MassDEP GHG Reporting Program Summary Report
For Retail Sellers of Electricity
Emissions Year 2011

December 2013
(with Appendix 3 added March 2014)

The information below summarizes the 2011 greenhouse gas (GHG) emissions and megawatt hours (MWh) of electricity sales reported to the Massachusetts Department of Environmental Protection (MassDEP) by the 77 retail sellers that sold electricity in Massachusetts during that year, as required by MassDEP regulation 310 CMR 7.71. Additional information about MassDEP's GHG program is available at http://www.mass.gov/eea/agencies/massdep/air/climate/ma-greenhouse-gas-emissions-reporting-program.html; see particularly *Retail Seller of Electricity Reporting*. MassDEP will use the information presented here in considering future measures to reduce emissions from the electric sector. This was the third year of reporting under the regulation. 2008 was the initial reporting year. Annual reporting began with the 2010 reporting year. Comparisons of the first three reporting years are provided in this summary.

MassDEP requires retail sellers to report emissions that occur from the generation of the electricity that they sell. The GHGs emitted from power plant smokestacks during combustion of fuels to generate electricity are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Biogenic and non-biogenic GHG emissions are reported separately. Biogenic GHG emissions are emissions of CO_2 that result from the combustion of biogenic (plant or animal) material, excluding fossil fuels. Non-biogenic GHG emissions include CO_2 released from the combustion of non-biogenic fuel, plus CH_4 and N_2O released from the combustion of any fuel.

For 2011, the retail seller reporting process consisted of 4 steps:

Step 1. Some retail sellers chose to report use of MWh from particular generating units, and any associated emissions.

Step 2. MassDEP developed initial GHG emission factors in terms of pounds of non-biogenic and biogenic GHGs in carbon dioxide equivalents per megawatt hour (lb CO_2e/MWh) based on all of the electricity consumed in Massachusetts.

Step 3. MassDEP developed final GHG emission factors for the electricity consumed in Massachusetts that was not reported in Step 1, by removing the MWh and emissions reported in Step 1 from the initial emission factors developed in Step 2.

Step 4. Retail sellers determined their GHG emissions by multiplying the final emission factors in Step 3 by the energy they sold that they did not report in Step 1, and then adding any emissions reported in Step 1.

The purpose of Step 1 is to allow retail sellers to document the use of clean energy. Because MWh associated with this clean energy are included in Step 2 but excluded in Step 3, the final emission factors are greater than the initial emission factors. For more details on the reporting process and development of GHG emission factors for electricity consumed in Massachusetts, see *Draft 2011 Greenhouse Gas (GHG) Emission Factors to be used by Retail Sellers of Electricity Reporting under 310 CMR 7.71(9) "Reporting Requirements for Retail Sellers of Electricity"* (http://www.mass.gov/eea/docs/dep/air/climate/rse11tsd.pdf).

GHG Emission Factors
For 2011, all Massachusetts- and regional-based emission factors decreased from the 2008 and 2010 values.

Table 1 shows the initial (Step 2) and final (Step 3) emission factors upon which retail seller GHG emissions are based. MassDEP recommends that consumers of electricity wishing to use Massachusetts-specific emission factors to report their GHG emissions from use of electricity should see Appendix 3 to this document for appropriate values. For an explanation of the "Massachusetts-based" and "Regional-based" approaches, see *Draft 2011 Greenhouse Gas (GHG) Emission Factors to be used by Retail Sellers of Electricity Reporting under 310 CMR 7.71(9) "Reporting Requirements for Retail Sellers of Electricity"* (http://www.mass.gov/eea/docs/dep/air/climate/rse11tsd.pdf).

Table 1. GHG Emission Factors for Electricity Consumed in Massachusetts, prior to and after accounting for particular generating units (lb CO_2e/MWh)

	Massachusetts-based approach		**Regional-based approach**	
	Non-Biogenic	**Biogenic**	**Non-Biogenic**	**Biogenic**
Initial Emission Factors: **prior to** accounting for particular generating units (Step 2)				
2008	854	97	700	139
2010	798	97	662	136
2011	686	89	584	122
Final Emission Factors: **after** accounting for particular generating units (Step 3)				
2008	871	98	708	141
2010	824	101	672	138
2011	712	93	595	124

MWh Sold by Retail Sellers and Reported from Particular Generating Units
For 2011, 3 electric utilities, 1 competitive supplier, and 25 municipal electric departments or light boards chose to report MWh from particular generating units in Step 1. All MWh reported from particular generating units in the first three reporting years have been from non-emitting units. The number of optional reporters, the amount of non-emitting MWh and total retail sales they reported, and the percent of non-emitting MWh to total retail sales all continued to increase from 2008 to 2011.

Tables 2 through 4 show the number of retail sellers reporting in 2008, 2010, and 2011, the amounts of non-emitting MWh from particular generating units that they chose to report, and the fuel types and locations of these particular generating units.

Table 2. Number of Retail Sellers Reporting and MWh Reported

		Electric Utilities	Competitive Suppliers	Municipal Light Depts.	Total Retail Sellers
Optional Reporting (Step 1)					
Number of Reporters	2008	2	0	17	19
	2010	2	1	24	27
	2011	3	1	25	29
Non-emitting MWh	2008	267,806	0	1,209,698	1,477,504
	2010	450,034	18,213	1,581,612	2,049,859
	2011	707,893	22,876	1,554,539	2,285,308
Mandatory Reporting					
Number of Reporters	2008	4	22	40	66
	2010	4	31	40	75
	2011	4	33	40	77
Total MWh of Retail Sales	2008	25,514,875	24,806,760	8,154,220	58,475,855
	2010	23,997,222	26,028,871	11,297,116	61,323,209
	2011	23,775,874	25,610,294	8,086,980[1]	57,473,148
Non-emitting MWh as % of Total MWh of Retail Sales					
%	2008	1.0%	0%	14.8%	2.5%
	2010	1.9%	0.1%	14.0%	3.3%
	2011	3.0%	0.1%	19.2%	4.0%

Table 3. Non-Emitting Generation Reported by Retail Sellers by Fuel Type

Fuel Type	Hydro	Nuclear	PV	Wind	Total
2008 MWh Reported (as % of Total)	418,238 (28%)	801,263 (54%)	94 (<1%)	257,909 (17%)	1,477,504 (100%)
2010 MWh Reported (as % of Total)	519,266 (25%)	1,155,435 (56%)	3,590 (<1%)	371,568 (18%)	2,049,859 (100%)
2011 MWh Reported (as % of Total)	714,116 (31%)	1,032,183 (45%)	22,117 (1%)	516,891 (23%)	2,285,307 (100%)

Table 4. Non-Emitting Generation Reported by Retail Sellers by State or Province in which Generator is Located

Location	MA	CT	ME	NH	RI	VT	NY	Quebec	PEI	Total
2008 MWh Reported (as % of Total)	253,532 (17%)	313,238 (21%)	12,192 (1%)	488,558 (33%)	0	0	235,427 (16%)	168,185 (11%)	6,372 (<1%)	1,477,504 (100%)
2010 MWh Reported (as % of Total)	257,262 (13%)	336,674 (16%)	167,106 (8%)	851,812 (41%)	4,222 (<1%)	28,837 (1%)	296,417 (14%)	85,537 (4%)	21,992 (1%)	2,049,859 (100%)
2011 MWh Reported (as % of Total)	406,842 (18%)	336,041 (15%)	241,564 (11%)	771,460 (34%)	4,745 (<1%)	53,448 (2%)	332,825 (15%)	71,594 (3%)	66,788 (3%)	2,285,307 (100%)

[1] Six municipalities show 'Sales for resale' MWh in their *Annual Returns* to the Massachusetts Department of Public Utilities (DPU). Because sales for resale MWh are not retail sales to the end user, municipalities have been asked to subtract the sales for resale MWh from the total MWh shown in their *Annual Returns.* Two municipalities did this in their 2011 GHG reports. For the remaining four municipalities, MassDEP subtracted the sales for resale (totaling 52,109 MWh) from the total MWh reported, resulting in the value shown in Table 2. The corrected, lower MWh values were used in reporting 2011 data throughout this summary. Several additional municipalities also had a few minor rounding or reporting errors resulting in a 1 to 3 MWh difference between what the municipalities reported to MassDEP and to DPU; the DPU value is used throughout this document.

GHG Emissions Reported by Retail Sellers

For 2011, the total reported GHG emissions in all four categories decreased from 2008 and 2010 values, following the trend of the emission factors. The differences in GHG emissions between 2008, 2010, and 2011 within each retail seller type would be caused by changes in the number of reporters, total MWh sales, and percent of MWh reported from particular generating units in Step 1 by each type of retail seller.

Table 5 shows the total GHG emissions reported by the three types of retail sellers. GHG emissions were calculated by each retail seller using the reporting process shown on page 1 of this summary. The GHG emissions reported by each retail seller can be found in Appendix 1.[2]

Table 5. GHG Emissions by Retail Seller Type (Short Tons CO_2e)

	Massachusetts-based approach		Regional-based approach	
	Non-Biogenic	**Biogenic**	**Non-Biogenic**	**Biogenic**
Electric Utilities				
2008	10,995,099	1,237,106	8,937,462	1,779,918
2010	9,701,441	1,189,133	7,911,855	1,624,756
2011	8,212,201	1,072,661	6,862,724	1,430,215
Competitive Suppliers				
2008	10,803,344	1,215,531	8,781,593	1,748,877
2010	10,716,391	1,313,538	8,739,581	1,794,735
2011	9,109,121	1,189,815	7,612,257	1,586,420
Municipal Electric Departments or Light Boards				
2008	3,024,275	340,274	2,458,309	489,578
2010	2,725,588	334,083	2,222,809	456,470
2011	2,324,329	303,599	1,942,381	404,799
Total				
2008	24,822,718	2,792,912	20,177,365	4,018,373
2010	23,143,420	2,836,754	18,874,246	3,875,961
2011	19,645,651	2,566,075	16,417,363	3,421,434

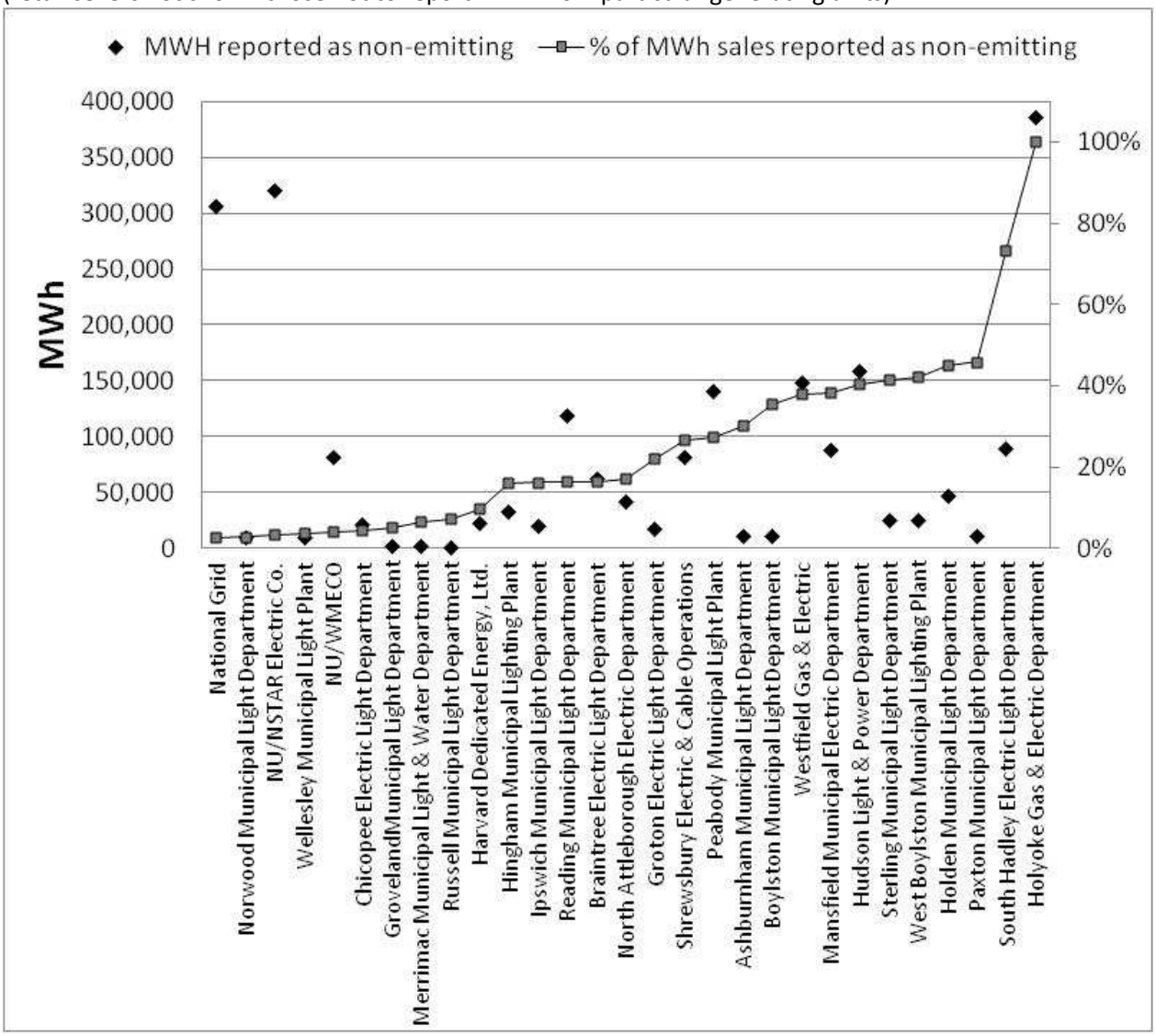
Individual Retail Seller Reporting for 2011

For each retail seller that chose to submit MWh from particular generating units in 2011, "individual" GHG emission factors were determined. These factors represent individual GHG emission rates for each retail seller based on their reported GHG emissions and MWh of electricity sales. The greater the percentage of total MWh electricity sales reported as non-emitting MWh, the lower a retail seller's individual emission factors.

[2] Holyoke Gas & Electric Department reported 385,889 MWh from particular generating units that it owns or contracts with for power. Subtracting this from the 372,655 MWh that Holyoke sold to its retail customers would result in a negative MWh value, negative GHG emission values and negative individual GHG emission rates for Holyoke. While Holyoke is to be commended for its clean power, the regulation at 310 CMR 7.71(9)(d)5. does not allow a retail seller to claim more generation from particular generating units than it sold to its retail customers. Because MassDEP was not aware of this issue, the 2011 EFs shown in Table 1 and finalized in June 2013 credited the full 385,889 MWh in the calculation of the 2011 EFs. Tables 1-4 of this summary report also reflect the full 385,889 MWh. However, MassDEP lists Holyoke's 2011 GHG emissions as zero, and not negative values, in Appendix 1, and in the calculations of the emissions totals shown in Table 5. To prevent this situation from occurring in future reporting years, MassDEP will require municipalities to submit page 57 of their *Annual Return*, showing their total retail sales, with their optional "Step 1" report on MWh from particular generating units. (This page is currently only required with the later mandatory "Step 4" report.)

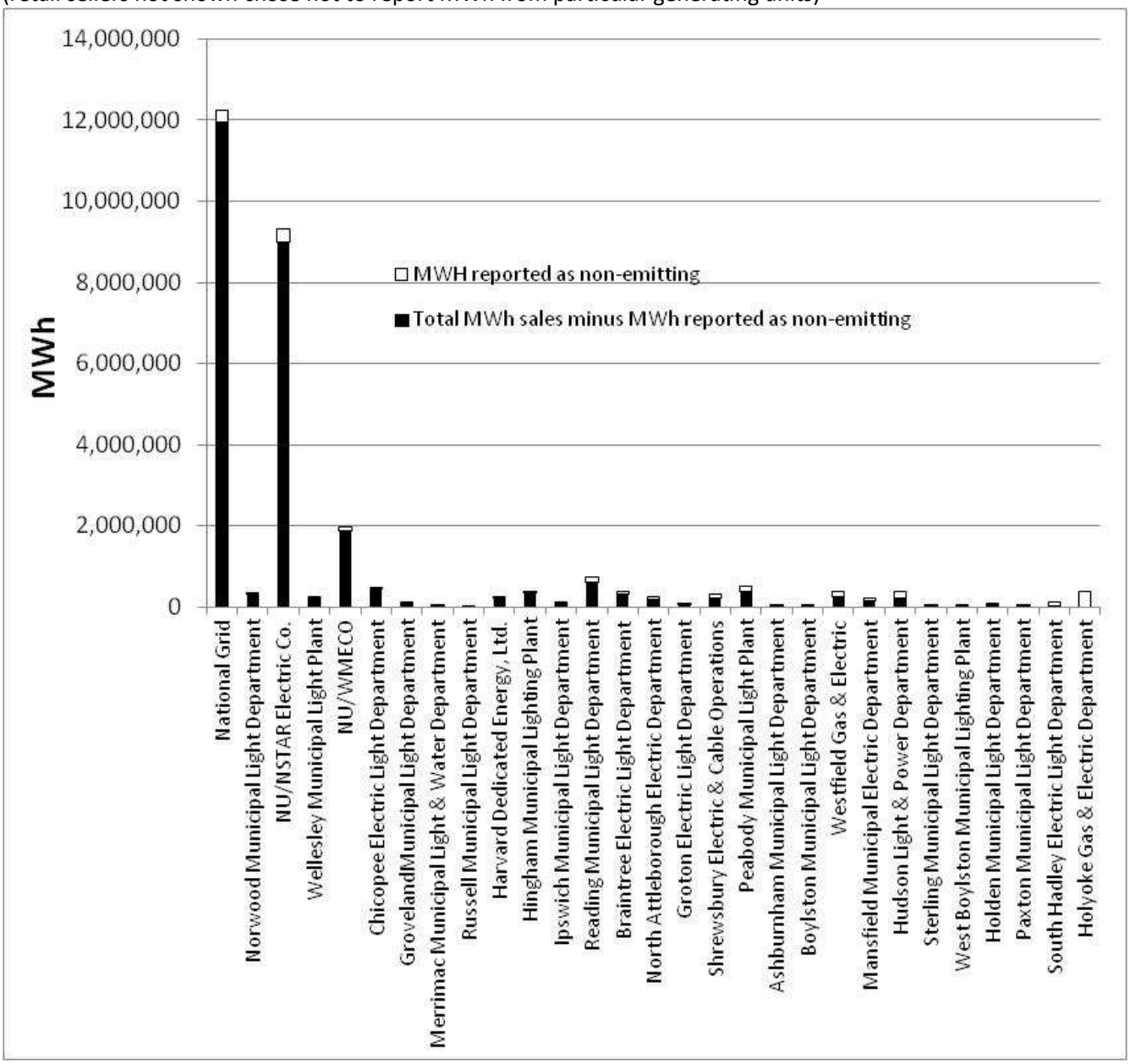
Figures 1 and 2 show the MWh reported, and the % those MWh were of that retail seller's 2011 electricity MWh sales, for each retail seller that chose to report use of particular generating units. To illustrate trends, the figures present the retail sellers in order of increasing percentage of reported non-emitting power. The figures compare optional MWh reported as a percentage of total retail sales, with the second figure showing the variation in total MWh sales. See Appendix 2 below for individual retail values used in these two figures.[3]

Figure 1. 2011 Electricity Sales Reported as Non-Emitting by Retail Seller (MWh and % of sales)
(retail sellers not shown chose not to report MWh from particular generating units)



[3] As explained in footnote 2, MassDEP lists the Holyoke Gas & Electric Department individual GHG emission rates as zero in Appendix 2, and lists Holyoke's percent of non-emitting MWh sales as 100% in Appendix 2 and Figures 1 and 2.

Figure 2. 2011 Electricity Sales by Retail Seller: Non-Emitting vs. All Other MWh Sales Reported
(retail sellers not shown chose not to report MWh from particular generating units)



Appendix 1: 2011 Individual Retail Seller GHG Emissions

Below are 2011 GHG emissions for each retail seller calculated by MassDEP based on:

- the final GHG emission factors from Step 3 above, and
- MWh reported to Department of Energy Resources by electric utilities and competitive suppliers and to DPU by municipal electric departments and light boards, less MWh from any particular generating units that a retail seller reported in Step 1. See footnotes 1 and 2 regarding the municipalities whose emissions differ from what was submitted.

Table 6. 2011 MA Retail Seller GHG Emissions (Short Tons CO_2e)

	Massachusetts-based approach		Regional-based approach	
	Non-Biogenic	**Biogenic**	**Non-Biogenic**	**Biogenic**
Electric Utilities				
NGRID (Mass. and Nantucket Elec.)	4,249,594	55,073	3,551,276	740,098
NU/NSTAR Electric Co.	3,199,681	417,936	2,673,890	557,248
NU/Western Mass. Electric Co.	671,390	87,696	561,063	116,927
Unitil (Fitchburg Gas & Electric Co.)	91,537	11,956	76,495	15,942
Competitive Suppliers				
Cianbro Energy, LLC	258	34	216	45
Consolidated Edison Solutions, Inc.	1,014,272	132,482	847,601	176,643
Constellation NewEnergy, Inc.	1,670,154	218,152	1,395,705	290,870
Devonshire Energy	42,609	5,565	35,607	7,421
Direct Energy Business, LLC	1,322,298	172,716	1,105,010	230,288
Direct Energy Services, LLC	9,001	1,176	7,522	1,568
Dominion Retail, Inc.	555,533	72,563	464,245	96,750
East Avenue Energy, LLC	362	47	303	63
Easy Energy of MA	11,469	1,498	9,585	1,997
First Point Power	85	11	71	15
GDF Energy of Massachusetts, Inc.	966,146	126,196	807,383	168,261
Glacial Energy of Massachusetts, Inc	214,145	27,971	178,955	37,295
Hampshire Council of Governments	19,664	2,568	16,432	3,425
Hannaford Energy	14,611	1,908	12,210	2,545
Harvard Dedicated Energy, Ltd.	77,208	10,085	64,521	13,446
Hess Corporation	699,238	91,333	584,335	121,777
Hudson Energy Services	8,014	1,047	6,697	1,396
Integrys Energy Services, Inc.	138,164	18,047	115,460	24,062
Just Energy Massachusetts	47,624	6,220	39,798	8,294
Liberty Power Holdings	151,116	19,738	126,283	26,318
Mint Energy, LLC	721	94	602	126
MXenergy Electric, Inc.	37,712	4,926	31,515	6,568
NextEra Energy	288,367	37,666	240,981	50,221
Noble Americas Energy Solutions	576,688	75,326	481,924	100,434
Open Book (ECM Energy Mgmt.)	16,094	2,102	13,449	2,803
Pepco Energy Services, Inc.	39,285	5,131	32,830	6,842
Public Power & Utility, Inc.	2,334	305	1,951	407
REP Energy	11,291	1,475	9,436	1,966
South Jersey Energy	28,608	3,737	23,907	4,982
Spark Energy, LP	3,232	422	2,701	563
TransCanada Power Marketing Ltd.	1,142,429	149,230	954,751	198,973
WFM Intermediary NE Energy	325	42	271	57

	Massachusetts-based approach		Regional-based approach	
	Non-Biogenic	Biogenic	Non-Biogenic	Biogenic
Xoom Energy Massachusetts LLC	1	0	1	0
Municipal Electric Departments or Light Boards				
Ashburnham Muni. Light Dept.	5,585	1,121	7,174	1,495
Belmont Municipal Light Dept.	48,128	6,286	40,219	8,382
Boylston Municipal Light Dept.	7,256	948	6,063	1,264
Braintree Electric Light Dept.	113,215	14,788	94,611	19,717
Chester Muni. Electric Light Dept.	2,055	268	1,717	358
Chicopee Electric Light Dept.	157,748	20,605	131,826	27,473
Concord Municipal Light Plant	65,703	8,582	54,906	11,443
Danvers Electric Division	120,084	15,685	100,351	20,914
Georgetown Municipal Light Dept.	18,483	2,414	15,446	3,219
Groton Electric Light Dept.	21,001	2,743	17,550	3,658
Groveland Municipal Light Dept.	13,063	1,706	10,916	2,275
Hingham Municipal Lighting Plant	61,191	7,993	51,136	10,657
Holden Municipal Light Dept.	20,436	2,669	17,078	3,559
Holyoke Gas & Electric Dept.	0	0	0	0
Hudson Light & Power Dept.	83,271	10,877	69,587	14,502
Hull Municipal Lighting Plant	19,631	2,564	16,405	3,419
Ipswich Municipal Light Dept.	36,167	4,724	30,224	6,299
Littleton Electric Light & Water	104,294	13,623	87,156	18,164
Mansfield Municipal Electric Dept.	50,576	6,606	42,265	8,808
Marblehead Municipal Light Dept.	39,892	5,211	33,337	6,947
Merrimac Muni. Light & Water	10,294	1,345	8,603	1,793
Middleborough Gas & Elec. Dept.	93,717	12,241	78,317	16,322
Middleton Muni. Electric Dept.	35,400	4,624	29,583	6,165
North Attleboro Electric Dept.	71,986	9,403	60,157	12,537
Norwood Municipal Light Dept.	116,973	15,279	97,751	20,372
Paxton Municipal Light Dept.	4,720	616	3,944	822
Peabody Municipal Light Plant	132,322	17,284	110,578	23,045
Princeton Municipal Light Dept.	5,756	752	4,810	1,002
Reading Municipal Light Dept.	214,892	28,069	179,580	37,425
Rowley Municipal Lighting Plant	15,924	2,080	13,307	2,773
Russell Municipal Light Dept.	1,693	221	1,415	295
Shrewsbury Electric & Cable Ops.	79,922	10,439	66,789	13,919
South Hadley Electric Light Dept.	11,647	1,521	9,733	2,028
Sterling Municipal Light Dept.	12,702	1,659	10,615	2,212
Taunton Municipal Lighting Plant	253,065	33,055	211,480	44,073
Templeton Muni. Light & Water	22,498	2,939	18,801	3,918
Wakefield Muni. Gas & Light	70,508	9,210	58,921	12,279
Wellesley Municipal Light Plant	84,948	11,096	70,989	14,794
West Boylston Muni. Light. Plant	12,221	1,596	10,213	2,128
Westfield Gas & Electric	82,363	10,758	68,828	14,344
2011 RETAIL SELLER TOTAL GHGs	**19,645,651**	**2,566,075**	**16,417,363**	**3,421,434**

Appendix 2: Individual 2011 Retail Seller Emission Factors

Below are the 2011 GHG emission factors for each retail seller that chose to report use of non-emitting MWh from particular generating units. These factors represent individual GHG emission rates for each retail seller based on their reported GHG emissions and MWh of electricity sales.

Table 7. Individual 2011 Retail Seller Emission Factors

	MWh reported as non-emitting	Massachusetts-based emission factors (lb CO_2e/MWh)		Regional-based emission factors (lb CO_2e/MWh)		% of sales reported as non-emitting MWh
		Non-Biogenic	Biogenic	Non-Biogenic	Biogenic	
Electric Utilities						
NGRID (Mass. and Nantucket Elec.)	306,275	694	91	580	121	2.5%
NU/NSTAR	319,704	688	90	575	120	3.4%
NU/WMECO	81,914	682	89	570	119	4.2%
Competitive Suppliers						
Harvard Dedicated Energy	22,876	644	84	538	112	9.5%
Municipal Electric Departments or Light Boards						
Ashburnham Muni. Light Dept.	10,334	498	65	417	87	30.0%
Boylston Municipal Light Dept.	11,208	459	60	384	80	35.5%
Braintree Electric Light Dept.	62,462	595	78	497	104	16.4%
Chicopee Electric Light Dept.	20,502	681	89	569	119	4.4%
Groton Electric Light Dept.	16,544	556	73	465	97	21.9%
Groveland Municipal Light Dept.	1,900	677	88	566	118	4.9%
Hingham Municipal Lighting Plant	33,001	597	78	499	104	16.1%
Holden Municipal Light Dept.	46,695	393	51	328	68	44.9%
Holyoke Gas & Electric Dept.	385,889	0	0	0	0	100.0%
Hudson Light & Power Dept.	158,436	424	55	355	74	40.4%
Ipswich Municipal Light Dept.	19,600	597	78	499	104	16.2%
Mansfield Municipal Electric Dept.	87,733	440	57	368	77	38.2%
Merrimac Municipal Light & Water Dept.	1,954	667	87	557	116	6.3%
North Attleboro Electric Dept.	41,231	591	77	494	103	16.9%
Norwood Municipal Light Dept.	9,392	692	90	578	121	2.8%

	MWh reported as non-emitting	Massachusetts-based emission factors (lb CO_2e/MWh)		Regional-based emission factors (lb CO_2e/MWh)		% of sales reported as non-emitting MWh
		Non-Biogenic	Biogenic	Non-Biogenic	Biogenic	
Paxton Municipal Light Dept.	11,214	386	50	322	67	45.8%
Peabody Municipal Light Plant	140,225	517	68	432	90	27.4%
Reading Municipal Light Dept.	118,257	596	78	498	104	16.2%
Russell Municipal Light Dept.	374	660	86	552	115	7.3%
Shrewsbury Electric & Cable Ops.	81,124	523	68	437	91	26.5%
South Hadley Electric Light Dept.	88,818	192	25	160	33	73.1%
Sterling Municipal Light Dept.	25,156	418	55	349	73	41.3%
Wellesley Municipal Light Plant	9,039	686	90	573	119	3.6%
West Boylston Municipal Lighting Plant	24,901	413	54	345	72	42.0%
Westfield Gas & Electric	148,550	441	58	369	77	38.0%
All Other Retail Sellers	0	712	93	595	124	**0%**

Appendix 3: 2011 Retail Level Emission Factors to be Used by Consumers of Electricity to Report Greenhouse Gas Emissions

Some electricity consumers have expressed interest in using MA-specific greenhouse gas (GHG) emission factors (EFs) to report their GHG emissions from use of electricity. The EFs shown earlier in this document are often not appropriate for use by electricity consumers for two reasons: first, the EFs earlier in this document are for the combination of CO_2, CH_4 and N_2O when many electricity consumers seek EFs for the individual gases and, second, the EFs earlier in this document are per wholesale MWh, rather than per retail meter MWh (or kWh) that electricity consumers see on their electric bill. In order to assist electricity consumers in reporting GHGs, this appendix presents the 2011 EFs that consumers of electricity would use to report their GHG emissions at a retail electricity level.

Combined, Biogenic & Non-Biogenic EFs: Progress on achieving the *Massachusetts Clean Energy and Climate Plan for 2020* limit of a 25% reduction in GHG emissions from 1990 by 2020 is determined using MA-based emission calculations. Thus, it is MA-Based EFs that consumers of electricity should use to determine GHG emissions. This includes all CO_2, CH_4 and N_2O emissions from non-biogenic (fossil) and biogenic (non-fossil) fuels combusted to generate the electricity sold by retail sellers of electricity in Massachusetts. The Combined EF can be determined by adding the Non-Biogenic and Biogenic EFs together.

2011 RS Wholesale Non-Biogenic MA-Based EF	686 lb Non-Biogenic CO_2e/Wholesale MWh
+ 2011 RS Wholesale Biogenic MA-Based EF	+ 89 lb Biogenic CO_2e/Wholesale MWh
2011 RS Wholesale Combined MA-Based EF	775 lb Combined CO_2e/Wholesale MWh

Wholesale v. Retail EFs (line losses): Power lines lose 7% (on average) of the electricity they carry. The amount of wholesale MWh needed to deliver a particular amount of electricity at the retail level is, therefore, 7% greater than the amount shown on a retail meter. The emissions released to produce the electricity can be spread out over either the larger number of wholesale MWh or the smaller number of retail MWh, such that the retail lb/MWh EF will always be higher than the wholesale lb/MWh EF:

Wholesale Combined EF / (100% of MWh – 7% of MWh due to line losses) = Retail Combined EF
Specifically: 775 lb CO_2e/Wholesale MWh / (1 - 0.07) = 834 lb CO_2e/Retail MWh

Table 8. 2011 MA-Based CO_2e GHG Emission Factors

	Retail Seller Wholesale Level (lb CO_2e/Wholesale MWh)	Electricity Consumer Retail Level (lb CO_2e/Retail MWh)
Non-Biogenic	686	738
Biogenic	89	96
Combined	775	834

Individual CO_2, CH_4, and N_2O EFs: If the entity to which you are reporting requires EFs by individual gas, then the lb CO_2e/MWh value needs to be separated into the individual components: lb CO_2/MWh, lb CH_4/MWh, and lb N_2O/MWh. MassDEP has separated the three gases by alternately zeroing out the other two gases on the 'Calculating CO2e' tab of the retail seller EF spreadsheet at http://www.mass.gov/eea/docs/dep/air/climate/rse11cal.xls. For the 2011 retail level Combined EF, this results in 829 lb of CO_2e from CO_2, 1 lb CO_2e from CH_4, and 3 lb of CO_2e from N_2O. The global warming potential (GWP) of each gas must then be taken into account to determine the EF for each gas. The GWPs used in recent years by MassDEP are: 1 for CO_2, 21 for CH_4, and 310 for N_2O.

lb CO_2e/MWh = ((lb CO_2 *1) + (lb CH_4 * 21) + (lb N_2O * 310)) / MWh

Specifically: 1 lb CO_2e from CH_4 / 21 = 0.051 lb CH_4 *and* 3 lb CO_2e from N_2O / 310 = 0.010 lb N_2O,

therefore

834 lb CO_2e/Retail MWh = (829 lb CO_2 + (0.056 lb CH_4 * 21) + (0.010 lb N_2O * 310)) / Retail MWh

The breakdown of the 834 lb CO_2e/Retail MWh value from Table 8 into individual gases, at various scales of electricity, is shown in Table 9.

Table 9. 2011 Electricity Consumers Retail-level MA-Based CO_2e GHG Emission Factors by Individual Gas

	CO_2e		
	CO_2	**CH_4**	**N_2O**
lb/Retail kWh	0.829	0.000056	0.000010
lb/Retail MWh	829	0.056	0.010
lb/Retail GWh	829,000	56	10

The lb/Retail kWh values in the upper row of Table 9 may be the values most likely to be used by electricity consumers since most electric bills show kWh use. The CO_2, CH_4, and N_2O EFs in lb/Retail GWh shown in the bottom row in Table 9 are used by MassDEP when voluntarily reporting emissions from its operations to The Climate Registry.

The breakdown of the 829 lb CO_2/Retail MWh value from Table 9 into its non-biogenic and biogenic components is shown in Table 10. All CH_4 and N_2O emissions are considered non-biogenic and thus cannot be further broken down.

Table 10. 2011 Electricity Consumers Retail-level MA-Based
Non-Biogenic and Biogenic CO_2 Emission Factors

	CO_2	
	Non-Biogenic CO_2	**Biogenic CO_2**
lb/Retail kWh	0.734	0.096
lb/Retail MWh	734	96
lb/Retail GWh	734,000	96,000