Summary of Massachusetts GHG Emissions

Non-Biogenic GHG Emissions (MMTCO2E)	2006	2007	2008
Energy Total	79.5	82.9	80.1
CO_2 from Fossil Fuel Combustion	76.5	80.0	77.4
Residential CO_2	12.8	13.5	14.2
Commercial CO_2	5.0	5.3	5.7
Industrial CO_2	4.5	4.4	4.1
Transportation CO_2	33.0	33.5	33.6
Electric Sector CO_2	21.2	23.3	19.8
Electricity Imports (CO_2, CH_4, N_2O)	2.9	2.6	3.0
Other Gases	3.0	2.9	2.8
Stationary Combustion, electric sector	0.1	0.1	0.1
Stationary Combustion, except electric sector	0.2	0.2	0.2
Mobile Combustion	1.0	0.9	0.8
Natural Gas and Oil Systems	1.8	1.8	1.8
Industrial Processes	3.1	3.1	3.2
Agriculture	0.3	0.3	0.3
Waste	2.3	2.3	2.4
Gross Emissions	**88.1**	**91.1**	**89.0**

Biogenic Emissions (MMTCO2E)	2006	2007	2008
Energy Total	4.3	4.6	4.6
CO_2 from Biomass Combustion Total	3.8	4.1	3.9
Residential CO_2	0.3	0.4	0.4
Commercial CO_2	0.2	0.2	0.1
Industrial CO_2	0.3	0.3	0.3
Transportation CO_2	1.1	1.4	1.2
Electric Sector CO_2	1.9	1.8	2.0
Electricity Imports (CO_2)	0.5	0.5	0.7
Forest Sequestration	-10.3	-10.6	-10.8
Land Use Change Emissions	1.1	0.9	0.6
Net Biogenic CO_2 Emissions	**-4.8**	**-5.0**	**-5.6**

2006-2008 MA GHG Inventory Development Process

Step 1: Report *SGITool* data, with modifications

The table below is the default output of the *EPA SGITool* (1/2011 version), with the following modifications:

1) The *CO2 Emissions from Combustion of Fossil Fuels Module* and *Stationary Combustion Module* were updated with EIA data through 2008. Only non-biogenic emissions are included on this Process tab (i.e., CO_2 from biomass combustion is not included).
2) The *Emissions from Natural Gas and Oil Systems Module* contains no defaults for MA, so it has been updated using data from U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration "Distribution, Transmission, and Liquid Annual Data" at http://phmsa.dot.gov/pipeline/library/data-stats.
3) The *Industrial Processes Module* output was extrapolated for missing lime production in certain years using a linear least-squares trendline to fill in the missing years' data.
4) The *Methane and Nitrous Oxide Emissions From Agriculture Module* provides the option of applying a "National Adjustment Factor" that reconciles the SGIT methodology for estimating nitrous oxide emissions from agricultural soils with that of the *National Inventory of Greenhouse Gas Emissions* . We have chosen not to apply this adjustment, which will result in a slightly higher and thus more conservative total emissions estimate.
5) The *Solid Waste Module* was modified by entering Massachusetts solid waste combusted and landfilled.

The following sector-by-sector yearly emissions numbers are linked to their corresponding SGIT summary tables, which are included as tabs in this spreadsheet.

Emissions (MMTCO2E)	2006	2007	2008
Energy	79.52	82.90	80.12
CO_2 from Fossil Fuel Combustion	76.52	80.01	77.36
Stationary Combustion	0.23	0.24	0.23
Mobile Combustion	0.97	0.86	0.76
Natural Gas and Oil Systems	1.80	1.79	1.78
Industrial Processes	3.05	3.09	3.17
Agriculture	0.31	0.31	0.31
Enteric Fermentation	0.10	0.09	0.10
Manure Management	0.02	0.02	0.03
Agricultural Soil Management	0.19	0.19	0.18
Waste	2.29	2.28	2.40
Municipal Solid Waste	1.67	1.65	1.76
Wastewater	0.62	0.63	0.63
Gross Emissions	**85.17**	**88.57**	**86.00**

Step 2: Adjust energy data to reflect electricity imports

Estimates of emissions from MA electricity imports for 2006-2008 have been derived following the method for GHG reporting by MA Retail Electricity Sellers, see http://www.mass.gov/dep/air/climate/reporting.htm#rse.

Emissions (MMTCO2E)	2006	2007	2008
Energy	82.46	85.48	83.12
CO_2 from Fossil Fuel Combustion	76.52	80.01	77.36
Residential CO_2	12.78	13.46	14.23
Commercial CO_2	4.99	5.31	5.66
Industrial CO_2	4.53	4.43	4.10
Transportation CO_2	32.97	33.53	33.56
Electric Generation CO_2	21.24	23.27	19.81
Electricity Imports CO_2, CH_4 & N_2O	2.94	2.58	2.99
Other Gasses	3.00	2.89	2.77
Stationary Combustion	0.23	0.24	0.23
Electric Power	0.07	0.08	0.07
Other	0.16	0.16	0.16
Mobile Combustion	0.97	0.86	0.76
Natural Gas and Oil Systems	1.80	1.79	1.78
Industrial Processes	3.05	3.09	3.17
Agriculture	0.31	0.31	0.31
Waste	2.29	2.28	2.40
Gross Emissions	**88.11**	**91.15**	**89.00**

Step 3: Sum electric sector emissions

Emissions (MMTCO2E)	2006	2007	2008
Energy	82.46	85.48	83.12
CO_2 from Fossil Fuel Combustion	55.28	56.75	57.55
Residential CO_2	12.78	13.46	14.23
Commercial CO_2	4.99	5.31	5.66
Industrial CO_2	4.53	4.43	4.10
Transportation CO_2	32.97	33.53	33.56
Electricity Consumption GHGs	24.25	25.92	22.87
Other Gasses, except Electric Sector	2.93	2.81	2.70
Stationary Combustion, except electric sector	0.16	0.16	0.16
Mobile Combustion	0.97	0.86	0.76
Natural Gas and Oil Systems	1.80	1.79	1.78
Industrial Processes	3.05	3.09	3.17
Agriculture	0.31	0.31	0.31
Waste	2.29	2.28	2.40

Gross Emissions	**88.11**	**91.15**	**89.00**

Biogenic CO_2 Emissions & Sequestration

MMTCO_2E	2006	2007	2008
Residential	0.34	0.37	0.39
Commercial	0.16	0.17	0.06
Industrial	0.33	0.34	0.33
Transportation	1.07	1.38	1.15
Electric Power	1.93	1.84	1.99
Electricity Imports	0.50	0.52	0.71
TOTAL Combustion Emissions	4.32	4.61	4.63
Forest Sequestration	-10.3	-10.6	-10.8
Land Use Change Emissions	1.1	0.9	0.6
Net Biogenic CO_2 Emissions	-4.8	-5.0	-5.6

To the extent that biomass harvested in MA is combusted in MA, associated CO_2 emissions are double-reported in combustion and land use change emission

CO_2 Emissions from Combustion of Fossil Fuels & Biomass - MA Summary

"Other" fuels listed in column G; not summed in sectors, only in last row of table

MMTCO_2E	2006	2007	2008	
Residential	12.78	13.46	14.23	
Coal	0.00	0.01	-	
Petroleum	7.22	7.30	7.07	
Natural Gas	5.56	6.16	7.15	
Other	0.34	0.37	0.39	Wood
Commercial	4.99	5.31	5.66	
Coal	0.03	0.05	-	
Petroleum	2.16	1.98	1.77	
Natural Gas	2.80	3.29	3.89	
Other	0.16	0.17	0.06	Wood, Other Biogas, Ethanol
Industrial	4.53	4.43	4.10	
Coal	0.18	0.21	0.21	
Petroleum	2.11	1.84	1.56	
Natural Gas	2.24	2.39	2.33	
Other	0.33	0.34	0.33	Wood, Ethanol
Transportation	32.97	33.53	33.56	
Coal	-	-	-	
Petroleum	32.85	33.40	33.46	
Natural Gas	0.12	0.13	0.10	
Other	1.07	1.38	1.15	Ethanol
Electric Power	21.24	23.27	19.81	
Coal	10.11	10.81	9.64	
Petroleum	1.88	2.39	1.67	
Natural Gas	9.25	10.07	8.49	
Other	1.93	1.84	1.99	Wood, Landfill gas, Biomass portion of Municipal Solid Waste
International Bunker Fuels	0.00	0.00	0.00	
Petroleum	0.00	0.00	0.00	
TOTAL	76.52	80.01	77.36	
Coal	10.33	11.07	9.85	
Petroleum	46.22	46.90	45.53	
Natural Gas	19.96	22.04	21.98	
Other	3.83	4.10	3.92	

CH4 and N2O Emissions from Stationary Combustion - MA Summary

Electric Power from LFG, and Commercial and Industrial from Ethanol added from next tab

MMTCO2E	2006	2007	2008
Residential	0.110	0.118	0.121
N2O	0.031	0.032	0.033
CH4	0.079	0.085	0.089
Commercial	0.030	0.030	0.023
N2O	0.009	0.009	0.007
CH4	0.021	0.022	0.016
Industrial	0.016	0.016	0.015
N2O	0.011	0.011	0.010
CH4	0.005	0.005	0.005
Electric Power	0.071	0.077	0.067
N2O	0.063	0.068	0.060
CH4	0.009	0.009	0.008
TOTAL	0.227	0.242	0.227

Landfill Gas, Biomass portion of Municipal Solid Waste and Ethanol GHG Emissions for specified sectors

Emission Factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 2: Stationary Combustion
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

	MASSACHUSETTS			CO2						CH4						N2O					
	Fuel Type	Fuel Codes from EIA	Form 923 Heat Input Consumed (MMBtu)	IPCC Emission Factors (CO2 kg/TJ) LHV	IPCC Emission Factors (CO2 lb/MMBtu) LHV	IPCC Emission Factors (CO2 lb/MMBtu) HHV	Calculated Biogenic CO2 (lb)	MMTCO2e	MMTCO2e	IPCC Emission Factors (CH4 kg/TJ) LHV	IPCC Emission Factors (CH4 lb/MMBtu) LHV	IPCC Emission Factors (CH4 lb/MMBtu) HHV	CH4 (lb)	CO2e (lb)	MMTCO2e	IPCC Emission Factors (N2O kg/TJ) LHV	IPCC Emission Factors (N2O lb/MMBtu) LHV	IPCC Emission Factors (N2O lb/MMBtu) HHV	N2O (lb)	CO2e (lb)	MMTCO2e
	Biogenic waste(s)			INT'L						INT'L						INT'L					
2006	landfill gas	LFG	1,738,250	54,600	127.00	114.30	198,681,349	0.09	1.74	1	0.00233	0.00209	3,639	76,416	0.00	0.1	0.00023	0.00021	364	112,804	0.00
	biogenic component of municipal solid waste	MSB	17,338,826	100,000	232.60	209.34	3,629,709,823	1.65													
2007	landfill gas	LFG	1,829,535	54,600	127.00	114.30	209,115,191	0.09	1.66	1	0.00233	0.00209	3,830	80,429	0.00	0.1	0.00023	0.00021	383	118,728	0.00
	biogenic component of municipal solid waste	MSB	16,483,504	100,000	232.60	209.34	3,450,656,716	1.56													
2008	landfill gas	LFG	1,985,230	54,600	127.00	114.30	226,911,074	0.10	1.80	1	0.00233	0.00209	4,156	87,273	0.00	0.1	0.00023	0.00021	416	128,832	0.00
	biogenic component of municipal solid waste	MSB	17,868,107	100,000	232.60	209.34	3,740,509,507	1.70													

	MASSACHUSETTS				CO2			CH4							N2O					
	Fuel Type	Fuel & Sector Codes from EIA (use_btu)	use_all_btu released 6-30-11	use_all_btu released 6-30-11	EIA Emission Factors (CO2 lb/MMBtu) HHV	Calculated Biogenic CO2 (lb)	MMTCO2e	Assigned* IPCC Emission Factors (CH4 kg/TJ) LHV	Assigned* IPCC Emission Factors (CH4 lb/MMBtu) LHV	Assigned* IPCC Emission Factors (CH4 lb/MMBtu) HHV	CH4 (lb)	CO2e (lb)	MMTCO2e	Assigned* IPCC Emission Factors (N2O kg/TJ) LHV	Assigned* \IPCC Emission Factors (N2O lb/MMBtu) LHV	Assigned* IPCC Emission Factors (N2O lb/MMBtu) HHV	N2O (lb)	CO2e (lb)	MMTCO2e
	Ethanol		Billion Btu	MMBtu	EIA			INT'L						INT'L					
2006	ethanol commercial	EMCC	17.51063	17,510.63	39.66	694,491.92	0.00031	10	0.02326	0.02093	367	7,698	0.00000	0.6	0.00140	0.00126	22	6,818	0.00000
	ethanol industrial	EMIC	224.25188	224,251.88	39.66	8,894,089.91	0.00403	3	0.00698	0.00628	1,408	29,575	0.00001	0.6	0.00140	0.00126	282	87,317	0.00004
2007	ethanol commercial	EMCC	23.92450	23,924.50	39.66	948,873.45	0.00043	10	0.02326	0.02093	501	10,518	0.00000	0.6	0.00140	0.00126	30	9,316	0.00000
	ethanol industrial	EMIC	237.30715	237,307.15	39.66	9,411,877.08	0.00427	3	0.00698	0.00628	1,490	31,297	0.00001	0.6	0.00140	0.00126	298	92,401	0.00004
2008	ethanol commercial	EMCC	20.54067	20,540.67	39.66	814,666.82	0.00037	10	0.02326	0.02093	430	9,030	0.00000	0.6	0.00140	0.00126	26	7,998	0.00000
	ethanol industrial	EMIC	188.83822	188,838.22	39.66	7,489,543.04	0.00340	3	0.00698	0.00628	1,186	24,905	0.00001	0.6	0.00140	0.00126	237	73,528	0.00003

*Most liquid fuels shown in IPCC Table 2.3 Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction and Table 2.4 for Default Emission Factors for Stationary Combustion in Commercial/Institutional Category.

The following table summarizes the preliminary and final 2006-2008 Massachusetts GHG inventory treatment of Electric sector wood, landfill gas, and municipal solid waste combustion emissions. Changes in the final inventory are italicized.

Fuel Type		preliminary			final		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Wood		CO2 from Fossil Fuel combustion (CO2FFC) module	Stationary module	Stationary module	CO2FFC module	Stationary module	Stationary module
Landfill gas		CO2FFC module	Stationary module	Stationary module	*New tab*	*New tab*	*New tab*
Solid waste	Biomass portion	CO2FFC module	Stationary module	Stationary & Solid Waste modules	*New tab*	*Solid Waste module*	*Solid Waste module only*
	Non-biomass portion	Solid Waste module	missing	Solid Waste module	Solid Waste module	*Solid Waste module*	Solid Waste module

CH4 and N2O Emissions from Mobile Combustion - MA Summary

Total CH4 and N2O Emissions from Mobile Sources (MTCO2E)

Fuel Type/Vehicle Type	2006	2007	2008
Gasoline Highway	892936	779139	672987
Passenger Cars	488905	427619	368441
Light-Duty Trucks	394427	342331	295536
Heavy-Duty Vehicles	8267	7738	7460
Motorcycles	1337	1451	1551
Diesel Highway	10990	11238	11353
Passenger Cars	81	80	78
Light-Duty Trucks	490	626	630
Heavy-Duty Vehicles	10418	10531	10644
Non-Highway	64295	62978	69742
Boats	3710	3050	2980
Locomotives	7107	6639	3429
Farm Equipment	921	734	309
Construction Equipment	13794	14075	13211
Aircraft	35091	34752	46164
Other*	3672	3728	3649
Alternative Fuel Vehicles	4320	4140	3857
Light Duty Vehicles	1381	1336	1189
Heavy Duty Vehicles	2562	2454	2370
Buses	377	350	299
Total	972541	857496	757939

* "Other" includes snowmobiles, small gasoline powered utility equipment, heavy-duty gasoline powered utility equipment, and heavy-duty diesel powered utility equipment.

CH4 Emissions from Mobile Sources (MTCO2E)

Fuel Type/Vehicle Type	2006	2007	2008
Gasoline Highway	49493	45034	41101
Passenger Cars	28877	26108	23533
Light-Duty Trucks	19394	17725	16374
Heavy-Duty Vehicles	686	619	573
Motorcycles	536	582	621
Diesel Highway	722	735	743
Passenger Cars	2	2	2
Light-Duty Trucks	20	26	26
Heavy-Duty Vehicles	699	707	714
Non-Highway	6649	6653	6259
Boats	605	497	486
Locomotives	1242	1160	599
Farm Equipment	254	203	85
Construction Equipment	1824	1862	1747
Aircraft	2239	2439	2859
Other*	486	493	483
Alternative Fuel Vehicles	1139	1149	1117
Light Duty Vehicles	341	330	287
Heavy Duty Vehicles	635	669	701
Buses	163	151	129
Total	58003	53572	49220

* "Other" includes snowmobiles, small gasoline powered utility equipment, heavy-duty gasoline powered utility equipment, and heavy-duty diesel powered utility equipment.

N2O Emissions from Mobile Sources (MTCO2E)

Fuel Type/Vehicle Type	2006	2007	2008
Gasoline Highway	843443	734105	631887
Passenger Cars	460028	401511	344907
Light-Duty Trucks	375033	324606	279163
Heavy-Duty Vehicles	7581	7118	6887
Motorcycles	801	870	930
Diesel Highway	10268	10503	10610
Passenger Cars	79	78	76
Light-Duty Trucks	470	600	604
Heavy-Duty Vehicles	9719	9825	9930
Non-Highway	57646	56325	63483
Boats	3105	2553	2494
Locomotives	5865	5479	2830
Farm Equipment	667	532	224
Construction Equipment	11970	12213	11464
Aircraft	32852	32314	43305
Other*	3186	3235	3167
Alternative Fuel Vehicles	3181	2991	2739
Light Duty Vehicles	1040	1007	901
Heavy Duty Vehicles	1928	1785	1669
Buses	214	199	170
Total	914538	803924	708719

* "Other" includes snowmobiles, small gasoline powered utility equipment, heavy-duty gasoline powered utility equipment, and heavy-duty diesel powered utility equipment.

Emissions from Natural Gas and Oil Systems - MA Summary

Emissions were not calculated for the following sources: Natural Gas Production, Natural Gas Flaring, and Oil.

Emissions (MMTCO2 Eq.)

	2006	2007	2008
Natural Gas	1.80	1.79	1.78
Oil	-	-	-

Emissions by Gas (MTCH4)

	2006	2007	2008
Natural Gas	85,779	85,263	84,868
Production	-	-	-
Transmission	16,602	16,612	16,612
Distribution	69,177	68,651	68,256
Oil	-	-	-
	0	0	0

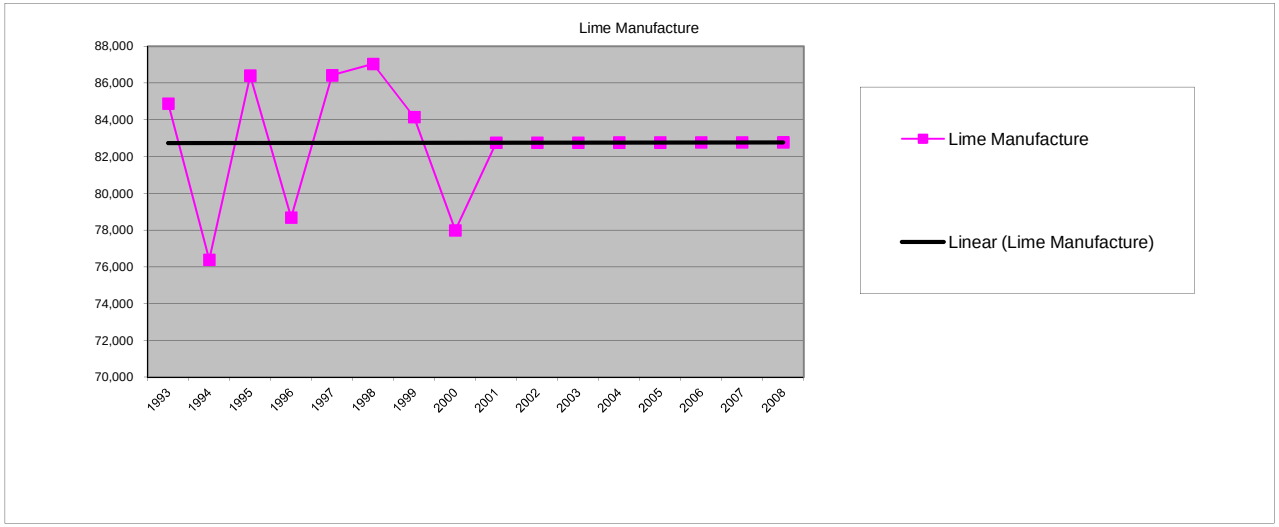
Emissions by Gas (MMTCO2)

	2006	2007	2008
Natural Gas Flaring	-	-	-

Emissions from Industrial Processes - MA Summary

Emissions were not calculated for the following sources: Cement Manufacture, Iron & Steel, Nitric Acid Production, Adipic Acid Production, Magnesium Production, HCFC-22 Production, and Aluminum Production.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Carbon Dioxide Emissions														147,802	142,949	139,225
Cement Manufacture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lime Manufacture	84,887	76,383	86,407	78,683	86,428	87,047	84,154	77,989	82,759	82,762	82,765	82,768	82,770	82,773	82,776	82,778
Limestone and Dolomite Use														9,770	6,681	5,051
Soda Ash														54,913	53,125	51,122
Ammonia & Urea														346	368	274
Iron & Steel Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrous Oxide Emissions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitric Acid Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Adipic Acid Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HFC, PFC, and SF6 Emissions														2,902,369	2,944,732	3,031,918
ODS Substitutes														2,364,859	2,420,150	2,483,074
Semiconductor Manufacturing														323,269	323,738	349,121
Magnesium Production														-	-	-
Electric Power Transmission and Distribution Systems														214,241	200,843	199,723
HCFC-22 Production														-	-	-
Aluminum Production														-	-	-
Total Emissions														3,050,170	3,087,681	3,171,143



= interpolated data

CH4 and N2O Emissions from Agriculture - MA Summary

Note: Totals below do not account for emissions from the following animals, fertilizers, crops, or harvested areas:

Enteric Fermentation:
Manure Management
and Ag Soils-Animal:
Ag Soils-Plant-Residues, Legumes,
Histosols:
Ag Soils-Plant-Fertilizers:
Rice Cultivation:
Ag Residue Burning:

Emissions (MMTCO2 Eq.)

	2006	2007	2008
Enteric Fermentation	0.096	0.094	0.097
Manure Management	0.024	0.024	0.029
Ag Soils	0.186	0.189	0.185
Rice Cultivation	-	-	-
Agricultural Residue Burning	-	-	-
TOTAL	**0.305**	**0.307**	**0.311**

Emissions by Gas (MMTCH4 or MMTN2O)

	2006	2007	2008
Methane	**0.005**	**0.005**	**0.005**
Enteric Fermentation	0.005	0.004	0.005
Manure Management	0.001	0.001	0.001
Rice Cultivation	-	-	-
Agricultural Residue Burning	-	-	-
Nitrous Oxide	**0.001**	**0.001**	**0.001**
Manure Management	0.000	0.000	0.000
Ag Soils	0.001	0.001	0.001
Agricultural Residue Burning	-	-	-

Nitrous Oxide Emissions from Ag Soils (metric tons N2O)

	2006	2007	2008
Direct	**480**	**493**	**484**
Fertilizers	243	236	208
Crop Residues	-	-	-
N-Fixing Crops	7	8	6
Histosols	-	-	-
Livestock	230	248	269
Indirect	**119**	**117**	**112**
Fertilizers	27	26	23
Livestock	17	18	20
Leaching/Runoff	74	73	69
Fertilizer Runoff/Leached	55	53	47
Manure Runoff/Leached	20	20	22
TOTAL	**599**	**610**	**596**

Emissions from Municipal Solid Waste - MA Summary

Total Emissions from Landfills and Waste Combustion (MMTCO2E)

	2006	2007	2008
CH4	(0.294)	(0.232)	(0.313)
CO2	1.919	1.839	2.029
N2O	0.044	0.042	0.045
Total	**1.669**	**1.649**	**1.762**

CH4 Emissions from Landfills (MTCO2E)

	2006	2007	2008
Potential CH4	**2,688,147**	**2,695,808**	**2,693,384**
MSW Generation	2,512,287	2,519,447	2,517,181
Industrial Generation	175,860	176,361	176,203
CH4 Avoided	**(3,015,886)**	**(2,955,247)**	**(3,042,345)**
Flare	(1,578,083)	(1,578,083)	(1,418,581)
Landfill Gas-to-Energy	(1,437,803)	(1,377,163)	(1,623,764)
Oxidation at MSW Landfills	**(50,360)**	**(43,580)**	**(52,516)**
Oxidation at Industrial Landfills	**17,586**	**17,636**	**17,620**
Total CH4 Emissions	**(294,965)**	**(233,495)**	**(314,065)**

CO2, CH4, and N2O Emissions from Waste Combustion (MTCO2E)

Gas/Waste Product	2006	2007	2008
CO2	**1,919,490**	**1,839,364**	**2,029,098**
Plastics	1,313,573	1,238,789	1,337,493
Synthetic Rubber in MSW	195,108	201,544	227,783
Synthetic Fibers	410,809	399,031	463,822
N2O	**43,590**	**41,762**	**45,418**
CH4	**1,181**	**1,132**	**1,231**
Total CO2, CH4 and N2O Emissions	**1,964,261**	**1,882,258**	**2,075,746**

Emissions from Wastewater - MA Summary

Emissions were not calculated for the following sources: Industrial Fruits & Vegetables, Industrial Red Meat & Poultry, and Industrial

Emissions (MMTCO2E)	2006	2007	2008
Municipal CH4	0.43	0.44	0.44
Municipal N2O	0.19	0.19	0.19
Industrial CH4	-	-	-
Fruits & Vegetables	-	-	-
Red Meat	-	-	-
Poultry	-	-	-
Pulp & Paper	-	-	-
Total Emissions	0.62	0.63	0.63

CO_2 Emissions Absorbed by Forest Sequestration and Emissions due to Land Use Change

			Aboveground									Belowground																
	Forest land (acres)[1]	Land Use Change (acres lost)	Carbon stock all trees & shrubs (Mg C)[2,3]	Carbon stock all trees & shrubs (Mg C/acre)[3]	Carbon stock all trees & shrubs (Mg CO_2/acre)	Live sequestration rate (Mg C/acre)[2,3]	Live sequestration rate (Mg CO_2/acre)	Sequestration (Mg CO_2)	Emissions due to LUC (Mg CO_2/acre)[4]	Emissions due to LUC (Mg CO_2)[4]	Net movement (LUC emissions + sequestration; no harvesting) (Mg CO_2)	Soil carbon stock (Mg CO_2/acre)[6]	Live carbon stock (Mg CO_2/acre)[7]	Total carbon stock (Mg CO_2/acre)	Soil carbon sequestration rate (Mg CO_2/acre)[8]	Live sequestration rate (Mg CO_2/acre)[9]	Total sequestration rate (Mg CO_2/acre)	Total sequestration (Mg CO_2)	Emissions due to LUC (Mg CO_2/acre)[10]	Emissions due to LUC (Mg CO_2)[10]	Net movement (LUC emissions + sequestration; no harvesting) (Mg CO_2)	Total carbon stock (Mg CO_2/acre)	Total carbon stock (Mg CO_2)	Total sequestration (Mg CO_2/acre)	Total sequestration (MMg CO_2)	Total emissions due to LUC (MMg CO_2)	Total net movement (LUC emissions + sequestration; no harvesting) (MMg CO_2)
2006	########	6,874	127,470,006	40	147	-0.66	-2.43	**-7,759,403**	103	**705,752**	-7,053,651	183	29	212	-0.3	-0.49	-0.79	**-2,507,899**	64	**437,266**	-2,070,633	359	##########	-3.22	**-10.3**	**1.1**	-9.1
2007	########	5,581	129,306,674	41	149	-0.69	-2.52	**-8,012,665**	104	**582,534**	-7,430,131	183	30	213	-0.3	-0.50	-0.80	**-2,556,489**	64	**356,347**	-2,200,142	362	##########	-3.32	**-10.6**	**0.9**	-9.6
2008	########	3,380	131,261,149	41	152	-0.71	-2.59	**-8,222,726**	106	**358,764**	-7,863,962	183	30	214	-0.3	-0.52	-0.82	**-2,596,827**	64	**216,631**	-2,380,197	365	##########	-3.41	**-10.8**	**0.6**	-10.2

[1]Forest acreage calculated from statewide orthophotos, MassGIS from 2005/2006 (combined) and 2008/2009
Forestland acreage between measured years estimated using residential building permit data (US Census Bureau)

[2]Stock data from FIA 1985, 1998, 2003-2006. Sequestration rate calculated from FIA growth data from the period 1985-1997 and 2006. Fletcher (2009) found 238 Mg CO_2/acre in old growth; 165 Mg CO_2/acre in forest reserves in 2008

[3]Conversion of tree growth to mass: Assumed 38.6 lbs per ft^3 of wood, weighted average of hard and softwood

Average annual net sequestration between 1998 - 2004/5/6 was 2.3 Mg CO_2/acre/yr (FIA FIDO II data retrieval: 25.1 Avg. annual net growth of live trees (> 5in dbh/drc) by species group and owner class (ft^3/yr))

[4]Aboveground land use change emissions: Aboveground, assumed 10% of biomass not removed, 80% of removed stock goes to biomass, fuelwood, or otherwise emitted (estimated 70% of total stock) (Adapted from Wienert, 2006)
Does not include lost future sequestration potential. Emissions based only on loss of existing carbon stock.

[6]Soil density: 50 Mg C/acre (183 Mg CO_2/acre, rounded to 180 Mg CO_2/acre) is an average weighted by forest type measured in 1997 (Heath et al., 2003), supported by 178 t CO_2/acre found in central NH (Wienert, 2006); all other years are estimated using 0.37 Mg CO_2/acre/yr sequestration (see note 7)
"Soil organic matter comprises the largest C pool in may forests, but changes in soil C pool size are difficult to detect because of high spatial variability" (Fahey et al., 2009)
Soil C pools exhibit complex responses to changes in land use such as deforestation and afforestation (Paul et al., 2002)

[7]Belowground biomass stock: 23% of aboveground (Jenkins et al., 2003) in 1985; 20% of aboveground growth used

[8]Soil carbon sequestration: 0.1 ton C/acre/yr (0.37 ton CO_2/acre/yr) (Post and Kwon, 2000; Gaudinski et al., 2000; Hooker and Compton, 2003)

[9]Belowground biomass sequestration: 20% of aboveground sequestration (Barford et al., 2001)

[10]Belowground emissions: assumed 30% of stored C is emitted, counted in the first year of the change (adapted from Weinert, 2006). Because of the slow rate of belowground accumulation, change over this time period assumed to fall within range of error. For purposes of emissions calculations, assumed stock is 50 tons C/acre.

Note: Biogenic CO_2 emissions due to combustion of biomass are reported on tab "CO2_FFC & Biomass," as the "Other" category for each sector.
To the extent that biomass harvested in MA is combusted in MA, associated CO_2 emissions are double-reported in combustion and land use change emissions.