Improved Temporalization of Small Non-CAMD EGUs

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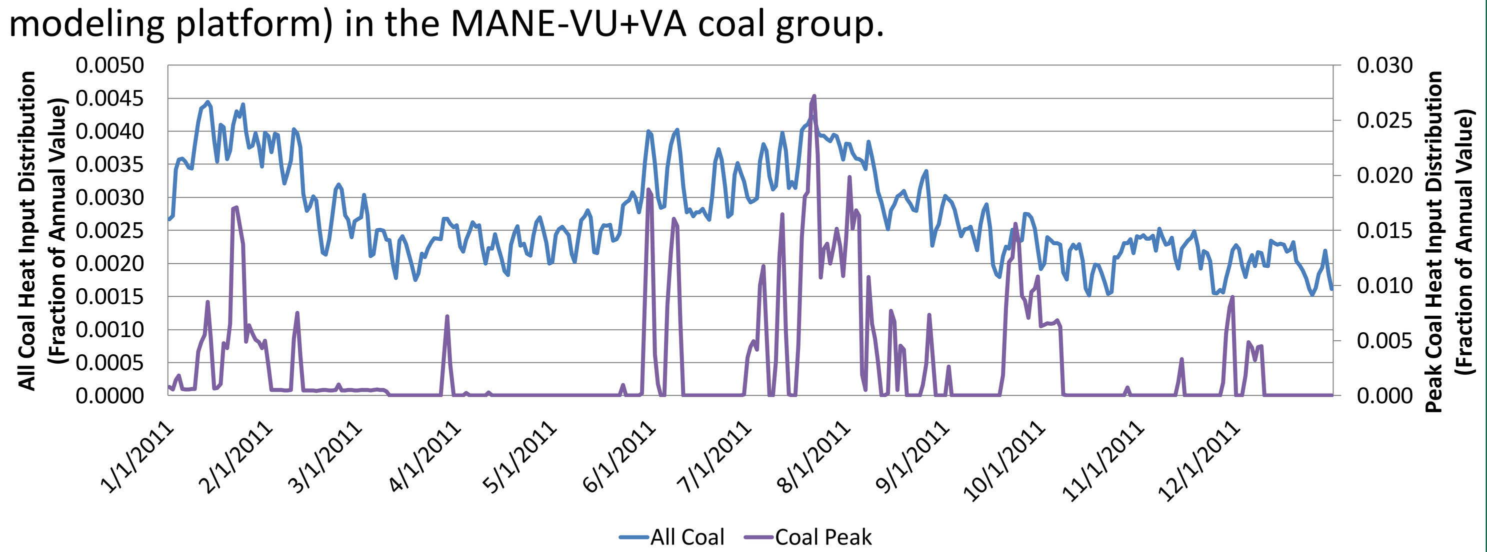
Introduction

The goal of MDE's small EGU effort was to examine the CEMS-based operating profiles for Electric Generating Units (EGUs) that report to EPA's Clean Air Markets Division (CAMD) and use the data to develop temporal profiles for smaller non-CAMD EGUs that more realistically reflect these units' operating behavior, particularly on peak electric demand days. These small units do not report hourly data to CAMD, but they typically operate for limited periods of time, such as on High Electricity Demand Days (HEDDs) or when larger units are offline for maintenance. The small EGUs may also operate at times when it is necessary to ensure grid reliability. Based on what is known about their typical operational patterns, profiles for these units should show limited annual operation and high peak day operation.

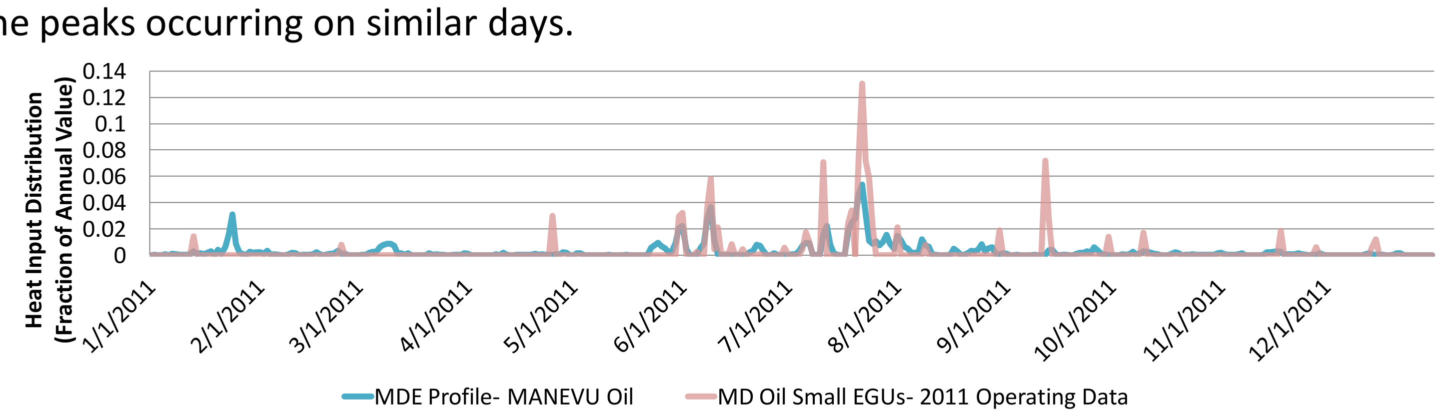
1. Building Temporal Profiles

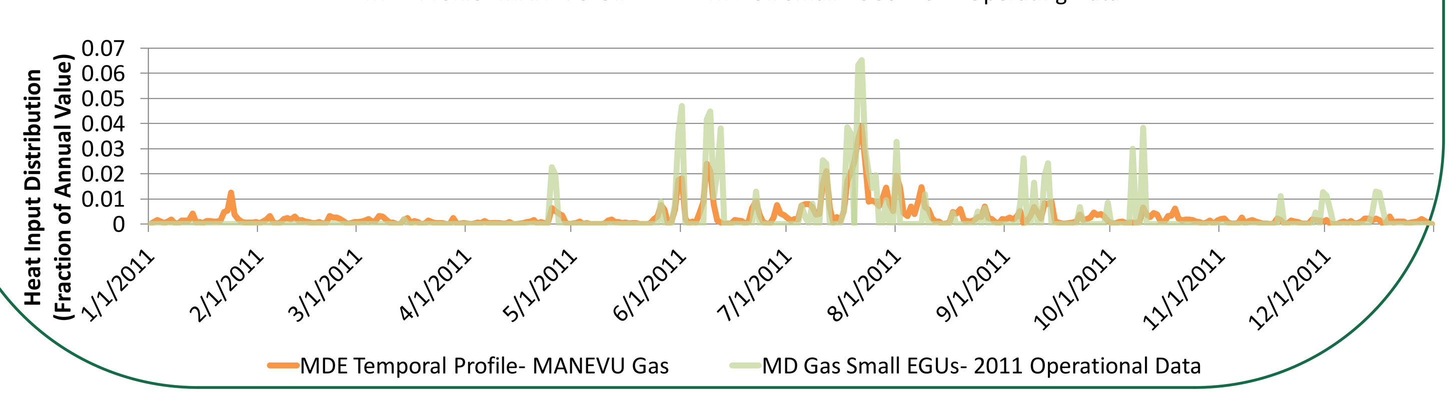
2011 daily heat input distribution was calculated using data from EPA's AMPD database. Units were separated by fuel type (coal, oil, and gas) and region (MANEVU+VA, LADCO, SESARM, and CENSARA). The figure below shows the daily heat input distribution for all units and for "peaking" units (as identified in EPA's 2011v1 modeling platform) in the MANE-VU+VA coal group.



The distribution for all units shows fairly consistent operation throughout the year, whereas the distribution for peaking units shows the expected limited annual operation during the summer months. The data for peaking EGUs was used to produce temporal profiles to apply to non-CAMD EGUs in the MANE-VU coal group; the same methodology was used for all other fuel/region groups.

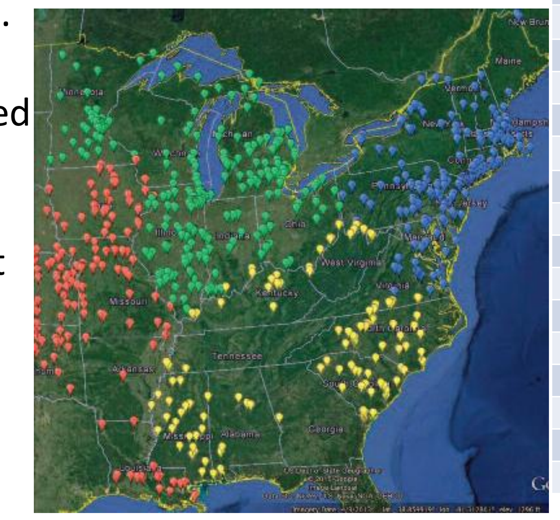
To assess the accuracy of these peaking temporal profiles in the MANEVU+VA region, MDE collected 2011 daily heat input data from a set of small EGU facilities in Maryland. The figures below show the temporal profiles developed for oil and gas-fired non-CAMD EGUs against the operating profiles for small oil and gas-fired EGUs in Maryland. The temporal profiles developed for this study matched well with the operational data, with the peaks occurring on similar days.





2. Identifying non-CAMD Small EGUs

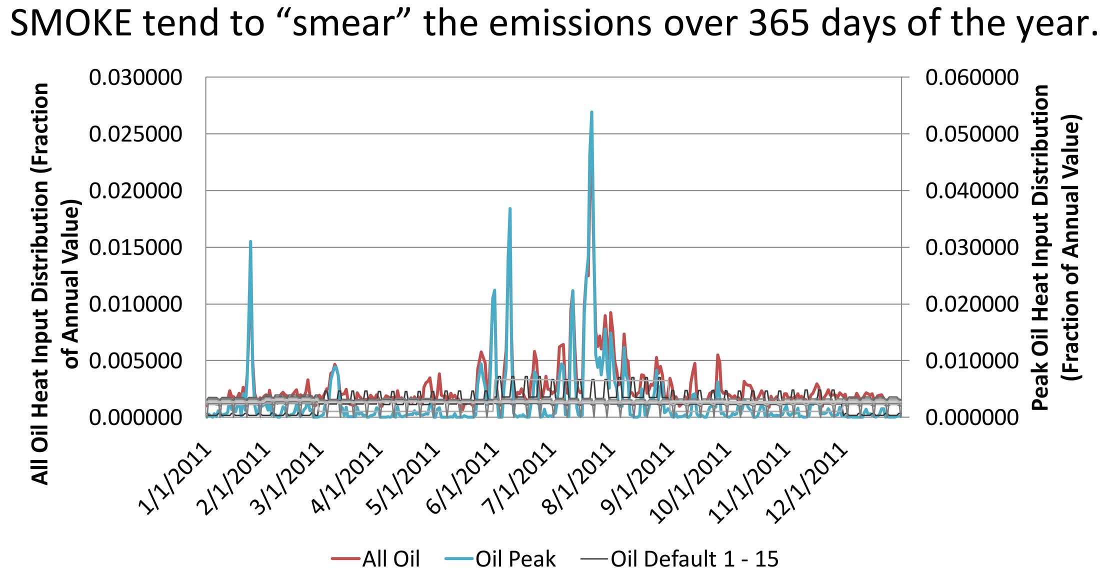
The inventory that was used in this effort was the 2011/2018 Alpha modeling emissions inventory as compiled by the Mid-Atlantic Regional Air Management Association (MARAMA). Units of interest for temporalization were in the point non-EGU sector of the inventory. Using MARAMA's installation of the Emissions Modeling Framework (EMF), the relevant facilities were identified and extracted using the North American Industry Classification System (NAICS) codes for electricity generation. Using the appropriate Source Classification Codes (SCCs), coal-, oil-, and gas-fired EGUs were extracted for the identified facilities. The list of units was quality assured and state comments were collected to ensure that units captured for temporalization were in fact small non-CAMD EGUs. The plot To the right shows the location of the identified non-CAMD small EGUs in MANE-VU+VA (blue), LADCO (green), SESARM (yellow), and CenSARA (red). The chart shows the number of units and the 2011 NOx mass attributed to these units.

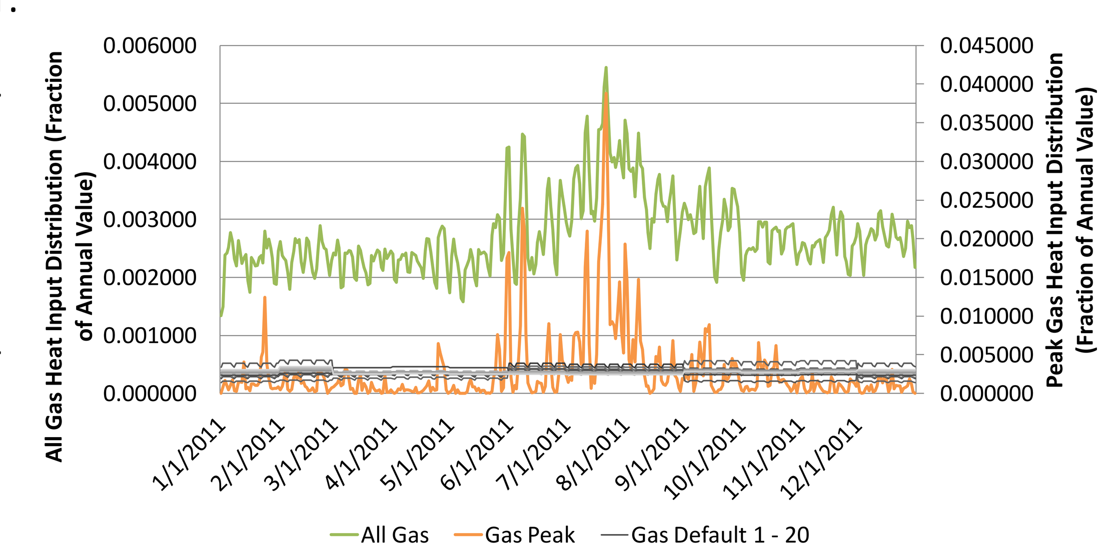


Region	Number of Units	Fuel	2011 Annual NOx Mass (Tons)
MANEVU+VA	462	Coal	N/A
		Oil	726
		Gas	308
MANEVU+VA Total			1,034
LADCO	755	Coal	5,217
		Oil	717
		Gas	1,189
LADCO Total			7,123
SESARM	304	Coal	225
		Oil	244
		Gas	1,535
SESARM Total			2,004
CENSARA	511	Coal	3,050
		Oil	671
		Gas	1,395
CENSARA Total			5,116
Total	2,032	Coal	8,491
		Oil	2,359
		Gas	4,426
Grand Total NOx Mass			15,276

3. Comparing Default Temporal Profiles to CEMS-Based Temporal Profiles

The figures below show the default temporal files assigned to oil and gas-fired small non-CAMD EGUs by the SMOKE emissions model overlaid against the distribution for (1) all EGUs greater than 25 MW and (2) oil and gas-fired peaking EGUs greater than 25 MW in the MANE-VU+VA region. Note: though a temporal profile was developed, the selection methodology yielded no coal-fired non-CAMD EGUs in the MANE-VU+VA region. The plots show the temporal profiles assigned to small non-CAMD EGUs by SMOKE tend to "smear" the emissions over 365 days of the year.





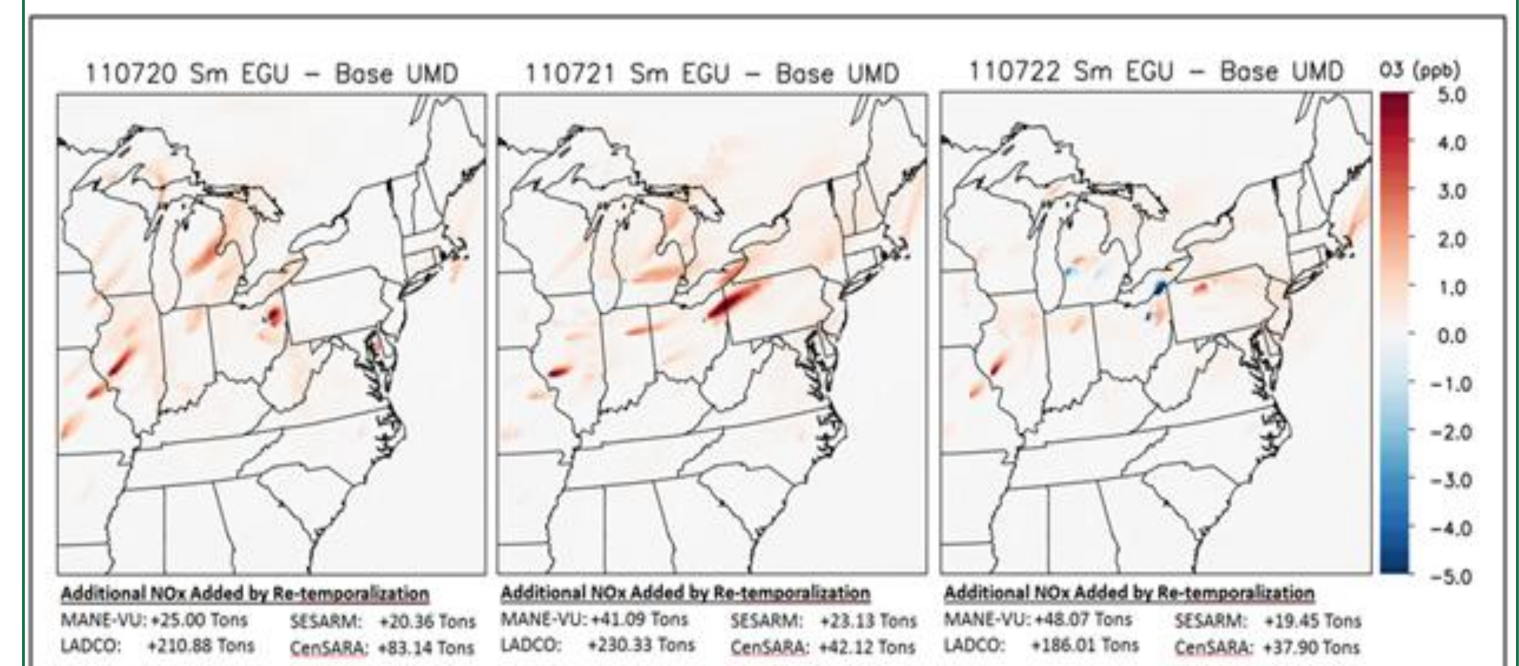
The table to the right shows the total annual NOx emissions for the small non-CAMD EGU units that were the subject of this study. On an annual basis, 15,276 tons of NOx is not a significant amount. Over 2 million tons of NOx were emitted from the electric generation sector in 2011 for the U.S. However, when these emissions occur is important. The table to the right shows the NOx emissions from small non-CAMD EGUs on July 22, 2011 (a peak ozone day in the North East) for all of the geographic regions analyzed. The figures in the fourth column represents that day's emissions as allocated by the default temporal profiles assigned to the units in SMOKE. The fifth column shows the daily NOx emissions from these units as allocated with the temporal profiles developed in this effort. NOx emissions on July 22, 2011 would be 337 tons using the temporal profiles from this study, versus the 45 tons using the SMOKE default temporal profiles. This represents a seven-fold increase in the amount of daily NOx emissions predicted for small non-CAMD EGUs on the July 22, 2011 peak demand day.

Region	Number of Units	Fuel	7/22 Mass using SMOKE Profile (Tons)	7/22 Mass using MDE Profile (Tons)	Difference SMOKE vs. MDE (Tons)	Peak Day % Increase
MANEVU+VA	462	Coal	N/A	N/A	N/A	N/A
		Oil	2	39	37	1,758%
		Gas	1	12	11	1,228%
MANEVU+VA Total			3	51	48	1,600%
LADCO	755	Coal	14	133	119	827%
		Oil	2	36	34	1,550%
		Gas	3	36	33	971%
LADCO Total			20	206	186	931%
SESARM	304	Coal	1	3	2	313%
		Oil	1	5	4	603%
		Gas	5	18	14	295%
SESARM Total			6	25	19	330%
CENSARA	511	Coal	9	42	33	375%
		Oil	2	0	-2	-100%
		Gas	5	12	7	152%
CENSARA Total			16	54	38	237%
Total	2,032	Coal	24	178	154	645%
		Oil	7	80	73	979%
		Gas	14	78	65	477%
Grand Total NOx Mass			45	337	292	650%

4. Modeling Results

Two Community Multi-Scale Air Quality (CMAQ) modeling runs were completed by modelers at the University of Maryland for the month of July 2011 using 2011 meteorology and 2011 Base Case emissions input: one with default temporal profiles and the other with small non-CAMD EGUs re-temporalized as discussed. The difference in modeled maximum 8-hour ozone concentrations between the two runs shows the ozone attributable to the small non-CAMD EGUs.

Difference plots from July 20 – 22 show that peaks in ozone from non-CAMD EGUs tend to "roll" from west to east. July 20th was a peak day in the CenSARA region, while July 21st was a peak day in the LADCO region and July 22nd was the highest peak day in the MANE-VU + VA region. On July 22nd, max 8-hour ozone increases 0.5-1 ppb in parts of Maryland and Delaware, 1-2 ppb off the coast of Massachusetts, and as high as 3 ppb in parts of Pennsylvania. The highest increase in ozone concentration occurred in Ohio on July 21st, reaching as high as 6 ppb.



Despite large increases in NOx emissions, ozone concentrations decreased by up to 5 ppb in some areas. This phenomenon of ozone dis-benefit occurs where ozone is scavenged and thereby reduced by excess NOx emissions. While NOx titration causes a decrease in ozone in areas in the Midwest surrounding the small EGUs, NOx from these small EGUs can still be transported and can increase ozone in downwind areas.

Conclusion & Recommendations

Using hourly data from EPA's Clean Air Markets Division has proven useful for improving the temporalization of small non-CAMD EGUs whose emissions are currently distributed evenly throughout the year using the default temporal profiles from the SMOKE model. Operating data collected from small non-CAMD EGUs within Maryland demonstrates that a profile developed from "peaking" units is appropriate to apply to these units as opposed to an average profile.

This analysis demonstrates that on a high electricity demand day, improved temporalization of small non-CAMD EGUs can lead to a seven-fold increase in predicted peak-day NOx emissions from these units relative to emissions predicted by using the default temporal profiles. Air quality modeling demonstrates that this can translate into a 6 ppb increase in ozone on peak days.

The results of this study have been used to improve subsequent modeling platforms. The temporal profiles presented here were incorporated into MARAMA's 2011/2017 Beta modeling platform and will be incorporated into MARAMA's 2011/2023 Gamma modeling platform. It is recommended that these temporal profiles are used in future modeling efforts.