

Base K/Round 4 Strategy Modeling: Emissions

The purpose of this document is to summarize the emission estimates prepared for the latest 2002 base year (Base K) and 2008, 2009, 2012, and 2018 future year (Round 4) modeling. A list of the Round 4 modeling scenarios is provided in Table 1¹. Sector-level emissions are presented in Figure 1 and Table 2. (For comparison, the sector-level emissions from Round 3 are presented in Figure 2.)

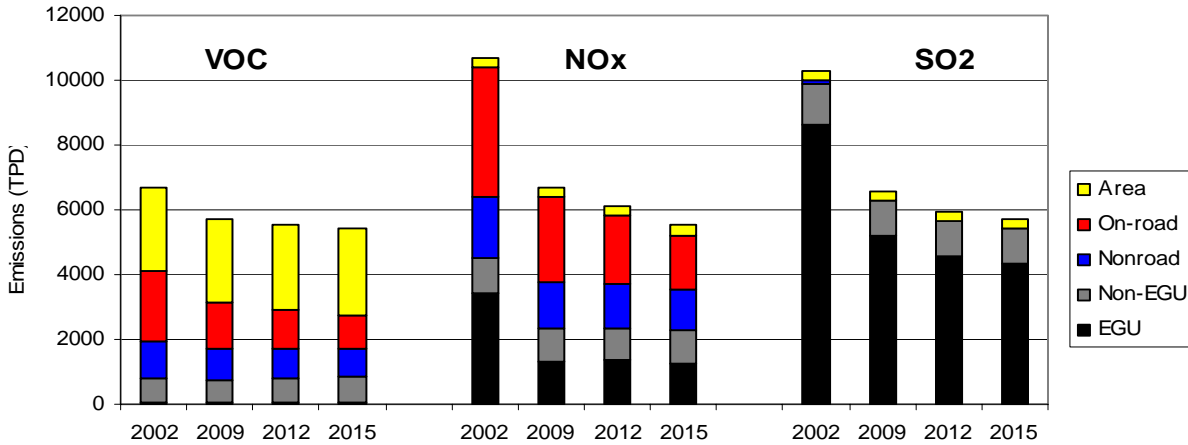


Figure 1. Round 4 Emissions Summary for 5-State LADCO Region (TPD, July weekday)

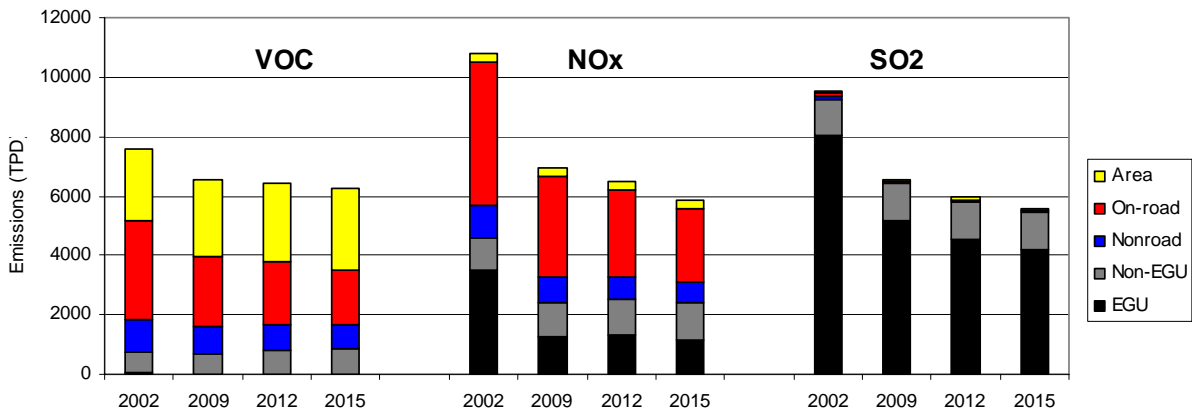


Figure 2. Round 3 Emissions Summary for 5-State LADCO Region (TPD, July weekday)

Base Year Emissions

Updates to the 2002 base year emissions compared to Base J include:

- Revised motor vehicle emissions: The new emission estimates are about 40% lower for VOC and 25% for NOx. This change is due to a correction in the calculation of motor vehicle emissions by EMS. (Previously, EMS was averaging the 25 different vehicle age emission rates in the database output, instead of doing a weighted-average based on mileage accumulation.) EMS was run to generate 36 days (weekday, Saturday, Sunday for each month) at 36 km, and 12 days (weekday, Saturday, Sunday for June – August) at 12 km.

¹ Two additional scenarios were included late in the Round 4 modeling: Scenario 4-reflects control measures under discussion by the MW and NE State Commissioners, and Scenario 5-reflects a control option developed by LADCO Project Team.

- Revised ammonia temporal profile: New temporal profiles were derived by several test runs of the new process based ammonia model. The previous profile was based on Pinder's process based model for dairy farms. The new profile reflects hogs, beef, and dairy. (We used hog farms to define poultry because the process based model does not have a fully functional poultry housing model.) It is probably most critical to see what happens during the colder months, because those are the months where we are generally ammonia limited (see Figure 3). One other change to the ammonia inventory was to remove the point source ammonia emissions from other RPO's inventories, because confined animal operations were included in the point source inventory for some states, which led to double-counting of emissions.

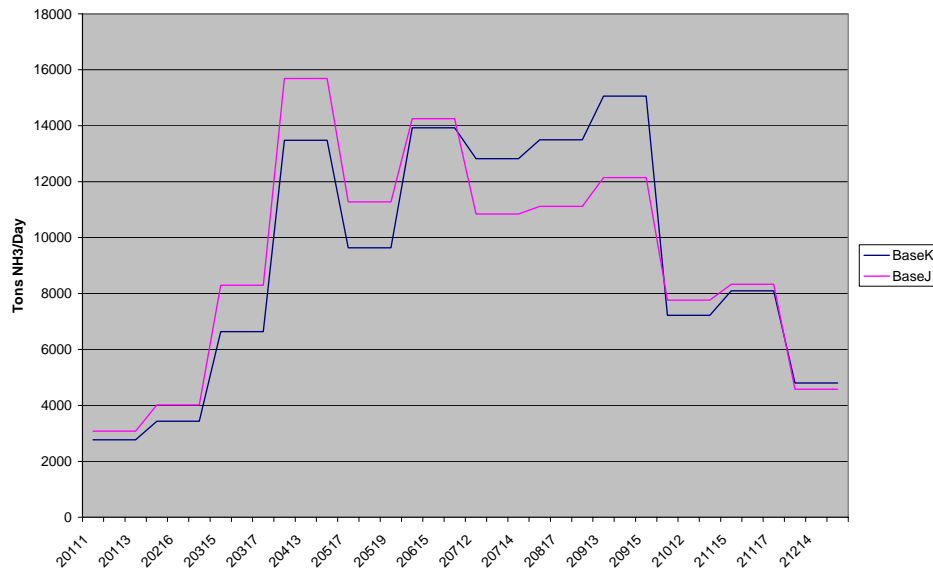


Figure 3. Base J v. Base K Regional Ammonia Emissions by Month

- Revised EGU temporal profile: Continuous emissions monitoring (CEM) data were processed to produce temporal profiles for EGUs which account for month of year, and day of week variations. Unit-specific profiles were developed. (Note, a contractor previously developed a limited number CEM-based temporal profiles, which were assigned to groups of EGUs, but these profiles became obsolete when the source ID numbers changed with the latest IPM modeling. For Base J, national default profiles were assumed.)
- New Canadian emissions: An updated inventory of Canadian stationary and mobile sources for 2000 was provided by Environment Canada. The new inventory reflects significantly lower emissions.
- Improved nonroad emissions: Two changes were made to the nonroad inventory: (1) commercial marine, airports, and railroads were included (note: these categories, which are not part of the NONROAD2004 model, were not included in Base J), and (2) NMIM (with NONROAD2004) was rerun with fuel parameter inputs consistent with the on-road emissions modeling (note – these emission estimates still do not include permeation effects).

- Point sources: All co-generation sources are now included in the EGU file. (Previously, some co-generation sources were in the EGU file and some in the non-EGU.) In addition, stack exit parameters were corrected for Ohio point sources.

Future Year Emissions

Four future year inventories were developed: 2008, 2009, 2012, and 2018. The emissions for 2009, 2012, and 2018 were derived by running the emissions model for each source sector for each year. For 2008, emissions were derived from interpolating between 2002 and 2009 for all sectors, except EGUs. For 2008 summer ozone modeling, the 2008 EGU emissions were processed based on the IPM modeling.

Scenario 1: This scenario represents the future year “base” inventory (i.e., growth to the future year of interest and application of existing [“on the books”] controls). The following controls were included in this scenario:

On-Highway Mobile Sources

- Tier II/Low sulfur fuel
- Inspection/Maintenance programs (nonattainment areas)
- Reformulated gasoline (nonattainment areas)

Off-Highway Mobile Sources

- Federal control programs incorporated into NONROAD model (e.g., nonroad diesel rule), plus the evaporative Large Spark Ignition and Recreational Vehicle standards
- Heavy-duty diesel (2007) engine standard/Low sulfur fuel
- Federal railroad/locomotive standards
- Federal commercial marine vessel engine standards

Power Plants

- Title IV (Phases I and II)
- NO_x SIP Call
- Clean Air Interstate Rule
- Clean Air Mercury Rule

Other Point Sources

- VOC 2-, 4-, 7-, and 10-year MACT standards
- Combustion turbine MACT
- Industrial boiler/process heater/RICE MACT

Updates to the future year “base” emissions compared to Base J include:

- Updated growth factors for several area and point source categories (see “Development of Updated Growth and Control Factors for Lake Michigan Air Directors Consortium”, Draft Report, December 29, 2005, E.H. Pechan)
- Updated control factors for several area and point source categories (see “Development of Updated Growth and Control Factors for Lake Michigan Air Directors Consortium?”, Draft Report, December 29, 2005, E.H. Pechan; and “Documentation for MACTEC NonEGU “On-the-Books” Control Factor File”, January 10, 2006, MACTEC). The changes include settlement agreement for petroleum refineries, and other non-EGU sources in the LADCO region.

- CAIR scenarios
 - 1a: "VISATASII_PC_1f" reflects the IPM scenario which assumed full trading and banking. The results of this IPM run were delivered in July 2005, and were used in Round 3.
 - 1b: "VISTASII_PC_3b" reflects the IPM scenario which assumed the CAIR state-specific emission budgets as an environmental constraint, but allowed banking. The results of this restricted trading IPM run were delivered in December 2005.
 - 1c: This scenario is the same as 1a, with the addition of BART reductions for non-EGU sources. The determination of sources subject to BART is based on the latest Midwest RPO analyses.
 - 1d: This scenario is based on 1a, but scales-back the emissions in each state to match the CAIR state-specific emission budgets (i.e., removes any excess introduced by banking).
- Inclusion of a pollution control retrofits at a few facilities (note: this information was not available at the time the IPM full trading was conducted in summer 2005)
 - MI – Monroe: SO₂ emissions from Units 3-4 reduced by 97% (based on November 9 letter from Skiles Boyd, DTE-Energy)
 - MI – Campbell: NO_x emissions from Units 2-3 reduced by 90% (based on information supplied by Louis Pocalujka, Consumers Energy)
 - IN – Gibson: SO₂ emissions from Units 1-3 reduced by 95% (based on information supplied by Dan Weiss, Cinergy)
 - IN – Cayuga: SO₂ emissions from Units 1-2 reduced by 95% (based on information supplied by Dan Weiss, Cinergy)
- Revised motor vehicle emissions: Unlike 2002, EMS was run for only a few days for 2009, 2012, and 2018. To provide emissions for all 36 days at 36 km, the 2002 emission files were scaled by the emission ratios for one day (i.e., September 13 for 2009, and August 16 for 2012). To provide emissions for all 12 days at 12 km, a similar approach was used, along with consideration of the spatially disaggregated 36 km derived emissions.

Scenario 2: This scenario reflects Scenario 1a plus the additional SO₂ and NO_x candidate control measures in the "Interim White Paper, Source Category: Electric Generating Units" (January 14, 2005):

- 2a reflects EGU² for the top 30 EGUs in the 5-state region (based on Q/d)
- 2b reflects EGU² for all EGUs within 100 km of a residual nonattainment area
- 2c reflects EGU² throughout the 5-state LADCO region
- 2d reflects EGU² throughout the 5-state LADCO region plus seven neighboring states: MN, IA, MO, KY, TN, WV, and PA
- 2e reflects EGU¹ throughout the 5-state LADCO region
- 2f reflects EGU¹ throughout the 5-state LADCO region based on recent IPM modeling
- 2g reflects EGU² throughout the 5-state LADCO region based on recent IPM modeling

Further discussion of the modeling for these scenarios is provided in the Appendix.

² EGU² and EGU¹ in Scenarios 2a – 2e were derived by applying control factors developed by MACTEC. The derivation of these control factors is explained in "Identification and Evaluation of Candidate Control Measures", prepared by MACTEC, April 14, 2005.

Scenario 3: This scenario reflects Scenario 2 plus additional white paper controls for stationary and mobile sources

Scenario 3a reflects the minimum control level for the EGU, non-EGU point, and area source White Paper controls, plus chip reflashing for HDDVs and a “highly cost effective” voluntary/incentive control program for HDDVs and construction equipment (i.e., < \$5,000/T)

EGU EGU1 (Scenario 2e)

Non-EGU ICI1 and GLASS1

Area SOLV1A-7

On-Road Reflashing – Base diesel NOx emissions derived by multiplying MOBILE6 emissions in 2002, 2009, 2012 by 1.04 to account for “true” compliance rates of chip reflashing (i.e., 10% in 2002, and 30% in 2009-2012 timeframe), based on MOBILE6 modeling by Chris Bovee, WDNR. (Note, MOBILE6 assumes a compliance rate of 90%.)

Controlled diesel NOx emissions derived by multiplying MOBILE6 emissions by 1.01 in 2009 and 2012 to account for expected compliance rates of chip reflashing (i.e., 60-80%).

HDDV Voluntary Programs (Diesel Retrofits) – Assume a reduction of 50 TPD (out of 850 TPD for Class 8 HDDV) – i.e., apply ratio of 0.94 to 2009 Class 8 HDDV inventory (or 0.95 to the entire on-road diesel inventory)

Low RVP Fuel - Controlled emissions derived using adjustment factors developed by Environ (see Fuel Sensitivity Runs, March 7, 2005) for the following areas:

Indianapolis: Boone, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Morgan, and Shelby
 Detroit: Livingston, Macomb, Monroe, Oakland, St.Clair, Washtenaw, and Wayne
 Cleveland: Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit
 Cincinnati: Butler, Clermont, Hamilton, Warren, and Clinton
 Dayton: Clark, Greene, Miami, and Montgomery

Nonroad Construction Equipment Voluntary Programs (Diesel Retrofits) – Assume a reduction of 45 TPD (out of 275 TPD) – i.e., apply ratio of 0.84 to diesel construction equipment

Scenario 3b reflects the maximum control level for the EGU, non-EGU point, and area source White Paper controls, plus chip reflashing for HDDVs and a “cost effective” voluntary/incentive control program for HDDVs, and construction and agricultural equipment (i.e., < \$10,000/T)

EGU EGU2 (Scenario 2c)

Non-EGU ICI3, KILN1, GLASS2, and 25% NOx reduction for asphalt plants

Area SOLV1B-4B 5A-7A

On-Road Reflashing – Base diesel NOx emissions derived by multiplying MOBILE6 emissions in 2002, 2009, 2012 by 1.04 to account for “true” compliance rates of chip reflashing (i.e., 10% in 2002, and 30% in 2009-2012 timeframe), based on MOBILE6 modeling by Chris Bovee, WDNR. (Note, MOBILE6 assumes a compliance rate of 90%.)

Controlled diesel NOx emissions derived by multiplying MOBILE6 emissions by 1.01 in 2009 and 2012 to account for expected compliance rates of chip reflashing (i.e., 60-80%).

HDDV Voluntary Programs (Diesel Retrofits) – Assume a reduction of 100 TPD (out of 850 TPD for Class 8 HDDV) – i.e., apply ratio of 0.88 to 2009 Class 8 HDDV inventory (or 0.91 to the entire on-road diesel inventory)

Low RVP Fuel - Controlled emissions derived using adjustment factors developed by Environ (see Fuel Sensitivity Runs, March 7, 2005) for the following areas:

Indianapolis: Boone, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Morgan, and Shelby

Detroit: Livingston, Macomb, Monroe, Oakland, St.Clair, Washtenaw, and Wayne

Cleveland: Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit

Cincinnati: Butler, Clermont, Hamilton, Warren, and Clinton

Dayton: Clark, Greene, Miami, and Montgomery

Nonroad Construction Equipment Voluntary Programs (Diesel Retrofits) – Assume a reduction of 45 TPD (out of 275 TPD) – i.e., apply ratio of 0.84 to diesel construction equipment

Agricultural Equipment Voluntary Programs – Assume a reduction of 55 TPD (out of 255 TPD) – i.e., apply ratio of 0.78 to diesel agricultural equipment

Scenario 4: This scenario reflects Scenario 1a plus the additional control measures under discussion by the MW and NE State Commissioners:

Non-EGU	ICI1
Area	AIM, consumer products, and portable fuel containers
On-Road	Reflashing (see discussion under Scenario 3)

In addition, the Commissioners have discussed a voluntary retrofit program (although it is unclear whether the objective is to reduce NO_x, VOC, and/or PM) and a regional gasoline. For the purposes of this model run, the Scenario 3a on-road and nonroad controls were assumed to reflect these possible other controls.

Scenario 5: This scenario reflects Scenario 1a plus the additional control measures identified by the LADCO Project Team as a possible control option:

EGU	EGU1 for SO ₂ , EGU2 for NO _x
Non-EGU	ICI1
Area	AIM, consumer products, and portable fuel containers
On-Road	Reflashing (see discussion under Scenario 3) HDDV voluntary programs (diesel retrofits) Low RVP fuel
Nonroad	Construction equipment voluntary programs (diesel retrofits)

In addition, the Project Team identified organic carbon control measures, case-by-case point source controls, and state programs (e.g., RACT rules). For the purposes of this model run, no emission reductions were assumed for these other controls due to the lack of specific control information.

Table 1. Round 4 Modeling Runs

Run	Description	2002	2008	2009	2012	2018
Base K	2002 baseyear emissions inventory	36,12				
Scenario 1	Existing (OTB) controls, plus CAIR					
	a. CAIR w/ full trading		12	36,12	36,12	36
	b. CAIR w/ restricted trading				36,12	
	c. CAIR w/ full trading and BART for non-EGUs					36
	d. EGU0 - CAIR w/ full trading scaled-back to state budgets			36,12	36,12	
Scenario 2	Scenario 1a plus EGU controls:					
	a. EGU2 for top 30 EGUs in 5-state region (based on Q/d)				36,12	
	b. EGU2 in 100 km radius of each residual NA area				36,12	
	c. EGU2 in 5-state region			36,12	36,12	36
	d. EGU2 in 12-state Midwest region				36,12	36
	e. EGU1 in 5-state region			36,12	36,12	
	f. EGU1-IPM in 5-state region					
	g. EGU2-IPM in 5-state region					
Scenario 3	a. Scenario 2 e plus "low" control level for non-EGU point, area, and mobile sources throughout 5-state region			36,12	36,12	
	Non-EGU Point Sources					
	* ICI Boilers - 40% SO ₂ , 60% NO _x reduction (ICI1)					
	* Glass manufacturing - 30% NO _x reduction (GLASS1)					
	Area Sources					
	* Consumer products - OTC model rule (SOLV2A)					
	* AIM coatings - OTC model rule (SOLV1A)					
	* Portable fuel containers - OTC model rule (SOLV3A)					
	* Auto refinishing - extend IL,IN,WI RACT rules (SOLV4A)					
	* Ind. surface coating - more stringent RACT (SOLV5A)					
	* Degreasing – more stringent RACT (SOLV6A)					
	* Gas. Dispensing - enhanced vapor recovery (SOLV7A)					
	Mobile Sources					
	* HDDV – reflashing and voluntary measures <\$5,000/T					
	* Construction Equipment - voluntary measures < \$5,000/T					
	* Low RVP fuel (IN, MI, OH counties)					
	b. Scenario 2 c plus "high" control level for non-EGU point, area, and mobile sources throughout 5-state region			36,12	36,12	
	Non-EGU Point Sources					
	* ICI Boilers - 90% SO ₂ , 80% NO _x reduction (ICI3)					
	* Cement kilns – 90% SO ₂ , 50% NO _x reduction (KILN1)					
	* Asphalt plants – 25% NO _x reduction					
	* Glass manufacturing - 75% NO _x reduction (GLASS2)					
	Area Sources					
	* Consumer products - SCAQMD rule (SOLV2B)					
	* AIM coatings - CARB 2003 rule (SOLV1BA)					

May 16, 2006

		* Portable fuel cont, - Accelerated phase in (SOLV3B)						
		* Auto refinishing - SCAQMD rule (SOLV4B)						
		* Ind. surface coating - more stringent RACT (SOLV5A)						
		* Degreasing - more stringent RACT (SOLV6A)						
		* Gas. dispensing - enhanced vapor recovery (SOLV7A)						
		* Asphalt paving applications - low VOC formulations						
		Mobile Sources						
		* HDDV - reflashing and voluntary measures <\$10,000/T						
		* Const. Equipment - voluntary measures < \$10,000/T						
		* Agricultural Equipment - voluntary measures < \$10,000/T						
		* Low RVP fuel (IN, MI, OH counties)						

Note: 12 = 12 km summer run, 36 = 36 km annual run

APPENDIX

Scenario 2 EGU Strategies

The Round 4 control strategy modeling includes five scenarios reflecting the EGU1 and EGU2 controls in the White Paper (“Interim White Paper – Midwest RPO Candidate Control Measures, Electric Generating Units”, January 14, 2005). A summary of the scenarios is provided below.

Overview of EGU1, EGU2

EGU1 and EGU2 represent regional emission caps (tons per year for SO₂ and NO_x, and tons per season for NO_x) based on the following emission limits:

SO ₂ (lb/MMBTU):	EGU1 0.36 (2009), 0.15 (2012) EGU2 0.24 (2009), 0.10 (2012)
NO _x (lb/MMBTU):	EGU1 0.15 (2009), 0.10 (2012) EGU2 0.12 (2009), 0.07 (2012)

For this round of modeling, the compliance date is assumed to be 2012, not 2013 as identified in the original White Paper. EGU1 and EGU2 are defined based on the 2012 regional emissions cap. The 2009 "interim limits" represent where we expect to be on the path to meeting the 2012 emissions cap. The proposed emission cap applies to the entire region (and not individual states) and incorporates demand growth (calculated by IPM) for the target year.

MACTEC derived unit-specific control factors for EGU1 and EGU2 in the following manner:

- For each control measure and year, calculate the 5-state region annual SO₂ emission caps and winter/summer NO_x emission caps based on the IPM-projected heat inputs (mmBtu) and the average emission rate (lbs/mmBtu) for the control measure/year;
- Identify all units with emission rates below the average emission rate for the control measure/year; set the future year percent control efficiency to 0 for these units since they are already below the average emission rate on which the caps are based;
- Subtract the emissions from units with emission rates below the average emission rate and calculate an “adjusted” emission rate (lbs/mmBtu) that units above the average emission rate must meet;
- Calculate the control factor (for units above the “adjusted” emission rate) as one minus the ratio of the “adjusted” average emission rate to the actual emission rate for that unit.

Description of Scenarios

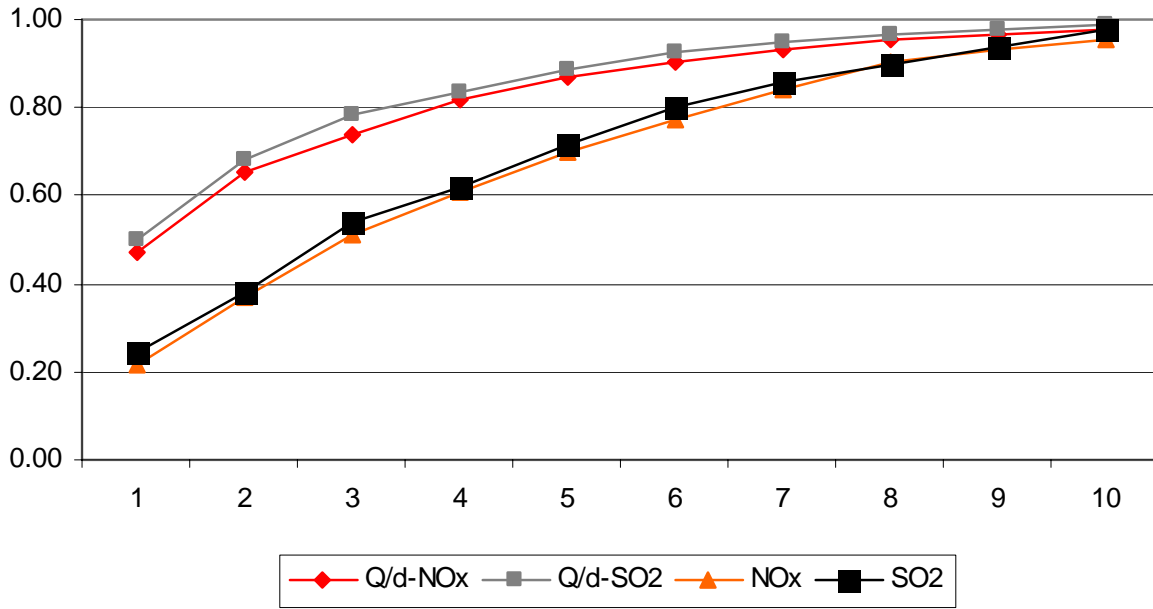
a. EGU2 for top 30 EGUs in 5-state region (based on Q/d)

EGUs in the 5-state region were ranked based on their Q/d value. These values were calculated using:

- 2012 SO₂ and NO_x emission estimates; and
- distances to residual nonattainment monitors (based on Round 3 modeling – i.e., ozone: Chicago, Milwaukee, and Cleveland; PM_{2.5}: Chicago, St.Louis/Granite City, Detroit, Cleveland, and Cincinnati) and nearby Class I areas.

The table below shows the Q/d values, emissions, and rankings for the top 40 facilities. The list is sorted based on the combined rankings of Q/d-NO_x and Q/d-SO₂.

The figure below shows the fraction of the total regional Q/d value for each group of 10 facilities (i.e., the top 10 facilities are represented by the first set of symbols, which are designated by the number "1"). This shows that the top 30 facilities represent 75-80% of the regional Q/d value and about 50% of the regional NOx and SO2 emissions. To model this scenario, the MACTEC EGU2 control factors for only these top 30 facilities will be applied.



b. EGU2 in 100 km radius of each residual ozone and PM2.5 nonattainment area

There are 162 EGUs within 105 km of at least one of the residual nonattainment monitors/areas noted above. (Note: 105 km was used to flag facilities instead of 100 km because there were five large facilities slightly beyond 100 km.) These 162 EGUs represent 80% of the regional Q/d value and about 47% of the regional NOx and SO2 emissions. To model this scenario, the MACTEC EGU2 control factors for only these 162 facilities will be applied.

c. EGU2 in 5-state region

To model this scenario, the MACTEC EGU2 control factors for all 392 EGUs in the 5-state region will be applied.

d. EGU2 in 12-state region (5-state region plus MN, IA, MO, KY, TN, WV, PA)

To model this scenario, the MACTEC EGU2 control factors for all EGUs in the 5-state region plus EGUs in several neighboring factors (MN, IA, MO, KY, TN, WV, and PA)³ will be applied.

e. EGU1 in 5-state region

To model this scenario, the MACTEC EGU1 control factors for all EGUs in the 5-state region will be applied.

³ The control factors for these other states were derived by MACTEC following the same procedures as those outlined above for the five LADCO states.

f. EGU1 in 5-state region based on IPM modeling

IPM modeling for EGU1 was conducted by ICF to provide the modeling emissions inventory.

g. EGU2 in 5-state region based on IPM modeling

IPM modeling for EGU2 was also conducted by ICF to provide the modeling emissions inventory.

Two assumptions in the IPM modeling should be noted:

- ICF assumed banking and withdrawal of allowances, which results in higher SO₂ and NO_x emissions in later years, such as 2012, compared to the EGU1 and EGU2 emission caps. If desired, then ICF can disable banking so that the emissions in the LADCO states are at the level of the SO₂ and NO_x caps.
- ICF assumed EGU1 and EGU2 policies independent of the CAIR policies. If one wants to see a net reduction in both the LADCO and the CAIR regions, then it is necessary to retire the Title IV SO₂ and the CAIR NO_x allowance budgets to the extent that the EGU1 and EGU2 caps are lower than the CAIR state level budgets. This, too, can be implemented in IPM.

To undo these assumptions (i.e., disable banking and force the EGU1/EGU2 emission caps) will require another IPM run. (No decision has been made whether to pursue further IPM modeling.)