MassDEP GHG Reporting Program Summary Report
For Retail Sellers of Electricity
Emissions Year 2016

May 2019

The information below summarizes the 2016 greenhouse gas (GHG) emissions and megawatt hours (MWh) of electricity sales reported to the Massachusetts Department of Environmental Protection (MassDEP) by the 106 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 reporting program is available at https://www.mass.gov/guides/massdep-greenhouse-gas-emissions-reporting-program; 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 eighth year of reporting under the regulation. 2008 was the initial reporting year. Annual reporting began with the 2010 reporting year. Comparisons of the first eight 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 2016, 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 2016 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"* (https://www.mass.gov/files/documents/2018/05/31/rsef16-tsd.pdf).

GHG Emission Factors

Table 1 shows the initial (Step 2) and final (Step 3) emission factors upon which retail seller GHG emissions are based. The combined non-biogenic and biogenic emission factors have been included in this summary report for information purposes. (Please note that Table 1 presents wholesale emission factors. 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 used to calculate the emission factors in Table 1, see *Draft 2016 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"* (https://www.mass.gov/files/documents/2018/05/31/rsef16-tsd.pdf).[1]

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

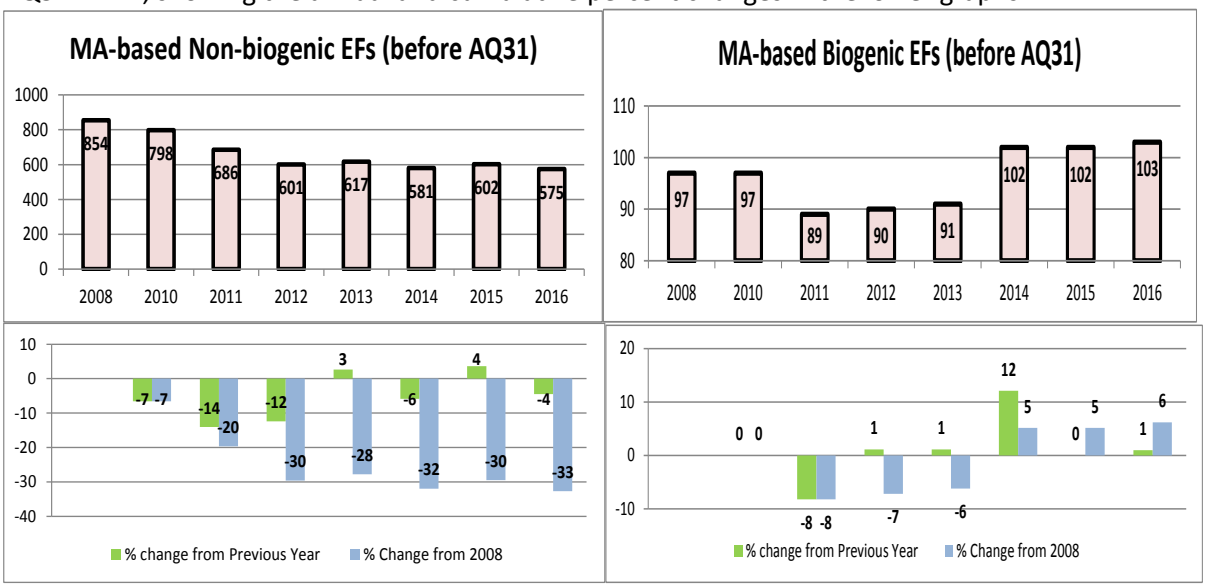
	Massachusetts-based approach			**Regional-based approach**		
	Non-Biogenic	**Biogenic**	**Combined**	**Non-Biogenic**	**Biogenic**	**Combined**
Initial Emission Factors: **prior to** accounting for particular generating units (Step 2)						
2008	854	97	951	700	139	839
2010	798	97	896	662	136	798
2011	686	89	775	584	122	706
2012	601	90	691	535	120	685
2013 corrected[2]	617	91	708	515	118	632
2014	581	102	683	527	132	659
2015	602	102	704	536	139	675
2016	575	103	678	503	141	644
Final Emission Factors: **after** accounting for particular generating units (Step 3)						
2008	871	98	970	708	141	849
2010	824	101	925	672	138	810
2011	712	93	805	595	124	719
2012	628	94	722	546	123	669
2013 corrected	654	97	751	528	121	650
2014	617	108	725	541	136	677
2015	640	109	749	552	143	695
2016	611	109	721	518	145	663

For 2016, non-biogenic emission factors decreased from the previous year. Figure 1 shows the MA-Based EFs (before accounting for AQ31 MWh). The percent changes from the year prior and from the first reporting year are shown in the lower graphs.

[1] The Department updated global warming potentials (GWPs) from the Intergovernmental Panel on Climate Change's (IPCC's) Second Assessment Report (SAR) to the IPCC's Fourth Assessment Report (AR4) starting with the 2014 EFs, similar to most other reporting programs.

[2] See the MassDEP GHG Reporting Program Summary Report For Retail Sellers of Electricity Emissions Year 2013 (https://www.mass.gov/files/documents/2016/08/tb/13rsesum.pdf).

Figure 1: MA-Based Non-Biogenic and Biogenic Emission Factors (CO_2e lb/MWh) prior to adjusting for AQ31 MWh, showing the annual and cumulative percent changes in the lower graphs



MWh Sold by Retail Sellers and Reported from Particular Generating Units

For 2016, 3 electric utilities, 3 competitive suppliers, and 37 municipal electric departments (MEDs)[3] or light boards chose to report MWh from particular generating units in Step 1. All MWh reported from particular generating units in the first eight reporting years have been from non-emitting units. The number of optional reporters, the amount of non-emitting MWh reported, and the percent of non-emitting MWh to total retail sales all continued to increase from 2008 to 2016.

Tables 2 and 3 show the number of retail sellers reporting in 2008, and 2010 through 2016. Figure 2 shows their total retail sales.[4] Figure 3 shows the amount of non-emitting MWh from particular generating units that they chose to report and Figure 4 shows the ratio of non-emitting MWh to total retail sales. Figures 5 and 6 show this non-emitting power by fuel type (as MWh and as a percent) and Figures 7 and 8 show the locations of these particular generating units (again as MWh and as a percent).

Table 2. Number of Retail Sellers Reporting GHG Emissions

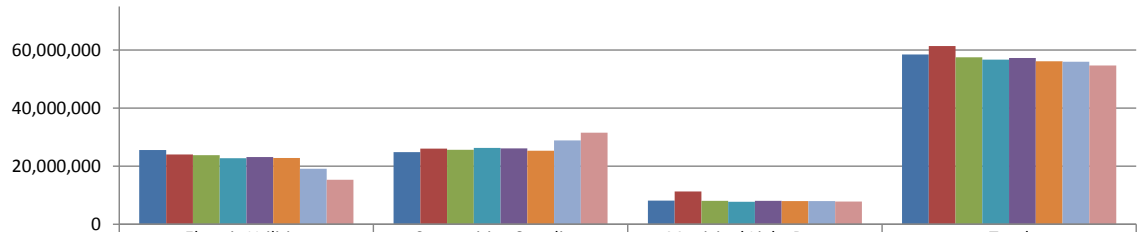
Mandatory Reporting:	Electric Utilities	Competitive Suppliers	Municipal Electric Departments	Total Retail Sellers
2008	4	22	40	66
2010	4	31	40	75
2011	4	33	40	77
2012	4	43	40	87
2013	4	44 of 47	40	88 of 91
2014	4	47 of 52	40	91 of 96
2015	4	54 of 56[5]	40	98 of 100
2016	4	62	40	106

[3] In this document, Municipal Electric Departments and Municipal Light Boards are collectively referred to as municipal electric departments (MEDs).

[4] The total retail sales reported by competitive suppliers for 2016 differs by 581 MWh from the total reported in DOER's *Massachusetts RPS & APS Annual Compliance Report for 2016* due primarily to some minor reporting differences.

[5] Fifty-six competitive suppliers sold retail electricity in Massachusetts in 2015. Two of these competitive suppliers that no longer operate in Massachusetts (Glacial Energy and Gulf Oil) failed to report their 2015 GHG emissions.

Figure 2. Total MWh of Retail Sales of Electricity Reported

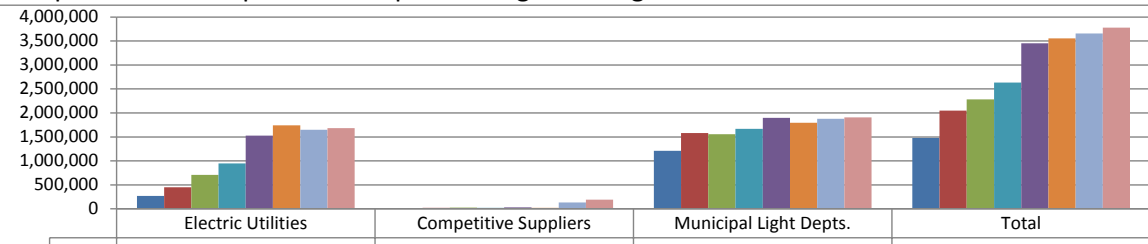


	Electric Utilities	Competitive Suppliers	Municipal Light Depts.	Total
2008	25,514,875	24,806,760	8,154,220	58,475,855
2010	23,997,222	26,028,871	11,297,116	61,323,209
2011	23,775,874	25,610,294	8,086,980	57,473,148
2012	22,736,900	26,255,523	7,708,611	56,701,034
2013	23,167,213	26,085,716	8,018,581	57,271,510
2014	22,828,147	25,301,147	7,946,541	56,077,849
2015	19,140,524	28,869,199	7,947,326	55,957,049
2016	15,336,547	31,527,882	7,811,587	54,676,016

Table 3. Number of Retail Sellers Reporting Optional MWh from particular generating units

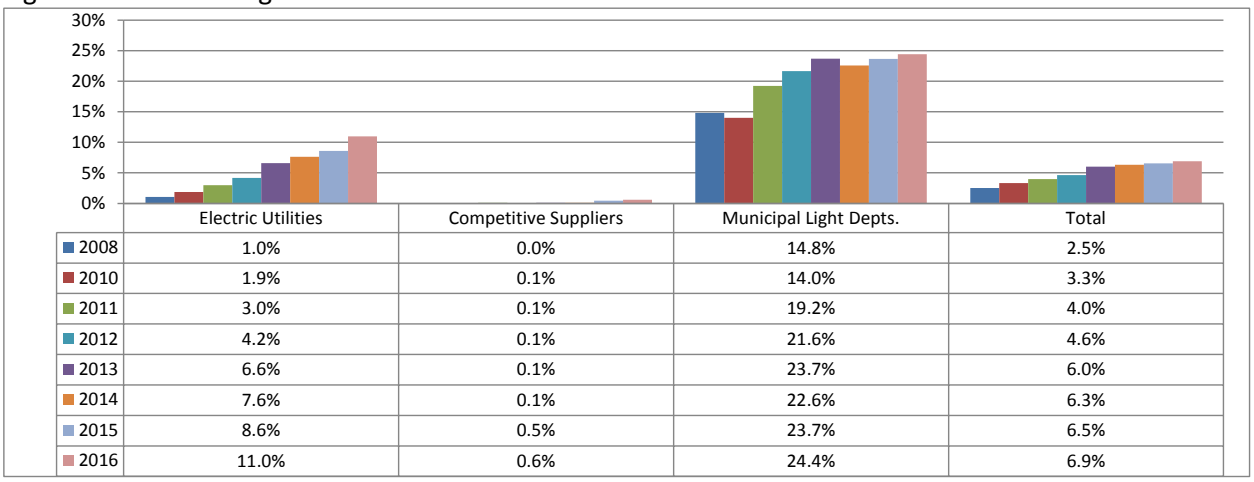
Optional Reporting (Step 1): Number of Reporters	**Electric Utilities**	**Competitive Suppliers**	**Municipal Electric Departments**	**Total Retail Sellers**
2008	2	0	17	19
2010	2	1	24	27
2011	3	1	25	29
2012	3	1	31	35
2013	3	1	33	37
2014	3	1	31	35
2015	3	2	36	41
2016	3	3	37	43

Figure 3. Optional MWh reported from particular generating units



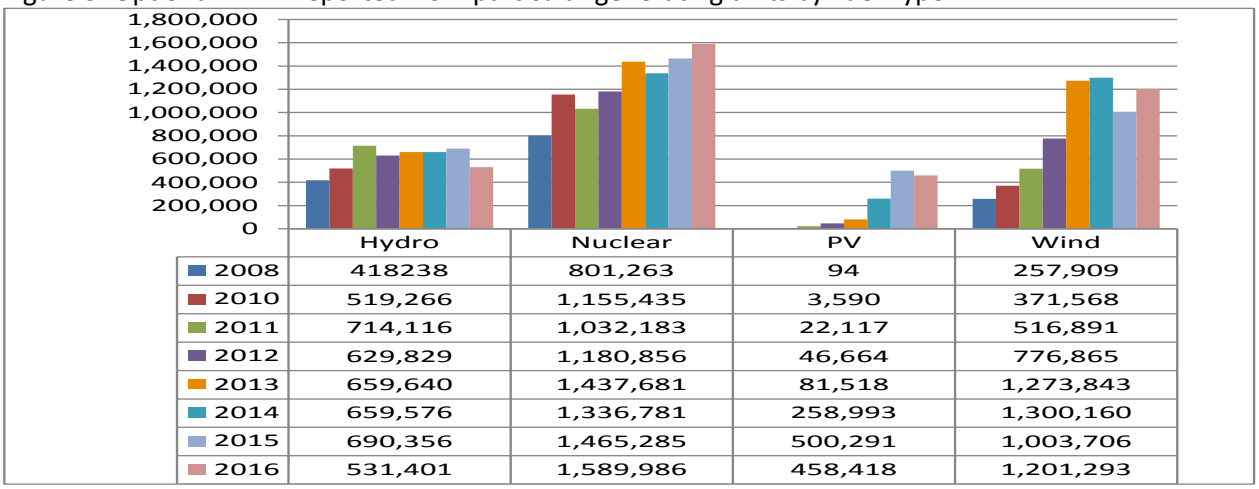
	Electric Utilities	Competitive Suppliers	Municipal Light Depts.	Total
2008	267,806	0	1,209,698	1,477,504
2010	450,034	18,213	1,581,612	2,049,859
2011	707,893	22,876	1,554,539	2,285,308
2012	947,525	18,772	1,667,919	2,634,216
2013	1,527,172	28,085	1,898,690	3,453,947
2014	1,739,524	21,473	1,794,509	3,555,506
2015	1,647,720	131,372	1,880,545	3,659,637
2016	1,682,577	191,605	1,906,916	3,781,098

Figure 4. Non-emitting MWh as % of Total MWh of Retail Sales



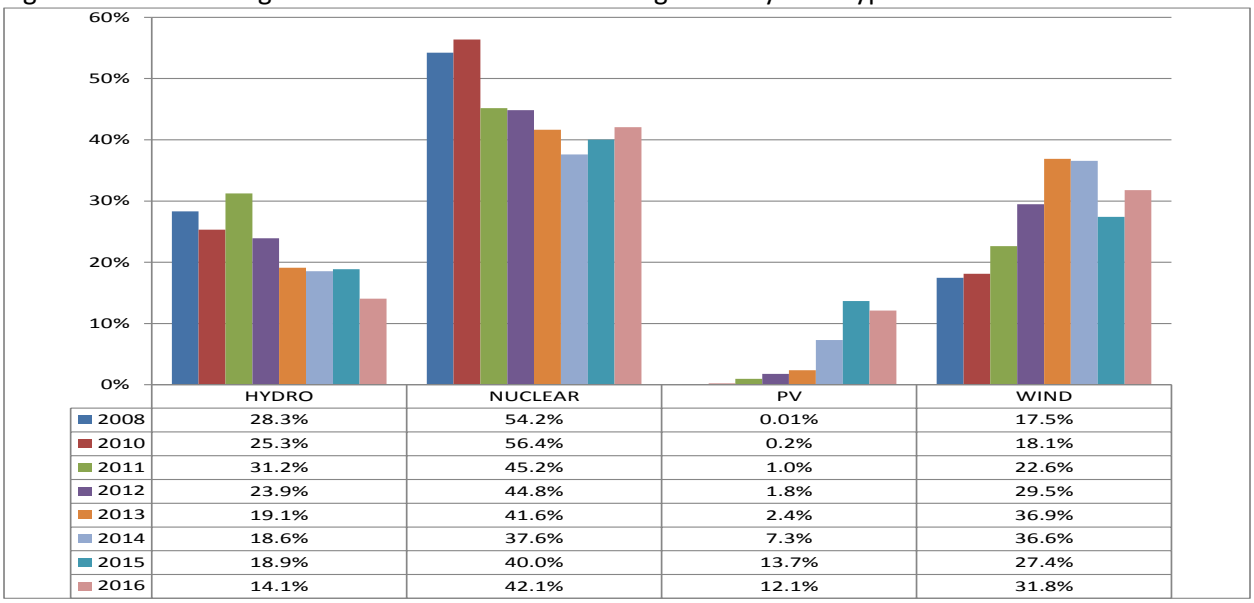
	Electric Utilities	Competitive Suppliers	Municipal Light Depts.	Total
2008	1.0%	0.0%	14.8%	2.5%
2010	1.9%	0.1%	14.0%	3.3%
2011	3.0%	0.1%	19.2%	4.0%
2012	4.2%	0.1%	21.6%	4.6%
2013	6.6%	0.1%	23.7%	6.0%
2014	7.6%	0.1%	22.6%	6.3%
2015	8.6%	0.5%	23.7%	6.5%
2016	11.0%	0.6%	24.4%	6.9%

Figure 5. Optional MWh reported from particular generating units by Fuel Type



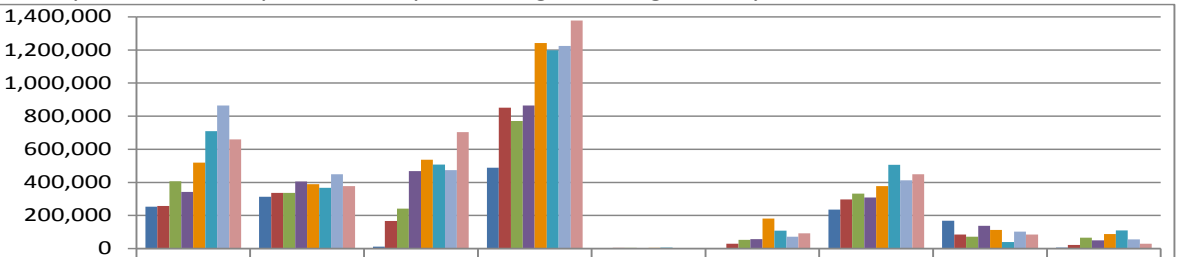
	Hydro	Nuclear	PV	Wind
2008	418238	801,263	94	257,909
2010	519,266	1,155,435	3,590	371,568
2011	714,116	1,032,183	22,117	516,891
2012	629,829	1,180,856	46,664	776,865
2013	659,640	1,437,681	81,518	1,273,843
2014	659,576	1,336,781	258,993	1,300,160
2015	690,356	1,465,285	500,291	1,003,706
2016	531,401	1,589,986	458,418	1,201,293

Figure 6. Non-Emitting MWh as % of Total Non-Emitting MWh by Fuel Type



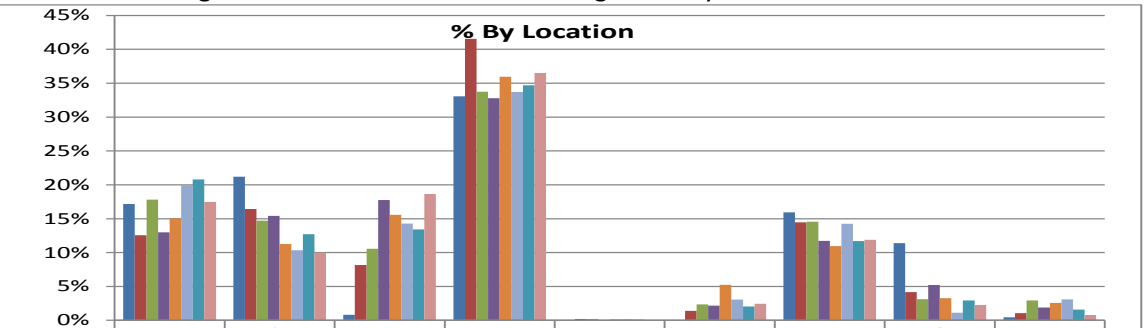
	HYDRO	NUCLEAR	PV	WIND
2008	28.3%	54.2%	0.01%	17.5%
2010	25.3%	56.4%	0.2%	18.1%
2011	31.2%	45.2%	1.0%	22.6%
2012	23.9%	44.8%	1.8%	29.5%
2013	19.1%	41.6%	2.4%	36.9%
2014	18.6%	37.6%	7.3%	36.6%
2015	18.9%	40.0%	13.7%	27.4%
2016	14.1%	42.1%	12.1%	31.8%

Figure 7. Optional MWh reported from particular generating units by Location



	MA	CT	ME	NH	RI	VT	NY	Q	PEI
2008	253,532	313,238	12,192	488,558	0	0	235,427	168,185	6,372
2010	257,262	336,674	167,106	851,812	4,222	28,837	296,417	85,537	21,992
2011	406,842	336,041	241,564	771,460	4,745	53,448	332,825	71,594	66,788
2012	342,423	405,995	467,702	863,859	1,448	56,681	309,087	137,150	49,869
2013	519,216	389,070	537,274	1,241,58	4,645	181,267	378,063	113,174	88,386
2014	710,136	367,938	508,091	1,198,08	6,260	108,832	506,797	40,048	109,319
2015	864,667	449,148	473,996	1,224,29	3,811	71,973	412,566	103,028	56,152
2016	660,230	377,212	703,630	1,378,21	1,189	91,938	449,120	84,871	29,173

Figure 8. Non-Emitting MWh as % of Total Non-Emitting MWh by Location



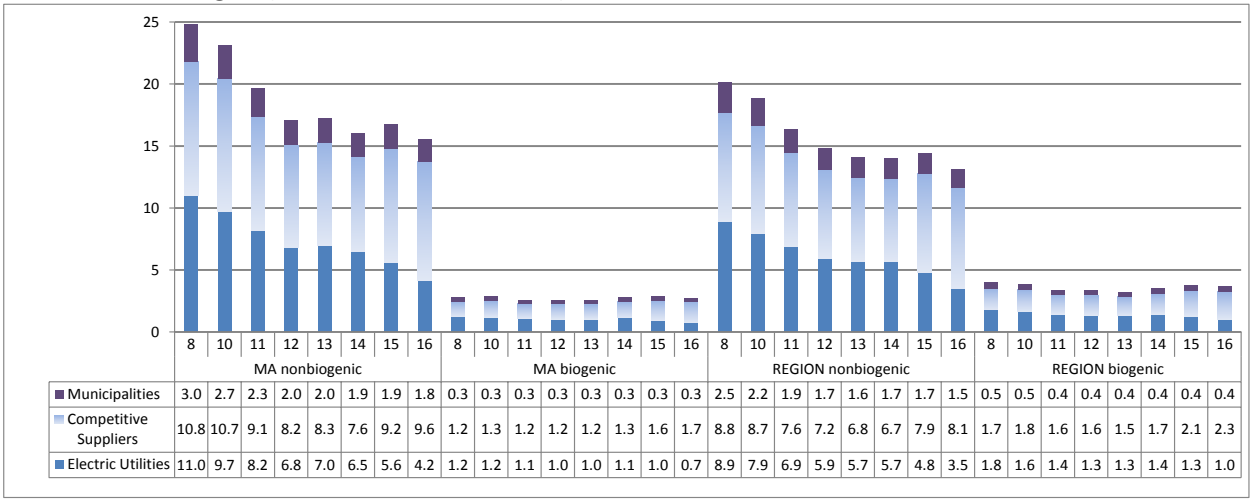
	MA	CT	ME	NH	RI	VT	NY	Q	PEI
2008	17.2%	21.2%	0.8%	33.1%	0.00%	0.00%	15.9%	11.4%	0.4%
2010	12.6%	16.4%	8.2%	41.6%	0.21%	1.41%	14.5%	4.2%	1.1%
2011	17.8%	14.7%	10.6%	33.8%	0.21%	2.34%	14.6%	3.1%	2.9%
2012	13.0%	15.4%	17.8%	32.8%	0.1%	2.2%	11.7%	5.2%	1.9%
2013	15.0%	11.3%	15.6%	36.0%	0.1%	5.3%	10.9%	3.3%	2.6%
2014	20.0%	10.3%	14.3%	33.7%	0.2%	3.1%	14.3%	1.1%	3.1%
2015	20.8%	12.7%	13.4%	34.7%	0.1%	2.0%	11.7%	2.9%	1.6%
2016	17.5%	10.0%	18.6%	36.5%	0.0%	2.4%	11.9%	2.2%	0.8%

GHG Emissions Reported by Retail Sellers

For 2016, emissions decreased to their lowest level for both MA-based and Regional-based non-biogenic GHG emissions due to the decrease in the EFs, as seen in Figure 1, and decreases in load, as seen in Figure 2. MA-based biogenic emissions remained constant while regional-based biogenic emissions increased slightly. The differences in GHG emissions between each reporting year within each retail seller type are caused by the changes in total MWh sales and percent of MWh reported from particular generating units in Step 1 by each type of retail seller. There has been a shift in load served; decreasing electric utility load and increasing competitive supplier load (see Figure 2). Thus there has been a corresponding decrease in electric utility emissions and an increase in competitive supplier emissions (see Figure 9).

Figure 9 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.

Figure 9. GHG Emissions Reported by Retail Seller Type and Year using the MA-Based and Regional-Based methodologies (Million Short Tons CO_2e)



	MA nonbiogenic								MA biogenic								REGION nonbiogenic								REGION biogenic							
	8	10	11	12	13	14	15	16	8	10	11	12	13	14	15	16	8	10	11	12	13	14	15	16	8	10	11	12	13	14	15	16
Municipalities	3.0	2.7	2.3	2.0	2.0	1.9	1.9	1.8	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2.5	2.2	1.9	1.7	1.6	1.7	1.7	1.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Competitive Suppliers	10.8	10.7	9.1	8.2	8.3	7.6	9.2	9.6	1.2	1.3	1.2	1.2	1.2	1.3	1.6	1.7	8.8	8.7	7.6	7.2	6.8	6.7	7.9	8.1	1.7	1.8	1.6	1.6	1.5	1.7	2.1	2.3
Electric Utilities	11.0	9.7	8.2	6.8	7.0	6.5	5.6	4.2	1.2	1.2	1.1	1.0	1.0	1.1	1.0	0.7	8.9	7.9	6.9	5.9	5.7	5.7	4.8	3.5	1.8	1.6	1.4	1.3	1.3	1.4	1.3	1.0

Individual Retail Seller Reporting for 2016

For each retail seller that chose to submit MWh from particular generating units in 2016, "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. [6]

Figures 10A and 10B show the non-emitting MWh reported, and the ratio of those MWh to the retail seller's 2016 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. Figure 10A compares optional MWh reported as a percentage of total retail sales. Figure 10B shows the variation in total MWh sales. Figures 11A and 11B show similar information specifically for MEDs. See Appendix 2 below for individual retail seller values used in these figures.

[6] In 2011, one MED reported a greater amount of MWh from particular generating units than its retail sales, resulting in apparently negative total retail sales, negative GHG emissions, and a negative GHG emission rate. 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. To prevent this situation from occurring again, MassDEP now requires MEDs 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.

Figure 10A. 2016 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)

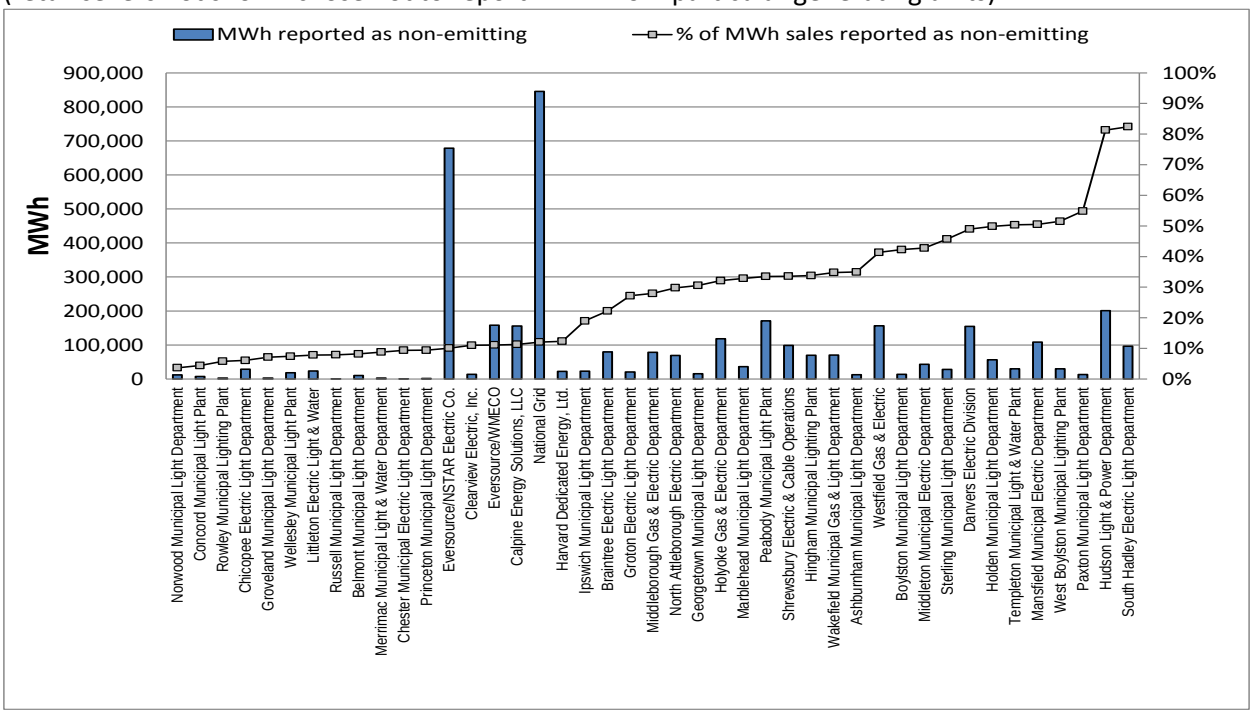


Figure 10B. 2016 Electricity Sales by Retail Seller: Non-Emitting vs. All Other MWh Sales Reported
(retail sellers not shown chose not to report MWh from particular generating units)

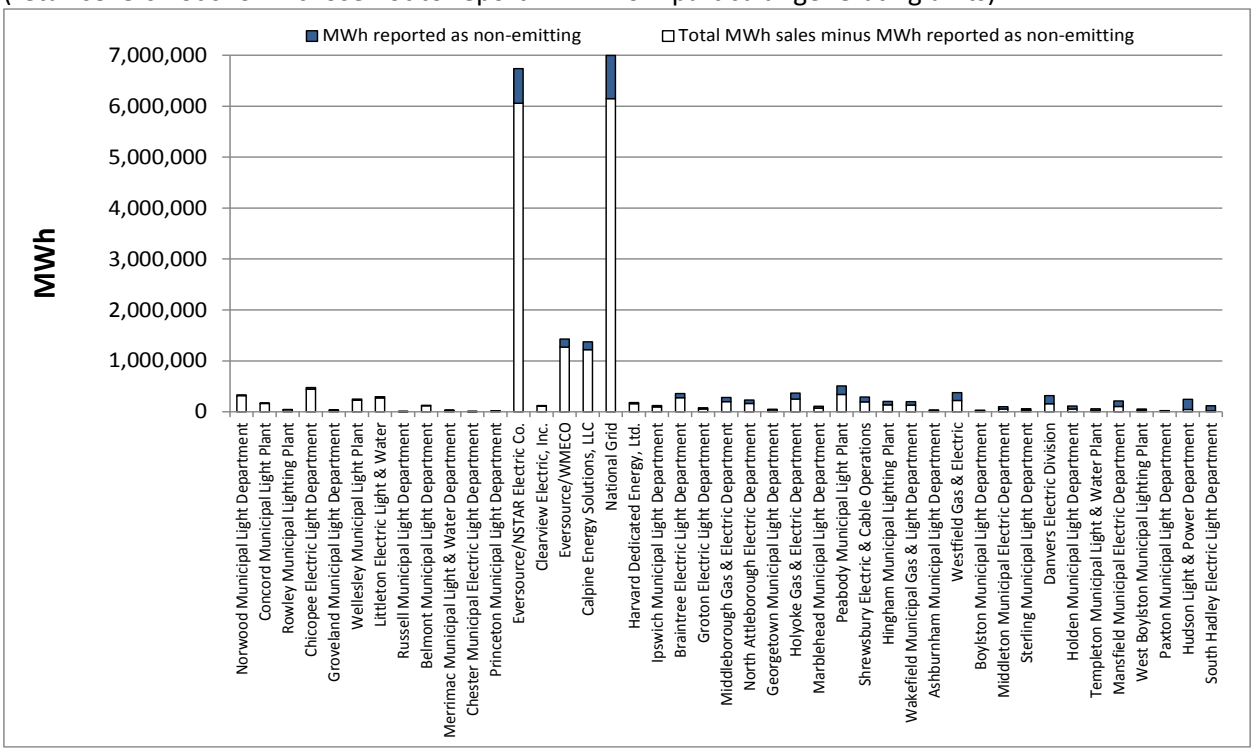


Figure 11A. 2016 Electricity Sales Reported as Non-Emitting by MEDs (MWh and % of sales) (MEDs not shown chose not to report MWh from particular generating units)

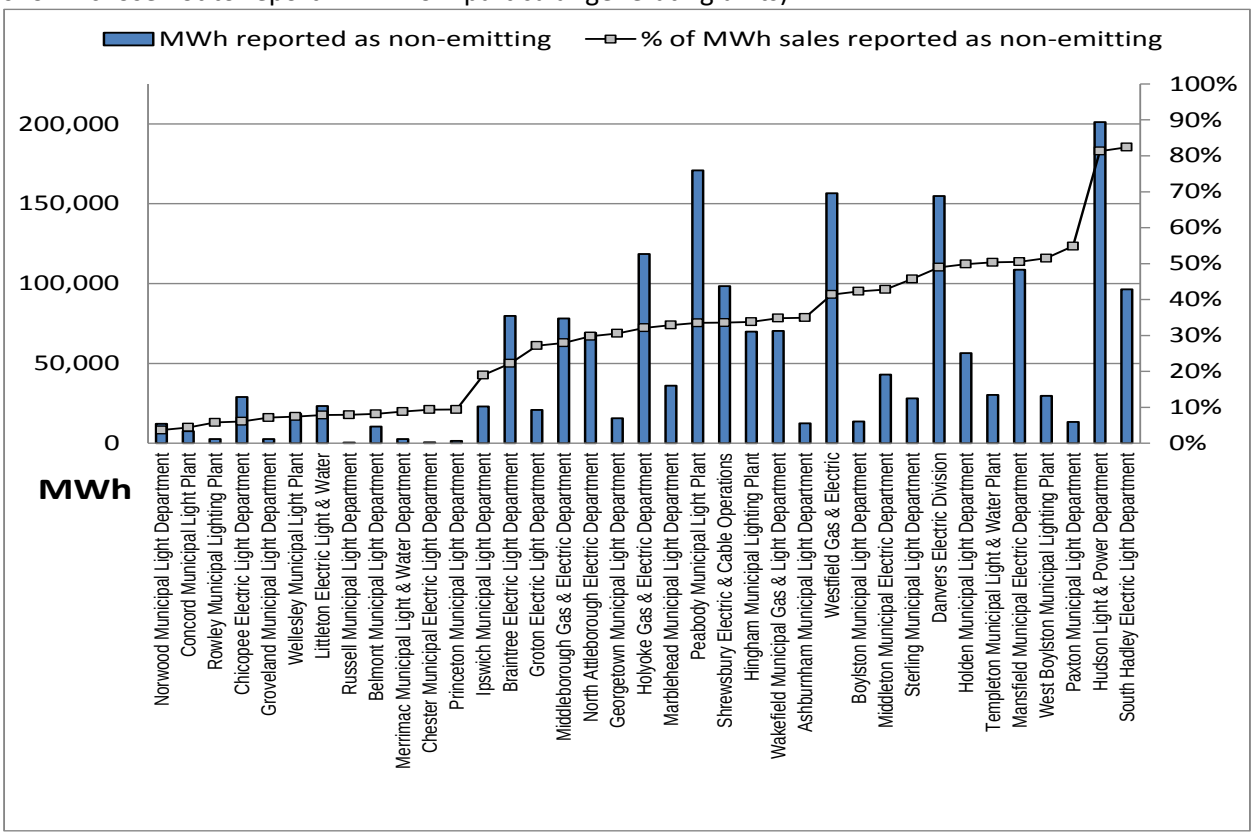
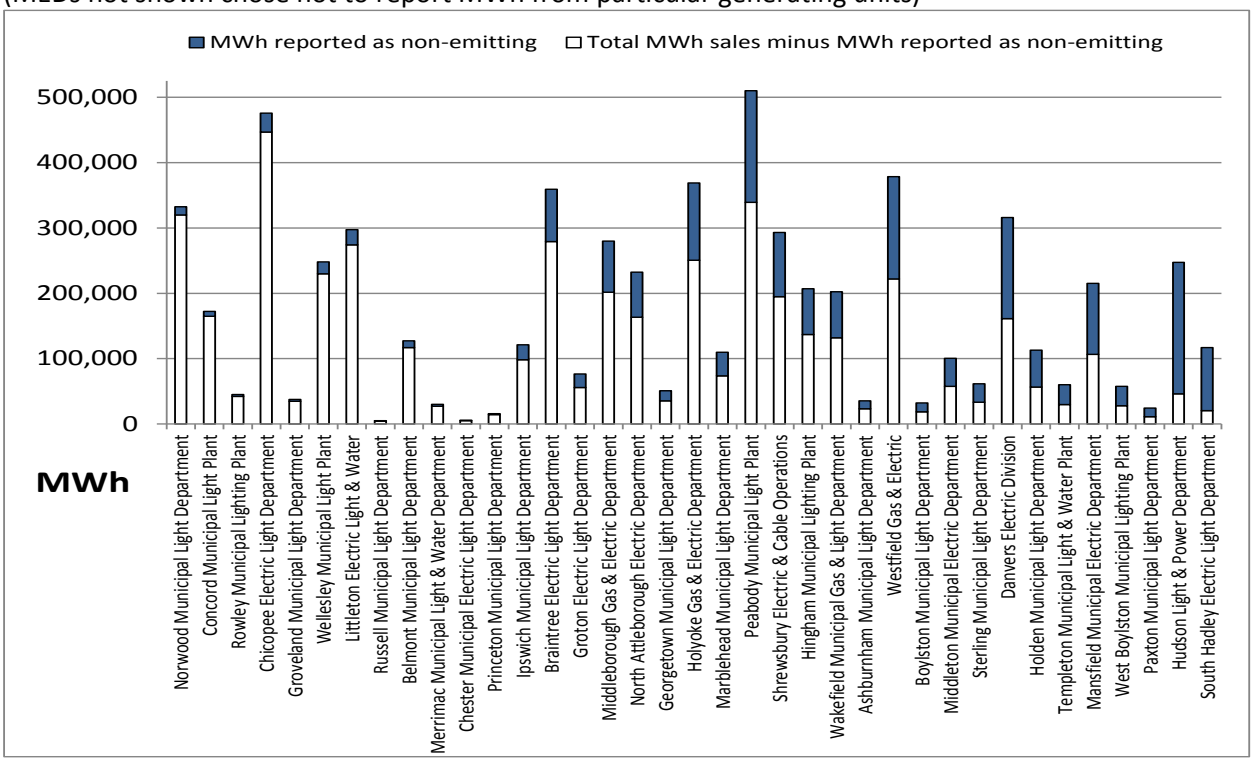


Figure 11B. 2016 Electricity Sales by MED: Non-Emitting vs. All Other MWh Sales Reported (MEDs not shown chose not to report MWh from particular generating units)



Appendix 1: 2016 Individual Retail Seller GHG Emissions

Below are 2016 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 MEDs, less MWh from any particular generating units that a retail seller reported in Step 1. See footnote 4 regarding the retail sales and emissions of competitive suppliers and MEDs.

Table 4. 2016 MA Retail Seller GHG Emissions (Short Tons CO_2e)

	Massachusetts-based approach			Regional-based approach		
	Non-Biogenic	Biogenic	Combined	Non-Biogenic	Biogenic	Combined
Electric Utilities[7]						
Unitil (Fitchburg Gas & Electric Co.)	54,669	9,753	64,422	46,348	12,974	59,322
NGRID (Mass. and Nantucket Elec.)	1,878,223	335,068	2,213,290	1,592,340	445,732	2,038,072
Eversource/NSTAR Electric Co.	1,850,626	330,144	2,180,770	1,568,943	439,183	2,008,126
Eversource/Western MA Electric Co.	387,771	69,177	456,947	328,748	92,024	420,772
Competitive Suppliers						
Abest Power & Gas, LLC	12,487	2,228	14,714	10,586	2,963	13,549
Agera Energy LLC	109,275	19,494	128,769	92,642	25,933	118,575
Ambit Northeast, LLC	41,987	7,490	49,477	35,596	9,964	45,560
Atlantic Energy LLC	587	105	691	497	139	636
Blue Rock Energy LLC	40	7	47	34	9	43
Calpine Energy Solutions LLC	372,862	66,517	439,380	316,109	88,486	404,595
Champion Energy Services	56,194	10,025	66,219	47,641	13,336	60,976
Clean Choice	2,154	384	2,539	1,826	511	2,338
Clearview Electric, Inc.	33,666	6,006	39,672	28,542	7,989	36,531
Connecticut Municipal Electric Energy Cooperative	19,573	3,492	23,064	16,594	4,645	21,239
Consolidated Edison Solutions, Inc.	1,293,983	230,841	1,524,824	1,097,026	307,083	1,404,109

[7] The April 2019 version showed the electric utilities' names in the wrong order.

	Massachusetts-based approach			Regional-based approach		
	Non-Biogenic	Biogenic	Combined	Non-Biogenic	Biogenic	Combined
Constellation Energy Power Choice	151,905	27,099	179,004	128,783	36,049	164,833
Constellation Energy Services, Inc.	366,057	65,303	431,360	310,339	86,871	397,211
Constellation NewEnergy, Inc.	1,588,180	283,325	1,871,505	1,346,444	376,900	1,723,344
Devonshire Energy, LLC	24,381	4,349	28,730	20,670	5,786	26,456
Direct Energy Business LLC	1,041,855	185,863	1,227,717	883,274	247,249	1,130,523
Direct Energy Business Marketing, LLC	291,421	51,988	343,409	247,064	69,159	316,223
Direct Energy Services, LLC	148,765	26,539	175,304	126,122	35,304	161,426
Discount Power, Inc.	11,958	2,133	14,091	10,138	2,838	12,976
East Avenue Energy	257	46	302	218	61	278
EDF	752	134	886	637	178	815
Eligio Energy MA LLC	5,264	939	6,204	4,463	1,249	5,712
Energy Plus Holdings	14,997	2,675	17,673	12,715	3,559	16,274
ENGIE Resources, LLC	659,623	117,674	777,297	559,222	156,539	715,761
ENGIE Retail, LLC (dba Think Energy)	65,693	11,719	77,412	55,694	15,590	71,283
First Point Power	185,387	33,072	218,460	157,170	43,995	201,165
Great Eastern Energy (aka BBPC LLC)	315,792	56,336	372,128	267,725	74,942	342,668
Green Mountain Energy Company	8,145	1,453	9,598	6,905	1,933	8,838
Hampshire Council of Governments	220,974	39,421	260,395	187,340	52,441	239,781
Harborside Energy of Massachusetts LLC	496	88	584	420	118	538
Harvard Dedicated Energy, Ltd.	48,400	8,634	57,034	41,033	11,486	52,519
Hudson Energy Services	159,837	28,514	188,351	135,508	37,932	173,440
Interstate Gas Supply, Inc. (dba IGS Energy)	1,037	185	1,222	879	246	1,125
Inspire Energy Holdings, LLC	14,886	2,656	17,541	12,620	3,533	16,153

	Massachusetts-based approach			Regional-based approach		
	Non-Biogenic	Biogenic	Combined	Non-Biogenic	Biogenic	Combined
Just Energy Mass.	81,911	14,613	96,524	69,444	19,439	88,882
Liberty Power Holdings	223,147	39,809	262,956	189,182	52,956	242,139
Major Energy Electric Service, LLCs	48,177	8,595	56,771	40,844	11,433	52,277
Massachusetts Gas & Electric Co.	69,403	12,381	81,784	58,839	16,470	75,310
Mega Energy Holdings, LLC	13,233	2,361	15,594	11,219	3,140	14,359
Mint Energy, LLC	55,211	9,849	65,061	46,808	13,102	59,910
NextEra Energy	281,846	50,280	332,127	238,947	66,887	305,833
Nordic Energy Services	77	14	90	65	18	83
Oasis Power, LLC	14,432	2,575	17,006	12,235	3,425	15,660
Palmco Power MA, LLC	22,063	3,936	25,998	18,704	5,236	23,940
Perigee Energy, LLC	5,766	1,029	6,795	4,889	1,368	6,257
Provider Power MASS, LLC	10,386	1,853	12,239	8,805	2,465	11,270
Public Power, LLC	2,278	406	2,685	1,932	541	2,472
Reliant Energy Northeast	206,929	36,915	243,844	175,432	49,107	224,540
REP Energy (now Summer Energy)	12,999	2,319	15,318	11,020	3,085	14,105
SFE Energy Massachusetts	30,258	5,398	35,656	25,653	7,181	32,833
SmartEnergy Holdings, LLC	9,017	1,609	10,625	7,644	2,140	9,784
South Jersey Energy	45,409	8,101	53,510	38,498	10,776	49,274
Spark Energy, LP	58,409	10,420	68,828	49,518	13,861	63,379
Starion Energy, Inc.	90,575	16,158	106,734	76,789	21,495	98,284
Sunwave Gas & Power Massachusetts, Inc.	2,434	434	2,868	2,063	578	2,641
Texas Retail Energy	30,689	5,475	36,164	26,018	7,283	33,301
Town Square Energy, LLC	2,542	454	2,996	2,155	603	2,759

	Massachusetts-based approach			Regional-based approach		
	Non-Biogenic	Biogenic	Combined	Non-Biogenic	Biogenic	Combined
TransCanada Power Marketing Ltd.	664,756	118,590	783,346	563,574	157,757	721,331
Union Atlantic Electricity LLC	0	0	0	0	0	0
Verde Energy USA Massachusetts, LLC	77,575	13,839	91,414	65,767	18,410	84,177
Viridian	214,027	38,182	252,209	181,450	50,792	232,242
Xoom Energy Massachusetts LLC	30,638	5,466	36,104	25,975	7,271	33,246
Municipal Electric Departments						
Ashburnham Muni. Light Dept.	7,057	1,259	8,316	5,983	1,675	7,658
Belmont Municipal Light Dept.	35,724	6,373	42,097	30,287	8,478	38,765
Boylston Municipal Light Dept.	5,693	1,016	6,709	4,826	1,351	6,178
Braintree Electric Light Dept.	85,344	15,225	100,569	72,353	20,253	92,607
Chester Muni. Electric Light Dept.	1,608	287	1,895	1,364	382	1,745
Chicopee Electric Light Dept.	136,508	24,353	160,861	115,731	32,396	148,126
Concord Municipal Light Plant	50,341	8,981	59,321	42,678	11,947	54,625
Danvers Electric Division	49,284	8,792	58,077	41,783	11,696	53,479
Georgetown Municipal Light Dept.	10,824	1,931	12,754	9,176	2,569	11,745
Groton Electric Light Dept.	17,077	3,046	20,124	14,478	4,053	18,531
Groveland Municipal Light Dept.	10,678	1,905	12,583	9,053	2,534	11,587
Hingham Municipal Lighting Plant	41,882	7,472	49,353	35,507	9,939	45,446
Holden Municipal Light Dept.	17,323	3,090	20,414	14,687	4,111	18,798
Holyoke Gas & Electric Dept.	76,526	13,652	90,177	64,878	18,161	83,038
Hudson Light & Power Dept.	14,121	2,519	16,640	11,971	3,351	15,322
Hull Municipal Lighting Plant	16,252	2,899	19,151	13,778	3,857	17,635
Ipswich Municipal Light Dept.	30,032	5,358	35,390	25,461	7,127	32,588
Littleton Electric Light & Water	71,553	12,765	84,318	60,662	16,981	77,643

	Massachusetts-based approach			Regional-based approach		
	Non-Biogenic	Biogenic	Combined	Non-Biogenic	Biogenic	Combined
Mansfield Municipal Electric Dept.	32,517	5,801	38,318	27,568	7,717	35,285
Marblehead Municipal Light Dept.	22,514	4,016	26,530	19,087	5,343	24,430
Merrimac Muni. Light & Water	8,370	1,493	9,863	7,096	1,986	9,082
Middleborough Gas & Elec. Dept.	61,613	10,992	72,604	52,235	14,622	66,857
Middleton Muni. Electric Dept.	17,594	3,139	20,732	14,916	4,175	19,091
North Attleboro Electric Dept.	49,885	8,899	58,784	42,292	11,839	54,131
Norwood Municipal Light Dept.	97,794	17,446	115,240	82,909	23,208	106,117
Paxton Municipal Light Dept.	3,372	602	3,974	2,859	800	3,659
Peabody Municipal Light Plant	103,619	18,485	122,105	87,848	24,591	112,438
Princeton Municipal Light Dept.	4,384	782	5,166	3,717	1,040	4,757
Reading Municipal Light Dept.	213,611	38,107	251,719	181,098	50,693	231,791
Rowley Municipal Lighting Plant	12,970	2,314	15,283	10,996	3,078	14,074
Russell Municipal Light Dept.	1,422	254	1,676	1,206	337	1,543
Shrewsbury Electric & Cable Ops.	59,513	10,617	70,129	50,454	14,123	64,578
South Hadley Electric Light Dept.	6,285	1,121	7,407	5,329	1,492	6,820
Sterling Municipal Light Dept.	10,195	1,819	12,014	8,643	2,419	11,063
Taunton Municipal Lighting Plant	212,206	37,857	250,062	179,906	50,360	230,266
Templeton Muni. Light & Water	9,104	1,624	10,728	7,718	2,161	9,879
Wakefield Muni. Gas & Light	40,297	7,189	47,486	34,164	9,563	43,727
Wellesley Municipal Light Plant	70,198	12,523	82,721	59,513	16,659	76,172
West Boylston Muni. Light. Plant	8,546	1,525	10,071	7,245	2,028	9,273
Westfield Gas & Electric	67,793	12,094	79,887	57,474	16,088	73,563
2016 distribution company total	4,171,288	744,141	4,915,429	3,536,378	989,913	4,526,291

	Massachusetts-based approach			Regional-based approach		
	Non-Biogenic	**Biogenic**	**Combined**	**Non-Biogenic**	**Biogenic**	**Combined**
2016 competitive supplier total	9,573,055	1,707,795	11,280,851	8,115,945	2,271,838	10,387,783
2016 MED total	1,719,630	319,620	2,111,250	1,518,257	425,182	1,944,109
2016 RETAIL SELLER TOTAL GHGs	**15,535,973**	**2,771,557**	**18,307,530**	**13,171,250**	**3,686,933**	**16,858,184**

Appendix 2: Individual 2016 Retail Seller Emission Factors

Below are the 2016 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, and are based on the EFs in Table 1.

Table 5. Individual 2016 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.)	845,447	537	96	455	127	12.1%
Eversource/NSTAR	678,718	549	98	466	130	10.1%
Eversource/WMECO	158,412	543	97	461	129	11.1%
Competitive Suppliers						
Calpine/Noble Americas Energy Solutions	155,676	542	97	459	129	11.3%
Clearview	13,647	544	97	461	129	11.0%
Harvard Dedicated Energy	22,282	536	96	454	127	12.3%
Municipal Electric Departments						
Ashburnham Muni. Light Dept.	12,462	397	71	337	94	35.0%
Belmont Municipal Light Department	10,416	561	100	476	133	8.2%
Boylston Municipal Light Dept.	13,649	353	63	299	84	42.3%
Braintree Electric Light Dept.	79,796	475	85	403	113	22.2%
Chester Municipal Electric Light Dept.	544	554	99	469	131	9.4%
Chicopee Electric Light Dept.	28,964	574	102	486	136	6.1%
Concord Municipal Light Plant	7,586	584	104	495	139	4.4%
Danvers Electric Division	154,796	312	56	264	74	49.0%
Georgetown Municipal Light Department	15,595	424	76	360	101	30.6%
Groton Electric Light Dept.	20,860	445	79	377	106	27.2%

	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	
Groveland Municipal Light Dept.	2,686	567	101	481	135	7.1%
Hingham Municipal Lighting Plant	69,947	405	72	343	96	33.8%
Holden Municipal Light Dept.	56,399	306	55	260	73	49.9%
Holyoke Gas & Electric Dept.	118,489	415	74	352	98	32.1%
Hudson Light & Power Dept.	201,175	114	20	97	27	81.3%
Ipswich Municipal Light Department	22,999	495	88	420	118	19.0%
Littleton Electric Light & Water	23,362	563	100	477	134	7.9%
Mansfield Municipal Electric Dept.	108,670	302	54	256	72	50.5%
Marblehead Municipal Light Dept.	36,093	410	73	348	97	32.9%
Merrimac Municipal Light & Water Dept.	2,649	557	99	472	132	8.8%
Middleborough Gas & Electric Dept.	78,218	440	79	373	104	27.9%
Middleton Municipal Electric Dept.	43,060	350	62	296	83	42.8%
North Attleboro Electric Dept.	69,218	429	77	364	102	29.8%
Norwood Municipal Light Dept.	12,196	589	105	499	140	3.7%
Paxton Municipal Light Dept.	13,410	276	49	234	65	54.9%
Peabody Municipal Light Plant	170,879	406	72	344	96	33.5%
Princeton Municipal Light Dept.	1,488	554	99	469	131	9.4%
Rowley Municipal Lighting Plant	2,613	576	103	488	137	5.8%
Russell Municipal Light Department	399	563	100	477	134	7.9%
Shrewsbury Electric & Cable Ops.	98,474	406	72	344	96	33.6%
South Hadley Electric Light Dept.	96,351	108	19	91	26	82.4%
Sterling Municipal Light Dept.	28,086	332	59	281	79	45.7%

	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	
Templeton Municipal Light & Water	30,231	303	54	257	72	50.4%
Wakefield Municipal Gas & Light Dept.	70,406	398	71	338	95	34.8%
Wellesley Municipal Light Plant	18,441	566	101	480	134	7.4%
West Boylston Municipal Lighting Plant	29,718	296	53	251	70	51.5%
Westfield Gas & Electric	156,591	358	64	304	85	41.4%
All Other Retail Sellers	**0**	**611**	**109**	**518**	**145**	**0%**

Appendix 3: 2016 Retail Level Emission Factors to be Used by Consumers of Electricity to Report Greenhouse Gas Emissions (MA-Based EFs)

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 2016 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. The MA-based EFs include 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.

2016 RS Wholesale Non-Biogenic MA-Based EF	575 lb	Non-Biogenic CO_2e/Wholesale MWh
+ 2016 RS Wholesale Biogenic MA-Based EF	+103 lb	Biogenic CO_2e/Wholesale MWh
2016 RS Wholesale Combined MA-Based EF	678 lb	Combined CO_2e/Wholesale MWh

Wholesale v. Retail EFs (line losses): Power lines lose 5.7%[8] (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, 5.7% 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 – 5.7% of MWh due to line losses) = Retail Combined EF

Specifically: 678 lb CO_2e/Wholesale MWh / (1 - 0.057) = 719 lb CO_2e/Retail MWh

Table 6. 2016 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	575	610
Biogenic	103	109
Combined	678	719

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 https://www.mass.gov/lists/massachusetts-greenhouse-gas-ghg-reporting-program-data#massdep-

[8] This value was updated from previously used value of 7% to reflect new data and to align with the line loss value used in the updated Massachusetts Clean Energy and Climate Plan for 2020, dated December 2015.

emission-factor-calculations-. For the 2016 retail level Combined EF, this results in 715 lb of CO_2e from CO_2, 2 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 through 2016 by MassDEP are: 1 for CO_2, 25 for CH_4, and 298 for N_2O.[9]

lb CO_2e/MWh = ((lb CO_2 *1) + (lb CH_4 * 25) + (lb N_2O * 298)) / MWh

Specifically: 1.5 lb CO_2e from CH_4 / 25 = 0.061 lb CH_4 *and* 2.7 lb CO_2e from N_2O / 298 = 0.009 lb N_2O, *therefore*

719 lb CO_2e/Retail MWh = (715 lb CO_2 + (0.061 lb CH_4 * 25) + (0.009 lb N_2O * 298)) / Retail MWh

The breakdown of the 719 lb CO_2e/Retail MWh value from Table 6 into individual gases, at various scales of electricity, is shown in Table 7.

Table 7. 2016 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	0.715	0.000061	0.000009
lb/Retail MWh	715	0.061	0.009
lb/Retail GWh	715,000	61	9

The lb/Retail kWh values in the upper row of Table 7 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 7 are used by MassDEP when voluntarily reporting emissions from its operations to The Climate Registry.

The breakdown of the 715 lb CO_2/Retail MWh value from Table 7 into its non-biogenic and biogenic components is shown in Table 8. All CH_4 and N_2O emissions are considered non-biogenic and thus cannot be further broken down.

Table 8. 2016 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	0.605	0.109
lb/Retail MWh	605	109
lb/Retail GWh	605,000	109,000

[9] The Department has updated to global warming potentials (GWPs) from the Intergovernmental Panel on Climate Change's (IPCC's) Fourth Assessment Report (AR4), published in 2007, with the 2014 EFs, similar to most other reporting programs. The global GWPs used with earlier EFs were from IPCC's Second Assessment Report (SAR) published in 1996.