Pragmatic Environmentalist of New York: NYS Air Pollution Emission Status Summary

I do not think that the general public understands how much improvement there has been to New York State's air quality and how big the emissions reductions have been. This is a summary of the trend of SO2, NOx and CO2 since 1999 in New York State and it shows extraordinary improvements. Later, I will prepare a summary of the changes to the air quality measurements which also show big improvements.

I have to apologize for my inability to incorporate tables and graphs in the body of a Wordpress blog post. If I had that ability then this post would be a heck of a lot easier to read. Instead I offer three alternatives. Each of the figures and tables is available by links in the following post. I also have prepared a version of this post and you can view that entire document here. Finally that document, three spreadsheets with the data, tables and graphs, and a detailed documentation summary of the data processing analysis are available at the NY Pragmatic Environmentalist dropbox.

The emissions and operating data used for this summary were downloaded from the EPA Clean Air Markets Division Air Markets Program Data website. The website includes a query tool that I have used for years to extract specific data from national emission monitoring programs. For this analysis I downloaded SO2, NOx and CO2 emissions data, operating time, heat input and load data as well as unit-specific information on fuel use and unit type so that I could show what changes caused the emissions reductions. Because this is a New York-centric blog I primarily focused on New York emissions.

Figure 1 documents the annual SO2 emissions from 1998 to 2017 by the primary fuel type reported to EPA. In 1998 SO2 emissions totaled 309,775 tons and in 2017 were only 2,561, a 99% reduction. Table 1 presents the emissions totals and includes the coal-firing totals. It turns out that reductions in coal-firing and residual-oil firing account for the reduction in SO2 mass. New York is unique in that there are five relatively new large residual oil-fired boiler units in the state. Although there were changes in the limit of sulfur in fuel the primary driver for the reductions was the cost of oil relative to natural gas coupled with the fact that there is essentially no SO2 emitted by natural gas firing. At this time these units survive because they can provide 1000s of MW when necessary and their operational costs are low enough that the payments to be able to provide that capacity are sufficient to be viable. Note, however, that they cannot reduce emissions much more because they still have to run a couple of times a year to prove that they can provide capacity. Coal-firing units in New York were older and were required to install extensive controls over this period to continue to operate. The cost differential between natural gas and coal was the final blow to viability and for all intents and purposes only one facility remains operating today. Governor Cuomo has proposed regulations to eliminate coal burning at even that unit by 2020. These data suggest the de minimus level of future SO2 emissions will be around 1,000 tons per year.

Figure 2 documents the annual NOx emissions from 1998 to 2017 by the primary fuel type reported to EPA. In the peak year of 2000 NOx emissions totaled 101,635 tons and in 2017 were only 11,253, an 89% reduction. The coal and residual oil units were also the largest sources for NOx so they account for most of the reduction. On the other hand there still are significant NOx emissions from natural gas firing

so the reductions are not as large. Eliminating coal firing will drop emissions another 2,770 tons from 2017 levels. Further reductions will come from replacing older, higher emitting units with new cleaner ones. If I had to guess on a future de minimus level it would be around 7,000 tons per year.

Figure 3 documents the changes in annual emission rates (lbs/mmBtu) over the same period. The reason for these changes is the same as the mass changes. Keep in mind that mass emissions are a function of these rates and the operating levels. If there is more demand on fossil-fired units then they will emit more. Of course, if renewable energy reduces the need for fossil-fired units or if demand for electrical energy goes down due to energy efficiency efforts then mass emissions will go down.

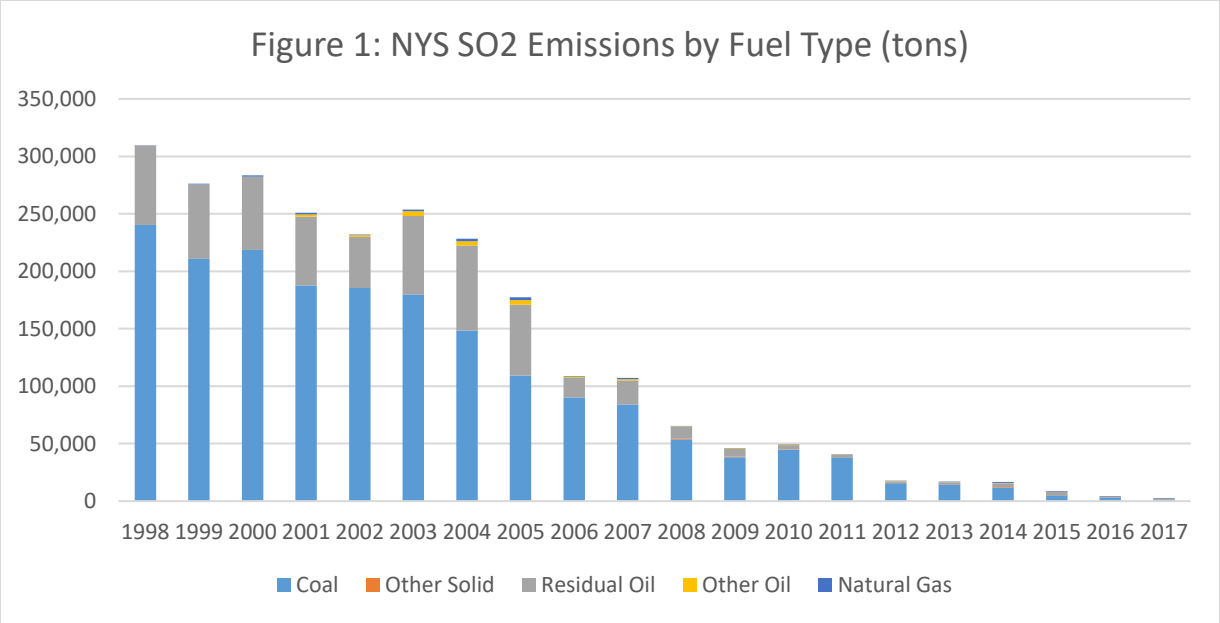


Figure 1: NYS SO2 Emissions by Fuel Type (tons)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Coal
Other Solid
Residual Oil
Other Oil
Natural Gas

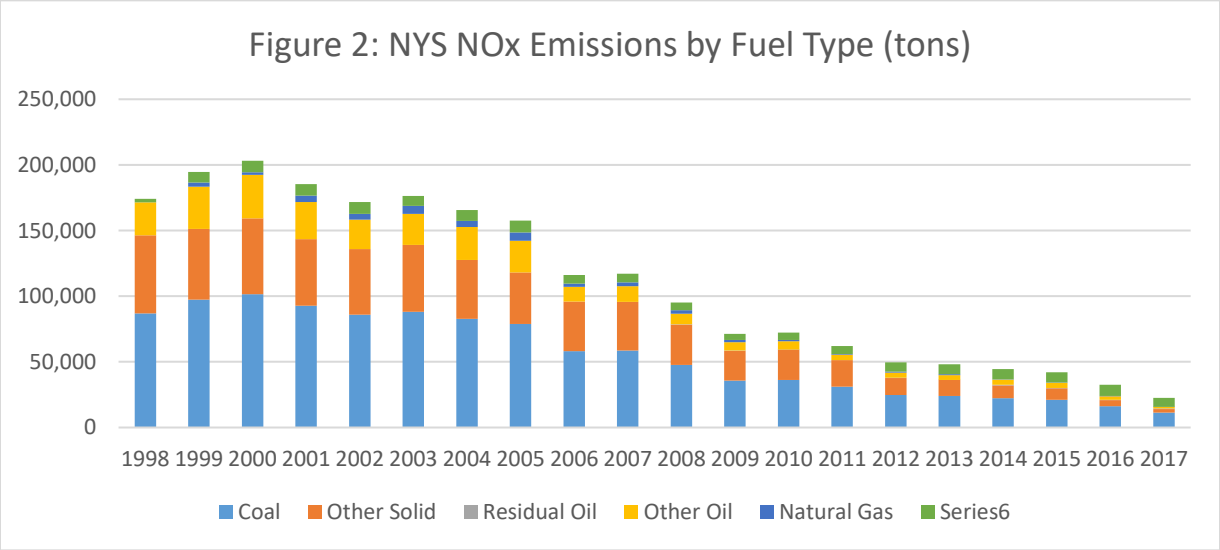


Figure 2: NYS NOx Emissions by Fuel Type (tons)
250,000
200,000
150,000
100,000
50,000
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Coal
Other Solid
Residual Oil
Other Oil
Natural Gas
Series6

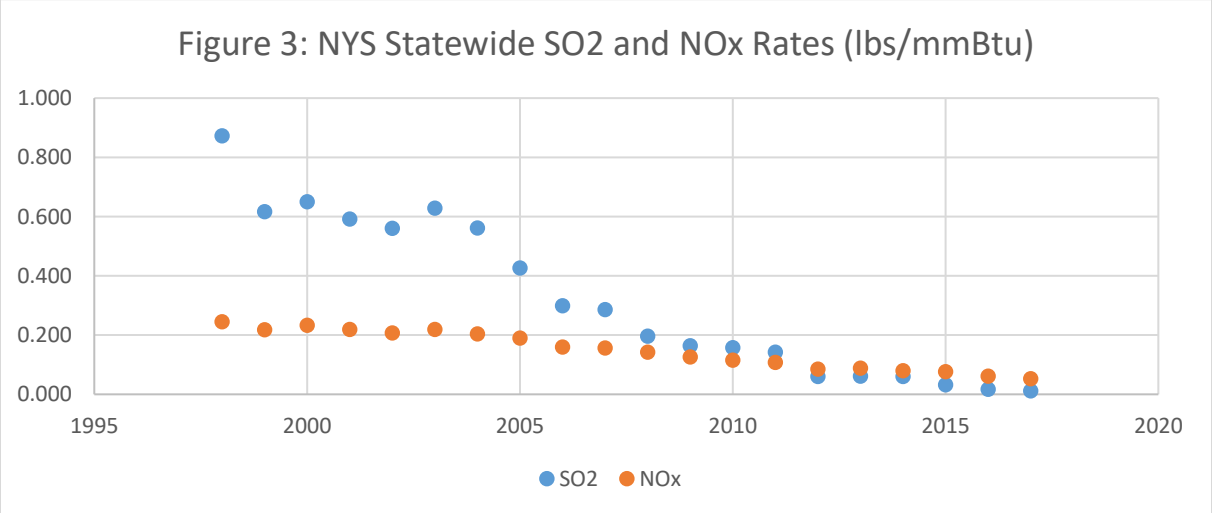


Figure 3: NYS Statewide SO2 and NOx Rates (lbs/mmBtu)
1.000
0.800
0.600
0.400
0.200
0.000
1995
2000
2005
2010
2015
2020
SO2
NOx

Table 1: EPA CAMD Data New York State Air Pollution Emissions from All Program Units

Year	SO2 Mass (tons)	SO2 Mass Coal-only (tons)	NOx Mass (tons)	NOx Mass Coal-only (tons)	CO2 Mass (tons)	CO2 Mass Coal-only (tons)	SO2 Rate (lbs/mmBtu)	NOx Rate (lbs/mmBtu)	CO2 Rate (lbs/mmBtu)
1998	309,775	240,393	87,027	59,377	57,228,699	27,584,834	0.872	0.245	161.122
1999	276,333	210,668	97,376	53,969	58,507,243	24,335,654	0.616	0.217	130.454
2000	283,345	218,649	101,635	57,727	57,114,439	25,546,641	0.649	0.233	130.858
2001	250,928	187,677	92,733	50,789	53,195,854	23,519,892	0.592	0.219	125.483
2002	231,985	185,458	85,917	50,084	51,546,524	24,073,494	0.560	0.207	124.365
2003	253,803	179,836	88,186	50,826	53,240,989	24,491,989	0.628	0.218	131.722
2004	228,267	148,407	82,813	44,704	55,125,941	23,673,988	0.562	0.204	135.622
2005	177,349	109,248	78,788	39,442	56,018,928	22,348,515	0.426	0.189	134.534
2006	108,686	90,134	58,035	37,863	47,912,271	22,183,541	0.299	0.160	131.688
2007	107,210	84,107	58,569	37,149	49,575,411	21,884,899	0.286	0.156	132.160
2008	65,427	53,730	47,556	30,719	42,844,448	18,679,355	0.196	0.142	128.252
2009	46,344	38,186	35,675	22,758	38,295,368	13,637,433	0.164	0.126	135.487
2010	49,568	44,909	36,143	23,274	42,563,848	14,950,792	0.157	0.115	134.974
2011	40,756	37,729	31,062	20,262	37,445,417	10,394,280	0.142	0.108	130.109
2012	17,637	15,631	24,823	12,976	35,800,053	5,030,164	0.060	0.085	122.543
2013	16,878	14,391	24,082	12,090	33,991,141	5,463,637	0.061	0.087	123.427
2014	16,676	11,824	22,214	9,979	34,692,213	4,667,127	0.060	0.079	124.058
2015	8,777	4,892	20,990	8,876	33,271,739	2,229,725	0.032	0.076	119.991
2016	4,533	3,121	16,222	4,576	31,440,502	1,588,950	0.017	0.061	118.073
2017	2,561	1,429	11,253	2,770	25,301,757	763,861	0.012	0.052	116.677

% Reduction	-99.1%	-99.3%	-88.4%	-94.9%	-56.8%	-96.9%	-98.1%	-76.1%	-10.6%
			-88.9%	from 2000 peak year					

CO2 emissions are a bit complicated. There are two CO2 data sets included: one from the Regional Greenhouse Gas Initiative (RGGI) program units and the other from all programs. In New York there are some small peaking turbines that are not presently included in RGGI. Unfortunately the annual emissions are not directly comparable because units that are not affected by RGGI do not have to report annual emissions only the ozone season (May through September). Also note that the RGGI CO2 Allowance Tracking System (COATS) data system also provides annual numbers for the RGGI only units and those numbers are the same as the RGGI only units from CAMD. Figure 4 lists the annual CO2 emissions from 1998 to 2017 by the primary fuel type reported to EPA. Table 2 lists the annual emissions from these units. These data show that CO2 emissions reductions to date have been caused by fuel switching but importantly there isn't much left to switch. As a result, future CO2 emission reductions will be more difficult.

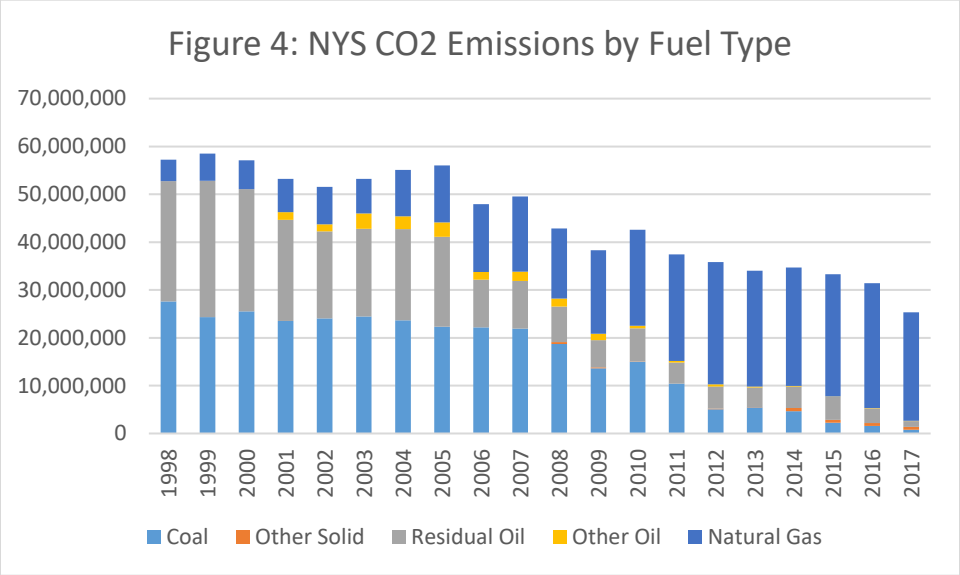
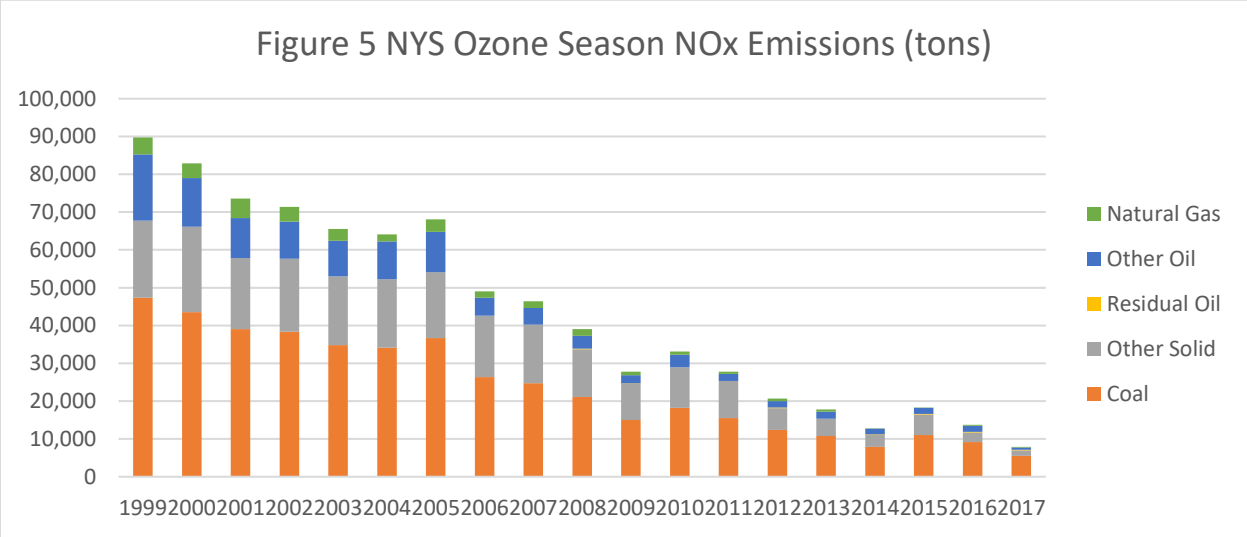


Table 2: EPA CAMD Data New York State Air Pollution Annual Emissions from RGGI Program Units

Year	SO2 Mass (tons)	NOx Mass (tons)	CO2 Mass (tons)	SO2 Rate (lbs/mmBtu)	NOx Rate (lbs/mmBtu)	CO2 Rate (lbs/mmBtu)
2009	43,901	24,186	37,861,408	0.166	0.091	142.953
2010	47,681	25,641	42,113,171	0.160	0.086	141.224
2011	39,654	21,250	37,148,379	0.145	0.078	135.596
2012	17,217	16,781	35,640,442	0.061	0.060	127.126
2013	16,584	17,237	33,759,593	0.063	0.066	128.524
2014	16,590	16,508	34,432,956	0.062	0.062	128.993
2015	8,707	12,575	33,017,594	0.033	0.048	124.919
2016	4,505	11,179	31,194,515	0.018	0.044	123.140
2017	2,538	8,131	25,090,258	0.012	0.040	122.117

In addition to annual market trading programs there are trading programs that run from May 1 to September 30 for NOx emissions to reduce ozone. Figure 5 shows the Ozone Season NOx emissions from 1999 to 2017 by the primary fuel type reported to EPA. In 1999 NOx emissions totaled 47,314 tons and in 2017 were only 5,533 tons, an 88% reduction. Figure 6 documents the changes in ozone season emission rates (lbs/mmBtu) over the same period. The state-wide NOx rate during the Ozone Season in 1999 was 0.202 lbs per mmBtu and was 0.053 in 2017, a 74% reduction. Similar to the annual numbers these reductions are primarily the result of fuel switching. Finally Table 3 lists the Ozone Season NOx mass, heat input and NOx rate values sorted by major unit types: boilers, combined-cycle turbines and simple cycle turbines.



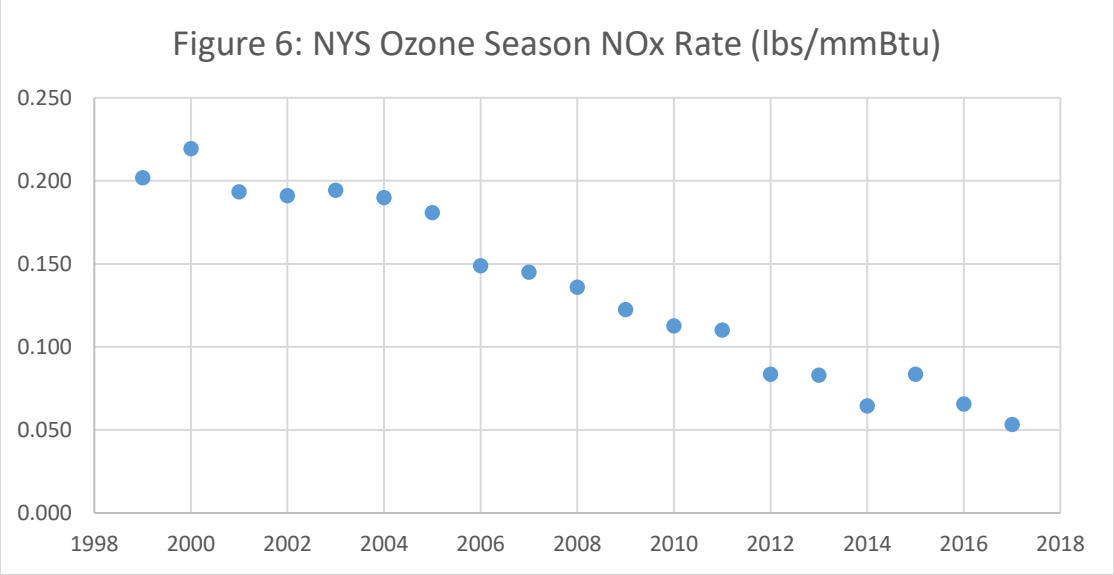


Table 3: New York State Ozone Season NOx Mass by Unit Type. Note Boiler category includes all but the combustion turbine and combined cycle turbine unit types. Cement kilns were not included.

	NOx Mass (tons)			Heat Input (mmBtu)			NOx Rate (lbs/mmBtu)		
Year	**Boiler**	**Combined-Cycle**	**Turbine**	**Boiler**	**Combined-Cycle**	**Turbine**	**Boiler**	**Combined-Cycle**	**Turbine**
1999	41,089	1,823	4,401	365,225,939	83,900,969	20,027,246	0.225	0.043	0.439
2000	39,001	1,520	3,025	304,596,771	78,284,822	14,130,961	0.256	0.039	0.428
2001	33,631	1,619	3,655	302,842,069	81,903,788	17,925,221	0.222	0.040	0.408
2002	32,729	1,598	4,027	304,733,820	69,656,328	27,077,473	0.215	0.046	0.297
2003	26,659	1,423	2,751	274,471,516	61,197,414	21,556,042	0.194	0.047	0.255
2004	26,970	1,173	2,377	270,215,598	69,290,448	20,195,684	0.200	0.034	0.235
2005	28,050	1,265	3,860	282,253,472	93,177,504	29,845,618	0.199	0.027	0.259
2006	19,773	1,123	2,005	225,798,810	107,704,689	20,668,912	0.175	0.021	0.194
2007	18,668	1,022	1,296	218,310,084	104,824,547	17,848,303	0.171	0.020	0.145
2008	15,124	867	1,619	193,267,261	97,721,664	18,209,131	0.157	0.018	0.178
2009	10,857	814	731	133,542,987	102,859,680	8,313,107	0.163	0.016	0.176
2010	12,715	1,026	1,398	179,507,489	125,491,553	17,268,977	0.142	0.016	0.162
2011	10,187	969	1,243	135,594,026	131,113,616	15,385,425	0.150	0.015	0.162
2012	7,393	1,460	1,554	113,499,345	165,501,711	17,158,982	0.130	0.018	0.181
2013	6,774	1,296	1,551	101,229,649	141,576,349	16,995,732	0.134	0.018	0.183
2014	5,210	1,017	472	96,485,970	137,451,645	10,903,577	0.108	0.015	0.087
2015	4,815	1,396	773	95,900,355	154,064,429	13,266,210	0.100	0.018	0.117
2016	5,387	1,682	1,061	112,363,546	152,469,224	15,968,441	0.096	0.022	0.133
2017	3,487	1,074	561	67,826,003	130,373,603	9,795,666	0.103	0.016	0.115
						Reduction since 1999	-54.3%	-62.1%	-73.9%