OTC / MANE-VU Joint Committees' Meeting

September 21, 2018

Francis Steitz, NJ
Chair
Stationary and Area Sources Committee





OZONE TRANSPORT COMMISSION

Stationary & Area Sources (SAS) Committee

SAS Charges – workgroup progress & products

- Good Neighbor SIP strategies: control limits, cost effectiveness, emissions reduction benefits
  - ✓ Uncontrolled & Poorly Controlled EGUs – input for Modeling completed
  - ➢ NG Pipeline Compressor Prime Movers: data ready for EMF → input for Modeling
- Charge Addendum on High Electricity Demand Day (HEDD) – in progress
  - ✓ unit inventory
  - ✓ choice of 2017 HEDD episodic days
  - ✓ control limits
- Products awaiting the Commission's final approval
  - ✓ Consumer Products Phase V Model Rule
  - ✓ NG Pipeline Compressor Prime Movers Model Rule
  - ✓ Whitepaper on strategies to reduce High Electricity Demand Day (HEDD) emissions

2018 SAS Charges

Charge: …Calculate & document emissions reductions inside & outside of the OTR for the recommended SAS GN SIP strategies:

GN SIP Strategies	Deliverables		
	Quantify Emissions Reduction	**Calculate Control Costs**	**Documentation**
Coal-fired EGUs: • Poorly controlled: Optimize use of existing SCR / SNCR NOx control technology each day of ozone season • Uncontrolled: Install SCR / SNCR control technology & optimize their use each day of ozone season	Modeling input files completed	Completed	In Progress
NG Pipeline Compressor Prime Movers	Modeling input files nearing completion	Completed	In Progress

Charge: GN SIP NOx Control Strategy for NG Pipeline Compressor Prime Movers

DELIVERABLES

Quantify Emissions Reduction

Status: EMF Inventory almost final

Extract point & nonpoint emissions in 2023 Gamma inventory of Eastern Modeling Domain minus partial states

⬇

Match permit data for individual facilities with inventory data

⬇

Compare Model Rule limits with permitted limits

⬇

Address data gaps (e.g. design capacity missing for many units→ difficult to apply model rule limits)

⬇

Develop EMF control packet to simulate NOx reductions from Model Rule limits)

⬇

Perform GN SIP air quality modeling (2011 platform with 2023 future year projection)

Calculate Control Costs

Status: Developed estimates

Cost effectiveness calculations based on:

- Mojave Desert AQMD IC Engine NOx RACT Analysis
- Technical Support Document General Permit GP-5 Bureau of Air Quality, Pennsylvania DEP, January 31, 2013
- Delaware's analysis

Documentation

Status: In progress

SAS Charge Addendum - 3 items

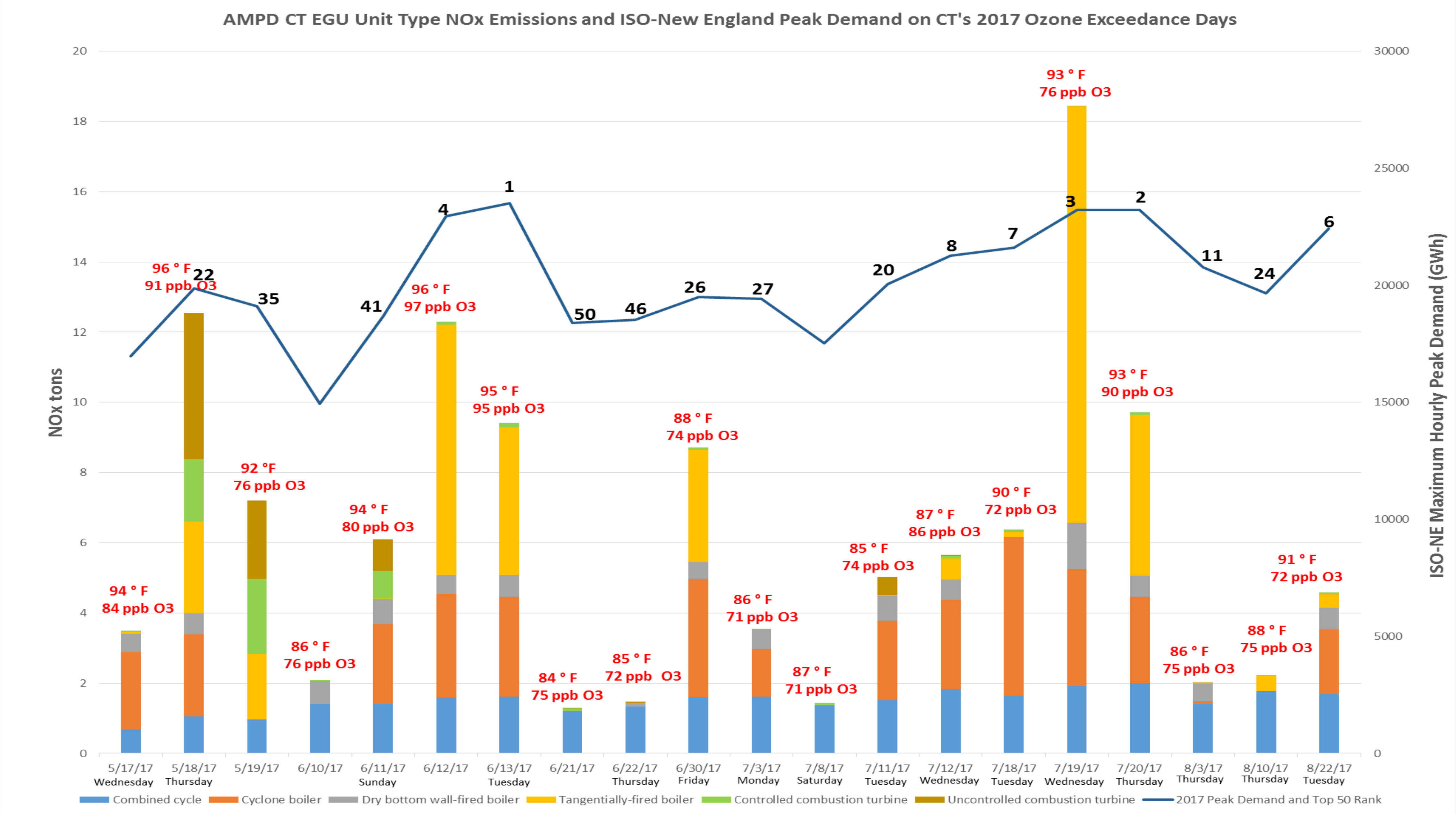
Perform following technical analysis of potential strategies for consideration and action by the OTC, to be completed & presented to the Air Directors by the 2018 Fall OTC Air Directors' Meeting:

- Data from analyses conducted by CT, DE, MD, ME, & NJ on high emitting EGUs on HEDD
- 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
- Evaluate a novel cost effectiveness metric based on ratio of Daily Emissions Reduction (tons/day) to Annualized Cost (in Million $)

SAS Charge Addendum - Item 1

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

CT Analysis: CT EGU NOx and Peak Demand for 2017 O_3 Days



DE Analysis: CSAPR-U/OTR EGU NOx Evaluation

DE's analysis of July 19 – 22, 2017 episode 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

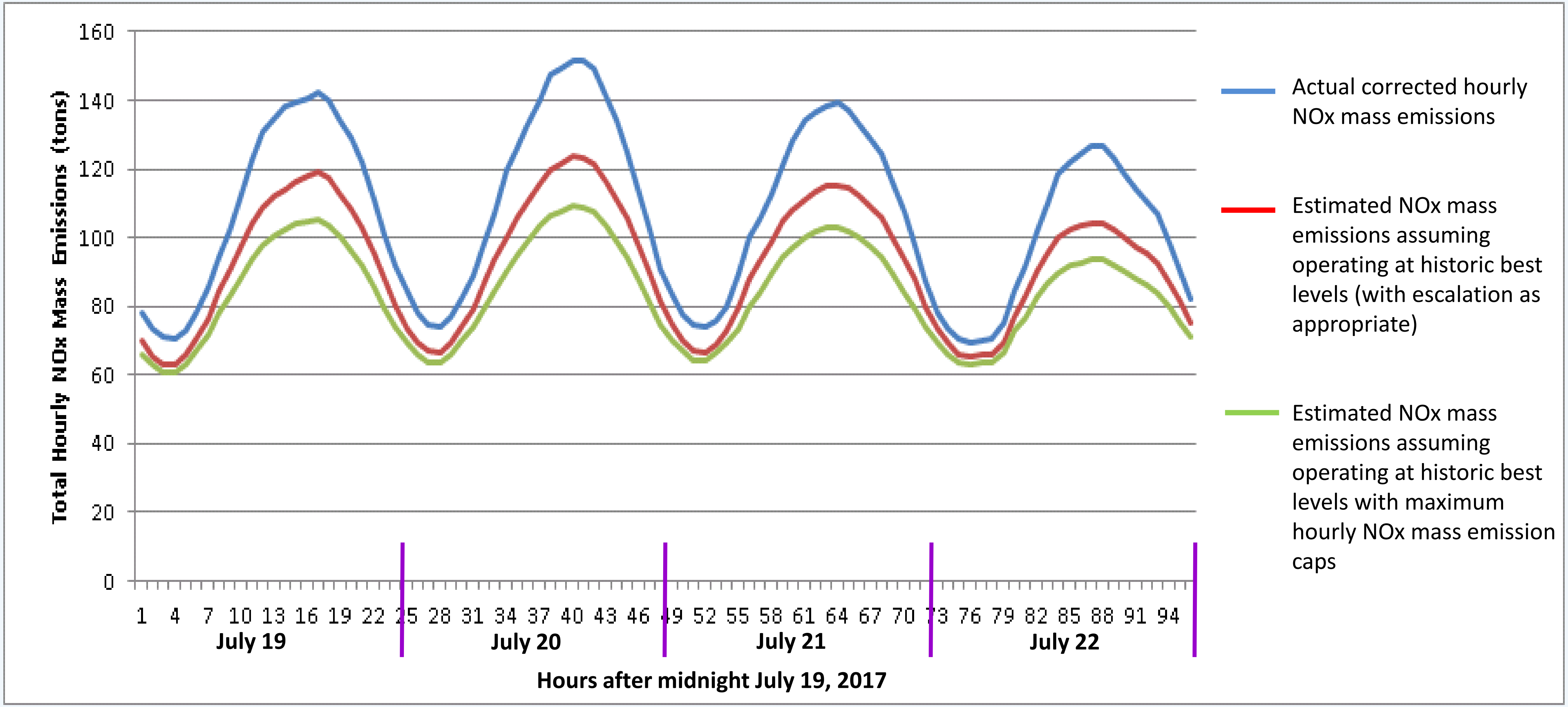
Summary of operating status of EGUs, by configuration, in CSAPR-U/OTR during the July 19 – 22, 2017 episode

	Coal Fired EGUs Equipped with SCR or SNCR	Non-Coal Fired Steam EGUs Equipped with SCR or SNCR	Steam EGUs Not Equipped with SCR or SNCR	Combined Cycle Combution Turbine EGUs	Simple Cycle Combustion Turbine EGUs
Number Operating Throughout Episode	182	29	182	285	2
Number Cycled at Least Once During Episode	53	18	170	204	888*
Number Not Operated During Episode	13	6	114	23	337

*substantial number of the "cycled" combustion turbines operated for very short periods of time, possibly due to the units failing to come on line or the combustion turbine operated only to bring the generator to speed for VAR control.

DE Analysis: CSAPR-U/OTR EGU NOx Evaluation

1st step: Assume all EGUs can achieve their best demonstrated OS average NOx emission rate plus 10% escalation factor (*Escalation factor not applied to turbines*) on an hourly basis



DE Analysis: CSAPR-U/OTR EGU NOx Evaluation

EGU Configuration	Episodic NOx Mass Emissions Reduction Potential (%)
SCR or SNCR Equipped Coal-Fired EGU	23.6
SCR or SNCR Equipped Non-Coal Fired EGU	20.5
Non-SCR and Non-SNCR Steam EGU	22.3
Combined Cycle Combustion Turbine EGU	1.3
Simple Cycle Combustion Turbine EGU	12.8

Conclusion

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

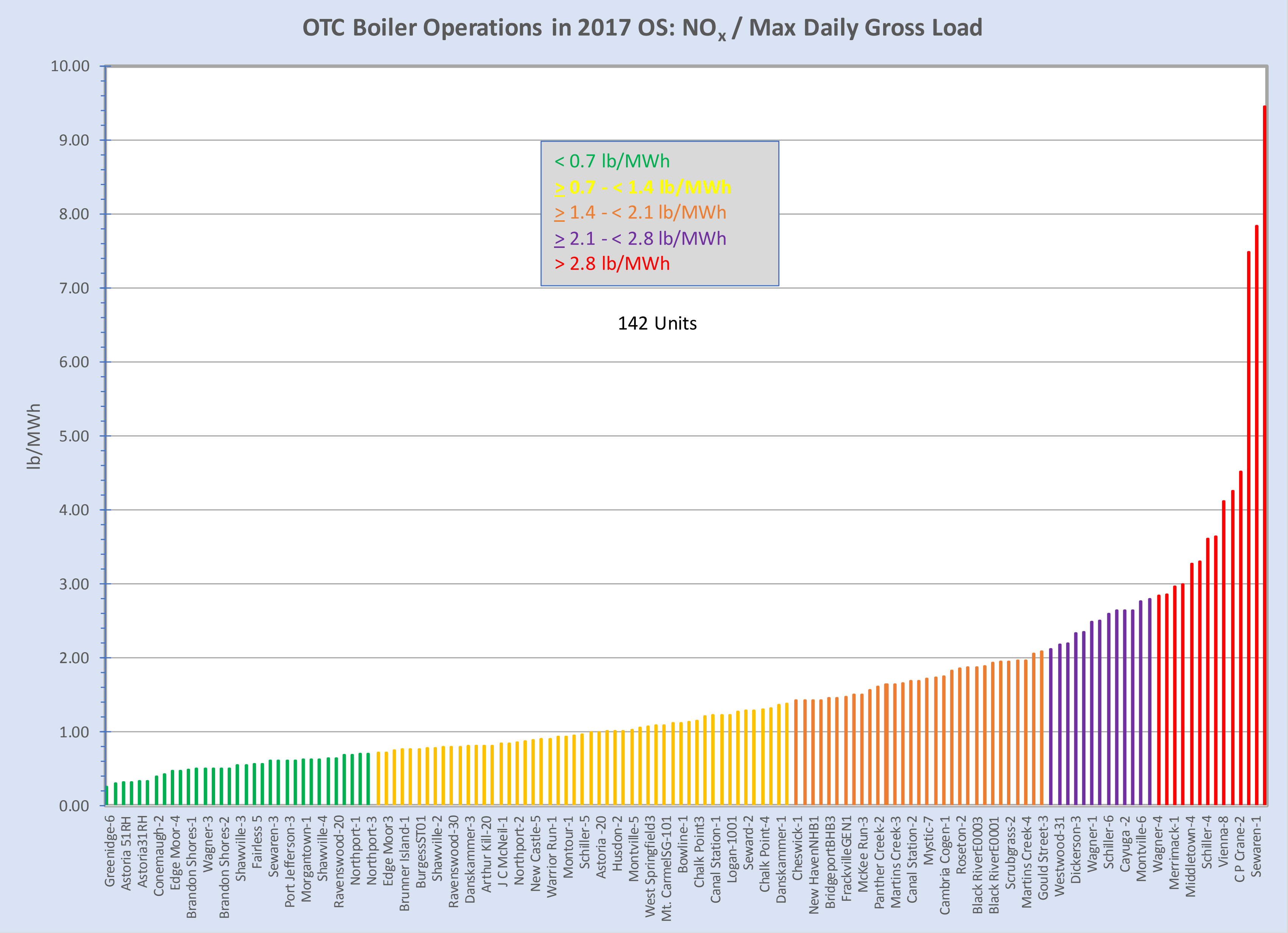
- Significant NOx emissions reduction potential exists for SCR & SNCR equipped coal-fired EGUs, and non-SCR & non-SNCR steam EGUs
- Modest NOx emissions reduction potential exists for SCR & SNCR non-coal steam EGUs, combined cycle combustion turbine EGUs, & simple cycle combustion turbine EGUs

NJ Analysis

NJ examined the following units for OTR states:

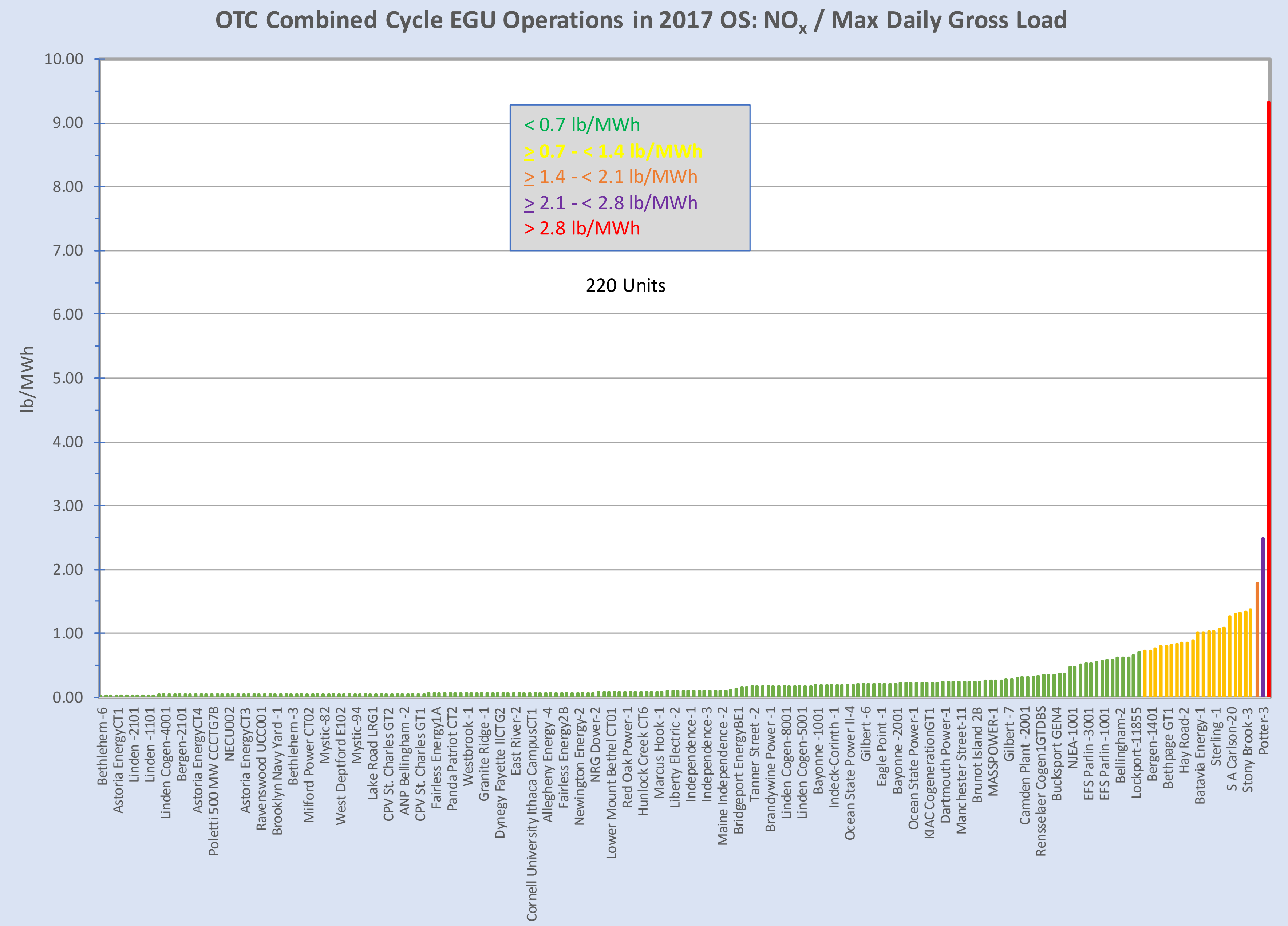
- Boilers
- Combined Cycle
- Simple Cycle

Boilers

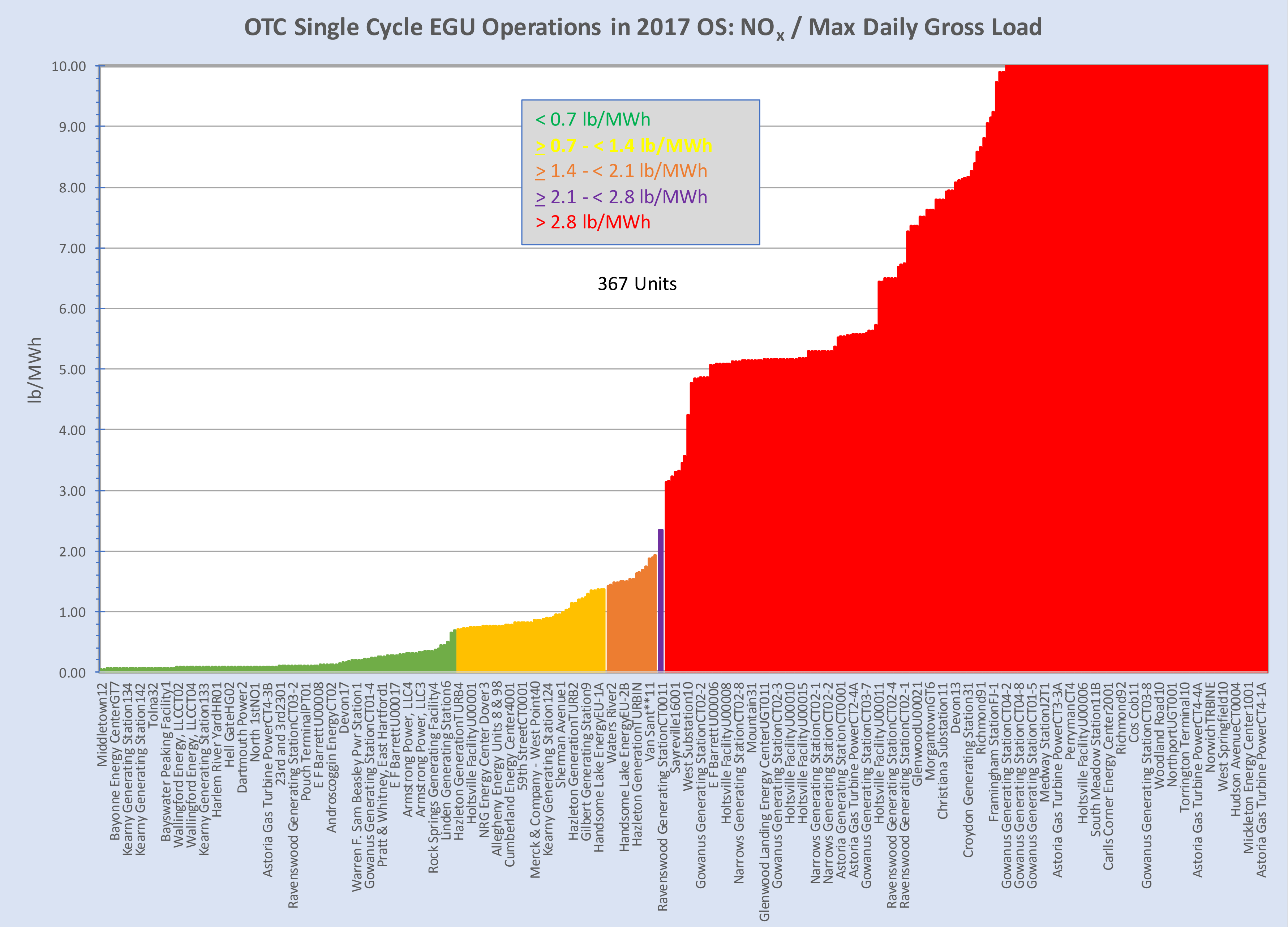


NJ Analysis

Combined Cycle



Simple Cycle



NJ Analysis Summary

Boilers

- Good progress, getting there
- >50% have low NOx (<1.4 lb/MWhr)
- Still significant number of high emitting units: 27/142 (~20%) are >2.1 lb/MWhr

Combined Cycle

- The champs
- 99% have low NOx (<1.4 lb/MWhr)
- >50% have very low NOx (<0.10 lb/MWhr)

Simple Cycle

- Our challenge
- >50% (~200 units) have very high NOx rates (>2.8 lb/MWhr)
- >20% (~80) are off the graph, well over 10 lb/MWh
- 21 are >20 lb/MWhr
- New Units are meeting 0.2 lb/MWh (1% of high emitting units)

NJ Analysis 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*
- >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

*To be discussed under Addendum Item 3

**Can also cause 1-hr NO_2 NAAQS exceedances

SAS Charge Addendum - Item 2

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

Data Needed for Episodic Modeling: Episode Selection

Days with at least 5 monitoring sites in the Ozone Transport Region that exceeded the 70 ppb ozone NAAQS

# Sites in the OTR >70ppb	Date
59	5/17/2017
59	5/18/2017
56	6/12/2017
36	6/13/2017
29	6/10/2017
23	6/11/2017
23	7/20/2017
22	7/19/2017
15	4/11/2017
15	6/22/2017
13	7/22/2017
9	8/1/2017
7	6/30/2017
6	5/19/2017
6	9/25/2017
5	7/21/2017
5	8/3/2017

Data Needed for Episodic Modeling: Episode Selection

Actual 2017 OS CSAPRU/OTR region peak NOx emissions values:

Date of Highest Region Daily NOx Mass Emissions	Highest Region Daily NOx Mass Emissions (tons)	End Date of 3-Day Highest Region NOx Mass Emissions	Highest Region 3-day NOx Mass Emissions (tons)
7/20/2017	**2,702**	**7/21/2017**	**7,860**

Data Needed for Episodic Modeling: Episode Selection

Highest 2017 Ozone Season NOx Mass Emissions Days in OTR & CSAPR-U Region Based on CAMD data

State	Highest NOx Mass Day Date	Highest NOx Mass Day Gross Load (MWh)	Highest NOx Mass Day Date NOx (tons)	Highest NOx Mass Day Heat Input (MMBtu)
CT	5/18/2017	40,550	25	384,614
DE	5/18/2017	35,984	11	374,394
MA	5/18/2017	73,097	22	675,476
MD	9/25/2017	105,524	55	1,081,179
ME	7/20/2017	19,298	6	160,468
NH	7/18/2017	27,64	14	281,821
NJ	7/20/2017	126,848	33	1,190,774
NY	6/13/2017	236,676	104	2,174,736
PA	6/13/2017	383,783	146	3,758,885
RI	9/27/2017	31,42	3	299,506
VA	7/20/2017	242,43	83	2,237,478
VT	9/22/2017	1,344	1	16,669
OH	8/17/2017	394,748	183	3,561,2245

State	Highest NOx Mass Day Date	Highest NOx Mass Day Gross Load (MWh)	Highest NOx Mass Day Date NOx (tons)	Highest NOx Mass Day Heat Input (MMBtu)
IL	9/22/2017	342,827	137	3,437,324
IN	7/19/2017	357,081	240	3,485,611
MI	6/14/2017	233,625	132	2,429,157
WI	7/20/2017	216,888	87	2,162,001
KY	5/17/2017	259,952	246	2,496,668
WV	7/20/2017	294,294	152	2,820,253
TN	6/12/2017	168,822	80	1,635,325
IA	7/19/2017	136,099	104	1,397,049
MO	7/20/2017	278,193	126	2,638,745
AR	7/20/2017	201,860	126	1,765,745
AL	7/17/2017	308,618	97	2,761,186
LA	7/28/2017	201,347	144	1,848,556
KS	7/22/2017	116,470	69	1,168,925
OK	7/16/2017	226,167	122	2,133,069
TX	7/28/2017	1,174,088	457	10,571,732

Yellow shading indicates where date coincides with a highest NOx mass day

Data Needed for Episodic Modeling: Episode Selection

Highest 2017 Ozone Season 3-Day Total NOx Mass Emissions in OTR & CSAPR-U Based on CAMD Data

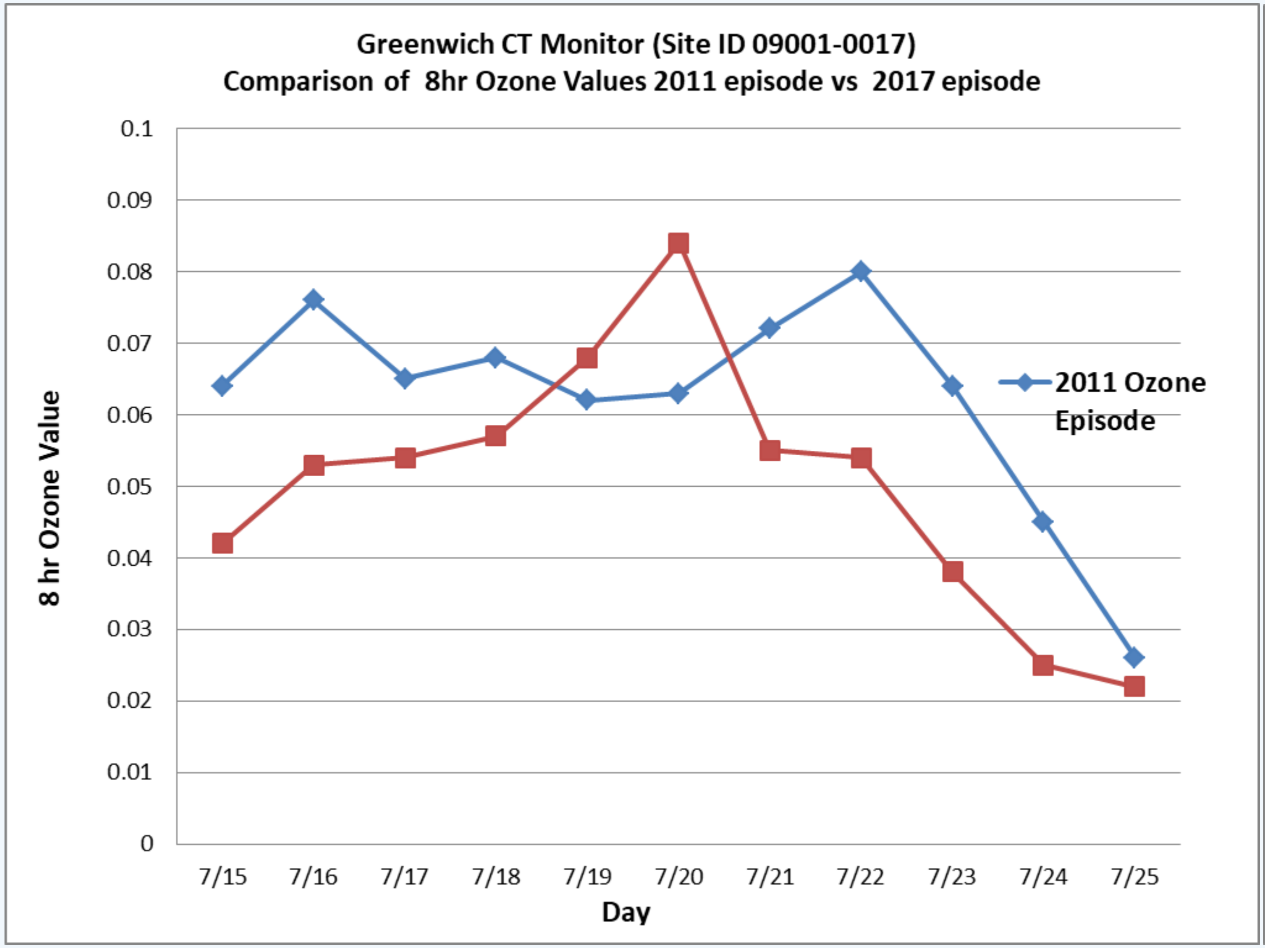
State	Highest 3-day NOx Mass Total Emission End Date	3-day Total NOx Mass (tons)
CT	5/19/2017	46
DE	5/19/2017	26
MA	5/19/2017	54
MD	9/27/2017	156
ME	7/21/2017	9
NH	7/19/2017	38
NJ	7/21/2017	83
NY	7/21/2017	213
PA	7/21/2017	422
RI	9/28/2017	7

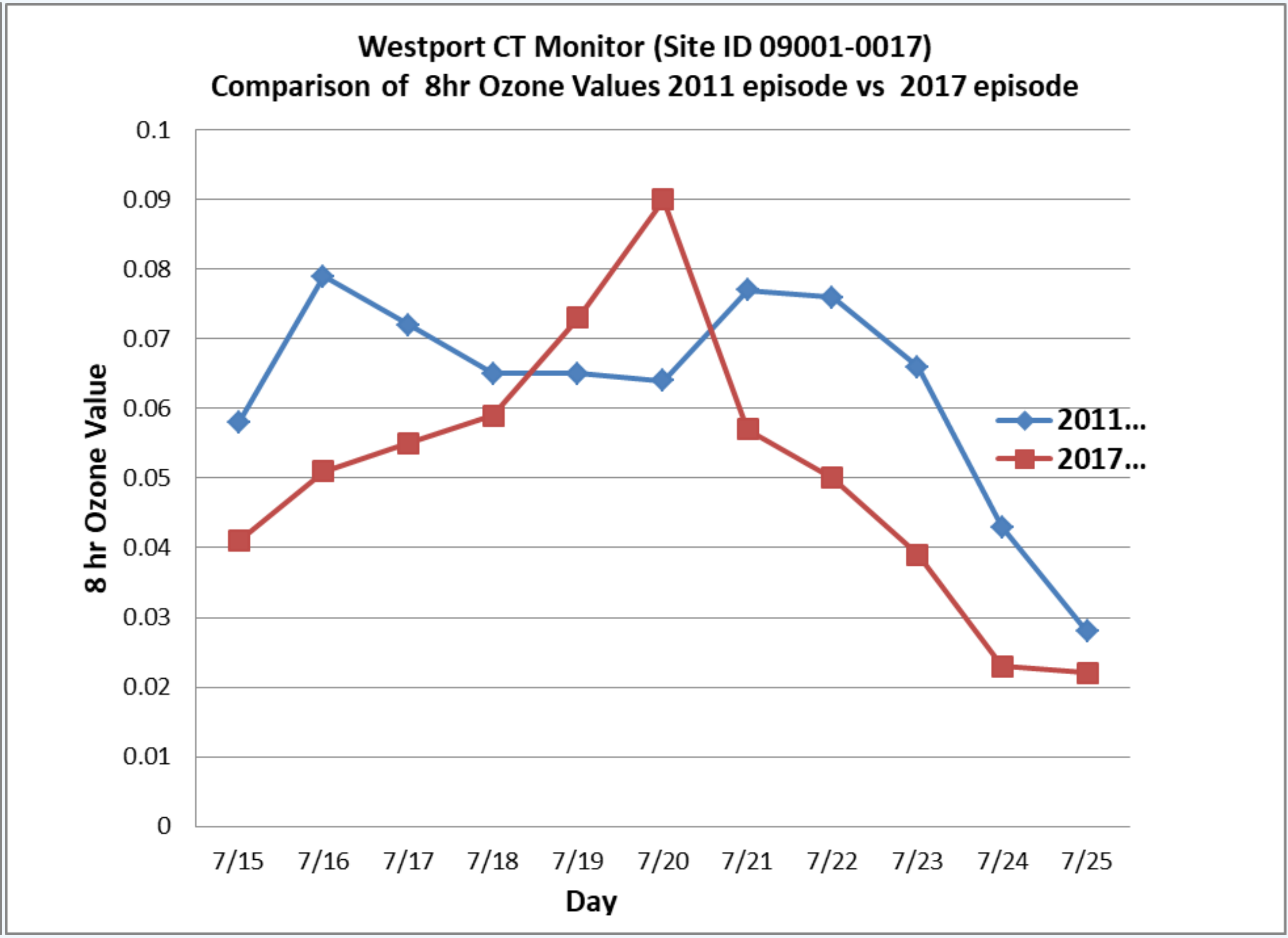
State	Highest 3-day NOx Mass Total Emission End Date	3-day Total NOx Mass (tons)
VA	7/21/2017	241
VT	9/24/2017	1.9
OH	8/18/2017	538
IL	9/22/2017	403
IN	7/21/2017	700
MI	6/14/2017	381
WI	7/20/2017	255
KY	5/19/2017	546
WV	7/20/2017	4,443
TN	7/23/2017	217
IA	7/20/2017	308
MO	7/21/2017	362

State	Highest 3-day NOx Mass Total Emission End Date	3-day Total NOx Mass (tons)
AR	7/21/2017	361
AL	7/19/2017	283
LA	7/28/2017	417
KS	7/23/2017	195
OK	7/23/2017	348
TX	7/29/2017	1,286

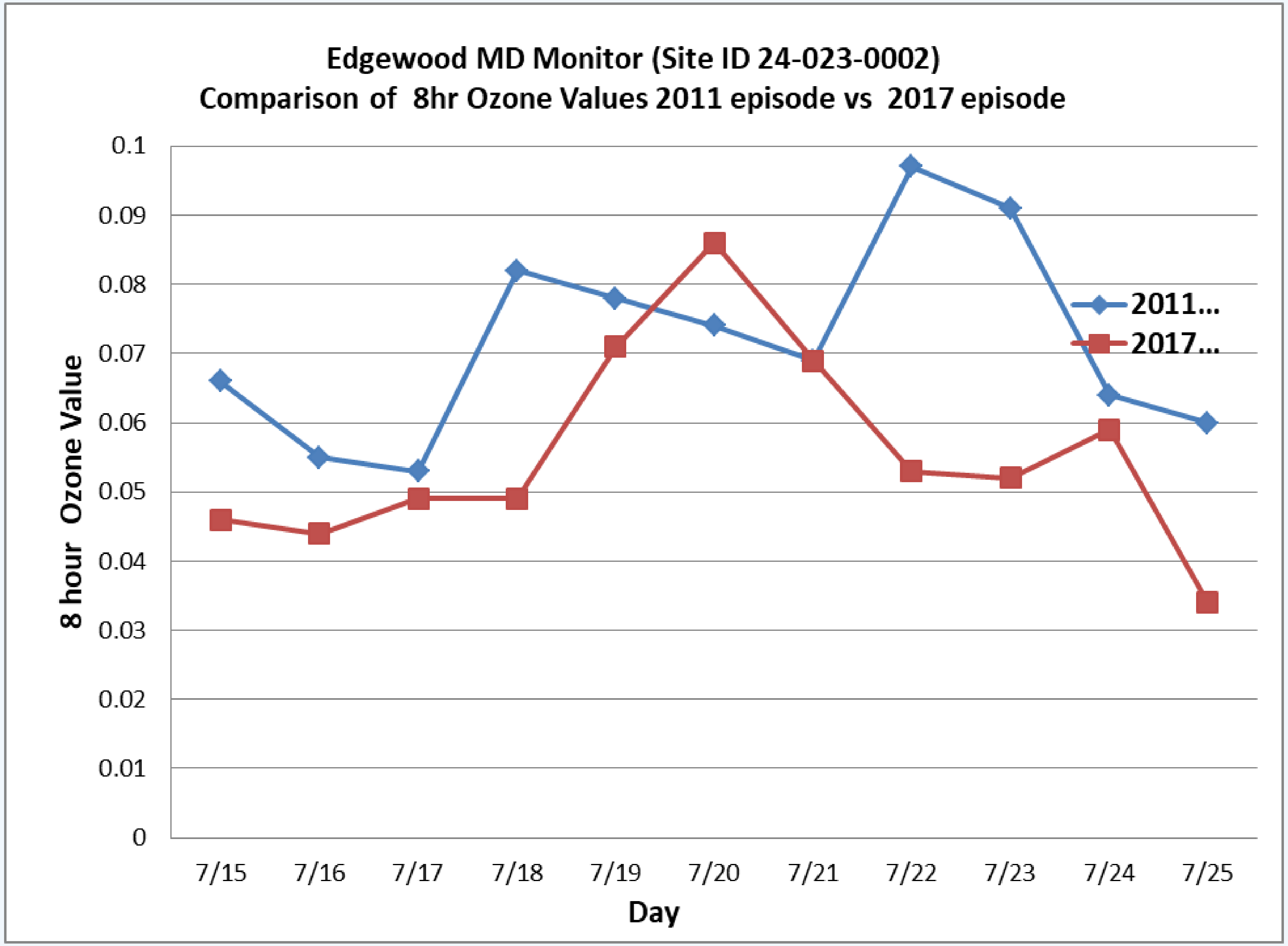
Yellow shading indicates where date coincides with highest 3-day total NOx mass emissions end date

Data Needed for Episodic Modeling: Episode Selection





Data Needed for Episodic Modeling: Episode Selection



Data Needed for Episodic Modeling

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

Data Needed for Episodic Modeling

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 ≥15 MW that report to CAMD & located in OTC/CSAPR-U*

*HEDD Workgroup will finalize this list and provide to Modeling Committee

SAS Charge Addendum - Item 3

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

New Cost Effectiveness Metric

Traditional cost benefit:

- Annual cost/annual emissions reduction
- OK for annual NAAQS &/or baseload units
- Not appropriate for short-term NAAQS (e.g. 8h O_3) or peaking units
- Inappropriately eliminates peaking units from consideration for controls, based on calculated low annual cost benefits

New Cost Effectiveness Metric

DERACR = Daily Emission Reduction to Annual Cost Ratio

Ratio of daily emissions reduction (TPD) to annualized cost (million)

<u>$DERACR Example:</u>

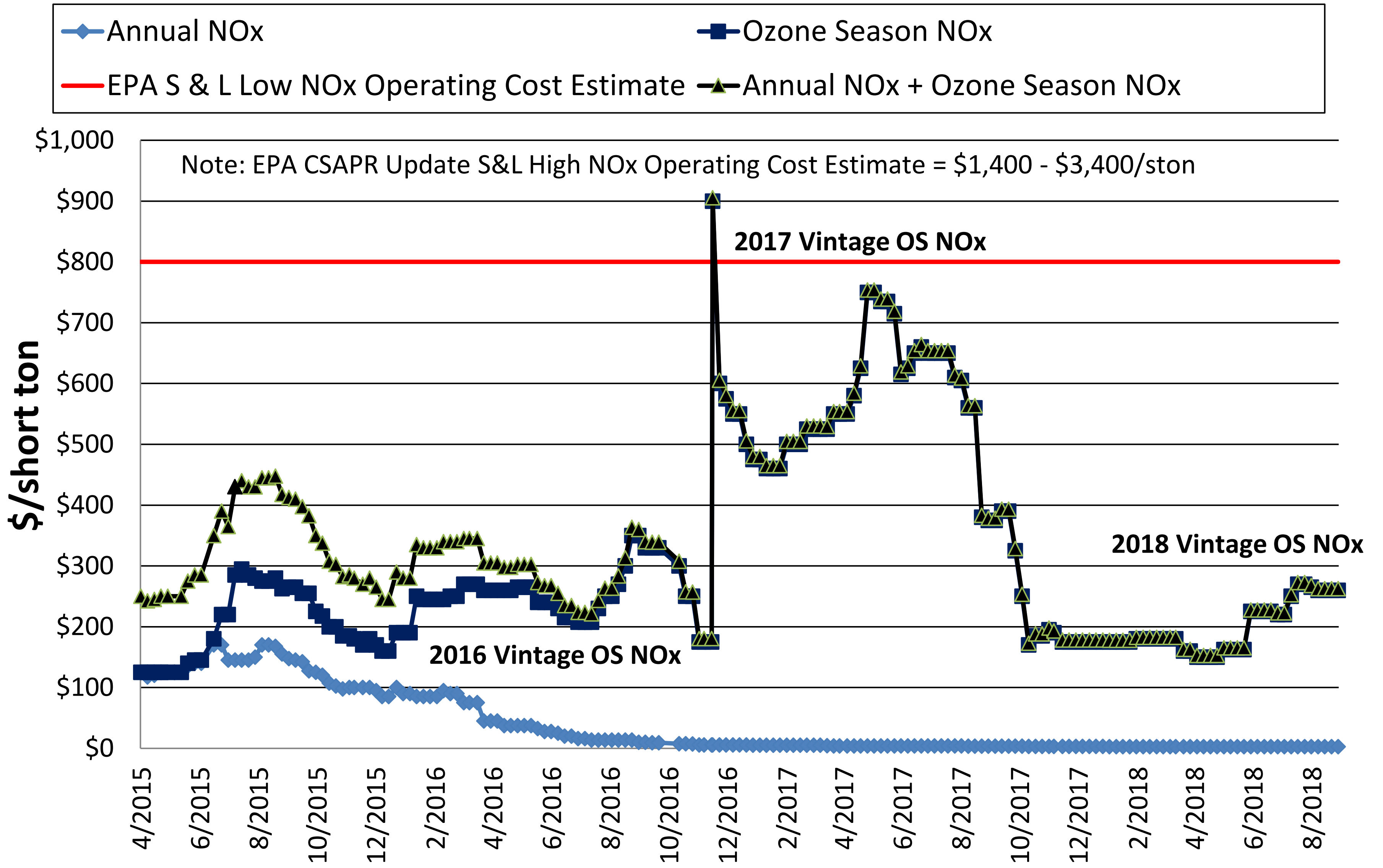
- Two EGU Sources adding 90% effective SCR
  - Coal boiler with LNB - 250 MW, 3 lb/MWhr, 60% capacity factor
  - Group of Simple Cycle turbines - 250 MW total, 10 lb NOx/MWhr, 10% capacity factor
- Daily Reduction
  - Coal achieves a reduction of 8 tons/day
  - SC Turbines achieves a reduction of 27 tons/day
- Annualized Cost (2017 $)
  - Coal Boiler - $ 10 million/yr
  - SC Turbines - $ 3.6 million/yr

New Cost Effectiveness Metric

- Daily Emission Reduction to Annualized Cost Ratio (TPD / million $)
    - 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 almost 10x more cost effective than an SCR on a coal fired power plant, when comparing ratios of daily emission reductions to annual cost

CSAPR Allowance Prices (4/17/15 – 9/14/18)



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!

Top 25 NO_x Emitters - CSAPR States, 2017 Ozone Season

	State	Facility Name	Facility - Unit ID	Avg. NOx Rate (lb/MMBtu)	NO_x (tons)	SCR?	Best Observed Rate (lb/mmBTU)	Year	2017 Allocations
1	AR	White Bluff	6009-1	0.296	3,748				2,116
2	IN	Rockport	6166-MB2	0.203	3,421				1,858
3	AR	Independence	6641-2	0.245	3,009				2,017
4	OH	W H Zimmer Generating Station	6019-1	0.191	2,972	Yes	0.056	2006	1,325
5	WV	Fort Martin Power Station	3943-2	0.312	2,584				875
6	OH	Killen Station	6031-2	0.267	2,561	Yes	0.089	2005	719
7	IA	Walter Scott Jr. Energy Center	1082-3	0.221	2,499				1,517
8	KY	Paradise	1378-3	0.231	2,425	Yes	0.100	2005	1,303
9	TX	Limestone	298-LM2	0.185	2,373				1,329
10	LA	Ninemile Point	1403-5	0.276	2,037				994
11	WV	Fort Martin Power Station	3943-1	0.302	1,870				912
12	TX	Limestone	298-LM1	0.168	1,850				1,206
13	MI	Belle River	6034-2	0.221	1,825				926
14	IA	Louisa	6664-101	0.191	1,817				1,523
15	OH	Gen J M Gavin	8102-1	0.105	1,806	Yes	0.069	2004	1,517
16	OK	Muskogee	2952-6	0.269	1,778				624
17	WV	Mountaineer (1301)	6264-1	0.099	1,773	Yes	0.039	2007	1,979
18	TX	Martin Lake	6146-1	0.160	1,714				1,166
19	IN	IPL - Petersburg Generating Station	994-4	0.237	1,696				750
20	IN	Rockport	6166-MB1	0.176	1,673				1,823
21	AR	Independence	6641-1	0.240	1,671				1,840
22	TX	Martin Lake	6146-2	0.160	1,631				1,126
23	LA	Ninemile Point	1403-4	0.237	1,618				877
24	MI	Belle River	6034-1	0.197	1,608				875
25	TX	H W Pirkey Power Plant	7902-1	0.166	1,598				1,090

- 5 SCR units in Top 25 sub-optimal operation although Gavin & Mountaineer are still quite good.
- Others have LNB, OFA, etc. but no SNCR
- Rockport MB1 (#20) installed SCR as of 7/26/17, but still doing some testing & did not have a full season of use
- Overall there is tremendous fleet improvement over the past couple years.

Top 25 NO_x Emitters Without SCR - CSAPR States, 2017 Ozone Season

	State	Facility Name	Facility - Unit ID	Avg. NOx Rate (lb/MMBtu)	NO_x (tons)	SCR?	2017 Allocations
1	AR	White Bluff	6009-1	0.296	3,748	No	2,116
2	IN	Rockport	6166-MB2	0.203	3,421	No	1,858
3	AR	Independence	6641-2	0.245	3,009	No	2,017
4	WV	Fort Martin Power Station	3943-2	0.312	2,584	No	875
5	IA	Walter Scott Jr. Energy Center	1082-3	0.221	2,499	No	1,517
6	TX	Limestone	298-LM2	0.185	2,373	No	1,329
7	LA	Ninemile Point	1403-5	0.276	2,037	No	994
8	WV	Fort Martin Power Station	3943-1	0.302	1,870	No	912
9	TX	Limestone	298-LM1	0.168	1,850	No	1,206
10	MI	Belle River	6034-2	0.221	1,825	No	926
11	IA	Louisa	6664-101	0.191	1,817	No	1,523
12	OK	Muskogee	2952-6	0.269	1,778	No	624
13	TX	Martin Lake	6146-1	0.160	1,714	No	1,166
14	IN	IPL - Petersburg Generating Station	994-4	0.237	1,696	No	750
15	AR	Independence	6641-1	0.240	1,671	No	1,840
16	TX	Martin Lake	6146-2	0.160	1,631	No	1,126
17	LA	Ninemile Point	1403-4	0.237	1,618	No	877
18	MI	Belle River	6034-1	0.197	1,608	No	875
19	TX	H W Pirkey Power Plant	7902-1	0.166	1,598	No	1,090
20	TX	Oklaunion Power Station	127-1	0.246	1,572	No	918
21	TX	Monticello	6147-3	0.138	1,549	No	1,055
22	LA	Little Gypsy	1402-3	0.251	1,493	No	520
23	TX	Welsh Power Plant	6139-1	0.178	1,489	No	651
24	IA	Ottumwa	6254-1	0.138	1,469	No	1,361
25	MO	Sioux	2107-1	0.215	1,402	No	554

- 3 LA Units – NG
- 1 TX Unit – coal, SNCR
- all others have LNB, OFA, etc. but no PCC except for TX- Monticello.

Thank you!

Questions?