce the rate of conversion from agriculture to developed use by 50% by 2025; maintain or increase forestland acreage by 2025, without converting agricultural land to forest, unless it has higher carbon sequestration potential; and protect and restore northern peatlands and other wetlands to prevent releases of GHGs, which will allow existing peatlands to continue to sequester carbon.

### AFW-7. Promotion of Farming Practices That Achieve GHG Benefits

This recommendation addresses both agricultural soil carbon management, as well as nutrient management to achieve GHG benefits. For soil carbon management, conservation-oriented management of agricultural lands, cropping systems, crop management, and agricultural practices may regulate the net flux of $CO_2$ from soil. This recommendation has four separate elements: (1) soil carbon management, where $CO_2$ reductions occur indirectly via the building of soil carbon levels; (2) nutrient management, where GHG reductions occur through more efficient use of fertilizer, which lowers fossil fuel use though lower application energy requirements in addition to reduced $N_2O$ emissions following application; also, life-cycle GHG reductions associated with the production and transportation of fertilizers are reduced; (3) an energy efficiency element that seeks to reduce GHG emissions by reducing the amount of fossil fuel consumed by farming and harvesting practices through improved technologies and increases in efficiency; and (4) the promotion of locally produced food, which reduces fossil fuel consumption by reducing food miles. The specific goals associated with these four policy elements are: increase conservation tillage farming to 4 million acres by 2025; adopt soil management and nutrient management practices on 5 million acres by 2025; reduce the net on-farm fossil fuel energy consumption by 50% by 2025; and increase the local/regional purchasing of locally grown agricultural produce and products by 50% by 2025.

### AFW-8. Forest Management for Carbon Sequestration and Biodiversity

This recommendation focuses on the state's existing forested lands, recognizing the significant role that Michigan's forests play in lowering the state's net GHG emissions (a sink of ~13 $MMtCO_2e/yr$) and that management could be enhanced to achieve greater net GHG benefits. The goals associated with this policy are: enhance forestland management (including improved stocking of understocked stands) across the state on 1 million acres through afforestation and reforestation by 2025; achieve 40% canopy cover in urban communities by 2025 (this element also provides energy savings through shading and wind protection); and implement wildfire reduction community-wide protection plans for 10–12 identified communities at risk by 2025 (reducing wildfire risk protects forest carbon stores and maintains forest carbon sequestration levels).

### AFW-9. Source Reduction, Advanced Recycling, and Organics Management

This recommendation seeks to improve the GHG profile of MSW management in the state by reducing waste generation, increasing recycling, and improving organics management. GHG savings occur through the reduction in landfill methane generation due to lower amounts of waste being landfilled in the future. Even more important from a GHG reduction perspective are the life-cycle emission reductions achieved via source reduction and recycling. Reducing or recycling products and packaging reduces the GHG emissions associated with their manufacture and transport, leading to significant overall reductions. While a large portion of these reductions would occur out of state, the MCAC recognizes the importance of this recommendation in achieving net GHG benefits. The policy goals are to achieve a 75% MSW recycling and

enhanced organics management rate by 2025, and a 50% recycling rate for industrial, commercial, and new construction waste by 2025.

### AFW-10. Landfill Methane Energy Programs

The renewable energy (methane) created at landfills during anaerobic degradation of wastes unable to be utilized in recycling and compost programs can be used to displace fossil fuel through the installation of methane control and collection systems. The goal of this policy is to implement controls or waste management options at MSW landfills, such that 50% of the methane emissions are avoided by 2025 that would be generated under business-as-usual conditions.