

# OTC / MANE-VU Joint Committees' Meeting

## April 11, 2019

Francis Steitz, NJ  
Chair

Stationary and Area Sources Committee

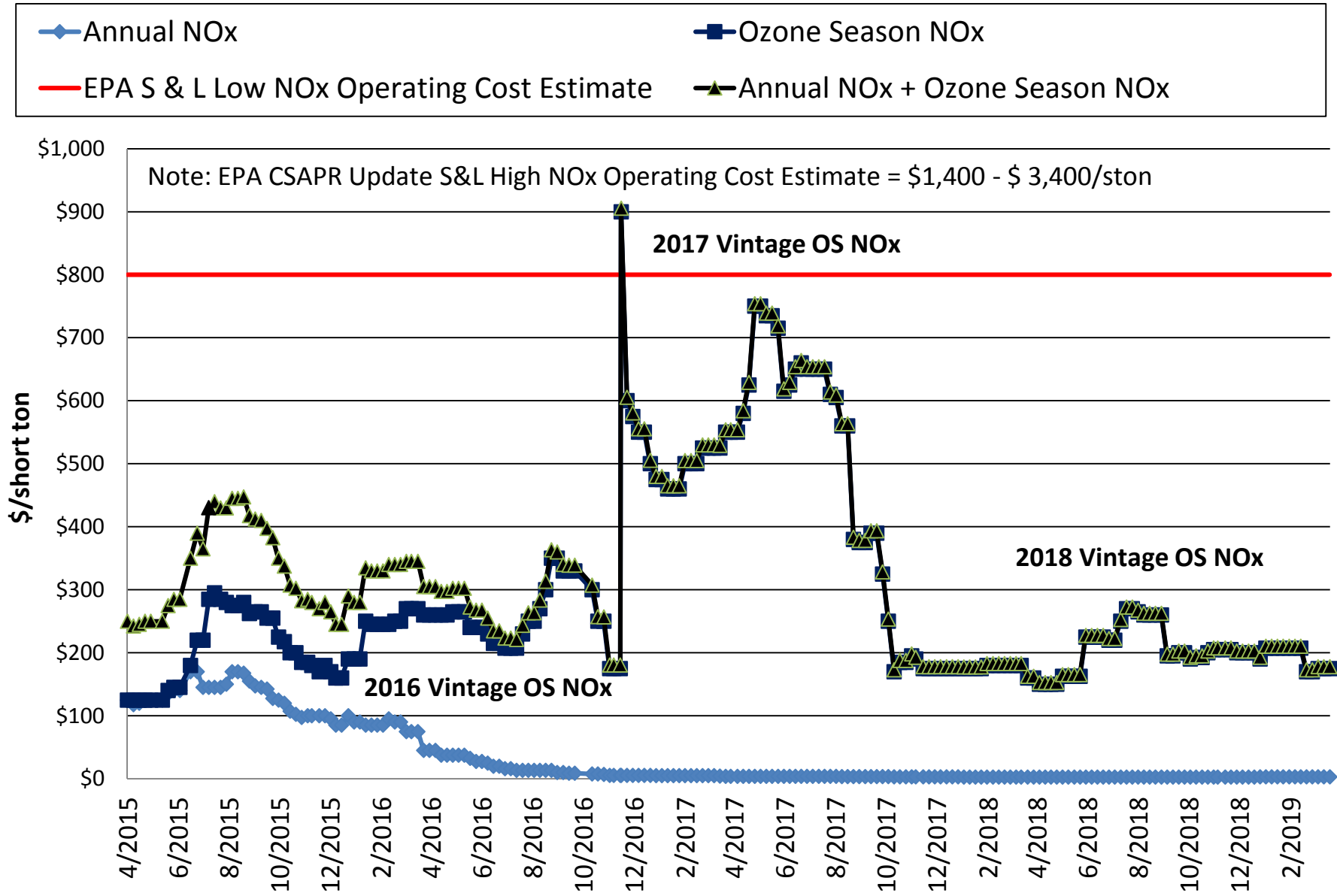


# OZONE TRANSPORT COMMISSION

## Emissions on High Ozone Days

- EGU Controls not run/not run optimally on High Ozone Days
- Uncontrolled power generation (EGU and distributed generation) sources on High Ozone Days
- Current EGU and power generation limits – not stringent enough &/or averaged over longer time periods, e.g. 30 days

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



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

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

17 of 25 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 <sub>x</sub> Rate (lb/MMBtu)	NO <sub>x</sub> (tons)	SCR?	Best Observed Rate	Year	NO <sub>x</sub> 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	<i>Killen Station</i>	<i>6031-2</i>	<i>49%</i>	<i>660</i>	<i>6,700</i>	<i>0.553</i>	<i>1,093</i>	<i>Yes</i>				<i>06/2018</i>
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 25 NO<sub>x</sub> Emitters in States Impacting OTR Monitors in 2023 Modeling

- 17 of 25 top emitting units have SCR controls
- Compared to 2014 (overall worst year for curtailment) NO<sub>x</sub> 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<sub>x</sub> reductions
  - Noted NO<sub>x</sub> reductions are relative to pre-SCR maximum reported NO<sub>x</sub> rate for each unit
    - Avg. NO<sub>x</sub> reduction at BOR = 89%
    - Avg. 2018 NO<sub>x</sub> reduction = 66% (34% - 85% reduction range)

# EGUs: Top 25 NO<sub>x</sub> 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<sub>x</sub> reduction benefit.

Emitting State	NO <sub>x</sub> (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
<b>Total</b>	<b>15,100</b>	<b>(2023 DV &gt;70 ppb – OTC modeling)</b>

# Summary of SAS Activities

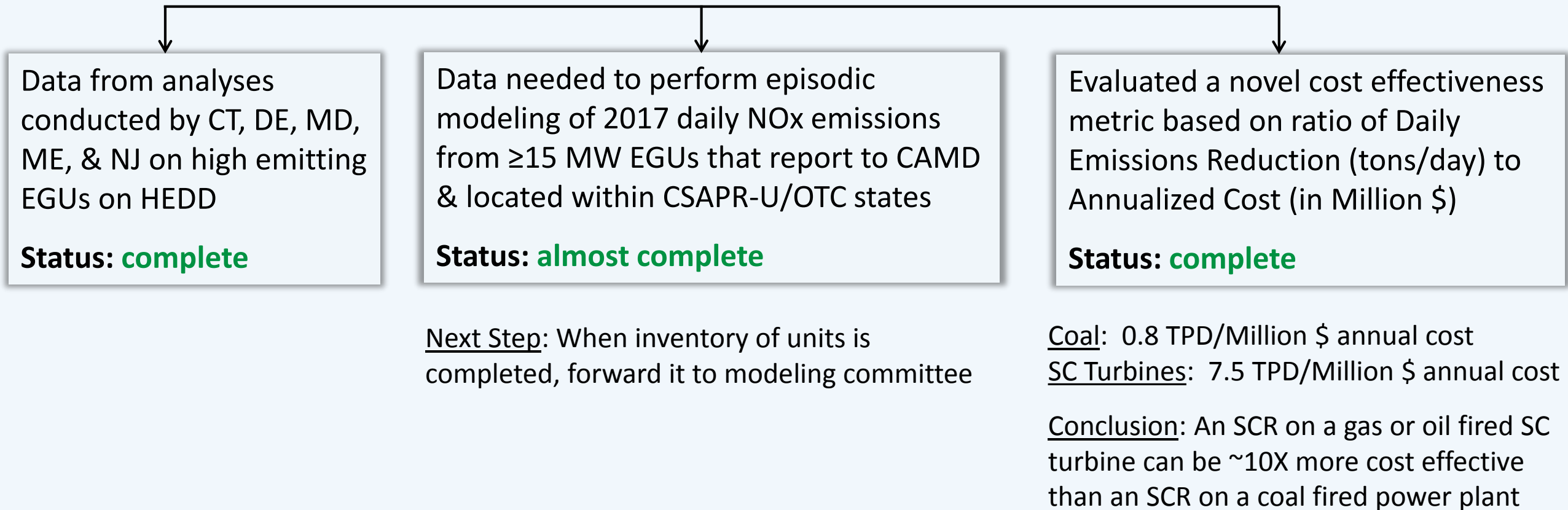
## Summary of SAS Activities

- Good Neighbor SIP strategies (uncontrolled & poorly controlled EGUs, NG pipeline compressor prime movers): control limits, cost effectiveness, emissions reduction benefits, & modeling - *analyses completed, finalizing documentation*
- Charge Addendum on High Electricity Demand Day (HEDD) - *almost complete*
- Final Products

# 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





**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

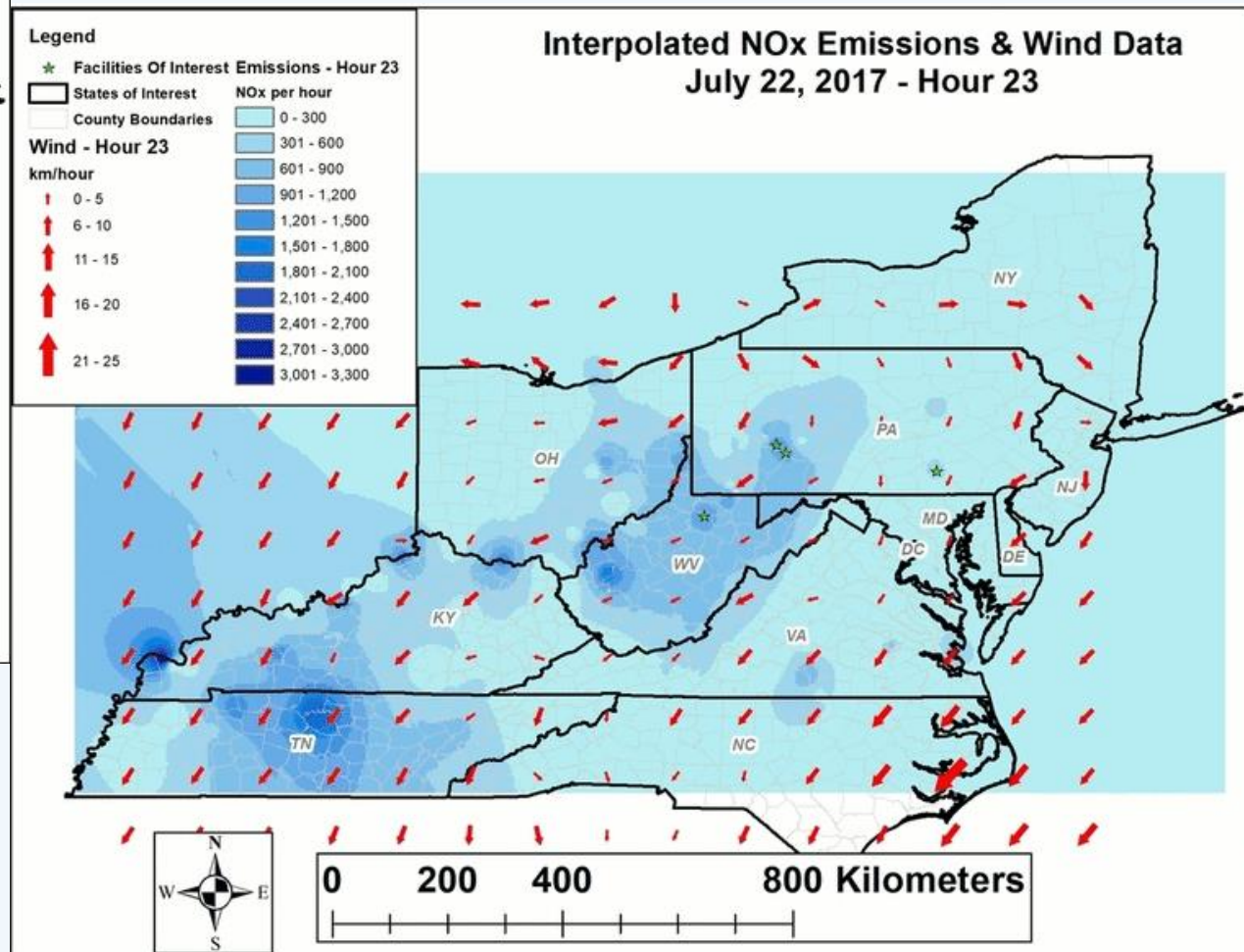
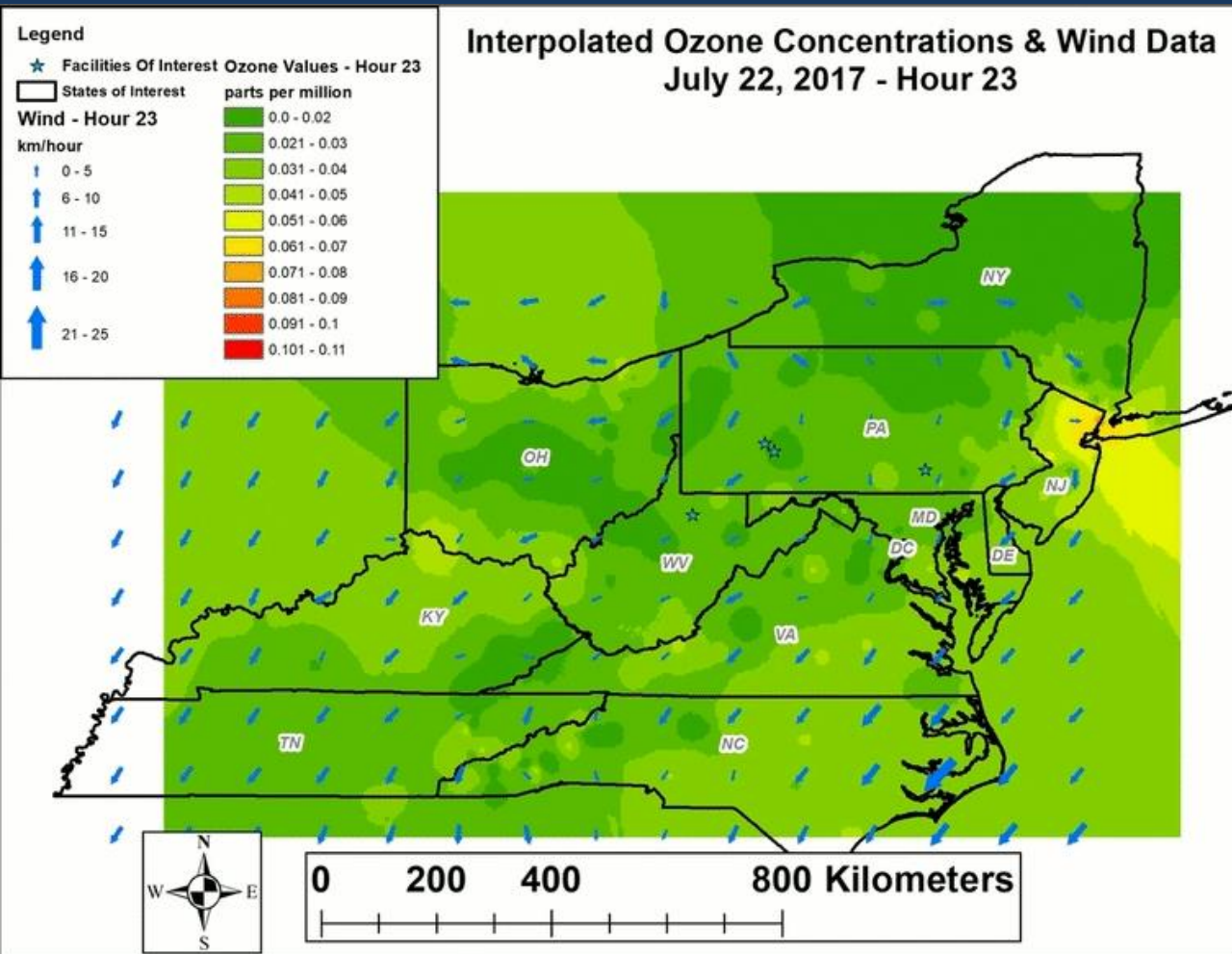
**Mark's Project:** Qualitative Correlation of EGU emissions on days with high ozone (exceedance days) similar to back trajectory analysis.

**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
  - Impacts from climate change have clear negative ozone implications
  - Finalize documentation for natural gas pipeline compressor fuel-fired prime movers white papers
- Develop enhanced tools for calculating cost-effectiveness for short term ozone standards
- Assist in stationary source inventory development for 2016 & appropriate future years

Develop peak day ozone reduction strategies:

- Optimization of existing SCR & SNCR controls
- Small generator rules, e.g. CT, DE, NJ
- Individual state NO<sub>x</sub> emissions reduction efforts
- Investigation of high emitting non-EGU stationary sources of NO<sub>x</sub> emissions on high ozone days

Conduct screening effort to identify any significant inside-the-OTR (TPD) NO<sub>x</sub> reductions 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

- Modeling work plan related to SAS Charge Addendum is ongoing
- Buying allowances continues to be cheaper than running controls in many cases
- Potential loss of NO<sub>x</sub> reduction benefit of 15,000 tons from Top 25 emitters compared with BORs
- Geospatial analysis shows potential usefulness

## Future SAS Work

- Currently drafting a work plan & project priorities list

**BONUS SLIDES**



# Top 25 NO<sub>x</sub> 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<sub>x</sub> reduction is relative to pre-SCR maximum reported NO<sub>x</sub> rate for each unit.
  - Relative to BOR emissions, these rates may result in 15,000 tons of lost NO<sub>x</sub> reduction
  - Avg. NO<sub>x</sub> reduction at BOR = 89%
  - Avg. 2018 NO<sub>x</sub> reduction = 66% (34 - 85% reduction range)
- Compared to 2014 (overall worst year for curtailment) NO<sub>x</sub> 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<sub>x</sub> reduction, which is essentially zero, is also from NC. These three NC units averaged NO<sub>x</sub> reductions of 67% then, with 35% in 2018.

# Charge Addendum – 3 Items

## Item 1: Data from analyses conducted by CT, DE, MD, ME, & NJ on high emitting EGUs on HEDD

### Analysis involving:

1. Coal EGUs with SCR or SNCR
2. Non-coal EGUs with SCR or SNCR
3. Steam EGUs without SCR or SNCR
4. Combined cycle turbines
5. Simple cycle turbines

### **DE Conclusions**

*Without requiring significant capital expenditures from the existing EGU fleet in the CSAPR-U/OTR,*

- Significant NOx emissions reduction potential exists for SCR & SNCR equipped coal-fired EGUs, and non-SCR & non-SNCR steam EGUs
- Modest NOx emissions reduction potential exists for SCR & SNCR non-coal steam EGUs, combined cycle combustion turbine EGUs, & simple cycle combustion turbine EGUs

### **NJ Conclusions**

- Simple cycle turbines operate on high ozone days
- Control of NOx or replacement of old units is cost effective based on ozone day benefit (Can also cause 1-hr NO<sub>2</sub> NAAQS exceedances)
- >200 SC units in OTR with very high NOx emissions – ~10x most boiler NOx rates & >100x most CC NOx rates
- SC units significantly increase, & can dominate EGU NOx emissions on high ozone days\*
- ~40% of SC units have low NOx rates, showing that much lower NOx from SC units is readily achievable & is already occurring

# Charge Addendum - 3 Items

**Item 2: Data needed to perform episodic modeling of 2017 daily NO<sub>x</sub> emissions from  $\geq 15$  MW EGUs that report to CAMD & located within CSAPR-U/OTC states**

## **Conclusions**

From 2017 emissions perspective, July 19 – 22, 2017 is a particularly good episode to model

- hourly data already available (saving a month's worth of effort)
- meteorology of this episode aligns with that of the previously modeled, July 19 – 22, 2011 episode, despite some differences

## **Recommendations & next steps:**

- Model July 19 – 22 (with appropriate ramp-up days) using current 2011 modeling platform & Beta 2017 inventory
- Perform brute force (zero out) modeling on emissions from EGUs  $\geq 15$  MW that report to CAMD & located in OTC/CSAPR-U\*

# Charge Addendum – 3 Items

## **Item 3: Evaluate a novel cost effectiveness metric based on ratio of Daily Emissions Reduction (tons/day) to Annualized Cost (in Million \$)**

Traditional cost benefit (Annual cost/annual emissions reduction) vs New Cost Effectiveness Metric (DERACR = Daily Emission Reduction to Annual Cost Ratio: Ratio of daily emissions reduction (TPD) to annualized cost (million))

**Conclusion:** An SCR on a gas or oil fired SC turbine can be almost 10x more cost effective than an SCR on a coal fired power plant, when comparing ratios of daily emission reductions to annual cost

# 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](http://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](http://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).