OTC / MANE-VU Annual Meeting
Wilmington, DE
June 11, 2019

Francis Steitz, NJ
Chair
Stationary and Area Sources Committee

OZONE
TRANSPORT
COMMISSION

OZONE TRANSPORT COMMISSION

Summary of 2018 -2019 OTC SAS Activities

- Good Neighbor SIP strategies (uncontrolled & poorly controlled EGUs, NG pipeline compressor prime movers: NOx control limits, cost effectiveness, emissions reduction benefits, & modeling) - *analyses & documentation completed*

- Charge Addendum on High Electricity Demand Day (HEDD) - *almost complete - finalizing EGU inventory for episodic modeling*

- 2018 - 2019 Work Products
    - OTC Regulatory and Technical Guideline for Reduction of Ozone Precursor Emissions from Consumer Products - Phase V November 21, 2018
    - OTC Regulatory and Technical Guideline for Control of Nitrogen Oxides (NOx) Emissions from Natural Gas Pipeline Compressor Fuel-Fired Prime Movers May 23, 2019
    - Analysis of Technical Feasibility & Cost Effectiveness for Regulatory & Technical Guideline for Control of NOx Emissions from Natural Gas Pipeline Compressor Fuel-Fired Prime Movers May 23, 2019

2018 SAS Charge Addendum - 3 items

Perform following technical analysis of potential strategies for consideration and action by the OTC, to be completed & presented to the Air Directors by the 2018 Fall OTC Air Directors' Meeting:

DELIVERABLES

Data from analyses conducted by CT, DE, MD, ME, & NJ on high emitting EGUs on HEDD

Status: complete

Data needed to perform episodic modeling of 2017 daily NOx emissions from ≥15 MW EGUs that report to CAMD & located within CSAPR-U/OTC states

Status: almost complete

Next Step: Finalize inventory of EGUs for episodic modeling & forward it to OTC Modeling Committee

Evaluated a novel cost effectiveness metric based on ratio of Daily Emissions Reduction (tons/day) to Annualized Cost (in Million $)

Status: complete

Coal: 0.8 TPD/Million $ annual cost
SC Turbines: 7.5 TPD/Million $ annual cost

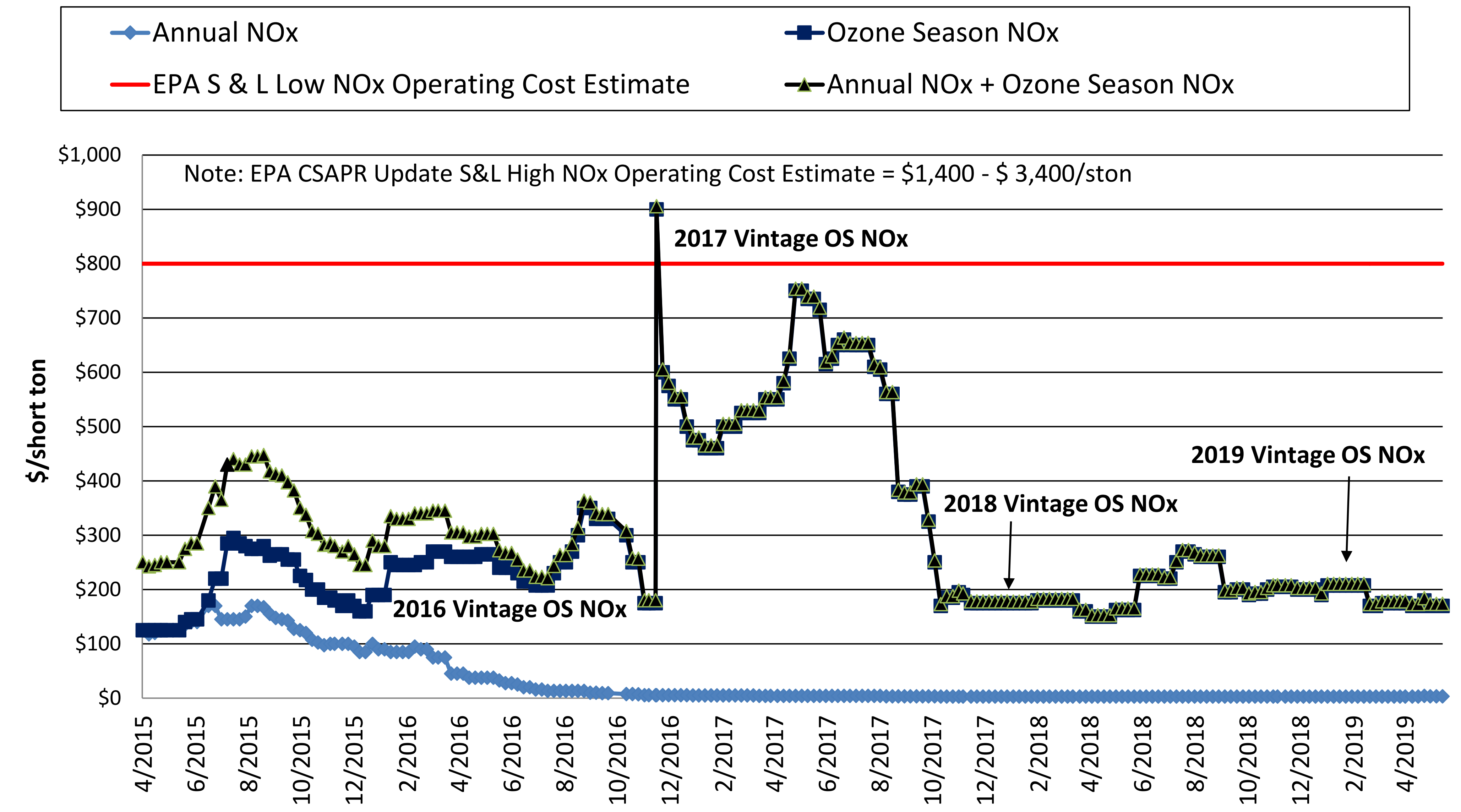
Conclusion: An SCR on a gas or oil fired SC turbine can be ~10X more cost effective than an SCR on a coal fired power plant

Focus of ongoing SAS Activities

NOx Emissions on High Ozone Days

- EGU NOx Controls not run/not run optimally on High Ozone Days
- NOx sources on High Ozone Days include uncontrolled sources (EGUs, Distributed Generation, Municipal Waste Combustors)
- Current stationary source NOx limits – not stringent enough &/or could be averaged over longer time periods, e.g. 30 days

CSAPR Allowance Prices (4/17/2015 to 5/31/2019)



Allowance Price Data Source: Argus Air Daily, Control cost estimates calculated using Sargent and Lundy method

Still Cheaper to Buy Allowances than to Run Controls in most cases!

EGUs Top 28 2018 Ozone Season OTR-Impacting State NOx Emitters

19 of 28 Units with SCR among Top Emitters, averaging 0.152 lb/mmBTU

	State	Facility Name	Facility - Unit ID	Percent Operating Time	NPC (MW)	Rated Fuel Capacity (mmBTU/hr)	Avg. NO_x Rate (lb/MMBtu)	NO_x (tons)	SCR?	Best Observed Rate	Year	NO_x Reduction	Off-line Date
1	OH	W H Zimmer Generating Station	6019-1	83%	1,300	12,900	0.187	2,805	Yes	0.056	2006	-60%	None
2	NC	Belews Creek	8042-1	89%	1,080	9,900	0.243	2,552	Yes	0.028	2007	-34%	None
3	KY	Paradise	1378-3	94%	1,150	11,800	0.162	2,540	Yes	0.100	2005	-76%	12/2020
4	NC	Marshall	2727-4	97%	648	6,000	0.243	2,100	SNCR	0.230	2016	-29%	None
5	IN	Rockport	6166-MB2	76%	1,300	12,800	0.157	1,954	by 6/1/2020				None
6	WV	Fort Martin Power Station	3943-1	96%	552	5,600	0.263	1,905					None
7	IN	IPL - Petersburg Generating Station	994-4	94%	574	6,100	0.224	1,821					None
8	OH	Gen J M Gavin	8102-2	88%	1,300	12,900	0.104	1,708	Yes	0.055	2005	-79%	None
9	IN	Rockport	6166-MB1	75%	1,300	12,800	0.119	1,698	Yes	0.119	2018	-70%	None
10	WV	Fort Martin Power Station	3943-2	77%	555	5,600	0.273	1,643					None
11	NC	Belews Creek	8042-2	77%	1,080	9,900	0.197	1,502	Yes	0.038	2009	-67%	None
12	WV	Pleasants Power Station	6004-2	96%	650	6,800	0.156	1,492	Yes	0.039	2005	-58%	6/1/2022
13	WV	John E Amos	3935-3	86%	1,300	13,000	0.109	1,489	Yes	0.061	2012	-85%	None
14	OH	Gen J M Gavin	8102-1	78%	1,300	13,000	0.103	1,478	Yes	0.069	2004	-81%	None
15	KY	Ghent	1356-2	98%	556	6,000	0.178	1,276					None
16	PA	Keystone	3136-1	96%	936	9,000	0.098	1,276	Yes	0.042	2003	-70%	None
17	OH	Miami Fort Power Station	2832-8	80%	558	5,800	0.192	1,218	Yes	0.054	2007	-66%	None
18	KY	Mill Creek	1364-1	97%	355	3,800	0.291	1,204					None
19	WV	Mountaineer (1301)	6264-1	64%	1,300	12,800	0.088	1,172	Yes	0.039	2007	-82%	None
20	IN	Alcoa Allowance Management Inc	6705-4	84%	323	3,500	0.252	1,162	Yes	0.095	2007	-41%	None
21	WV	Harrison Power Station	3944-3	92%	650	6,600	0.116	1,122	Yes	0.066	2005	-75%	None
22	OH	*Killen Station*	*6031-2*	*49%*	*660*	6,700	*0.553*	*1,093*	*Yes*				*06/2018*
23	KY	Mill Creek	1364-2	94%	355	3,900	0.288	1,071					*None*
24	OH	Miami Fort Power Station	2832-7	71%	557	5,700	0.188	1,070	Yes	0.054	2007	-66%	None
25	PA	Keystone	3136-2	85%	936	9,000	0.104	1,061	Yes	0.043	2008	-71%	None
26	OH	Conesville	2840-6	66%	444	4,800	0.443	1,034					5/1/2019
27	KY	Ghent	1356-3	93%	556	6,100	0.172	993	Yes	0.027	2005	-39%	None
28	NC	Roxboro	2712-2	90%	657	5,600	0.283	959	Yes	0.058	2011	-4%	None

EGUs: Top 28 NO_x Emitters in States Impacting OTR Monitors in 2023 Modeling

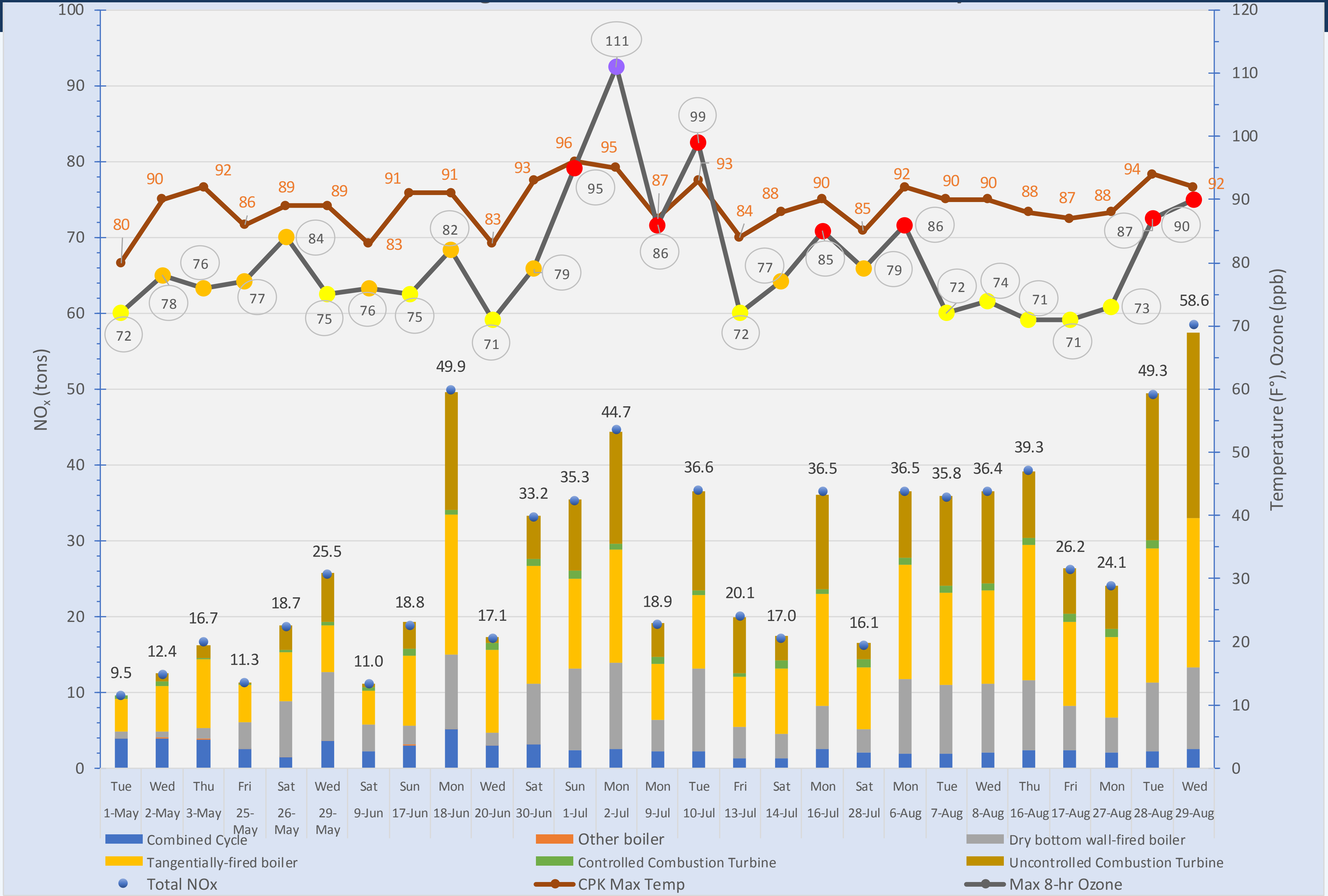
- 19 of 28 top emitting units have SCR controls
- Compared to 2014 (overall worst year for curtailment) NO_x reduction in these units increased from 55% to 66%, however,
  - Relative to BOR emissions, 2018 rates resulted in 15,000 tons of lost ozone season NO_x reductions
  - Noted NO_x reductions are relative to pre-SCR maximum reported NO_x rate for each unit
    - ❑ Avg. NO_x reduction at BOR = 89%
    - ❑ Avg. 2018 NO_x reduction = 66% (34% - 85% reduction range)

EGUs: Top 28 NO_x Emitters in States Impacting OTR Monitors in 2023 Modeling

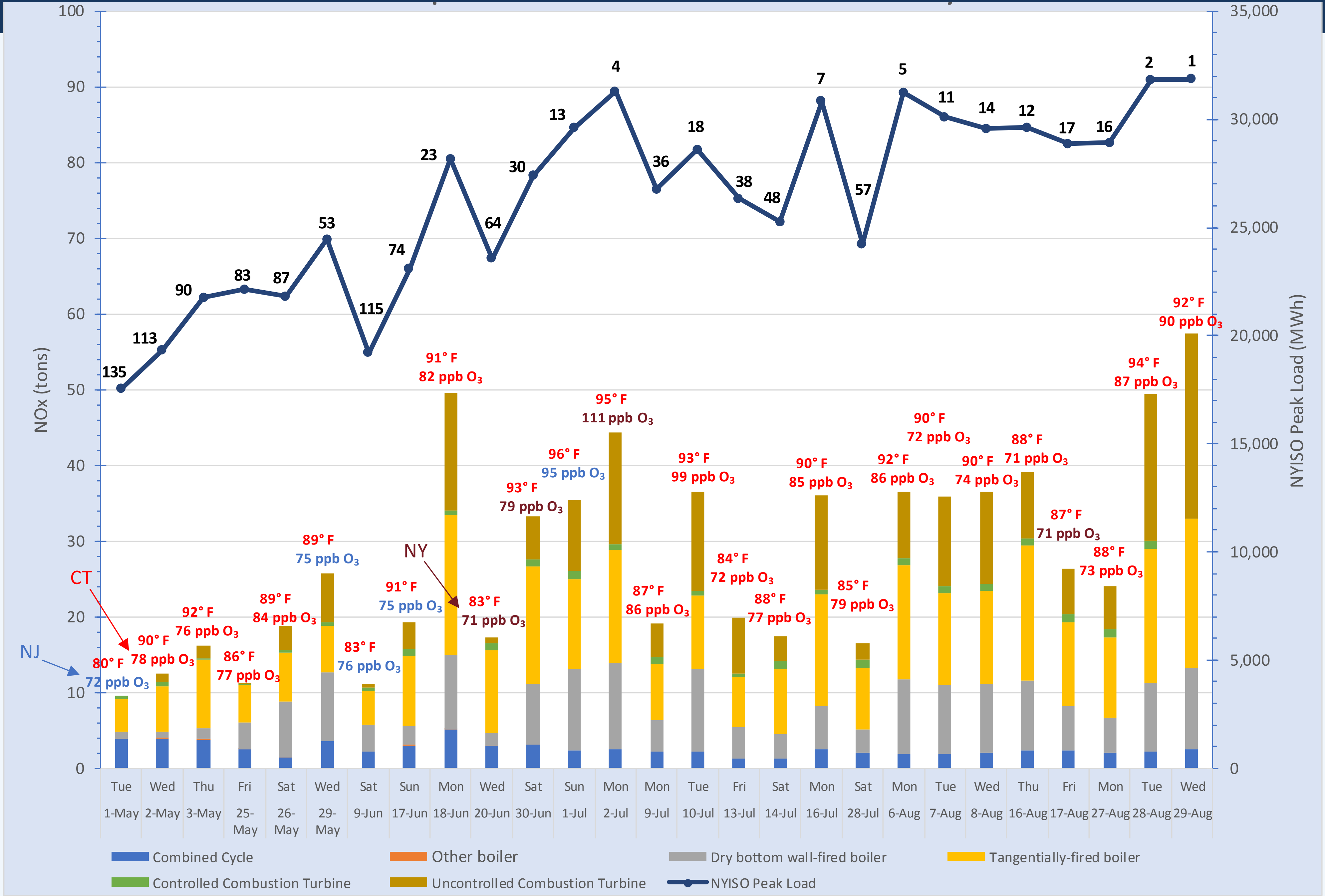
Relative to BOR emissions, less-than-optimal rates result in 15,000 tons of potentially lost NO_x reduction benefit.

Emitting State	NO_x (tons)	Contributing to monitors in:
OH	4,900	CT, DE, DC, MD, MA, NJ, NY, PA, RI, VA
NC	3,500	DE, DC, MD, VA
WV	2,900	CT, DE, DC, MD, MA, NJ, NY, PA, VA
KY	1,800	CT, DE, DC, MD, MA, NJ, NY, PA, VA
PA	1,300	CT, DE, DC, MD, MA, NJ, NY, PA, RI, VA
IN	700	CT, DE, DC, MD, MA, NJ, NY, PA, RI, VA
Total	**15,100**	(2023 DV >70 ppb – OTC modeling)

NYMA EGU NOx with Maximum Central Park Temperatures & 8-hour Ozone Values, & AQI Categories on 2018 NAA Ozone Exceedance Days



NYMA EGU NOx with NYISO Peak Loads, Peak 8-hour Ozone, & Maximum Central Park Temperatures on 2018 NAA Ozone Exceedance Days



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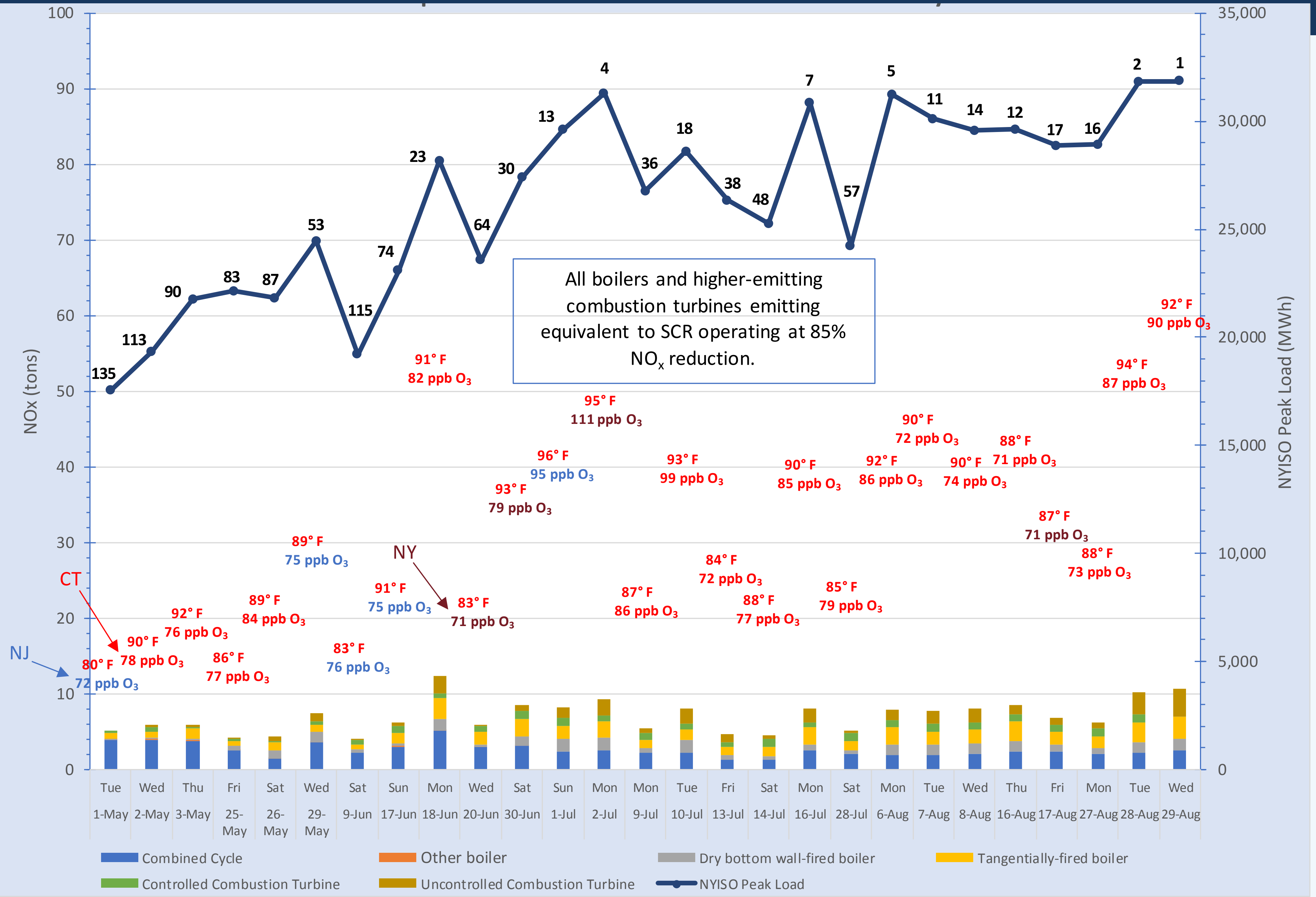
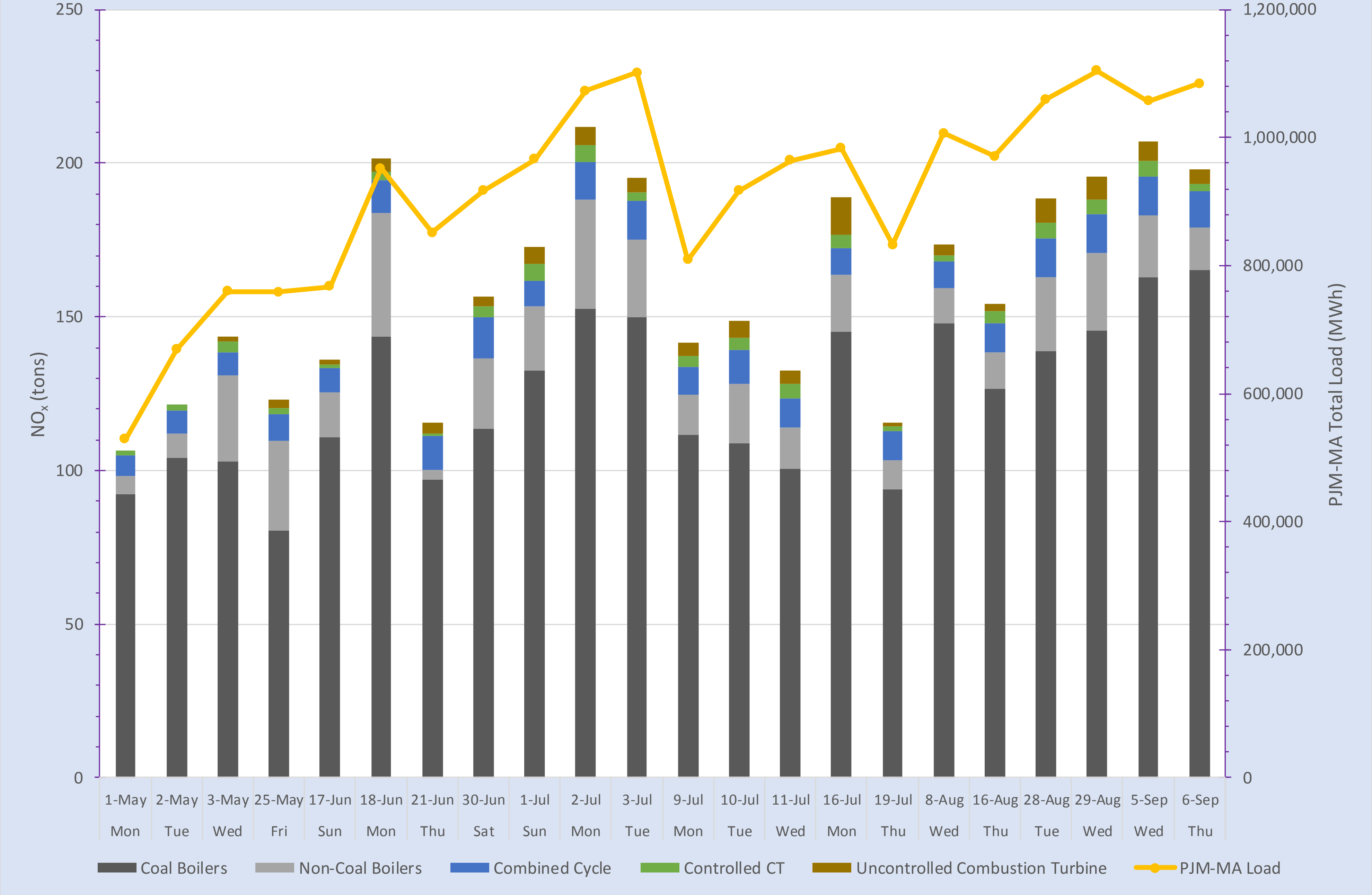
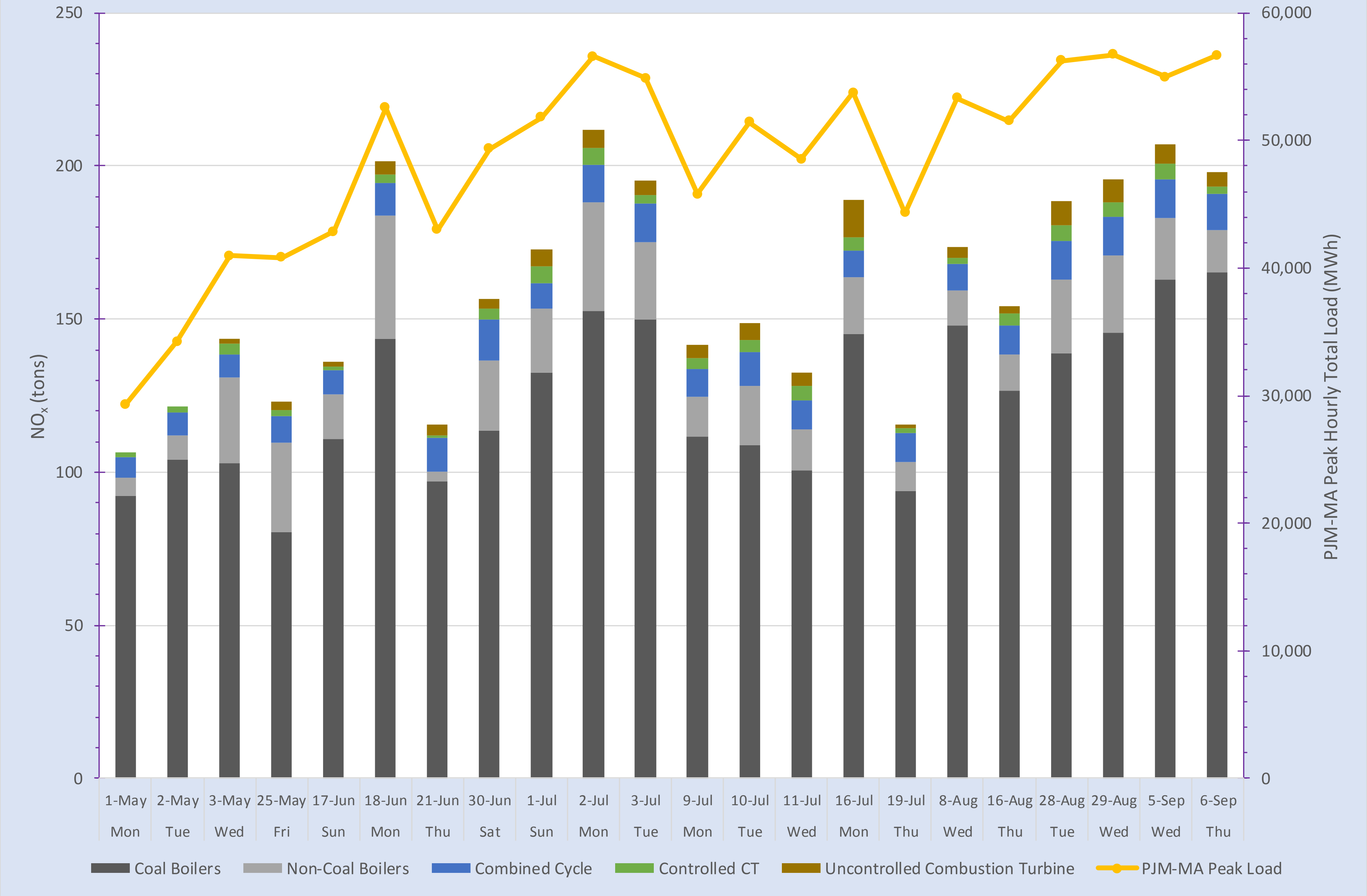


DE MD PA NOx Emissions on NJ Southern NAA 2018 Ozone Exceedance Days with PJM-MA Total Load



DE MD PA NOx Emissions on NJ Southern NAA 2018 Ozone Exceedance Days with PJM-MA Peak Hourly Load



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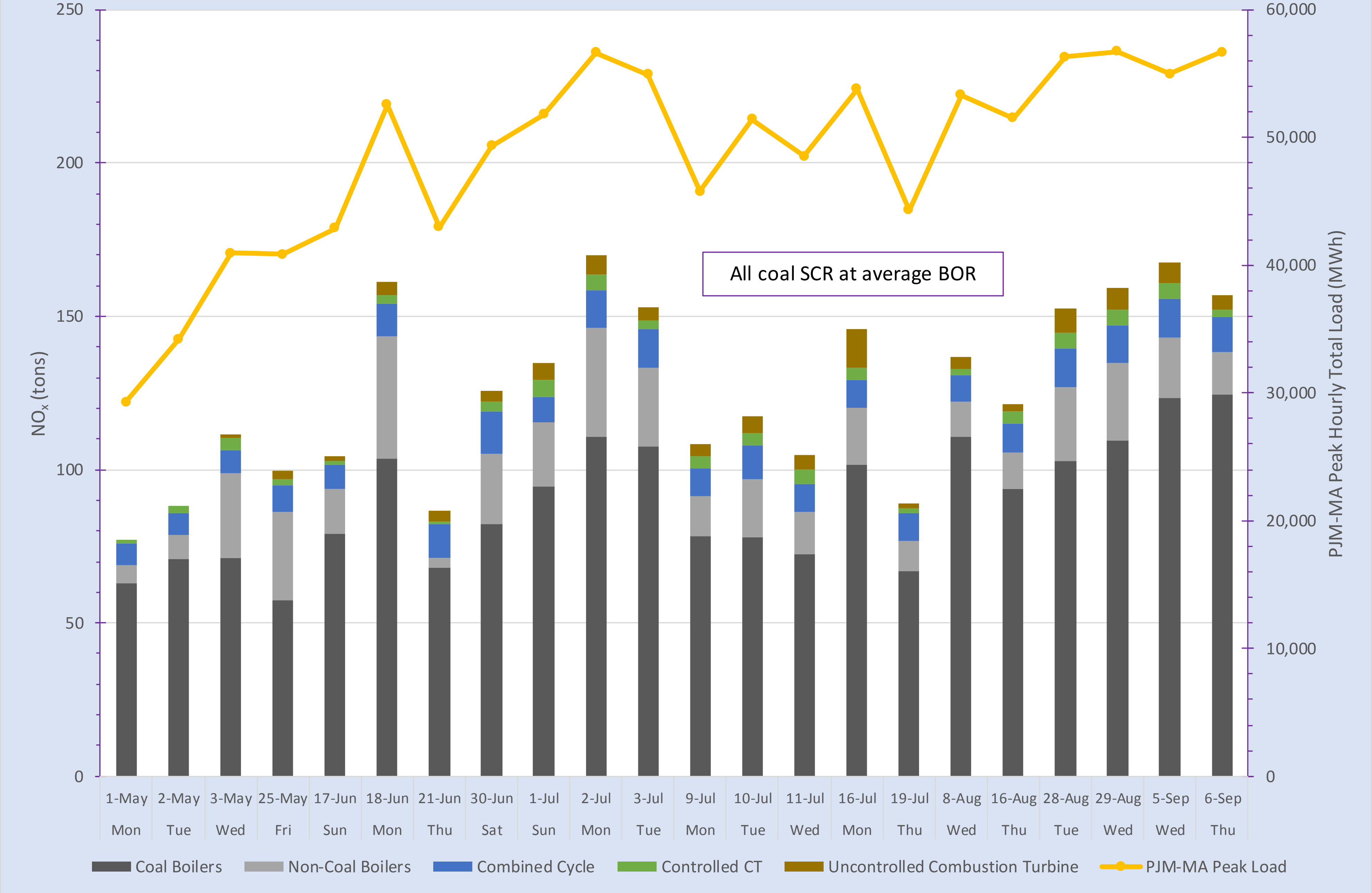
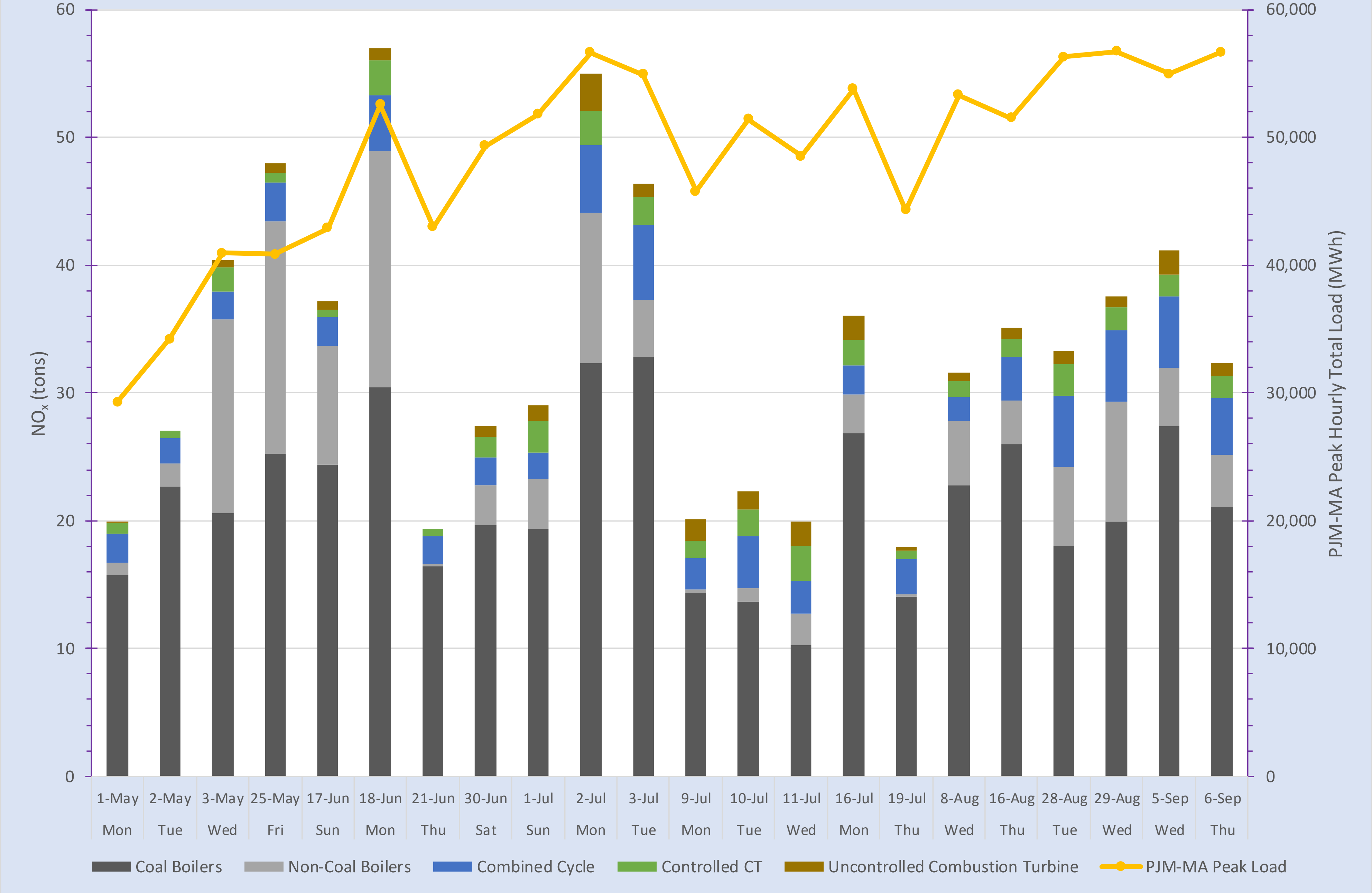
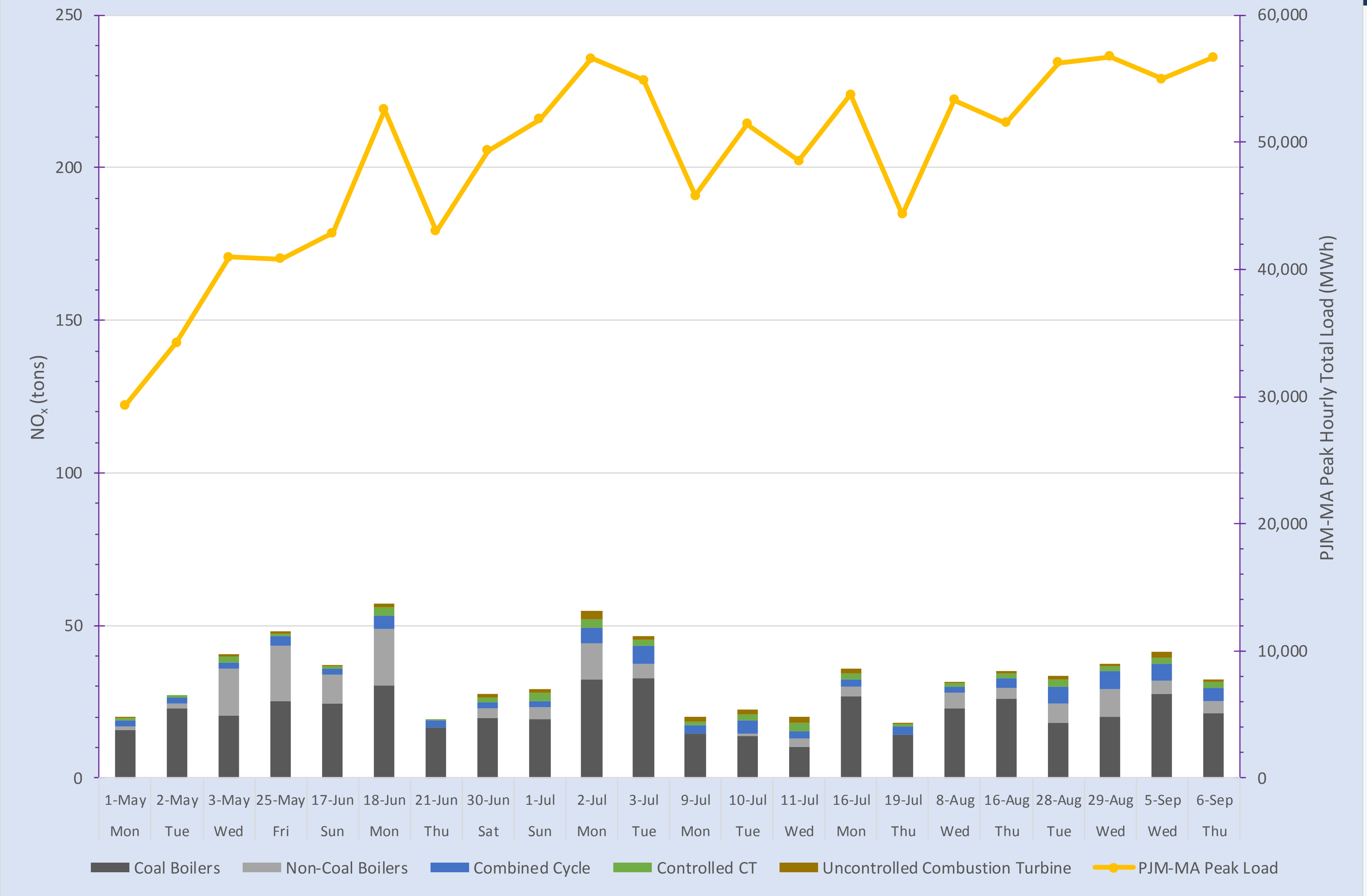


DE MD ~~PA~~ NOx Emissions on NJ Southern NAA 2018 Ozone Exceedance Days with PJM-MA Peak Hourly Load



DE MD ~~PA~~ NOx Emissions on NJ Southern NAA 2018 Ozone Exceedance Days with PJM-MA Peak Hourly Load



New Tool for Geospatial Analysis of EGU Emissions & Monitored Ozone Data

Author: Mark Prettyman (DE DNREC) for Masters of GIS program at Penn State U

- Shared with OTC SAS Committee
- Simplifies unit-specific hourly data pull from CAMD
- Affords a GIS analysis of such data including back-trajectory
- Use analysis to determine the impact of specific EGUs on ozone concentrations at specific monitors in OTR

Geospatial Analysis of EGU Emissions & Monitored Ozone Data

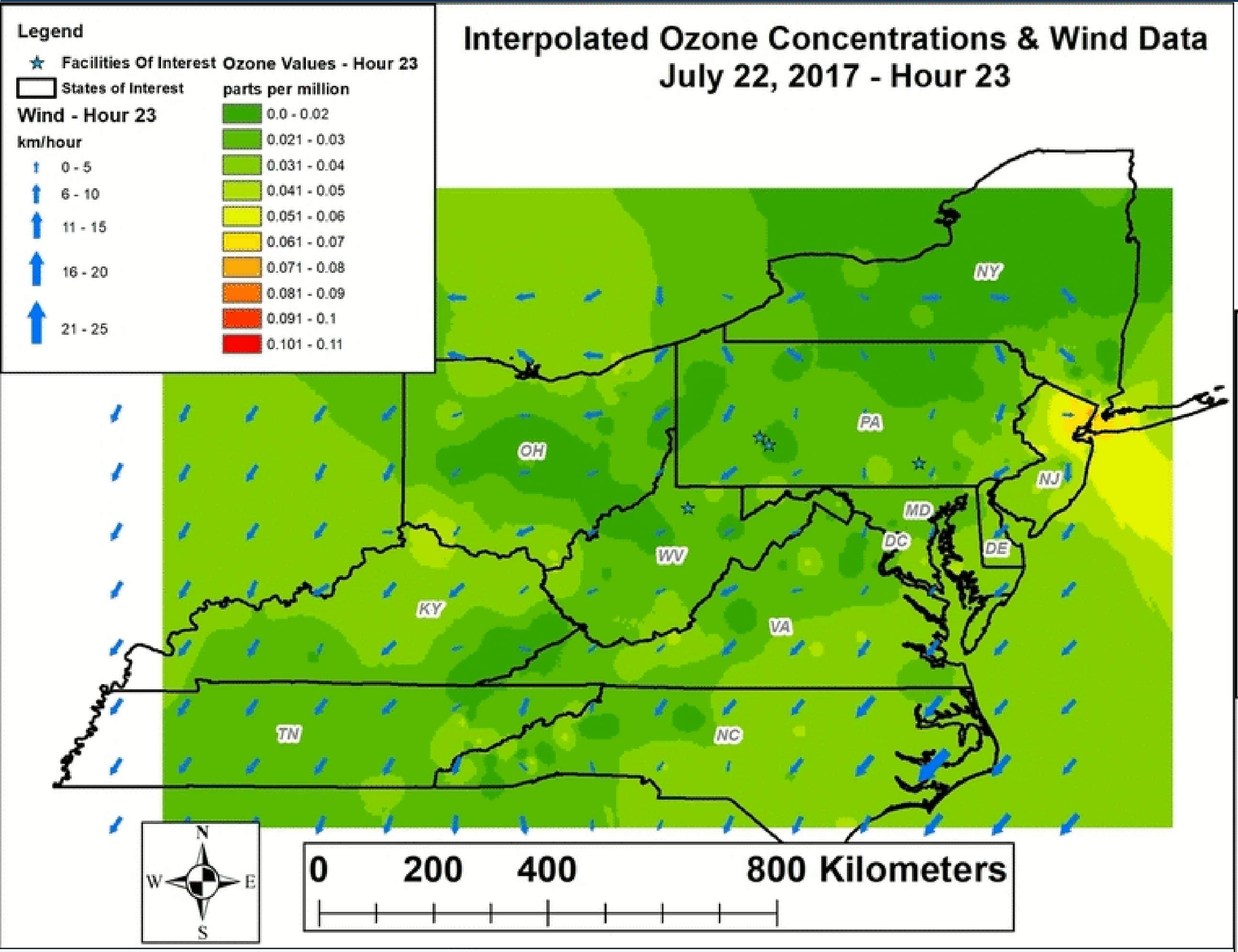
Mark's Project: Qualitative Correlation of EGU emissions on days with high ozone (exceedance days) similar to back trajectory analysis.

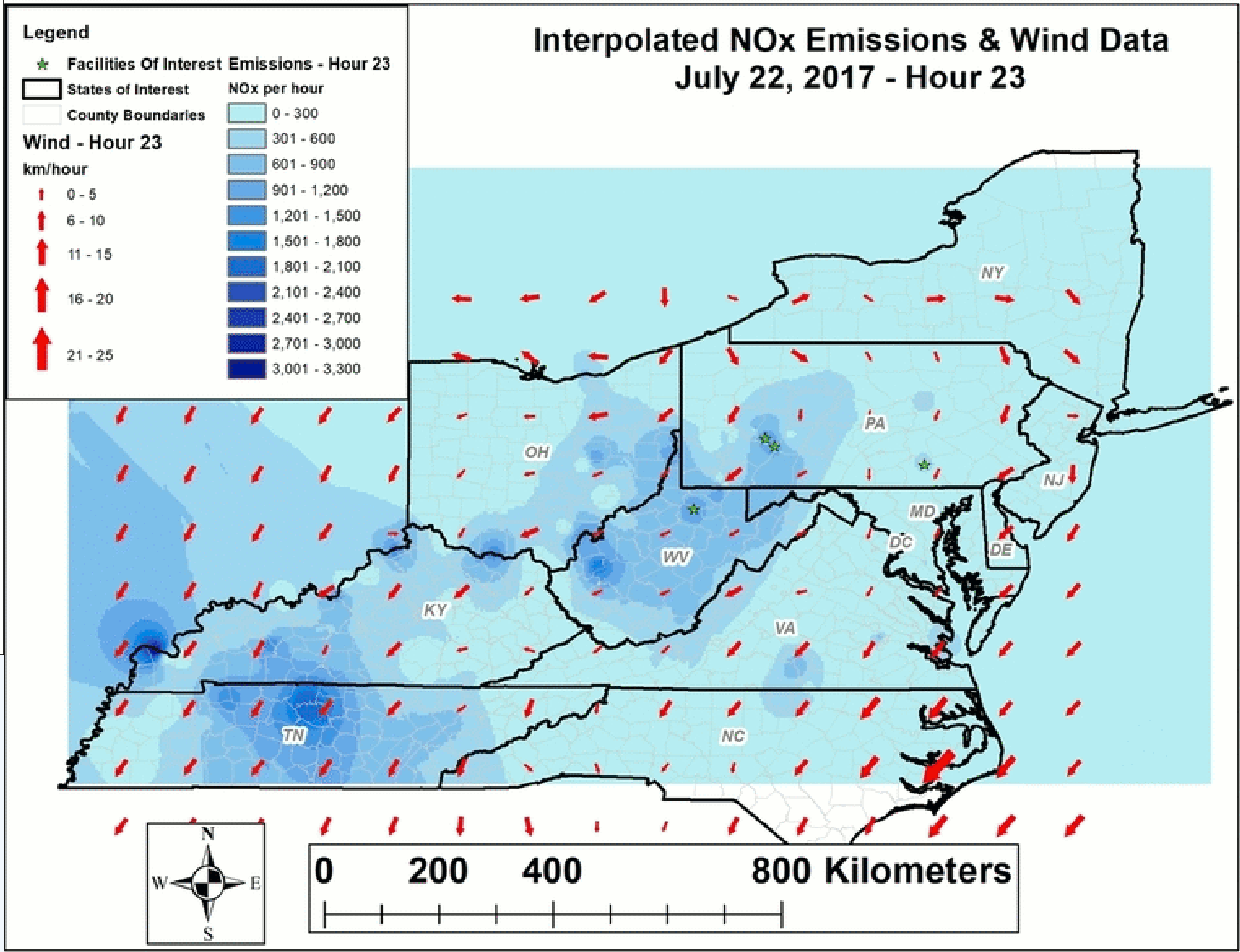
Resources: Emissions & monitor data on July 22, 2017 for all EGUs in the region were considered, but emissions from only 4 facilities were analyzed in relation to Philadelphia NAA.

Conclusions:

- Emissions from Brunner Island, Conemaugh, Harrison, & Homer City EGUs did not contribute to ozone exceedances in Philadelphia NAA on that day, based on direction of wind.
- Python programming was used to automate some of the GIS work (ArcGIS necessary).
- More high ozone days should be analyzed (before & after) for complete analysis.
- A full script would need to be developed to completely automate the effort.
- Much of the analysis was the setup - future efforts on more units over more days could take half the time.

Example of Geospatial Analysis Results





OTC SAS Draft Work Plan – Technical Priorities Projects

Continue to:

- Evaluate ozone reduction strategies for reducing NOx emissions from natural gas infrastructure including compressor stations
    - Fugitive emissions have negative impacts on ozone & climate change (e.g. methane)
- Develop enhanced tools for calculating cost-effectiveness for short term ozone standards
- Assist in stationary source inventory development for 2016 & appropriate future years

OTC SAS Draft Work Plan – Technical Priorities Projects

Develop peak day ozone reduction strategies:

- Optimal operation of existing SCR & SNCR controls
- Small generator rules, e.g. CT, DE, NJ
- Individual state NOx emissions reduction efforts
- Investigation of high emitting non-EGU stationary sources of NOx emissions on high ozone days

OTC SAS Draft Work Plan – Technical Priorities Projects

Conduct screening effort to identify any significant inside-the-OTR NOx reductions (TPD) from strengthened RACT requirements (for 2015 Ozone NAAQS)

- Inventory analysis of multiple source sectors
- Refined cost analysis for daily impacts

Summary & Conclusions

Current SAS Work

- Finalizing inventory of EGUs for episodic modeling to complete SAS Charge Addendum
- Developing 2018 EGU NOx emission inventory for high ozone day/peak day ozone reduction strategies to be used in episodic modeling
- Buying allowances continues to be cheaper than running controls in many cases
- Potential loss of NOx reduction benefit of 15,000 tons from Top 28 emitters compared with BORs
- Geospatial analysis shows potential usefulness

Future SAS Work

- Draft work plans to address new SAS Charge

Proposed New SAS Charge

Technical analyses to be conducted by the SAS Committee:

- Collection of updated data necessary for the development of high ozone day/peak day ozone reduction strategies with emission limits based on daily averaging times:
    - Optimization of existing EGU controls (e.g. SCR and SNCR)
    - Natural Gas Pipeline Compressor Prime Movers
    - Small Electric Generators (e.g. review CT, DE, NJ rules)
    - Industrial/Commercial/Institutional boilers (ICI boilers)
    - Municipal Waste Combustors
    - Cement kilns

Proposed New SAS Charge

Technical analyses to be conducted by the SAS Committee:

- Development of emission inventories for high ozone day/peak day ozone reduction strategies to be used in episodic modeling (e.g. EGUs, turbines, boilers, etc.); Assess and report how peak day ozone emissions may have changed, and likelihood of future changes;
- Recommendation of cost-effectiveness thresholds for presumptive and case-by-case basis RACT determinations for the 2015 8-hour ozone NAAQS (Ozone National Ambient Air Quality Standards), and the development of a refined tool for calculating cost-effectiveness based upon daily emissions reductions for attainment and maintenance of both the 2008 and 2015 8-hour ozone NAAQS; and
- Development of a screening analysis to identify any significant inside-the-OTR potential NOx reductions (TPD) from strengthened RACT requirements for attainment and maintenance of 2015 Ozone NAAQS.

BONUS SLIDES

Top 28 NO_x Emitters in States Impacting OTR Monitors in 2023 Modeling

- Excluding Rockport MB-1 (started in 2017, BOR in 2018) & Killen-2 (closed in June), all SCR units curtailing use to varying degrees
- NO_x reduction is relative to pre-SCR maximum reported NO_x rate for each unit.
  - Relative to BOR emissions, these rates may result in 15,000 tons of lost NO_x reduction
  - Avg. NO_x reduction at BOR = 89%
  - Avg. 2018 NO_x reduction = 66% (34 - 85% reduction range)
- Compared to 2014 (overall worst year for curtailment) NO_x reduction increased from 55 to 66%, however,
  - 8 units are equivalent to their 2014 operations, averaging 58% (2014) vs 60% (2018) reductions
  - 5 units are substantially better in 2018, average reduction of 20% (2014) vs 56% (2018)
  - 3 units did better in 2014: 1 in OH, 2 in NC, (79% then vs 42%)

    #26 on the modified list, with a 6% NO_x reduction, which is essentially zero, is also from NC. These three NC units averaged NO_x reductions of 67% then, with 35% in 2018.

Jupyter Notebook/Python Automation

Automated analysis of hourly data from AMPD using:

- Python for downloading data from AMPD FTP site
- ArcGIS API for Python for mapping data but not necessary for "number crunching"
- R statistical software for graphing capabilities
- Jupyter Notebook to set up the project as a "how-to" document

Jupyter Notebook (jupyter.org)

- Open-source web application for creating documents that contain live code, equations, visualizations, & text.
- Support for multiple programming languages.
- Standalone documents which are easier to follow than typical scripts.
- Easily shared
- Must be installed via "Anaconda Navigator" so that specific packages can be installed & used in the programming environment which is created.

Jupyter Notebook/Python Automation

Jupyter Notebook (jupyter.org)

- Current Jupyter Notebook project is set up to download all AMPD data for a specified state from January 2010 to now.
- Could readily be converted to download data for all states for a single year.
- Summarized data includes daily average NOx rates (min & max), ozone season NOx rate averages, ozone season operational percentage, & total ozone season NOx emissions.
- Additional Python scripts can be easily added to calculate other values from the AMPD data.
- Jupyter Notebook code lines (which are run individually, line by line) could be aggregated into a single Python script to run altogether, once input parameters are set (state/year).