Biomass Inventory: Animal Waste to Energy

- Estimate based on 2005 data for Michigan cattle, poultry, and hogs, using Michigan Department of Agriculture estimates for average manure solids per animal unit.
- Estimates exclude sheep, horses and other livestock, and do not assume any organic co-feeds available on the farm such as crop waste or feed spoilage.
- Estimate assumes only 55% of the DTY are located on farms of sufficient size (CAFO), and with sufficient economic incentive, to install biogas/energy generating systems.
- The estimate does not assume additional air quality regulations are imposed on farms, which could significantly increase the number of farms deciding to (or forced to) install systems.

Livestock Type	Number	GAL/Day	% Solids	Dry Tons/Yr	Biogas Potential (CF/dt)	1000 CF Biogas/Yr (60% CH4)	MM BTU/ YR
Milk Cows	311,000	25	8%	908,120	9,835	8,931,360	5,401,687
Other cattle	500,000	10	14%	1,022,000	9,835	10,051,370	6,079,069
Turkeys	5,000,000	0.15	45%	492,750	12,565	6,191,404	3,744,561
Chickens	1,300,000	0.1	40%	75,920	12,565	953,935	576,940
Hogs	950,000	0.5	5%	34,675	22,715	787,643	476,366
			TOTALS	**2,533,465**	**67,515**	**26,915,711**	**16,278,622**

Assuming 100% of the DTY were converted, there would be significant reductions in greenhouse gas emissions due to the aggregation and conversion of methane that would otherwise be emitted to the atmosphere.

Biogas cft/yr	26,915,711,000
% CH4	60%
CH4 cft/yr	16,149,426,600
CH4 tons	336,292
GWP value	7,734,722
Equivalent Metric tons CO2	7,018,804
MWh Production	1,812,977
Add. MT CO2 reduction	1,136,736

Source: Norma McDonald, Phase 3 Investments, proprietary biogas production model
Dulcey Simpkins, Michigan Biomass Energy Program

Renewable Energy Workgroup
Capacity Needs Forum Update

Biomass Inventory: Wastewater Treatment Plant Energy

- A database of wastewater treatment plants (WWTP) was created by water discharge permits, biomass reporting documents, 1985 survey of wastewater treatment plants processes, current wastewater surveys filled out by plants, and waste water website system information.
- Anaerobic digestion can destroy up to 70% of Volatile Organic Solids (VSS), which is the organic material in wastewater sludge. VSS normally comprise 70% of wastewater sludge. The study assumes 40% total solids destruction which is approx 57% Volatile Solids destruction based on 70% VSS. This is a conservative assumption since many systems can achieve 65-70% destruction.
- One lb of VSS destruction produces approximately 17 cubic feet of 600 Btu/ft^3 biogas, or approximately 9-10 thousand Btu. In an efficient system, this amount of gas produces approximately 1 kWh. This is assuming electrical only. The CHP systems also produce approx 1.5 kWh of heat, offsetting boilers that are less than 85% efficient.
- Even though there are no operating CHP systems on the existing anaerobic digester system, based on these figures, existing digesters at Michigan are destroying approx 36,312,000 lbs (~18,800 tons)of volatile organic solids per year--or enough for a constant 4.145 MWh. If the non-digester WWTP systems were to add digesters these would destroy another 132,320 tons of VSS, creating approximately 30.210 MW of power. Including heat these system would produce approx 85 MWh of total energy production.
- Database note: In the digester column, items in bold have been verified where non-bold are from a state study from 1985.

Source: Greg Mulder, Coffman Electric
Dulcey Simpkins, Michigan Biomass Energy Program

New Cellulosic Biomass Production In Michigan

Although there is no argument that agricultural crops will play a roll in Michigan's future energy economy, woody biomass from our forests and other sources has the potential to contribute much more. Initial estimates made here indicate that woody biomass has the potential to contribute more than FOUR TIMES the biomass as non-traditional agricultural sources for the production of heat, electricity, and liquid fuels.

Four broad sources of new biomass are considered here:

1. **Surplus growth from commercial forest land.** Commercial forest land must meet minimal productivity standards and be available for forest management activities (not on restricted or sensitive sites). There are approximately 19.3 million acres of commercial forests in Michigan[1] compared to 8 million acres of agricultural cropland[2]. One third of the annual forest growth is harvested each year to supply Michigan's forest products industry[1]. The remaining two thirds either accumulates in the forest or is lost to mortality. Most of this surplus growth (*15.4 million dry tons*) could be harvested for energy.

2. **Biomass produced on abandoned cropland.** Approximately 3.2 million acres of cropland has been abandoned in Michigan since 1950[3]. Some of this land has been converted into urban sprawl but much of it is standing idle. A complete accounting of this land is not readily available, but here it is assumed that about 1.9 million acres is idle and available for growing willow, poplar, or switchgrass energy crops. If these plantings yielded 3 dry tons per acre per year[4]., this would contribute about *5.7 million dry tons* to the annual energy needs of the state.

3. **Agricultural Residues and Planting on Conservation Reserve Program Lands.** Active cropland is producing a range of commodities, some of which can be diverted into energy feedstocks. These crops are not included here since it is assumed that farming will continue regardless of the end product. The potential for additional production lies in the use of non-traditional sources like crop residues and perennial crops (like switchgrass) growing on Conservation Reserve and Wetland Reserve lands. Together these sources of biomass might yield about *5.1 million dry tons* of biomass[5].

These estimates indicate that there are potentially 27.5 million dry tons per year of <u>new</u> biomass sources available in Michigan (82% from woody sources and 18% from agricultural sources). That is equivalent to 2.75 gigawatts of electric power[6] or 2 billion gallons of ethanol[7].

Michigan's total electric generating capacity is about 29.3 gigawatts[8] and we use about 4 billion gallons of gasoline each year. Biomass resources projected here could meet 10% of our demand for electricity or 35% of our demand for gasoline[9]. Improvements to biomass yields and to conversion efficiencies could steadily increase this potential over the next 10 years.

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[1] Source: USDA Forest Service – Forest Inventory and Analysis for Michigan - 2004. Commercial Forests are those that meet a minimum productivity threshold and are available for timber management.
[2] Source: USDA Agriculture Statistics Service.
[3] Source: USDA Agriculture Statistics Service.
[4] Based on actual yields observed by Michigan State University in northern Michigan.
[5] Source: USDOE National Renewable Energy Laboratory, 2005.
[6] Assuming 10,000 dry tons of biomass will produce 1 Megawatt of electricity.
[7] Assuming 1 dry ton of lingo-cellulosic biomass will produce 72 gallons of ethanol.
[8] Source: US Energy Information Administration / State Electricity Profiles 2002.
[9] Assuming that 1.43 gallons of ethanol are needed to replace 1 gallon of gasoline.