REINHOLD ENVIRONMENTAL ®

2022 Reinhold/PCUG Round Table Presentation

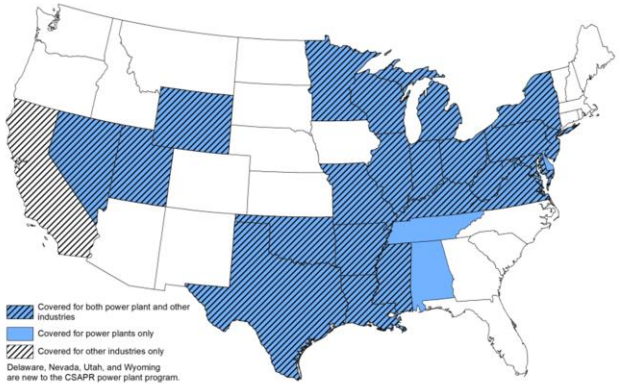
Hosted by Duke Energy in the Charlotte Sheraton/Le Meridien Hotel, Charlotte, NC on June 27-28, 2022

EPA's Proposed Ozone Good Neighbor FIP – Implications for Electric Generating Units

Presentation to

Reinhold Environmental Conference

June 28, 2022



Morning Safety Moment

Situational Awareness –

- Being aware of what is happening around you and whether anyone or anything around you is a threat to your health and safety.

- Steps to Situational Awareness:
  1. Information gathering
  2. Understanding the information, you are receiving
  3. Reacting to the information

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Weekend Experience:

- Backpacking Foothills Trail to the Chattooga River in SC
- Focused on the trail ahead and watching for rocks and roots as tripping hazard
- Maintaining a good pace to get to the river by lunch time
- Periphery vision: The mind recognized a shape that brought a sudden stop and backpedaling

Morning Safety

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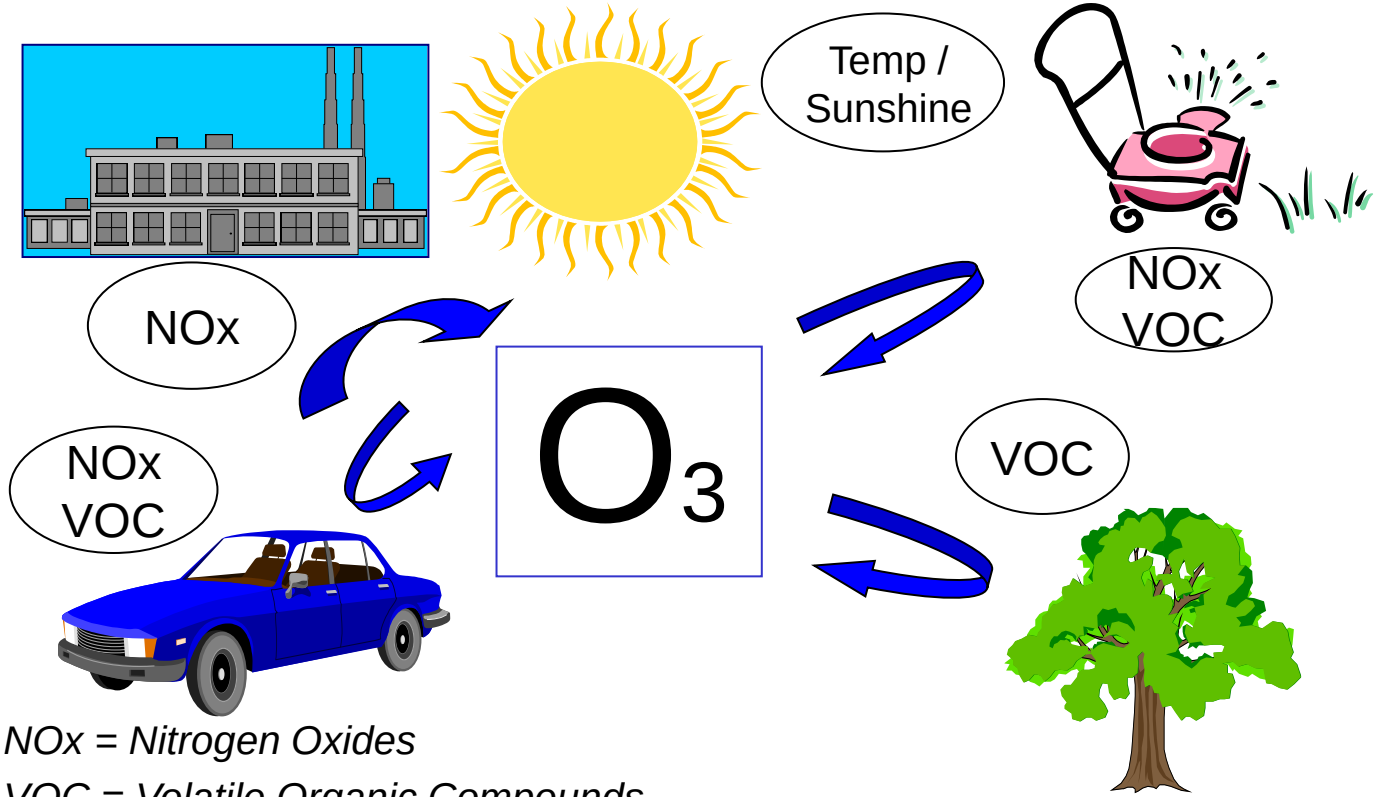
Clean Air Act and Air Quality Standards – Ozone NAAQS

- **National Ambient Air Quality Standards (NAAQS):**
  - Set for key pollutants at levels to protect public health
  - Ground level ozone is included
- **State and Federal Implementation Plans (SIPs and FIPs):**
  - States must develop plans to assure NAAQS attainment
  - Plans must also address any "significant" contribution to downwind ozone concerns
  - EPA can require SIP revision or impose a FIP if it determines a SIP is inadequate
- **Since 1997, the Ozone NAAQS has been set as an eight-hour average:**
  - Pre-1997: 0.12 ppm one-hour standard, set in 1979
  - 1997: 0.08 ppm (The last digit is important! That allowed up to 84.9 ppb.)
  - 2008: 0.075 ppm (75 ppb, non-attainment at 76 ppb)
  - 2015: 0.070 ppm (70 ppb, non-attainment at 71 ppb)

How Ozone (O_3)Forms



NOx = Nitrogen Oxides

VOC = Volatile Organic Compounds

Background on the EGU Interstate Transport Rules

- Pre-1990: Ozone attainment plans focused largely on VOC emissions
- 1990 Clean Air Act Amendments – Required states to address NOx Control in attainment planning to address continuing non-attainment
- 1995: Ozone Transport Assessment Group (OTAG) formed
  - Two-year study: Upwind NOx from Eastern US states contributes to downwind non-attainment

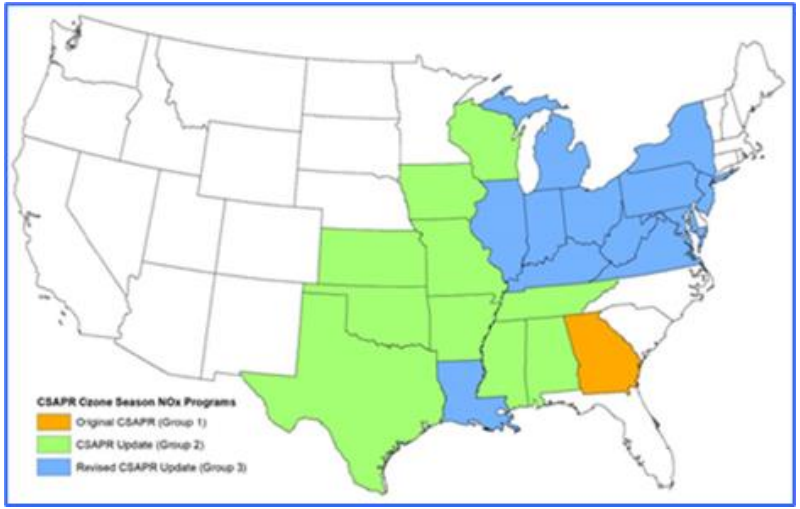
- **OTAG resulted in EPA issuing the 1998 NOx SIP Call:**
  - EPA set NOx Budgets for 22 states based on modeled downwind impacts and "cost-effective" controls
  - Separate budgets for EGUs and other sources – EGU control based on 0.15 lb/MMBtu
  - EPA established the NOx Budget Trading Program for EGUs to encourage rapid deployment of advanced controls in a cost-effective manner
  - NOx Trading Program implemented in 2004 under state (SIP) or federal (FIP) rules

The Transport Rules

EPA has issued five interstate transport Good Neighbor FIPs since 1998:

- 2003 NOx Budget Trading Program
- 2009 Clean Air Interstate Rule (CAIR)
- 2015 Cross-State Air Pollution Rule (CSAPR)
- 2017 CSAPR Update Rule
- 2021 Revised CSAPR Update Rule

The Revised CSAPR Update Rule created the new CSAPR "Group 3" trading program and is the starting point for the proposed 2015 Ozone NAAQS FIP.

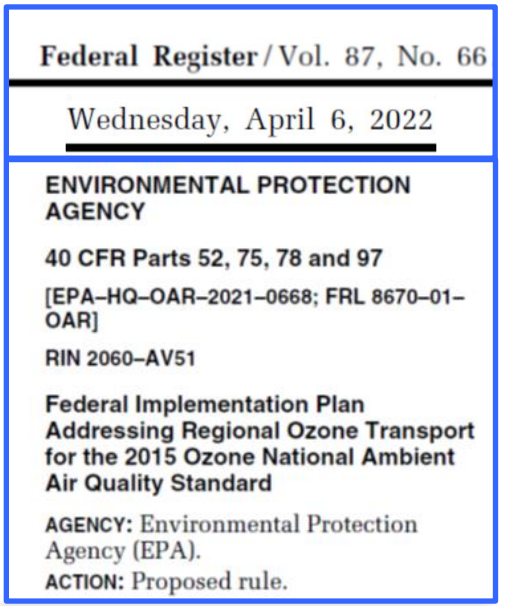


Current CSAPR Ozone Season Trading Regions

Proposed Good Neighbor FIP for 2015 Ozone NAAQS

Addresses "Good Neighbor" Obligations for the 2015 Ozone NAAQS

- EPA: States have a "significant" impact on downwind ozone and failed to submit adequate plans
- "Significant" is 1% of NAAQS modeled emissions impact from all sources
- The proposal singles out EGUs and certain industrial sources although models show these controls will have a small impact on ozone
- Final rule expected by May 2023, with additional provisions over 5 years


Federal Register / Vol. 87, No. 66

Wednesday, April 6, 2022

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 52, 75, 78 and 97

[EPA–HQ–OAR–2021–0668; FRL 8670–01–OAR]

RIN 2060–AV51

Federal Implementation Plan Addressing Regional Ozone Transport for the 2015 Ozone National Ambient Air Quality Standard

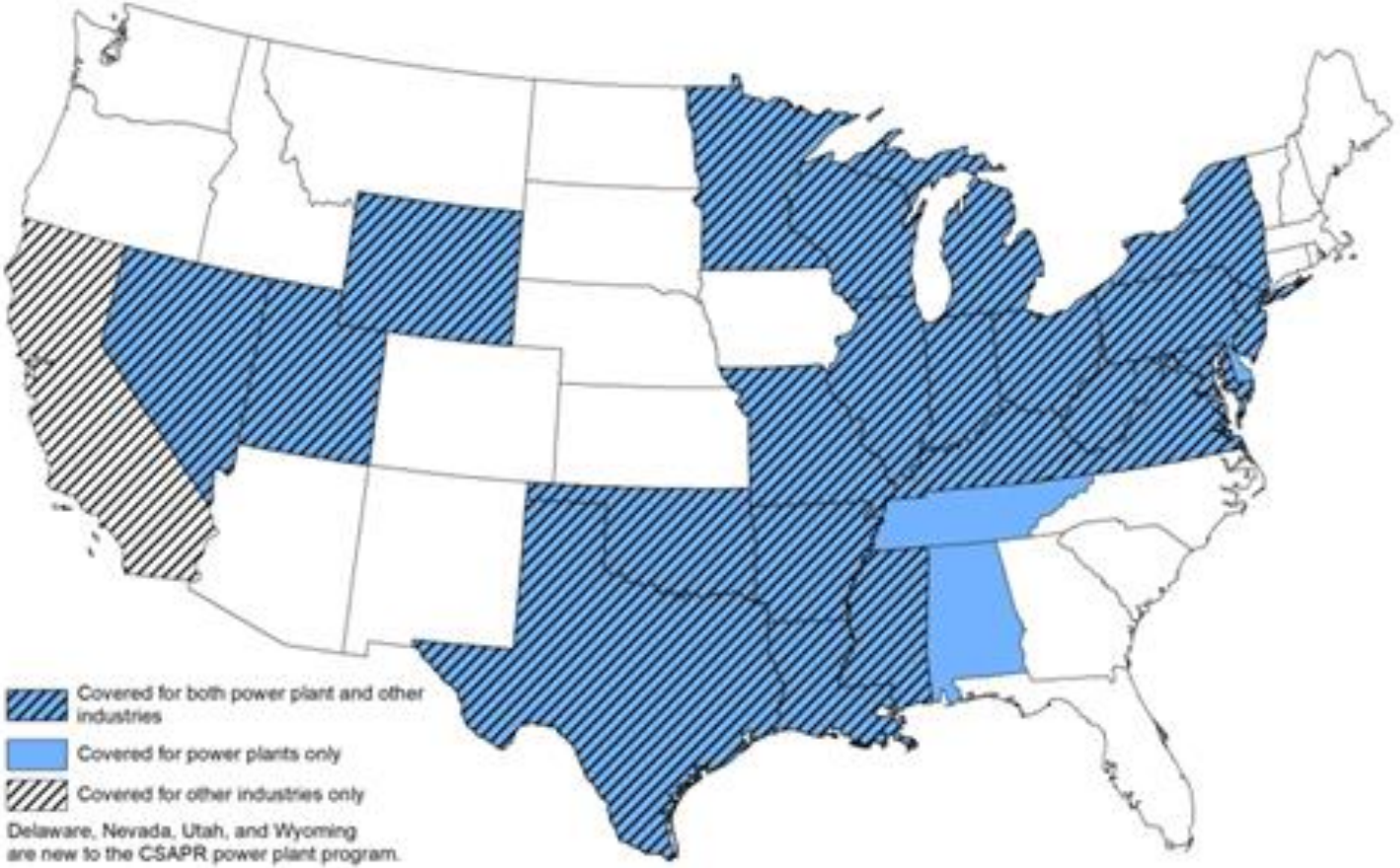
AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

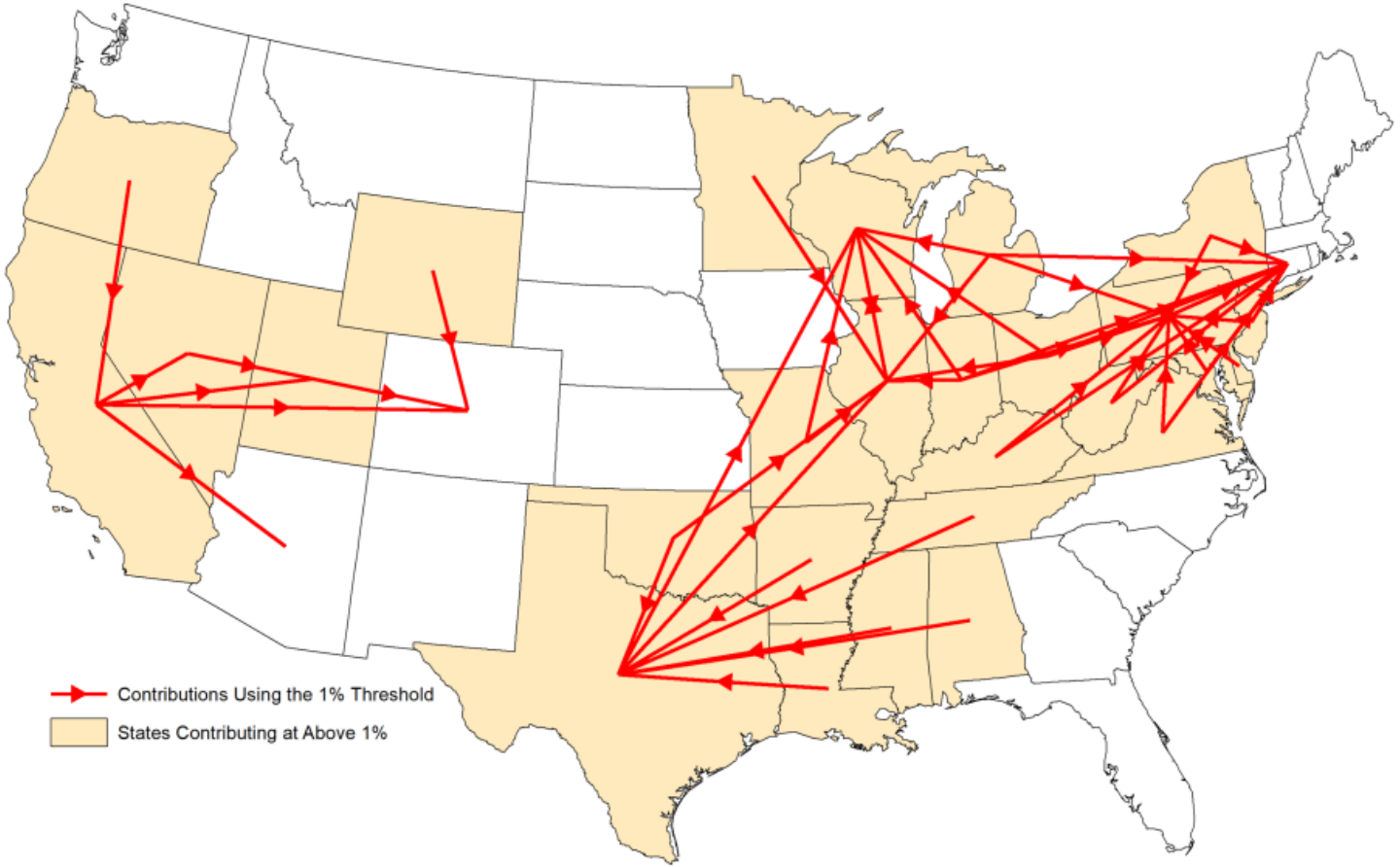
Proposed Rule Summary – EGU Sector Requirements:

- Expands CSAPR Group 3 Trading Program to 25 states in 2023
- NOx budgets and allocations based on optimized use of existing controls
- Further reductions in 2024 based on combustion controls and in 2026 based on SCR installation on all large coal-fired units
- Adds restrictions and penalties to trading which will require optimal NOx performance and the risk of allowance market impacts
- Expect retirement of many units without SCR due to timing and cost

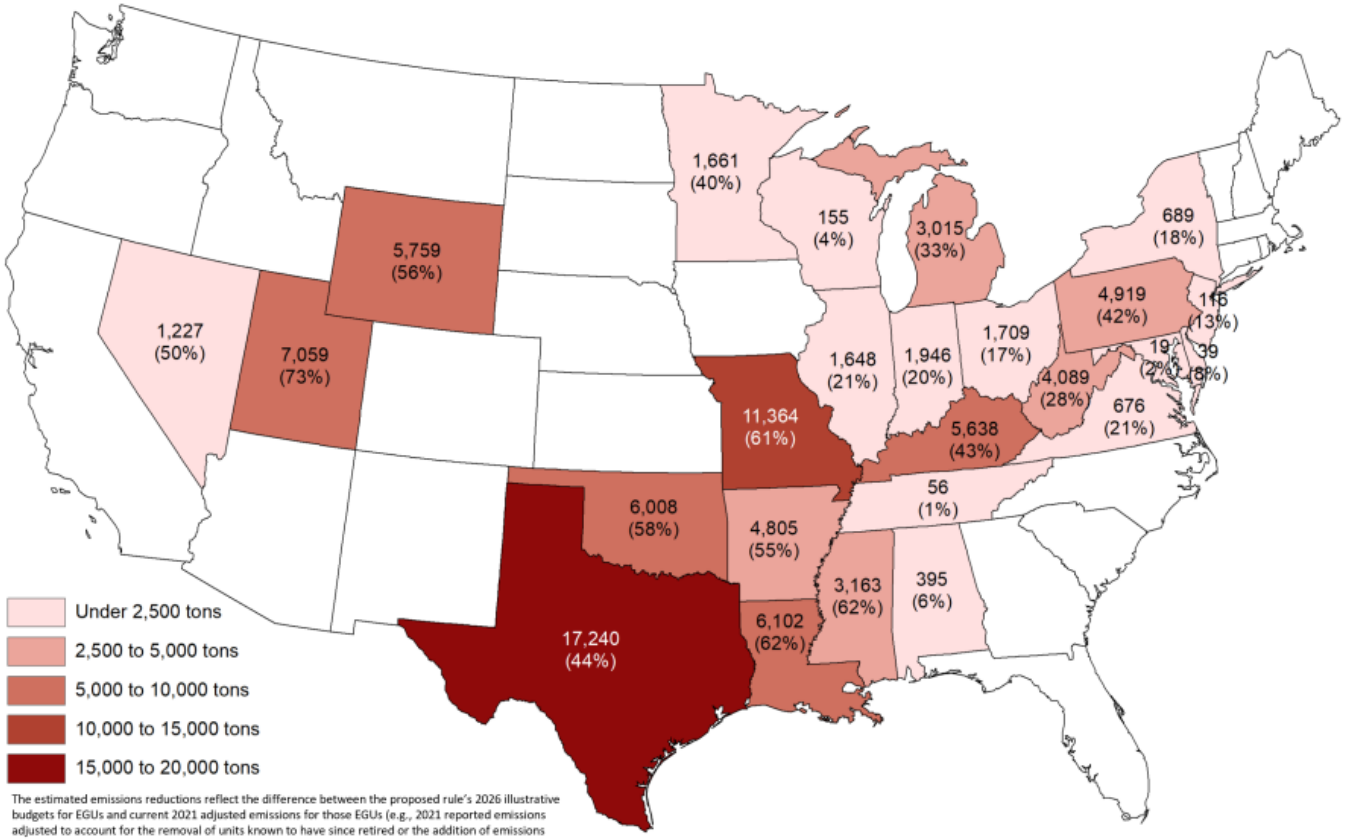
Proposed Rule – Expanded Group 3 NOx Budget Region



Proposed Rule – Linkage to Downwind Ozone Concerns



Proposed Rule – EPA Estimated EGU NOx Reductions



The estimated emissions reductions reflect the difference between the proposed rule's 2026 illustrative budgets for EGUs and current 2021 adjusted emissions for those EGUs (e.g., 2021 reported emissions adjusted to account for the removal of units known to have since retired or the addition of emissions from under-construction new fossil plants). In other words, the estimated reductions reflect changes known to have happened and be happening in the power sector, as well as the impact of the proposed rule. Because these estimated reductions reflect the overall change from current levels of operation, they are higher, on average, than the values reflected in the regulatory impact analysis (emissions reductions relative to projected future levels of operation) and other communications materials for the proposal.

NOx Controls Requirements Under Proposed Rule

EGU NOx controls requirements phased in from 2023 to 2026:

- 2023: Optimize performance of existing EGU controls:
  - SCR: Coal boilers 0.08 lb/MMBtu
    Combined cycle 0.012 lb/MMBtu
    Gas boilers and turbines: 0.03 lb/MMBtu
  - SNCR: Unit specific rates based on EPA analysis
- 2024: Install "state-of-the-art" NOx Combustion Control:
  - Achieve 0.199 lb/MMBtu for all boiler and fuel types
- 2026:
  - SCR: All large boilers (>100 MW) EPA estimate - 88 boilers
    0.05 lb/MMBtu coal
    0.03 lb/MMBtu gas
  - SNCR: Small boilers (<100 MW) 25% Reduction Coal and Gas
    (50% Reduction CFB Boilers)

Proposed Rule – Setting Budgets and Allocations

- Initial State NOx Budgets are set for 2023 and 2024 by applying EPA's assigned control level for each unit to the 2021 actual heat input. Recently retired units are excluded from the budget.

- In-State Generation Shifting: EPA is proposing to require "generation shifting" as a control measure – based on EPA's estimate of cost-effectiveness of controls ($/ton NOx removal)

- 2025 and beyond: Budgets will be based on actual heat input from two-year's prior ozone season.

- Allocations: Budgets are divided among operating units pro rata by the average three-highest heat input years for each unit over the past five years.

Group 3 NOx Budgets Under Proposed Rule

State	2021 Actual	Proposed FIP Budget		"Example" FIP Budget	
	Actual Ozone NOx Tons	2023	2024	2025	2026
Alabama	6,648	6,364	6,306	6,306	6,306
Arkansas	8,955	8,889	8,889	8,889	3,923
Delaware	423	384	434	434	434
Illinois	11,276	7,364	7,463	7,463	6,115
Indiana	14,162	11,151	9,391	8,714	7,791
Kentucky	14,571	11,640	11,640	11,134	7,573
Louisiana	11,456	9,312	9,312	9,179	3,752
Maryland	1,422	1,187	1,187	1,187	1,189
Michigan	13,554	10,718	10,718	10,759	6,114
Minnesota	5,652	3,921	3,921	3,910	2,536
Mississippi	5,790	5,024	4,400	4,400	1,914
Missouri	20,388	11,857	11,857	10,456	7,246
Nevada	2,457	2,280	2,372	2,372	1,211
New Jersey	1,322	799	799	799	799
New York	3,997	3,763	3,763	3,763	3,238
Ohio	11,728	8,369	8,369	8,369	8,586
Oklahoma	10,470	10,265	9,573	9,393	4,275
Pennsylvania	12,792	8,855	8,855	8,855	6,819
Tennessee	4,319	4,234	4,234	4,008	4,008
Texas	42,760	38,284	38,284	36,619	21,946
Utah	15,762	14,981	15,146	15,146	2,620
Virginia	3,329	3,090	2,814	2,948	2,567
West Virginia	14,686	12,478	12,478	12,478	10,597
Wisconsin	6,307	5,963	5,057	4,198	3,473
Wyoming	11,643	9,125	8,573	8,573	4,490
Total	255,868	210,297	205,835	200,352	129,522
Total Reduction - Actual 2021 to Budget 2023					18%
Total Reduction - Actual 2021 to "Example" 2026					49%

Note: Budgets include new unit set-aside allowances

States highlighted in orange are in the current Revised CSAPR Update Group 3 program

Proposed Rule – "Enhancements" to NOx Budget Program

- Daily Backstop Limit:
  - Units with SCR must be below 0.14 lb/MMBtu or be penalized 3-for-1 allowance surrender for daily excess emissions
  - Applies in 2024 for existing SCR and 2027 for units subject to new SCR
- Enforceable Ozone Season Limit:
  - Unit with emissions > 125% of historic best or > 0.10 lb/MMBtu)
  - Applies in 2024 if the state exceeds the 121% Assurance Level
- Restricted Banking:
  - Group 2 units will have current bank reduced by approximately 6 to 1
  - Beginning in 2024, the Group 3 allowance bank will be capped at 10.5% of the 25 State region Group 3 budget
- Dynamic Budgeting:
  - For 2025 and later, budgets will be reset each year to account for retirements and changes/shifts in operation (heat input)

What to Expect – Lessons from Revised CSAPR Update

- Final Revised CSAPR Update published April 30, 2021
  and effective 60 days later – June 29, 2021
  - NOx Budgets included coal EGU SCRs at 0.08 lb/MMBtu
  - 37% Reduction from 2020 Group 2 Budget for the 12 states
  - Group 2 bank converted at 8:1 ratio
  - Due to delay past May 1, EPA awarded supplemental allowances

- Actual 2021 Emissions vs. Allowances
  - Total Regional Budget: 107,085 tons
  - Total with Bank and Supplement 131,430 tons
  - Total 2021 Emissions: 114,293 tons – 107% of Budget

- Allowance Market – Little liquidity, with few allowances offered:
  - Began at $3,000 May 1 – up from Group 2 prices < $200 per ton
  - By June 2021 Compliance Deadline – Average market at $25,000 !!!
  - Current Market - $30,500 per ton, and Group 2 allowances now at $2,500

What to Expect – Preparing for Compliance

- Develop a compliance planning strategy – Short and long-term goals
  - Get started !
  - Big decisions may come later but there will be little time to act.
  - Focus on performance:
    - Get the most from what you have
    - Daily Backstop Limit: Every ton counts, but some more than others (3 for 1) !
    - Management and staff committed to daily tracking and actions to optimize performance and initiate priority actions to address O&M concerns
  - Importance of maintaining a Catalyst Management Plan
- Allowance Management: Anticipate uncertainty – cost and availability
  - Develop and manage to long term allowance position requirements
  - Generation cost impacts: 0.08 lb/MMBtu = ~ $12/MWH @ $30,000/ton
  - Understand restrictions on allowances: Banking and Penalties
- Resource Planning:
  - Difficult and near-term decisions on controls and retirement

Potential SCR Installations

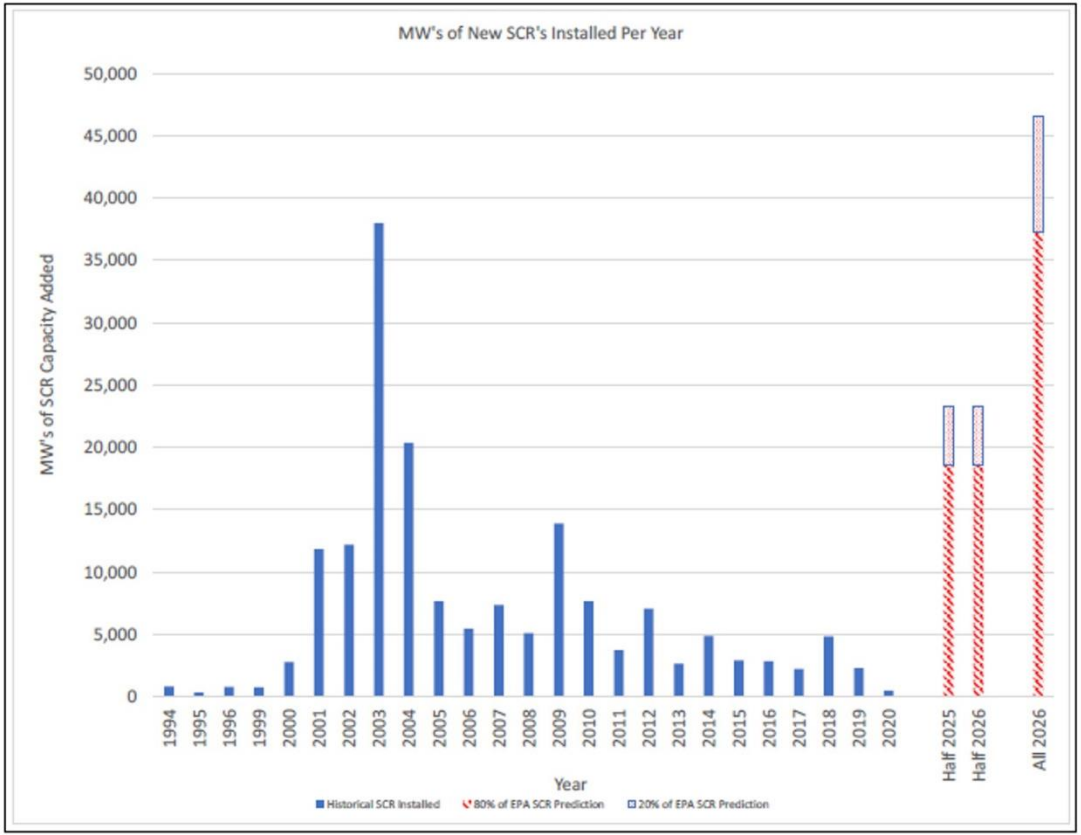


Figure 5-5 from "Technical Comments on Electric Generating Unit Control Technology Options and Emission Allocations Proposed by the Environmental Protection Agency in Support of the Proposed 2015 Ozone NAAQS Transport Rule" by J. Edward Cichanowicz, et al. for MOG, NRECA, APPA

Impact of Daily NOx Limits – Duke Energy Example

2021 Ozone Season - Days Exceeding Proposed FIP Daily Limit of 0.14 lb/MMBtu

		All Days			Startup/Shutdown (Operating Hours < 24)		
	2021 Season NOx Rate lb/MMBtu	Days > 0.14 lb/MMBtu	Total Tons Exceeding 0.14 lb/MMBtu	Allowance Penalty (Excess x 2)	Days > 0.14 lb/MMBtu	Total Tons Exceeding 0.14 lb/MMBtu	Allowance Penalty (Excess x 2)
Cayuga 1	0.067	5	5	9	3	1	2
Cayuga 2	0.07	3	1	1	3	1	1
Gibson 1	0.065	4	6	11	2	2	4
Gibson 2	0.072	7	8	16	5	3	6
Gibson 3	0.065	8	9	17	2	1	2
Gibson 4	0.071	10	6	11	7	3	5
Gibson 5	0.058	9	5	9	7	5	9
East Bend 2	0.097	12	31	62	5	9	18
Total Duke			68	136		24	47

- EPA's proposed limit at 0.14 lb/MMBtu (calendar day) is unforgiving and does not account for operations that do not allow optimized performance:
  - Startup, Shutdown, and Sustained Low Load Operation
- Duke Energy actual 2021 data demonstrates effective overall SCR performance but would still incur significant penalties for excess NOx under the proposed rule

Duke Energy's Experience With the Revised CSAPR Rule

- All Duke IN and KY coal units have SCR, but performance has varied year to year
- Little time to implement – October 2020 Proposal to May 2021 Ozone Season
- Focus on Operational Excellence:
  - Commitment from Executive Management to Staff
  - Set expectations for results
  - Optimize existing investments in controls – Use existing O&M budgets
  - Ongoing communication, analysis/actions, and documentation
- Initiated a unit-by-unit evaluation of what impacts/degrades NOx performance:
  - Ammonia injection system reliability and optimization
  - SCR process monitoring and control
  - Boiler combustion control (NOx and gas distribution)
  - Low load operation on SCR
  - SCR maintenance and continued optimization of the Catalyst Management Plan
  - Managing SCR control set points to provide dynamic optimization
- Results: Significant reductions (all Indiana units below 0.08 lb/MMBtu),
  Providing bank of allowances for long-term compliance needs

Conclusion

- EPA's proposed rule will be a significant challenge
- Budgets based on SCR on all coal units will require difficult decisions
- Look ahead and understand what's needed
- But keep focused on the opportunities to maximize your investment in the tools you have – equipment, processes, and people !