Improving EPA Emissions Forecasts

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Underlying thought for this project...

....when planning strategically
for the future,
it is better to use a compass
rather than a map...

Overview

- Goals for Improved Emissions Projections
- Brief Background
- Plans for Initial Improvements
- Enhancements to methods in later stages
- Conclusions

*Includes only stationary non-EGU source categories.

Goals for Improved Methods

- *Transparent,*
- *Scientifically based,*
- *Consistent with current knowledge,*
- *Easily updated for significant changes in future events, and*
- *Allows for ease of altering future year scenario assumptions*

Key Considerations of Project

- Relevant for stationary non-EGU sources
- Forecasts to 2030 currently with consideration of extensions to 2050
- Results shown in this presentation are deliberative and subject to change.

Background

- Equation Typically Used to Forecast Emissions:

  Forecast Year Emissions =

  *Base Year Emissions * **Emission Activity Change (Growth Factor)** * Emission Control Change (Control Factor)*

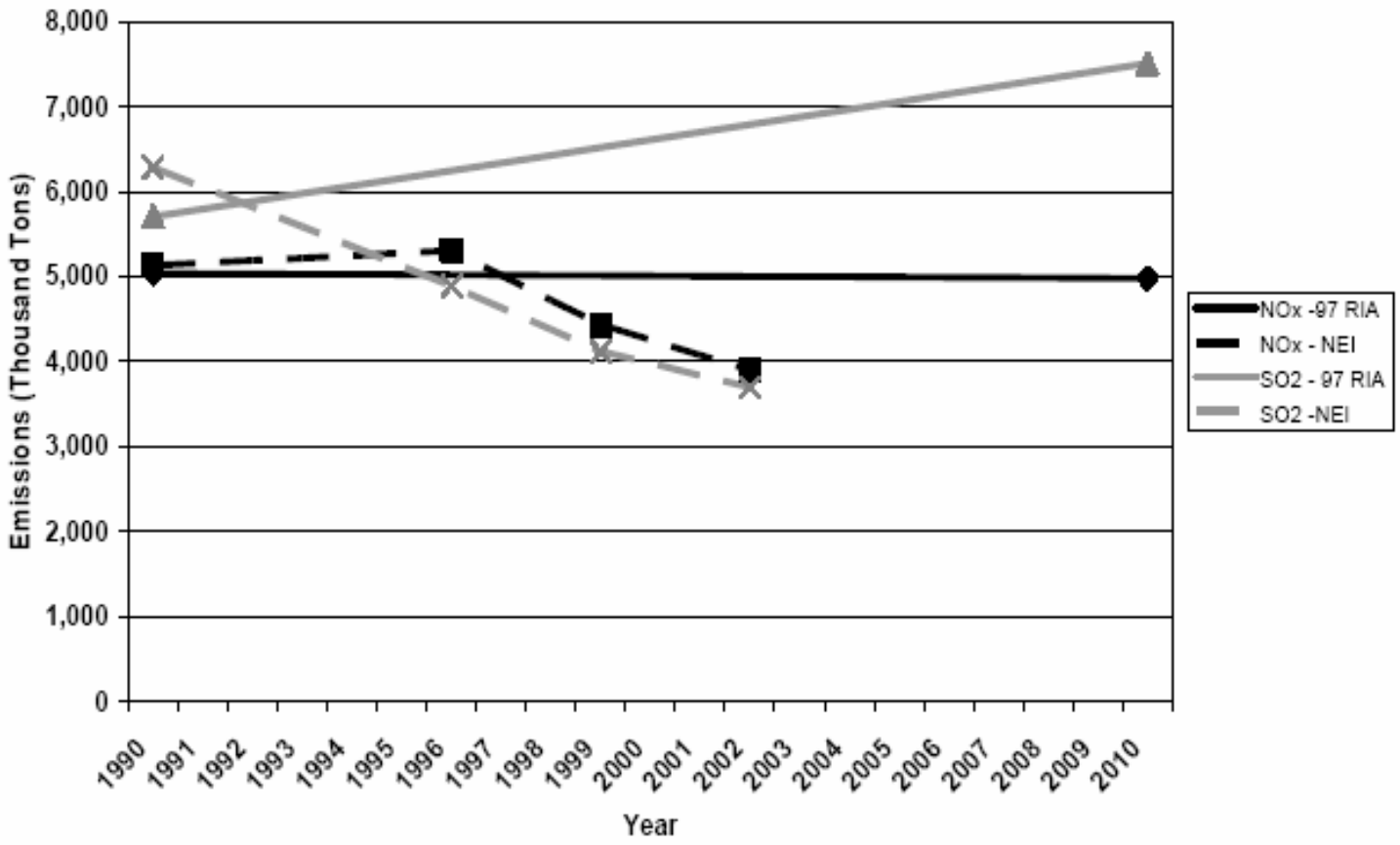
Challenges:

- How accurate are our Projections of Future Activity Levels?
- How accurate are our estimates of Future Emission Rates?

Background (cont'd)

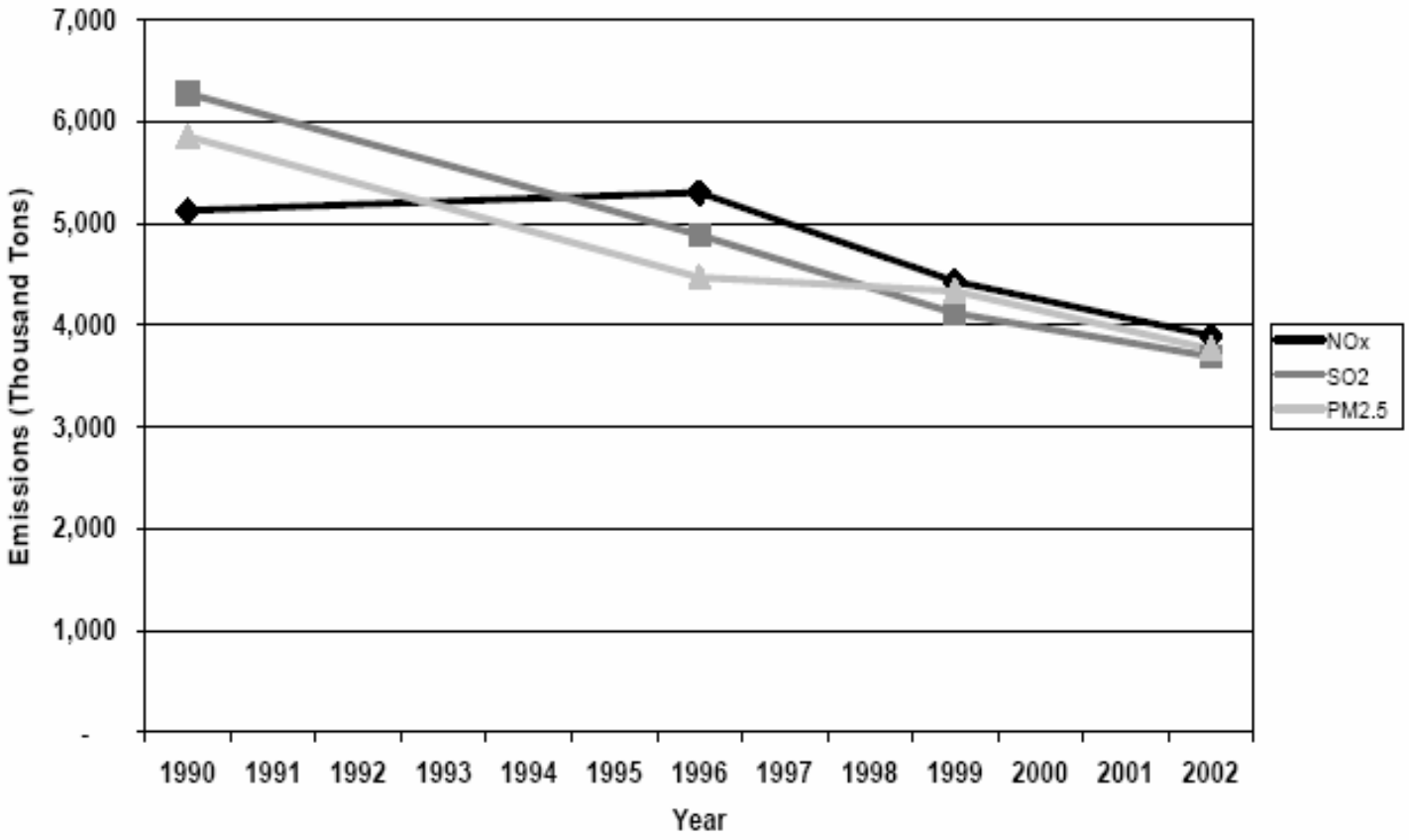
- Emission Activity Projections – Growth Factors
  - EGAS Defaults—Typically Use Regional/National Fuel Consumption Projections from DOE or State-level Industry Sector Sales Projections from Regional Economic Model Inc. (REMI)
  - How Closely Do Growth Surrogates Match Each Emission Activity?
  - How Well Do the Surrogate Forecasts Project Actual Emission Activity Changes?

Comparison of Total NOx and SO2: NEI Actual vs. Forecast from 1997 PM NAAQS RIA



[1] Sources: National Emissions Inventory and Regulatory Impact Analysis for the Ozone and PM NAAQS, 1997.

Non-EGU Stationary Source Emission Trends: NOx, SO2, and PM2.5



[1] Emissions shown reflect non-utility stationary point and non-point sources only, excluding fires. Source: National Emissions Inventory

Current Study- Initial Improvements

- Source Category Prioritization
- Combustion sources – Use AEO 2008 (forecasts to 2030)
- Non-Combustion sources – Use EMPAX-CGE[1] as the economic driver and use other improved activity measures
  - Non-point/non-combustion – identified improvements in activity measures for priority sources
  - Point /non-combustion – Use statistical relationship of historical emissions to production/factors of production

[1] Documentation of EMPAX-CGE is available at www.epa.gov/ttn/ecas

Current Study (cont'd)

- Selected Priority Nonpoint Categories
  - Unpaved Roads (PM)
  - 11 Residential Woodstove/Fireplace SCCs (VOC, PM, or NOx)
  - Agricultural Crop Tilling (PM)
  - Residential Outdoor Wood Burning Equipment (VOC)
  - 189 Solvent Utilization SCCs (VOC)

Current Study (cont'd)

Alternative 2015 Emission Projections for CAPs

					2015					
SCC	Short Description	Top Pollutant	Pollutants Included	Base Emissions (2005)	Pechan	REMI 5.5	REMI 6.0	EMPAX	AEO 2007	AEO 2008
2440000000	Miscellaneous Industrial Solvents	VOC	NOX, PM25-PRI, SO2, VOC	339,806	448,212	514,045	506,993	464,250	428,871	409,929
2401001000	Architectural Coatings	VOC	NOX, PM25-PRI, SO2, VOC	317,116	295,921	411,445	399,495	437,743	351,826	
2425000000	Graphic Arts	VOC	NOX, PM25-PRI, SO2, VOC	188,511	230,134	222,552	189,541	261,731	196,744	
2801000003	Agricultural Tilling	PM10-PRI	PM25-PRI	535,993	534,554	688,511	635,778	475,283	521,631	
2104008000	Woodstoves and Fireplaces	VOC	NH3, NOX, PM25-PRI, SO2, VOC	592,656	588,598	593,827	593,827	646,523	588,598	552,461
2104008001	Fireplaces: General	VOC	NH3, NOX, PM25-PRI, SO2, VOC	729,855	724,859	731,298	731,298	796,192	724,859	680,355
2104008002	Fireplaces: Inserts, non-EPA certified	VOC	NOX, PM25-PRI, SO2, VOC	147,033	119,314	147,323	147,323	160,396	146,026	137,061
2104008003	Fireplaces: Inserts, EPA-certified, non-catalytic	PM10-PRI	NOX, PM25-PRI, SO2, VOC	5,090	11,026	5,100	5,100	5,553	5,055	4,745
2104008004	Fireplaces: Inserts, EPA-certified, catalytic	PM10-PRI	NOX, PM25-PRI, SO2, VOC	2,603	5,639	2,608	2,608	2,840	2,585	2,426
2104008010	Woodstoves: General	VOC	NH3, NOX, PM25-PRI, SO2, VOC	305,203	247,666	305,806	305,806	332,943	303,114	284,504
2104008030	Catalytic Woodstoves: General	PM10-PRI	NOX, PM25-PRI, SO2, VOC	9,194	19,917	9,212	9,212	10,030	9,131	8,571
2104008050	Non-catalytic Woodstoves, EPA certified	PM10-PRI	NOX, PM25-PRI, SO2, VOC	26,263	56,891	26,315	26,315	28,650	26,083	24,482
2104008051	Non-catalytic Woodstoves, non-EPA certified	VOC	NOX, PM25-PRI, SO2, VOC	58,580	47,537	58,696	58,696	63,905	58,179	54,607
2104008052	Woodstoves: Low Emitting	PM10-PRI	NH3, NOX, PM25-PRI, SO2, VOC	18,813	18,684	18,850	18,850	20,523	18,684	17,537
2104008053	Woodstoves: Pellet Fired	NOX	NOX, PM25-PRI, SO2, VOC	851	845	853	853	929	845	793
2104008070	Outdoor Wood Burning Equipment	VOC	NH3, NOX, PM25-PRI, SO2, VOC	41,290	77,483			45,043	41,008	38,490
2296000000	Unpaved Roads	PM10-PRI	PM25-PRI	535,993	534,554	688,511	635,778	475,283	521,631	
			TOTAL:	3,854,850	3,961,835	4,424,953	4,267,473	4,227,815	3,944,871	
Notes:			All But Outdoor Wood Burning	3,813,560	3,884,352	4,424,953	4,267,473	4,182,772	3,903,864	
Highest projected emissions for source category			Fireplaces & Woodstoves	1,896,142	1,840,976	1,899,889	1,899,889	2,068,482	1,883,160	1,767,541
Lowest projected emissions per source category										

Note results shown in column labeled Pechan use improved methods. These results are deliberative and may change.

Current Study (cont'd)

Alternative 2030 Emission Projections for CAPs

					2030					
SCC	Short Description	Top Pollutant	Pollutants Included	Base Emissions (2005)	Pechan	REMI 5.5	REMI 6.0	EMPAX	AEO 2007	AEO 2008
2440000000	Miscellaneous Industrial Solvents	VOC	NOX, PM25-PRI, SO2, VOC	339,806	679,502	792,978	840,660	709,478	601,505	507,396
2401001000	Architectural Coatings	VOC	NOX, PM25-PRI, SO2, VOC	317,116	295,921	544,737	486,332	657,754	436,411	-
2425000000	Graphic Arts	VOC	NOX, PM25-PRI, SO2, VOC	188,511	230,134	310,819	265,842	406,246	221,250	-
2801000003	Agricultural Tilling	PM10-PRI	PM25-PRI	535,993	521,732	883,943	786,572	643,482	516,051	
2104008000	Woodstoves and Fireplaces	VOC	NH3, NOX, PM25-PRI, SO2, VOC	592,656	568,524	594,673	594,673	729,189	568,524	500,418
2104008001	Fireplaces: General	VOC	NH3, NOX, PM25-PRI, SO2, VOC	729,855	700,137	732,340	732,340	897,995	700,137	616,265
2104008002	Fireplaces: Inserts, non-EPA certified	VOC	NOX, PM25-PRI, SO2, VOC	147,033	85,116	147,533	147,533	180,905	141,046	124,149
2104008003	Fireplaces: Inserts, EPA-certified, non-catalytic	PM10-PRI	NOX, PM25-PRI, SO2, VOC	5,090	17,385	5,107	5,107	6,263	4,883	4,298
2104008004	Fireplaces: Inserts, EPA-certified, catalytic	PM10-PRI	NOX, PM25-PRI, SO2, VOC	2,603	8,890	2,612	2,612	3,203	2,497	2,198
2104008010	Woodstoves: General	VOC	NH3, NOX, PM25-PRI, SO2, VOC	305,203	176,680	306,242	306,242	375,514	292,776	257,703
2104008030	Catalytic Woodstoves: General	PM10-PRI	NOX, PM25-PRI, SO2, VOC	9,194	31,402	9,225	9,225	11,312	8,820	7,763
2104008050	Non-catalytic Woodstoves, EPA certified	PM10-PRI	NOX, PM25-PRI, SO2, VOC	26,263	89,699	26,352	26,352	32,313	25,194	22,176
2104008051	Non-catalytic Woodstoves, non-EPA certified	VOC	NOX, PM25-PRI, SO2, VOC	58,580	33,912	58,780	58,780	72,076	56,195	49,463
2104008052	Woodstoves: Low Emitting	PM10-PRI	NH3, NOX, PM25-PRI, SO2, VOC	18,813	18,047	18,877	18,877	23,147	18,047	15,885
2104008053	Woodstoves: Pellet Fired	NOX	NOX, PM25-PRI, SO2, VOC	851	816	854	854	1,047	816	719
2104008070	Outdoor Wood Burning Equipment	VOC	NH3, NOX, PM25-PRI, SO2, VOC	41,290	88,455	-	-	50,803	39,609	34,864
2296000000	Unpaved Roads	PM10-PRI	PM25-PRI	535,993	521,732	883,943	786,572	643,482	516,051	
			TOTAL	3,854,850	4,068,084	5,319,016	5,068,575	5,444,210	4,149,810	
Notes:			All except Outdoor Wood Burning	3,813,560	3,979,629	5,319,016	5,068,575	5,393,407	4,110,201	
Highest projected emissions for source category			Fireplaces & Woodstoves	1,896,142	1,730,607	1,902,596	1,902,596	2,332,964	1,818,933	1,601,036
Lowest projected emissions per source category										

Note results shown in column labeled Pechan are improved estimates. These results are deliberative and may change.

Current Study (cont'd)

Priority Nonpoint Category Growth Surrogate Summary

		Alternative Emission Activity Growth Surrogates				
SCC	DESCRIPTION	Pechan	EGAS (REMI Ver 5.5)	EGAS (REMI Ver 6)	EMPAX	AEO
2440000000	Solvent Utilization; Miscellaneous Industrial; All Processes	Freedonia's All Other Manufacturing Markets Solvents Demand (lbs) per $ of Manufacturing shipments	Manufacturing sector output ($)	Manufacturing sector output ($)	Sum of Materials ($) for 19 sectors comprising Manufacturing sector	Shipments ($) for Manufacturing sector
2401001000	Solvent Utilization; Surface Coating; Architectural Coatings - Total: All Solvents	Freedonia's Architectural Paints & Coatings Solvents Demand (lbs)	Housing expenditures ($)	Housing expenditures ($)	Materials ($) for Construction sector	Shipments ($) for Construction sector
2425000000	Solvent Utilization; Graphic Arts	Freedonia's Printing Ink Solvents Demand (lbs)	Printing and Publishing sector output ($)	Printing sector output ($)	Materials ($) for Printing sector	Shipments ($) for Printing sector
2801000003	Miscellaneous Area Sources; Agriculture Production - Crops; Agriculture Crops; Tilling	Combination of USDA planted acreage projections for major crops and projected % of crops planted using conservation tillage from EPA's Section 812 projections	Farm SIC 01and 02 value added ($)	Agriculture sector output ($)	Petroleum Input ($) for Agriculture sector	Distillate fuel consumption in the Agriculture sector (national only)
2104008000	Stationary Source Fuel Combustion; Residential; Wood; Total: Woodstoves and Fireplaces	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008001	Stationary Source Fuel Combustion; Residential; Wood; Fireplaces: General	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008002	Stationary Source Fuel Combustion; Residential; Wood; Fireplaces: Insert; non-EPA certified	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008003	Stationary Source Fuel Combustion; Residential; Wood; Fireplaces: Insert; EPA certified; non-catalytic	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008004	Stationary Source Fuel Combustion; Residential; Wood; Fireplaces: Insert; EPA certified; catalytic	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008010	Stationary Source Fuel Combustion; Residential; Wood; Woodstoves: General	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008030	Stationary Source Fuel Combustion; Residential; Wood; Catalytic Woodstoves: General	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008050	Stationary Source Fuel Combustion; Residential; Wood; Non-catalytic Woodstoves: EPA certified	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008051	Stationary Source Fuel Combustion; Residential; Wood; Non-catalytic Woodstoves: Non-EPA certified	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008052	Stationary Source Fuel Combustion; Residential; Wood; Non-catalytic Woodstoves: Low Emitting	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008053	Stationary Source Fuel Combustion; Residential; Wood; Non-catalytic Woodstoves: Pellet Fired	Combination of AEO 2007 Residential renewable energy projections and 2% turnover from conventional fireplaces/woodstoves to EPA-certified units	AEO 2004 Regional Residential Renewable Energy	AEO 2004 Regional Residential Renewable Energy	Population	Regional Residential Renewable Energy
2104008070	Stationary Source Fuel Combustion; Residential; Wood; Outdoor Wood Burning Equipment	Exponential extrapolation thru 2006; linear extrapolation thru 2008; rural population growth thereafter	Not in EGAS 5.5 (new SCC)	Not in EGAS 6.0 (new SCC)	Population	Regional Residential Renewable Energy
2296000000	Mobile Sources; Unpaved Roads; All Unpaved Roads; Total: Fugitives	Regression equation that reflects inverse relationship between unpaved roads and GDP	Population	Population	Population	Light-Duty Vehicle Miles Traveled

Methods described in column labeled Pechan are improvements. These results are deliberative and subject to change.

Current Study - Point Sources Priority Categories

- Petroleum refining
- Paper and Allied Products
- Chemical and Allied Products
- Primary Metals
- Stone, Clay, Glass and Concrete
- Oil and Gas Extraction
- Others

Example: Paper and Allied Products

- Combustion Sources Categories – Use

  AEO 2008 forecasts

  - Combustion categories are major for SO2 and NOx (2002 NEI)
    - SO2 - 84%
    - NOx - 71%
- Non-combustion sources – use statistical regression analysis that relates historical emissions to production measures or factors of production

Comparison of Alternative Projection Methods: Pulp and Paper Point Sources

	2005 Base Emissions (tpy)1	Forecast Emissions by Alternative Projection Method							
		2015				2030			
Combustion Emissions		REMI5.5	REMI6.0	EMPAX	AEO 2007	REMI5.5	REMI6.0	EMPAX	AEO 2007
NOx	213,445.0	238,391.5	238,391.5	197,167.7	223,956.2	275,294.5	275,294.5	242,086.1	257,286.1
SO2	372,797.0	394,542.0	394,542.0	344,367.5	372,391.4	427,414.2	427,414.2	422,820.7	388,889.2
Non-Combustion Emissions									
EMPAX results represents simple trend of production forecasts									
NOx	88,763.0	110,500.7	105,191.9	119,226.5	100,685.7	163,614.1	136,079.2	136,650.6	121,675.7
SO2	69,850.0	87,384.7	83,061.1	93,821.5	79,232.7	130,884.8	107,584.2	107,534.0	95,750.3
EMPAX results related to historical trend of production (regression analysis)									
NOx	88,763.0	110,500.7	105,191.9	86,580.0	100,685.7	163,614.1	136,079.2	83,484.0	121,675.7
SO2	69,850.0	87,384.7	83,061.1	84,033.3	79,232.7	130,884.8	107,584.2	94,247.4	95,750.3
Emissions comparison - EMPAX results related to historical trend of factors of production (regressions analysis)									
NOx	88,763.0	110,500.7	105,191.9	86967.63	100,685.7	163,614.1	136,079.2	67,578.2	121,675.7
SO2	69,850.0	87,384.7	83,061.1	54,804.1	79,232.7	130,884.8	107,584.2	25,158.8	95,750.3
use trend of number of employees									
Emissions comparison - EMPAX results related to historical trend of factors of production (regressions analysis)									
NOx	88,763.0	110,500.7	105,191.9	113,517.7	100,685.7	163,614.1	136,079.2	161,361.3	121,675.7
SO2	69,850.0	87,384.7	83,061.1	110247.0	79,232.7	130,884.8	107,584.2	140,154.0	95,750.3
use EMPAX wages forecasts									

[1] Source NEI.

AEO 2008 not shown, data expected to be released by the end of May.

Emissions shown above do not consider emission control programs that become effective in the future (e.g.,CAIR).

Illustrative data shown for EMPAX results above - do not quote or cite

More work to be done on Point Source Emission Projections

- Future year forecasts are greatly affected by underlying activity assumptions and relationships
- Determine relationships that best represent expected future year emissions
- Evaluate EMPAX forecasts as basis for emissions projections
- Compare multiple industry results to determine overall trends

Enhancements – Later Phase

- Consider future year alternative scenarios for key factors affecting emissions - e.g., population, land use, technology change, location of new facilities, etc.
- Use a technology model that allows for alternative future scenarios
  - e.g., MARKAL (model developed by EPA/ORD)
- Use population/land use models to forecast alternative future scenarios
  - e.g., ICLUS/SERGOM (model developed by EPA/ORD)
- Multipollutant approach
  - CAPs, HAPs, and GHGs
- Consider location of large new point sources

Conclusion

- Improvements of Emissions Projections Methodology are ongoing and a work in progress
- Constructive input is welcome
- Questions?

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