

Final Report

**Future Year Electricity Generating Sector Emission Inventory Development Using the
Integrated Planning Model (IPM[®]) in Support of Fine Particulate Mass and Visibility
Modeling in the VISTAS and Midwest RPO Regions**

Prepared for

Visibility Improvement State and Tribal Association of the Southeast (VISTAS)

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A. Overview

In order to model regional haze, visibility and other air quality issues, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) awarded a contract to ICF Resources, L.L.C. (ICF) in August 2004, seeking ICF's services to generate future year emission inventory for the electric generating sector of the contiguous United States using the Integrated Planning Model (IPM[®]).

IPM is a dynamic linear optimization model that can be used to examine air pollution control policies for various pollutants throughout the contiguous U.S. for the entire electric power system. The dynamic nature of IPM enables the projection of the behavior of the power system over a specified future period. The optimization logic determines the least-cost means of meeting electric generation and capacity requirements while complying with specified constraints including air pollution regulations, transmission bottlenecks, and plant-specific operational constraints. The versatility of IPM allows users to specify which constraints to exercise and populate IPM with their own datasets.

This report summarizes the analysis that ICF has performed in generating the future year electricity generating sector emission inventory by using IPM (hereafter, the analysis is referred to as the VISTAS analysis). The model assumptions and data used in this analysis are presented in Section B and the Appendix. The results are presented in Section C and the analysis limitations are presented in Section D.

Since the modeling is based on the EPA's prior analyses for which detailed public documentation is available, we have summarized only the incremental changes that were proposed by VISTAS and MRPO as part of this analysis. For detailed documentation on EPA's prior modeling using IPM, please visit www.epa.gov/airmarkets/epa-ipm.

B. Modeling Assumptions

The VISTAS analysis is based on the USEPA Modeling Applications Using IPM (V.2.1.6). As per the analytical needs of VISTAS and MRPO, the following changes were made to the underlying assumptions in the US EPA Base Case (V2.1.6) in this analysis:

i) The underlying database in the VISTAS analysis is US EPA's National Electric Energy Data System (NEEDS¹) NODA Database, with changes based upon the comments and technical directions from VISTAS and MRPO's stakeholders. The changes focused on existing installations of NO_x, SO₂ and particulate matter (PM) controls, NO_x emission rates, SO₂ emission limits, capacity of existing units, heat rate and unit identifications of selected units in the VISTAS and MRPO regions. These changes are summarized in detail in Appendix 1.

¹ The NEEDS database contains the existing and planned/committed unit data in EPA modeling applications of IPM. NEEDS includes basic geographic, operating, air emissions, and other data on these generating units. For data sources underlying NEEDS and description of fields as well as the documentation on EPA Modeling Applications Using IPM (V.2.1.6), please visit website <http://www.epa.gov/airmarkets/epa-ipm/index.html>

ii) The analysis covers the period between 2007 and 2030. To make the model size and run time tractable, IPM is run for a number of selected years within the study horizon known as run years. Each run year represents several calendar years in the study horizon, and all calendar years within the study horizon are mapped to their representative run years. Although results are only reported for the run years, IPM takes into account all years in the study horizon while developing the projections. Table 1 summarizes the mapping between the run years and the calendar years. Model results are available for all run years; the last run year (2026) results are, however, not recommended to be used because of end-year effects.

Table 1: IPM Run Years

Run Year	Calendar Years
2007	2007-2007
2009	2008-2009
2010	2010-2012
2015	2013-2017
2018	2018-2018
2020	2019-2022
2026	2023-2030

iii) The Duke Power and Progress Energy SO₂ and NO_x control technology investment strategies for complying with North Carolina's Clean Smokestacks Rule were explicitly hardwired in the analysis.

iv) The CAIR rule implemented as part of this analysis is broadly consistent with the Environmental Protection Agency 40 CFR Parts 51, et al. Supplemental Proposal for the Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule), proposed on June 10, 2004. Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, Wisconsin are the states affected by the CAIR SO₂ and the CAIR annual NO_x policies starting 2010. Connecticut is affected by an ozone season NO_x policy. The CAIR plants affected by the annual NO_x policy are capped at 1.6 million tons starting 2010 and 1.33 million tons starting 2015. The power plants affected by the CAIR SO₂ policy have to surrender 2 Title IV SO₂ allowances for every ton of SO₂ emitted starting 2010 and 3 Title IV SO₂ allowances for every ton of SO₂ emitted starting 2015.

C. Analysis Results

ICF ran IPM under two future scenarios – Base Case and CAIR Case. The Base Case represents the current operation of the power system under currently known laws and regulations, including those that come into force in the study horizon. The CAIR Case is the Base Case with the proposed CAIR rule superimposed. The run results were parsed at the unit level for the 2009 and 2018 run years. Appendix 2 summarizes the SO₂ and NO_x emission results on a state level. The following paragraphs discuss the results from the two runs.

1. Emissions

Table 2 presents the emissions from the Base Case and the CAIR Case in the VISTAS analysis.

Table 2: SO₂ and NO_x Emissions from the Electric Power Sector (Million Tons)

		Base Case		CAIR Case	
		2009	2018	2009	2018
CAIR Affected Region	SO ₂	9.1	8.2	5.3	4.1
	NO _x *	2.9	3.0	2.8	1.4
VISTAS States	SO ₂	3.44	2.96	2.28	1.42
	NO _x	1.09	1.09	1.07	0.44
Midwest RPO States	SO ₂	3.05	2.61	1.51	1.33
	NO _x	0.83	0.88	0.83	0.34

*Note: Excludes Connecticut

In the CAIR region, compared with the Base Case, SO₂ emissions would be reduced by 3.8 million tons in 2009 and by 4.1 million tons in 2018. The NO_x emissions would be cut by 1.6 million tons annually in 2018, compared with the Base Case.

Total projected state-level emissions for SO₂ and NO_x for both the Base Case and the CAIR Case are included in Tables A11, A12, A13, and A14 in the Appendix.

2. Projected Costs

For the proposed CAIR region, the analysis projects the annualized incremental cost for the US to be \$2.1 billion in 2009 and \$3.6 billion in 2018. This represents a 3.3% increase in production cost in 2009 and a 4.6% increase in 2018 over the base case. The production cost as projected by IPM includes the capital costs of new investment decisions, fuel costs and the operation and maintenance costs of power plants. The marginal costs of emission reductions (allowance prices) in the CAIR case are shown in Table 3.

Table 3: Marginal Costs of Emission Reductions in CAIR Case (1999 \$)

		2009	2018
Marginal Cost (\$/ton)	SO₂	700	1,100
	NO_x	1,500	1,700

3. Projected Control Technology Retrofits

In the VISTAS analysis, the proposed CAIR policy requires the installation of an additional 67 GW of SO₂ scrubbers and an additional 35 GW of selective catalytic reduction (SCR) on existing coal capacity by 2018 (see Table 4). The pool of existing SCR's that are used during the ozone season in the NO_x SIP call region in the Base Case are allowed to operate year-round in the CAIR Case.

Table 4: Pollution Control Installations by Technology in 2018 (GW)

Technology	Base Case (Cumulative)	CAIR Case (Cumulative)
Scrubber	19	86
SCR	33	67

4. Projected Generation Mix

Table 5 shows the generation mix under the proposed CAIR policy. Coal-fired generation and natural gas-fired generation are projected to remain relatively unchanged due to the phased-in nature of the proposed CAIR.

Relative to the Base Case, in 2009, 2.7 GW of coal-fired capacity is projected to be uneconomic to maintain (approximately 1%) and 90 MW of coal-fired capacity is projected to repower to natural gas in the CAIR Case.

Table 5: National Generation Mix (BkWh's)

Generating Fuel Use	2009		2018	
	Base Case	CAIR Case	Base Case	CAIR Case
Coal	2,115	2,072	2,219	2,154
Oil/Natural Gas	821	862	1,301	1,364
Other	1,197	1,197	1,196	1,194

5. Projected Coal Production for the Electric Power Sector

Coal production for electricity generation is expected to increase with or without the proposed CAIR (Table 6). The reductions in emissions from the power sector will be met through the installation of pollution controls for SO₂ and NO_x.

Table 6: Coal Production in the Electric Power Sector (Million Tons)

Supply Area	2009		2018	
	Base Case	CAIR Case	Base Case	CAIR Case
Appalachia	327	296	297	306
Interior	182	184	189	212
West	528	545	611	550
National	1,038	1,025	1,096	1,067

6. Projected Retail Electricity Prices

National average retail electricity prices in the CAIR Case are projected to increase 2.4 percent in 2009 and 1.6 percent in 2018. Table 7 and Table 8 summarize the national and regional level retail electricity prices. These estimates were developed using the Retail Electricity Price Model.

Table 7: National Average Retail Electricity Prices (1999 Mills/kWh)

	Base Case	CAIR Case	Percent Change
2009	59.4	60.9	2.4%
2018	63.2	64.3	1.6%

Source: Retail Electricity Price Model as documented in http://www.epa.gov/clearskies/tech_sectiong.pdf

Retail electricity prices by NERC region are in Table 8

Table 8: Retail Electricity Prices by NERC Region (1999 Mills/kWh)

Power Region	Primary States Included	Base Case		CAIR Case	
		2009	2018	2009	2018
ECAR	OH,MI,IN,KY,WV,PA	51.3	56.7	53.8	58.7
ERCOT	TX	53.0	65.0	54.8	65.3
MAAC	PA,NJ,MD,DC,DE	56.9	69.3	59.5	71.6
MAIN	IL,MO,WI	51.9	60.3	53.6	61.7
MAPP	MN,IA,SD,ND,NE	54.6	49.4	54.7	49.8
NY	NY	80.0	88.1	81.8	89.6
NE	VT,NH,ME,MA,CT,RI	73.8	82.8	75.4	83.5
FRCC	FL	70.8	68.8	71.7	69.6
STV	VA,NC,SC,GA,AL,MS,TN,AR,LA	56.4	54.1	57.4	55.3
SPP	KS,OK,MO	52.8	57.4	53.7	58.0
PNW	WA,OR,ID	50.1	48.0	50.6	48.0
RM	MT,WY,CO,UT,NM,AZ,NV,ID	61.5	65.1	62.1	65.2
CALI	CA	96.8	98.2	97.6	98.3

Source: Retail Electricity Price Model as documented in http://www.epa.gov/clearskies/tech_sectiong.pdf

7. Projected Fuel Price Impacts

The impacts of the CAIR on mine mouth coal prices and natural gas prices at the Henry Hub are summarized in Table 9.

Table 9: Average Coal Mine Mouth and Henry Hub Natural Gas Prices (1999\$/MMBtu)

Fuel	Base Case		CAIR Case	
	2009	2018	2009	2018
Coal	0.62	0.55	0.60	0.55
Natural Gas	2.77	2.97	2.9	2.99

D. Limitations of Analysis

VISTAS modeling using IPM is based on various economic and engineering input assumptions that are inherently uncertain, such as assumptions for future fuel prices, electricity demand growth and the cost and performance of control technologies. As configured, IPM does not take into account demand response (i.e., consumer reaction to changes in electricity prices).

E. Appendix

1. Changes made to the NEEDS NODA Database for the VISTAS Analysis

NEEDS NODA is the most recent version of the NEEDS database that EPA has made public. It contains existing and planned/committed generation unit data in the contiguous United States. In Appendix 1, the changes suggested by VISTAS and MRPO stakeholders are presented side by side against the values in the original NEEDS NODA for comparison. For description of the items changed, please visit website <http://www.epa.gov/airmarkets/epa-ipm/index.html>.

Table A1 Changes made to NO_x Post Combustion Control Installations on Existing Units

Plant Name	Unique ID	Post Combustion NO _x Control (NEEDS NODA)	Post Combustion NO _x Control (VISTAS)	Data Source*
ASHEVILLE	2706_B_1	SNCR	None	Progress Energy **
BARRY	3_B_1	SNCR	None	Southern Company
BARRY	3_B_2	SNCR	None	Southern Company
BARRY	3_B_3	SNCR	None	Southern Company
BARRY	3_B_4	SNCR	None	Southern Company
Barry	3_G_A1	None	SCR	Southern Company
Barry	3_G_A2ST	None	SCR	Southern Company
MT STORM	3954_B_3	None	SCR	NC-WV-SC
PLEASANTS	6004_B_1	None	SCR	NC-WV-SC
PLEASANTS	6004_B_2	None	SCR	NC-WV-SC
Victor J Daniel Jr	6073_G_3	None	SCR	Southern Company
Victor J Daniel Jr	6073_G_3CT	None	SCR	Southern Company
Victor J Daniel Jr	6073_G_4CT	None	SCR	Southern Company

* Data Source shows the names of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

** Progress Energy Compliance Plan for NC Clean Smokestacks Rule shows the existing NO_x control as AEFLGR and not SNCR.

Table A2 Changes made to NO_x Emission Rates (lbs/MMBtu)

Plant Name	Unique ID	Mode1 Rate** (VISTAS)	Mode2 Rate** (VISTAS)	Mode3 Rate** (VISTAS)	Mode4 Rate** (VISTAS)	Data Source*
GREENE COUNTY	10_B_1	0.718	0.718	0.468	0.468	Southern Company
GREENE COUNTY	10_B_2	0.416	0.416	0.380	0.380	Southern Company
Greene County	10_G_GT10	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT2	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT3	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT4	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT5	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT6	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT7	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT8	0.090	0.090	0.090	0.090	Southern Company
Greene County	10_G_GT9	0.090	0.090	0.090	0.090	Southern Company
CROSS	130_B_1	0.100	0.100	0.100	0.100	SC
CROSS	130_B_2	0.100	0.100	0.100	0.100	SC
EATON	2046_B_1	0.280	0.280	0.280	0.280	Southern Company
EATON	2046_B_2	0.280	0.280	0.280	0.280	Southern Company
EATON	2046_B_3	0.280	0.280	0.280	0.280	Southern Company
Chevron Oil	2047_G_1	0.320	0.320	0.320	0.320	Southern Company
Chevron Oil	2047_G_2	0.320	0.320	0.320	0.320	Southern Company
Chevron Oil	2047_G_3	0.320	0.320	0.320	0.320	Southern Company
Chevron Oil	2047_G_4	0.320	0.320	0.320	0.320	Southern Company
Chevron Oil	2047_G_5	0.064	0.064	0.064	0.064	Southern Company
SWEATT	2048_B_1	0.280	0.280	0.280	0.280	Southern Company
SWEATT	2048_B_2	0.280	0.280	0.280	0.280	Southern Company
Sweatt	2048_G_A	0.320	0.320	0.320	0.320	Southern Company
JACK WATSON	2049_B_1	0.280	0.280	0.280	0.280	Southern Company
JACK WATSON	2049_B_2	0.280	0.280	0.280	0.280	Southern Company
JACK WATSON	2049_B_3	0.280	0.280	0.280	0.280	Southern Company
JACK WATSON	2049_B_4	0.470	0.470	0.415	0.415	Southern Company
JACK WATSON	2049_B_5	0.590	0.590	0.415	0.415	Southern Company
Jack Watson	2049_G_A	0.880	0.880	0.880	0.880	Southern Company
E C GASTON	26_B_1	0.473	0.473	0.473	0.473	Southern Company
E C GASTON	26_B_2	0.473	0.473	0.473	0.473	Southern Company
E C GASTON	26_B_3	0.457	0.457	0.457	0.457	Southern Company
E C GASTON	26_B_4	0.457	0.457	0.457	0.457	Southern Company
E C GASTON	26_B_5	0.429	0.060	0.429	0.060	Southern Company
E C Gaston	26_G_GT4	0.880	0.880	0.880	0.880	Southern Company
ASHEVILLE	2706_B_1	0.491	0.319	0.491	0.319	-
CLIFFSIDE	2721_B_5	0.294	0.070	0.294	0.070	NC-WV-SC
BARRY	3_B_1	0.500	0.500	0.500	0.500	Southern Company
BARRY	3_B_2	0.500	0.500	0.500	0.500	Southern Company
BARRY	3_B_3	0.300	0.300	0.300	0.300	Southern Company
BARRY	3_B_4	0.290	0.290	0.290	0.290	Southern Company
BARRY	3_B_5	0.380	0.380	0.380	0.380	Southern Company
Barry	3_G_A1	0.013	0.013	0.013	0.013	Southern Company
Barry	3_G_A1CT	0.013	0.013	0.013	0.013	Southern Company
Barry	3_G_A1ST	0.013	0.013	0.013	0.013	Southern Company
Barry	3_G_A2C1	0.013	0.013	0.013	0.013	Southern Company
Barry	3_G_A2C2	0.013	0.013	0.013	0.013	Southern Company
Barry	3_G_A2ST	0.013	0.013	0.013	0.013	Southern Company
W S LEE	3264_B_1	0.393	0.393	0.250	0.250	NC-WV-SC
W S LEE	3264_B_2	0.415	0.415	0.250	0.250	NC-WV-SC
W S Lee	3264_G_4	0.320	0.320	0.320	0.320	SC
W S Lee	3264_G_5	0.320	0.320	0.320	0.320	SC
W S Lee	3264_G_6	0.320	0.320	0.320	0.320	SC
MCMEEKIN	3287_B_MC	0.350	0.350	0.350	0.350	SC

Plant Name	Unique ID	Mode1 Rate** (VISTAS)	Mode2 Rate** (VISTAS)	Mode3 Rate** (VISTAS)	Mode4 Rate** (VISTAS)	Data Source*
	M1					
MCMEEKIN	3287_B_MC M2	0.350	0.350	0.350	0.350	SC
MT STORM	3954_B_3	0.604	0.060	0.604	0.060	NC-WV-SC
JAMES H MILLER JR	6002_B_1	0.275	0.060	0.275	0.060	Southern Company
JAMES H MILLER JR	6002_B_2	0.247	0.060	0.247	0.060	Southern Company
JAMES H MILLER JR	6002_B_3	0.306	0.070	0.306	0.070	Southern Company
JAMES H MILLER JR	6002_B_4	0.275	0.070	0.275	0.070	Southern Company
PLEASANTS	6004_B_1	0.302	0.060	0.302	0.060	NC-WV-SC
PLEASANTS	6004_B_2	0.335	0.060	0.335	0.060	NC-WV-SC
WANSLEY	6052_B_1	0.405	0.070	0.405	0.070	Southern Company
WANSLEY	6052_B_2	0.390	0.070	0.390	0.070	Southern Company
Wansley	6052_G_5A	0.880	0.880	0.880	0.880	Southern Company
VICTOR J DANIEL JR.	6073_B_1	0.310	0.310	0.310	0.310	Southern Company
VICTOR J DANIEL JR.	6073_B_2	0.350	0.350	0.350	0.350	Southern Company
Victor J Daniel Jr	6073_G_3	0.013	0.013	0.013	0.013	Southern Company
Victor J Daniel Jr	6073_G_3C T	0.013	0.013	0.013	0.013	Southern Company
Victor J Daniel Jr	6073_G_3S T	0.013	0.013	0.013	0.013	Southern Company
Victor J Daniel Jr	6073_G_4	0.013	0.013	0.013	0.013	Southern Company
Victor J Daniel Jr	6073_G_4C T	0.013	0.013	0.013	0.013	Southern Company
Victor J Daniel Jr	6073_G_4S T	0.013	0.013	0.013	0.013	Southern Company
MCINTOSH	6124_B_1	0.613	0.613	0.410	0.410	Southern Company
McIntosh	6124_G_CT 1	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 2	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 3	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 4	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 5	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 6	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 7	0.090	0.090	0.090	0.090	Southern Company
McIntosh	6124_G_CT 8	0.090	0.090	0.090	0.090	Southern Company
WINYAH	6249_B_1	0.100	0.100	0.100	0.100	SC
WINYAH	6249_B_2	0.120	0.120	0.120	0.120	SC
WINYAH	6249_B_3	0.120	0.120	0.120	0.120	SC
WINYAH	6249_B_4	0.120	0.120	0.120	0.120	SC
SCHERER	6257_B_1	0.450	0.450	0.150	0.150	Southern Company
SCHERER	6257_B_2	0.450	0.450	0.150	0.150	Southern Company
SCHERER	6257_B_3	0.300	0.300	0.150	0.150	Southern Company
SCHERER	6257_B_4	0.300	0.300	0.150	0.150	Southern Company
Wilson	6258_G_5A	0.880	0.880	0.880	0.880	Southern Company
Wilson	6258_G_5B	0.880	0.880	0.880	0.880	Southern Company
Wilson	6258_G_5C	0.880	0.880	0.880	0.880	Southern Company
Wilson	6258_G_5D	0.880	0.880	0.880	0.880	Southern Company
Wilson	6258_G_5E	0.880	0.880	0.880	0.880	Southern Company
Wilson	6258_G_5F	0.880	0.880	0.880	0.880	Southern Company
Wilson	6258_G_IC1	0.880	0.880	0.880	0.880	Southern Company
CRIST	641_B_2	0.280	0.280	0.280	0.280	Southern Company
CRIST	641_B_3	0.280	0.280	0.280	0.280	Southern Company
CRIST	641_B_4	0.400	0.400	0.240	0.240	Southern Company

Plant Name	Unique ID	Mode1 Rate** (VISTAS)	Mode2 Rate** (VISTAS)	Mode3 Rate** (VISTAS)	Mode4 Rate** (VISTAS)	Data Source*
CRIST	641_B_5	0.400	0.400	0.240	0.240	Southern Company
CRIST	641_B_7	0.482	0.060	0.482	0.060	Southern Company
SCHOLZ	642_B_1	0.540	0.540	0.320	0.320	Southern Company
SCHOLZ	642_B_2	0.570	0.570	0.320	0.320	Southern Company
SMITH	643_B_1	0.490	0.490	0.240	0.240	Southern Company
SMITH	643_B_2	0.410	0.410	0.410	0.410	Southern Company
Lansing Smith	643_G_CT1	0.880	0.880	0.880	0.880	Southern Company
GADSDEN	7_B_1	0.544	0.544	0.544	0.544	Southern Company
GADSDEN	7_B_2	0.544	0.544	0.544	0.544	Southern Company
Atkinson	700_G_5A	0.320	0.320	0.320	0.320	Southern Company
Atkinson	700_G_5B	0.320	0.320	0.320	0.320	Southern Company
BOWEN	703_B_1BL R	0.405	0.070	0.405	0.070	Southern Company
BOWEN	703_B_2BL R	0.405	0.070	0.405	0.070	Southern Company
BOWEN	703_B_3BL R	0.409	0.070	0.409	0.070	Southern Company
BOWEN	703_B_4BL R	0.419	0.070	0.419	0.070	Southern Company
Bowen	703_G_6	0.880	0.880	0.880	0.880	Southern Company
HAMMOND	708_B_1	0.800	0.800	0.410	0.410	Southern Company
HAMMOND	708_B_2	0.800	0.800	0.410	0.410	Southern Company
HAMMOND	708_B_3	0.800	0.800	0.410	0.410	Southern Company
HAMMOND	708_B_4	0.404	0.070	0.404	0.070	Southern Company
HARLLEE BRANCH	709_B_1	0.800	0.800	0.519	0.519	Southern Company
HARLLEE BRANCH	709_B_2	0.800	0.800	0.374	0.374	Southern Company
HARLLEE BRANCH	709_B_3	0.800	0.800	0.381	0.381	Southern Company
HARLLEE BRANCH	709_B_4	0.800	0.800	0.381	0.381	Southern Company
JACK MCDONOUGH	710_B_MB1	0.450	0.450	0.230	0.230	Southern Company
JACK MCDONOUGH	710_B_MB2	0.450	0.450	0.230	0.230	Southern Company
Jack McDonough	710_G_3A	0.320	0.320	0.320	0.320	Southern Company
Jack McDonough	710_G_3B	0.320	0.320	0.320	0.320	Southern Company
MCMANUS	715_B_1	0.310	0.310	0.310	0.310	Southern Company
MCMANUS	715_B_2	0.310	0.310	0.310	0.310	Southern Company
McManus	715_G_3A	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_3B	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_3C	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_4A	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_4B	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_4C	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_4D	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_4E	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_4F	0.880	0.880	0.880	0.880	Southern Company
McManus	715_G_IC1	3.200	3.200	3.200	3.200	Southern Company
MITCHELL	727_B_3	0.625	0.625	0.625	0.625	Southern Company
Mitchell	727_G_4A	0.880	0.880	0.880	0.880	Southern Company
Mitchell	727_G_4B	0.880	0.880	0.880	0.880	Southern Company
Mitchell	727_G_4C	0.880	0.880	0.880	0.880	Southern Company

* Data Source shows the names of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories. "SC" reflects the spreadsheet CopyofSCIPMdata.xls. Rate changes include VISTAS interpretation of stakeholder submitted data.

**

Mode 1 Rate (Uncontrolled Base Rate) – This emission rate reflects current configuration of combustion controls. If a post combustion NO_x control such as a SCR or a SNCR exists, it is assumed that it is not operating.

Mode 2 Rate (Controlled Base Rate) – This emission rate reflects current configuration of combustion controls. If a post combustion NO_x control such as a SCR or a SNCR exists, it is assumed that it is operating.

Mode 3 Rate (Uncontrolled Policy Rate) – This emission rate reflects a state of the art configuration of combustion controls. If a post combustion NO_x control such as a SCR or a SNCR exists, it is assumed that it is not operating.

Mode 4 Rate (Controlled Policy Rate) – This emission rate reflects a state of the art configuration of combustion controls. If a post combustion NO_x control such as a SCR or a SNCR exists, it is assumed that it is operating.

For more details on the development of these rates please refer to <http://www.epa.gov/airmarkets/epa-ipm/section3powsysop.pdf>

Table A3 Changes made to SO₂ Scrubber Installations on Existing Units

Plant Name	Unique ID	Wet/DryScrubber (NEEDS NODA)	Wet/DryScrubber (VISTAS)	Data Source*
NORTH BRANCH POWER STATION	7537_B_1A	Dry Scrubber	-	NC-WV-SC
NORTH BRANCH POWER STATION	7537_B_1B	Dry Scrubber	-	NC-WV-SC
Morgantown Energy Facility	10743_G_GEN1	Dry Scrubber	-	NC-WV-SC

* Data Source shows the name of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

Table A4 Changes made to SO₂ Emission Rate Limits (lbs/MMBtu)

Plant Name	Unique ID	SO ₂ Rate (NEEDS NODA)	SO ₂ Rate (VISTAS)	Data Source*
GREENE COUNTY	10_B_1	4.000	1.197	Southern Company
GREENE COUNTY	10_B_2	4.000	1.197	Southern Company
EATON	2046_B_1	4.800	0.001	Southern Company
EATON	2046_B_2	4.800	0.001	Southern Company
EATON	2046_B_3	4.800	0.001	Southern Company
SWEATT	2048_B_1	4.800	0.001	Southern Company
SWEATT	2048_B_2	4.800	0.001	Southern Company
JACK WATSON	2049_B_1	4.800	0.001	Southern Company
JACK WATSON	2049_B_2	4.800	0.001	Southern Company
JACK WATSON	2049_B_3	4.800	0.001	Southern Company
JACK WATSON	2049_B_4	4.800	0.885	Southern Company
JACK WATSON	2049_B_5	4.800	0.885	Southern Company
E C GASTON	26_B_1	3.800	1.667	Southern Company
E C GASTON	26_B_2	3.800	1.667	Southern Company
E C GASTON	26_B_3	3.800	1.667	Southern Company
E C GASTON	26_B_4	3.800	1.667	Southern Company
E C GASTON	26_B_5	3.800	1.667	Southern Company
BUCK	2720_B_5	2.300	1.630	NC-WV-SC
BUCK	2720_B_6	2.300	1.630	NC-WV-SC
BUCK	2720_B_7	2.300	1.630	NC-WV-SC
BUCK	2720_B_8	2.300	1.630	NC-WV-SC
BUCK	2720_B_9	2.300	1.630	NC-WV-SC
CLIFFSIDE	2721_B_1	2.300	2.200	NC-WV-SC
CLIFFSIDE	2721_B_2	2.300	2.200	NC-WV-SC
CLIFFSIDE	2721_B_3	2.300	2.200	NC-WV-SC
CLIFFSIDE	2721_B_4	2.300	2.200	NC-WV-SC
CLIFFSIDE	2721_B_5	2.300	2.200	NC-WV-SC
DAN RIVER	2723_B_1	2.300	1.810	NC-WV-SC
DAN RIVER	2723_B_2	2.300	1.810	NC-WV-SC
DAN RIVER	2723_B_3	2.300	1.810	NC-WV-SC
BARRY	3_B_1	1.800	1.197	Southern Company
BARRY	3_B_2	1.800	1.197	Southern Company
BARRY	3_B_3	1.800	1.197	Southern Company
BARRY	3_B_4	1.800	1.197	Southern Company
BARRY	3_B_5	1.800	1.197	Southern Company
JAMES H MILLER JR	6002_B_1	1.800	0.795	Southern Company
JAMES H MILLER JR	6002_B_2	1.800	0.795	Southern Company
JAMES H MILLER JR	6002_B_3	1.800	0.795	Southern Company
JAMES H MILLER JR	6002_B_4	1.800	0.795	Southern Company
VICTOR J DANIEL JR.	6073_B_1	4.800	0.885	Southern Company
VICTOR J DANIEL JR.	6073_B_2	4.800	0.885	Southern Company
SCHERER	6257_B_1	1.200	0.796	Southern Company
SCHERER	6257_B_2	1.200	0.796	Southern Company
SCHERER	6257_B_3	1.200	0.796	Southern Company
SCHERER	6257_B_4	1.200	0.796	Southern Company
CRIST	641_B_2	0.740	0.001	Southern Company

Plant Name	Unique ID	SO ₂ Rate (NEEDS NODA)	SO ₂ Rate (VISTAS)	Data Source*
CRIST	641_B_3	0.740	0.001	Southern Company
CRIST	641_B_4	5.900	1.197	Southern Company
CRIST	641_B_5	5.900	1.197	Southern Company
CRIST	641_B_6	5.900	1.197	Southern Company
CRIST	641_B_7	5.900	1.197	Southern Company
SCHOLZ	642_B_1	6.170	1.200	Southern Company
SCHOLZ	642_B_2	6.170	1.200	Southern Company
SMITH	643_B_1	6.170	1.197	Southern Company
SMITH	643_B_2	6.170	1.197	Southern Company
GADSDEN	7_B_1	4.000	2.500	Southern Company
GADSDEN	7_B_2	4.000	2.500	Southern Company
BOWEN	703_B_1BLR	4.580	1.667	Southern Company
HAMMOND	708_B_1	4.580	1.667	Southern Company
HAMMOND	708_B_2	4.580	1.667	Southern Company
HAMMOND	708_B_3	4.580	1.667	Southern Company
HAMMOND	708_B_4	4.580	1.667	Southern Company
HARLLEE BRANCH	709_B_1	4.580	1.667	Southern Company
HARLLEE BRANCH	709_B_2	4.580	1.667	Southern Company
HARLLEE BRANCH	709_B_3	4.580	1.667	Southern Company
HARLLEE BRANCH	709_B_4	4.580	1.667	Southern Company
JACK MCDONOUGH	710_B_MB1	4.580	1.667	Southern Company
JACK MCDONOUGH	710_B_MB2	4.580	1.667	Southern Company
MCMANUS	715_B_1	3.159	2.620	Southern Company
MCMANUS	715_B_2	3.159	2.620	Southern Company
MITCHELL	727_B_3	4.580	2.500	Southern Company
YATES	728_B_Y2BR	4.580	1.667	Southern Company
YATES	728_B_Y3BR	4.580	1.667	Southern Company
YATES	728_B_Y4BR	4.580	1.667	Southern Company
YATES	728_B_Y5BR	4.580	1.667	Southern Company
KRAFT	733_B_1	4.580	1.270	Southern Company
KRAFT	733_B_2	4.580	1.270	Southern Company
KRAFT	733_B_3	4.580	1.270	Southern Company
KRAFT	733_B_4	0.800	0.001	Southern Company
RIVERSIDE	734_B_11	2.632	0.001	Southern Company
RIVERSIDE	734_B_12	3.159	0.001	Southern Company
RIVERSIDE	734_B_4	2.632	0.001	Southern Company
RIVERSIDE	734_B_5	2.632	0.001	Southern Company
RIVERSIDE	734_B_6	2.632	0.001	Southern Company
GORGAS	8_B_10	4.000	1.667	Southern Company
GORGAS	8_B_6	4.000	2.500	Southern Company
GORGAS	8_B_7	4.000	2.500	Southern Company
GORGAS	8_B_8	4.000	1.667	Southern Company
GORGAS	8_B_9	4.000	1.667	Southern Company

- Data Source shows the names of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

Table A5 Changes made to Particulate Matter (PM) Control Installations on Existing Units

Plant Name	Unique ID	PM Control (NEEDS NODA)	PM Control (VISTAS)	Data Sources *
G G ALLEN	2718_B_3	Hot-side ESP	Cold-side ESP	NC-WV-SC
G G ALLEN	2718_B_5	Hot-side ESP	Cold-side ESP	NC-WV-SC
WESTON	4078_B_3	Hot-side ESP + Fabric Filter	Fabric Filter	Wisconsin

* Data Sources shows the name of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

Table A6 Changes made to Summer Net Dependable Capacity (MW)

Plant Name	Unique ID	Capacity (NEEDS NODA)	Capacity (VISTAS)	Data Source*
VACA_SC_Combined Cycle	077_C_077	1317	807	SC
CRIST	641_B_1	24	0 **	Southern Company
Lansing Smith	A274_G_A274	500	530	Southern Company
Atkinson	700_G_5A	32	15.3	Southern Company
Atkinson	700_G_5B	32	15.3	Southern Company
Dahlberg	7709_G_10	75	80	Southern Company
Dahlberg	7709_G_9	75	80	Southern Company
FRANKLIN	A7840_G_A331	570	630	Southern Company
Mill Creek	A294_G_A294	320	326.8	NC-WV-SC
Mill Creek	A295_G_A295	240	245.1	NC-WV-SC
Mill Creek	A296_G_A296	80	81.7	NC-WV-SC
SCE&G Hardeeville	3286_C_2		170	SC
SCE&G Hardeeville	3286_C_3		170	SC
SCE&G Hardeeville	3286_C_4		170	SC
Cross 3	130_C_3		660	SC

* Data Source shows the name of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories. "SC" reflects the spreadsheet CopyofSCIPMdata.xls.

** Zero capacity denotes that the unit was retired in 2002.

Table A7 Changes made to Heat Rate (Btu/kWh)

Plant Name	Unique ID	ORIS Code	BGCI	Unit ID	Heat Rate (NEEDS NODA)	Heat Rate (VISTAS)	Data Source*
ALLEN S KING	1915_B_1	1915	B	1	8879	9229	Minnesota

* Data Source shows the name of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

Table A8 Changes made to Unit ID

Plant Name	Unique ID	ORIS Code	BGCI	Unit ID (NEEDS NODA)	Unit ID (VISTAS)	Data Source*
Talbot County Energy	A397_G_A397	7916	G	397	1	Oglethorpe
Talbot County Energy	A398_G_A398	7916	G	398	2	Oglethorpe
Talbot County Energy	A399_G_A399	7916	G	399	3-4	Oglethorpe
Talbot County Energy	A400_G_A400	7916	G	400	5-6	Oglethorpe
Mill Creek	A294_G_A294	7981	G	294	1-4	NC-WV-SC
Mill Creek	A295_G_A295	7981	G	295	5-7	NC-WV-SC
Mill Creek	A296_G_A296	7981	G	296	8	NC-WV-SC

* Data Source shows the name of sheets in NEEDS-NODA-VISTAS-Aug18Rev.xls, provided by Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

Table A9 Duke and Progress Energy SO₂ Control Plan for North Carolina Clean Smokestacks Rule

Unit	Technology	Operation Date	Company
Asheville 1	Scrubber	2005	Progress Energy
Asheville 2	Scrubber	2006	Progress Energy
Cape Fear 5	Scrubber	2012	Progress Energy
Cape Fear 6	Scrubber	2011	Progress Energy
Mayo 1	Scrubber	2008	Progress Energy
Roxboro 1	Scrubber	2009	Progress Energy
Roxboro 2	Scrubber	2007	Progress Energy
Roxboro 3	Scrubber	2007	Progress Energy
Roxboro 4	Scrubber	2007	Progress Energy
Sutton 3	Scrubber	2012	Progress Energy
Allen 1	Scrubber	2011	Duke Power
Allen 2	Scrubber	2011	Duke Power
Allen 3	Scrubber	2011	Duke Power
Allen 4	Scrubber	2012	Duke Power
Allen 5	Scrubber	2012	Duke Power
Belews Creek 1	Scrubber	2008	Duke Power
Belews Creek 2	Scrubber	2008	Duke Power
Cliffside 5	Scrubber	2009	Duke Power
Marshall 1	Scrubber	2007	Duke Power
Marshall 2	Scrubber	2007	Duke Power
Marshall 3	Scrubber	2006	Duke Power
Marshall 4	Scrubber	2006	Duke Power

Source: Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

Table A10 Duke and Progress Energy NO_x Control Plan for North Carolina Clean Smokestacks Rule

Unit	Technology	Operation Date	Company
Asheville 1	SCR	2009	Progress Energy
Lee 2	ROFA	2007	Progress Energy
Lee 3	SCR	2010	Progress Energy
Sutton 2	ROFA	2006	Progress Energy
Allen 1	SNCR	2003	Duke Power
Allen 2	SNCR	2007	Duke Power
Allen 3	SNCR	2005	Duke Power
Allen 4	SNCR	2006	Duke Power
Allen 5	SNCR	2008	Duke Power
Belews Creek 1	SCR	2003	Duke Power
Belews Creek 2	SCR	2004	Duke Power
Buck 3	SNCR	2009	Duke Power
Buck 4	SNCR	2008	Duke Power
Buck 5	SNCR	2006	Duke Power
Buck 6	SNCR	2007	Duke Power
Cliffside 1	SNCR	2009	Duke Power
Cliffside 2	SNCR	2009	Duke Power
Cliffside 3	SNCR	2008	Duke Power
Cliffside 4	SNCR	2008	Duke Power
Cliffside 5	SCR	2002	Duke Power
Dan River 1	SNCR	2009	Duke Power
Dan River 2	SNCR	2009	Duke Power
Dan River 3	SNCR	2007	Duke Power
Marshall 1	SNCR	2007	Duke Power
Marshall 2	SNCR	2006	Duke Power
Marshall 3	SNCR	2005	Duke Power
Marshall 4	SNCR	2008	Duke Power
Riverbend 4	SNCR	2007	Duke Power
Riverbend 5	SNCR	2008	Duke Power
Riverbend 6	SNCR	2008	Duke Power
Riverbend 7	SNCR	2007	Duke Power

Source: Gregory Stella, VISTAS Technical Advisor for Emissions Inventories.

2. Emission Results

Tables A11, A12, A13 and A14 present the Base Case and the CAIR Case NO_x and SO₂ emissions by state and season in 2009 and 2018 run years.

Table A11 State Level Base Case NO_x Emissions by Season (Thousand Tons)

NO _x Emission (Base Case)	Winter		Summer	
	2009	2018	2009	2018
CAIR Affected States				
Alabama	97.93	100.12	34.06	34.89
Arkansas	23.92	24.68	19.73	19.96
District Of Columbia	0.00	0.03	0.00	0.05
Delaware	6.09	7.30	2.78	3.42
Florida	80.78	86.48	67.84	72.61
Georgia	92.95	94.65	38.95	34.29
Iowa	39.67	47.64	30.90	36.59
Illinois	101.87	119.29	27.74	37.91
Indiana	176.21	183.22	61.12	61.74
Kansas	46.35	50.19	36.58	39.32
Kentucky	131.21	132.43	47.76	49.80
Louisiana	27.55	28.46	22.92	23.26
Massachusetts	9.80	11.69	5.64	8.74
Maryland	48.93	50.40	9.07	9.88
Michigan	80.77	85.49	35.64	34.26
Minnesota	39.60	44.65	30.21	34.14
Missouri	84.20	86.01	33.32	30.67
Mississippi	20.98	21.97	17.68	18.21
North Carolina	40.99	39.94	25.74	24.73
New Jersey	10.93	13.57	4.76	5.79
New York	31.75	30.74	18.00	18.79
Ohio	221.12	234.60	50.99	47.99
Pennsylvania	139.63	144.99	58.57	54.52
South Carolina	33.44	35.53	17.06	19.70
Tennessee	88.26	88.30	18.75	24.15
Texas	91.74	91.77	92.76	102.30
Virginia	44.06	37.63	21.15	19.35
Wisconsin	44.08	44.81	35.52	35.59
West Virginia	146.12	147.16	27.86	23.37
Total	2,000.92	2,083.74	893.12	926.01
Non CAIR States				
Arizona	43.51	45.10	35.05	35.71
California	21.46	18.71	13.13	12.91
Colorado	38.20	39.43	30.04	30.90
Connecticut	3.56	4.49	2.63	2.81
Idaho	0.85	0.76	0.65	0.34
Maine	1.03	1.04	0.81	0.82
Montana	21.40	21.42	16.92	17.01
North Dakota	39.97	39.97	31.67	31.67
Nebraska	27.26	27.49	21.75	21.96
New Hampshire	1.33	1.65	0.74	1.18
New Mexico	40.80	40.90	32.70	32.97
Nevada	18.94	21.12	10.94	16.55
Oklahoma	41.56	41.86	36.02	38.41

NO _x Emission (Base Case)	Winter		Summer	
	2009	2018	2009	2018
Oregon	7.54	7.79	5.89	6.07
Rhode Island	0.29	0.32	0.23	0.30
South Dakota	8.10	8.11	6.44	6.44
Utah	33.87	33.83	26.88	26.43
Vermont	0.01	0.01	0.01	0.02
Washington	16.48	14.94	12.19	11.79
Wyoming	45.24	45.24	35.93	35.93
Total	411.39	414.19	320.62	330.23
National Total	2,412.31	2,497.93	1,213.74	1,256.23

Table A12 State Level Base Case SO₂ Emissions by Season (Thousand Tons)

SO ₂ Emission (Base Case)	Winter		Summer	
	2009	2018	2009	2018
CAIR Affected States				
Alabama	279.95	209.76	185.64	165.55
Arkansas	45.95	45.95	36.49	36.49
District Of Columbia	0.00	0.00	0.00	0.00
Delaware	22.94	26.88	15.11	17.45
Florida	122.20	120.04	97.19	95.45
Georgia	328.97	310.23	253.11	243.79
Iowa	86.91	101.85	66.32	78.32
Illinois	215.50	242.21	130.41	177.13
Indiana	434.76	300.46	291.49	228.01
Kansas	45.06	47.83	36.59	37.99
Kentucky	279.82	241.21	203.42	188.21
Louisiana	55.29	55.29	43.92	43.92
Massachusetts	9.55	10.21	2.21	6.86
Maryland	179.99	187.19	129.98	143.59
Michigan	219.48	227.46	160.86	177.17
Minnesota	52.19	53.20	39.47	39.43
Missouri	153.41	158.24	110.96	119.58
Mississippi	47.72	47.72	37.90	37.90
North Carolina	109.66	80.15	72.83	53.68
New Jersey	31.74	19.49	22.99	14.08
New York	100.81	89.14	48.13	53.50
Ohio	860.12	647.74	584.09	460.62
Pennsylvania	525.90	503.94	359.82	361.58
South Carolina	93.19	99.82	70.44	79.21
Tennessee	274.69	184.91	161.76	138.75
Texas	221.74	231.04	184.26	188.83
Virginia	133.86	103.85	87.09	77.75
Wisconsin	87.01	85.93	69.31	67.53
West Virginia	349.02	274.96	249.54	208.00
Total	5,367.45	4,706.71	3,751.31	3,540.37
Non CAIR States				
Arizona	33.81	28.38	26.85	22.54
California	3.64	3.64	2.88	2.88
Colorado	51.13	51.13	40.59	40.61
Connecticut	3.62	3.62	2.85	2.85
Idaho	0.03	0.03	0.02	0.02
Maine	3.01	3.01	2.42	2.42
Montana	11.32	12.90	8.95	10.28
North Dakota	74.59	74.54	58.98	58.94
Nebraska	39.52	39.92	31.48	31.63
New Hampshire	5.20	4.62	2.26	2.98
New Mexico	29.49	29.49	23.42	23.42
Nevada	12.09	13.32	6.14	10.25
Oklahoma	65.56	65.56	52.08	52.08

SO ₂ Emission (Base Case)	Winter		Summer	
	2009	2018	2009	2018
Oregon	5.67	5.67	4.50	4.50
Rhode Island	0.00	0.00	0.00	0.00
South Dakota	6.74	6.74	5.35	5.35
Utah	29.65	20.86	23.43	15.04
Vermont	0.02	0.02	0.01	0.01
Washington	6.63	6.65	5.15	5.17
Wyoming	41.73	28.93	33.14	22.98
Total	423.46	399.05	330.53	313.96
National Total	5,790.90	5,105.76	4,081.84	3,854.33

Table A13 State Level CAIR Case NO_x Emissions by Season (Thousand Tons)

NO _x Emission (CAIR Case)	Winter		Summer	
	2009	2018	2009	2018
CAIR Affected States				
Alabama	96.01	21.06	36.32	18.89
Arkansas	24.01	17.81	19.73	14.41
District Of Columbia	0.00	0.05	0.02	0.04
Delaware	4.92	3.86	0.92	3.01
Florida	80.05	30.71	67.84	28.83
Georgia	88.13	33.33	31.30	32.22
Iowa	39.36	23.69	30.64	16.83
Illinois	108.01	38.49	33.62	30.78
Indiana	174.47	49.88	64.17	37.28
Kansas	46.51	17.41	36.48	14.84
Kentucky	129.41	36.28	47.90	28.43
Louisiana	27.80	16.91	22.92	14.01
Massachusetts	10.03	8.38	6.43	6.23
Maryland	46.83	7.76	11.25	6.58
Michigan	80.25	39.64	35.94	30.88
Minnesota	40.35	21.80	30.79	17.02
Missouri	82.31	50.25	36.39	27.68
Mississippi	20.98	5.68	17.78	5.11
North Carolina	40.69	33.56	26.50	26.49
New Jersey	11.08	6.73	4.27	5.64
New York	25.18	22.18	19.25	17.99
Ohio	214.10	47.83	43.53	34.32
Pennsylvania	129.93	42.08	54.03	33.21
South Carolina	34.01	20.39	16.20	16.00
Tennessee	87.13	15.77	17.44	16.68
Texas	91.58	82.32	92.49	90.41
Virginia	39.54	23.15	23.53	17.15
Wisconsin	41.88	21.25	33.52	16.56
West Virginia	145.07	24.52	29.50	17.70
Total	1,959.60	762.79	890.73	625.24
Non CAIR States				
Arizona	43.50	45.11	35.04	35.68
California	20.40	18.52	13.00	12.91
Colorado	38.14	39.55	30.05	30.88
Connecticut	3.90	5.06	3.00	3.50
Idaho	0.85	0.78	0.65	0.34
Maine	1.03	1.08	0.76	0.85
Montana	21.40	21.42	16.98	17.01
North Dakota	38.73	39.97	29.27	31.76
Nebraska	27.43	27.52	21.83	22.08
New Hampshire	0.97	1.71	0.75	1.35
New Mexico	40.80	40.92	32.70	32.98
Nevada	19.96	22.36	11.06	17.60
Oklahoma	41.64	42.42	36.06	40.57

NO _x Emission (CAIR Case)	Winter		Summer	
	2009	2018	2009	2018
Oregon	7.54	7.79	5.89	6.07
Rhode Island	0.29	0.34	0.21	0.30
South Dakota	8.10	8.11	6.44	6.45
Utah	33.87	33.83	26.86	26.43
Vermont	0.01	0.02	0.01	0.02
Washington	16.48	14.94	12.19	11.78
Wyoming	45.24	45.24	35.93	35.93
Total	410.29	416.69	318.68	334.51
National Total	2,369.89	1,179.48	1,209.41	959.75

Table A14 State Level CAIR Case SO₂ Emissions by Season (Thousand Tons)

SO ₂ Emission (CAIR Case)	Winter		Summer	
	2009	2018	2009	2018
CAIR Affected States				
Alabama	190.85	125.61	124.00	100.91
Arkansas	45.95	45.95	36.49	36.49
District Of Columbia	0.00	0.00	0.00	0.00
Delaware	16.78	9.84	5.14	7.09
Florida	110.87	70.51	89.28	56.09
Georgia	244.73	117.05	149.70	104.56
Iowa	89.51	97.92	68.86	71.77
Illinois	141.81	149.61	93.99	113.51
Indiana	200.81	182.52	140.39	139.08
Kansas	44.63	40.60	35.76	32.84
Kentucky	197.05	127.58	145.63	98.20
Louisiana	34.59	18.80	27.47	14.93
Massachusetts	10.70	9.48	2.93	6.73
Maryland	41.64	14.40	25.23	10.01
Michigan	216.30	221.63	157.75	174.22
Minnesota	45.46	47.48	35.48	35.41
Missouri	148.86	151.22	110.16	118.11
Mississippi	47.72	28.96	37.90	23.00
North Carolina	80.70	41.41	51.49	36.93
New Jersey	19.09	11.35	15.17	8.65
New York	57.16	26.70	37.60	20.71
Ohio	259.36	122.94	144.93	88.31
Pennsylvania	128.67	74.04	77.16	57.49
South Carolina	85.48	85.74	58.09	66.81
Tennessee	168.50	53.32	111.44	50.29
Texas	216.76	195.36	178.90	159.08
Virginia	89.83	66.57	51.09	49.68
Wisconsin	83.88	78.63	66.32	62.03
West Virginia	154.15	64.86	92.70	47.07
Total	3,171.82	2,280.08	2,171.02	1,789.98
Non CAIR States				
Arizona	33.81	28.38	26.85	22.54
California	3.64	3.64	2.88	2.88
Colorado	50.79	51.16	40.28	40.61
Connecticut	3.62	3.62	2.58	2.85
Idaho	0.03	0.03	0.02	0.02
Maine	3.01	3.01	2.10	2.42
Montana	11.32	13.00	9.01	10.33
North Dakota	71.08	74.54	54.63	59.20
Nebraska	39.82	39.92	31.63	31.70
New Hampshire	0.92	4.47	0.70	3.52
New Mexico	29.49	29.49	23.42	23.42
Nevada	12.90	14.33	6.23	11.09
Oklahoma	65.56	65.56	52.08	52.08

SO ₂ Emission (CAIR Case)	Winter		Summer	
	2009	2018	2009	2018
Oregon	5.67	5.67	4.50	4.50
Rhode Island	0.00	0.00	0.00	0.00
South Dakota	6.74	6.74	5.35	5.35
Utah	29.65	20.86	23.35	15.04
Vermont	0.02	0.02	0.01	0.01
Washington	6.11	6.65	4.80	5.17
Wyoming	39.68	28.93	31.52	22.98
Total	413.87	400.02	321.96	315.72
National Total	3,585.68	2,680.10	2,492.97	2,105.71

3. Generation Results

Tables A15 and A16 present the generation in the Base Case and the CAIR Case by state and season in 2009 and 2018 run years.

Table A15 State Level Base Case Generation by Season (GWh)

Base Case Generation	Winter		Summer	
	2009	2018	2009	2018
CAIR Affected States				
Alabama	89,306	107,340	71,273	89,828
Arkansas	27,458	35,937	27,331	29,377
District Of Columbia	-	70	-	113
Delaware	3,688	4,873	2,754	4,030
Florida	103,348	140,092	91,525	117,000
Georgia	93,099	103,667	73,028	86,929
Iowa	26,718	32,128	20,016	23,757
Illinois	111,860	120,671	79,329	91,331
Indiana	78,544	86,210	57,036	65,667
Kansas	26,507	27,819	21,332	22,583
Kentucky	61,480	62,605	46,396	48,451
Louisiana	35,891	48,346	35,855	38,090
Massachusetts	31,527	37,098	22,173	27,421
Maryland	31,487	33,118	22,747	26,002
Michigan	61,566	75,353	45,410	54,723
Minnesota	27,529	31,431	21,104	23,976
Missouri	51,304	54,766	38,644	42,737
Mississippi	20,631	32,250	24,165	29,593
North Carolina	72,173	77,731	54,210	58,315
New Jersey	31,669	38,312	26,922	29,698
New York	86,175	90,403	66,311	69,245
Ohio	98,345	111,448	69,610	80,018
Pennsylvania	129,591	140,974	93,686	101,509
South Carolina	57,536	66,909	47,731	54,364
Tennessee	57,630	59,073	40,526	43,453
Texas	175,132	192,596	176,889	210,649
Virginia	44,517	55,805	34,038	42,987
Wisconsin	37,353	40,072	29,408	31,217
West Virginia	60,407	61,029	45,922	47,604
Total	1,732,468	1,968,124	1,385,371	1,590,666
Non CAIR States				
Arizona	68,796	84,020	58,556	66,427
California	153,862	193,482	115,891	148,755
Colorado	24,277	29,820	17,665	22,200
Connecticut	18,145	20,347	12,832	13,661
Idaho	6,535	6,859	5,123	4,814
Maine	4,510	4,554	3,259	3,284
Montana	14,651	15,017	11,972	12,277
North Dakota	15,999	15,999	12,683	12,688
Nebraska	17,523	17,985	14,926	15,717
New Hampshire	19,201	18,995	14,611	14,436
New Mexico	16,508	17,492	13,485	14,417
Nevada	21,432	24,996	15,590	20,097
Oklahoma	42,002	45,145	36,058	40,794

Base Case Generation	Winter		Summer	
	2009	2018	2009	2018
Oregon	34,193	37,710	25,959	28,498
Rhode Island	2,822	3,045	1,865	2,474
South Dakota	5,103	5,116	4,200	4,210
Utah	18,558	18,525	14,807	14,561
Vermont	3,328	3,284	2,102	1,985
Washington	61,086	64,342	43,874	47,400
Wyoming	24,650	24,627	19,574	19,555
Total	573,182	651,360	445,030	508,249
National Total	2,305,650	2,619,484	1,830,401	2,098,915

Table A16 State Level CAIR Case Generation by Season (GWh)

CAIR Case Generation	Winter		Summer	
	2009	2018	2009	2018
CAIR Affected States				
Alabama	94,570	114,813	74,254	91,185
Arkansas	28,520	38,336	27,342	30,538
District Of Columbia	-	164	27	140
Delaware	4,109	4,888	1,395	3,816
Florida	103,047	134,673	91,525	114,079
Georgia	90,975	106,074	68,713	87,944
Iowa	26,654	32,155	20,160	22,069
Illinois	113,576	118,442	83,009	91,406
Indiana	77,812	85,811	59,219	64,105
Kansas	26,553	25,090	21,262	21,729
Kentucky	60,623	61,425	45,949	47,837
Louisiana	39,178	47,708	35,792	37,296
Massachusetts	32,086	35,865	22,315	26,056
Maryland	30,432	33,919	22,226	26,140
Michigan	61,409	77,361	45,712	55,464
Minnesota	28,657	31,549	22,190	24,725
Missouri	50,909	54,005	38,878	43,636
Mississippi	20,654	38,386	26,053	31,804
North Carolina	72,011	76,972	54,051	59,626
New Jersey	32,728	37,732	26,430	30,620
New York	86,621	90,452	67,306	70,406
Ohio	94,457	109,773	66,893	80,432
Pennsylvania	125,813	135,339	93,940	100,257
South Carolina	59,092	67,948	47,929	54,154
Tennessee	57,255	55,011	40,017	42,531
Texas	174,956	188,405	176,614	205,557
Virginia	42,300	55,560	34,556	41,982
Wisconsin	37,205	41,005	28,850	31,286
West Virginia	59,826	59,948	43,305	46,823
Total	1,732,029	1,958,806	1,385,910	1,583,642
Non CAIR States				
Arizona	68,764	84,088	58,527	66,182
California	153,862	193,060	115,905	148,764
Colorado	23,897	29,789	17,750	22,086
Connecticut	17,851	20,146	12,783	13,817
Idaho	6,535	6,907	5,123	4,809
Maine	4,510	5,032	3,213	3,605
Montana	14,651	15,018	11,996	12,275
North Dakota	15,380	15,999	11,862	12,738
Nebraska	17,566	18,061	14,947	15,816
New Hampshire	18,921	19,856	14,663	15,201
New Mexico	16,514	17,636	13,485	14,519
Nevada	21,896	25,564	15,641	20,582
Oklahoma	42,459	50,227	36,383	45,539

CAIR Case Generation	Winter		Summer	
	2009	2018	2009	2018
Oregon	34,193	37,678	25,959	28,474
Rhode Island	2,822	3,032	1,651	2,410
South Dakota	5,103	5,116	4,200	4,220
Utah	18,558	18,525	14,796	14,561
Vermont	3,328	3,446	2,102	2,096
Washington	61,086	64,281	43,874	47,356
Wyoming	24,650	24,627	19,574	19,555
Total	572,547	658,087	444,434	514,605
National Total	2,304,577	2,616,893	1,830,343	2,098,247

4. Cost Results

Tables A17, A18, A19 and A20 present the fixed operation and maintenance cost (FOM), variable operation and maintenance cost (VOM), fuel cost and the capital cost in the Base Case and the CAIR Case by IPM model region and season in 2009 and 2018 run years respectively.

Table A17 FOM Cost by IPM Model Region (Million 1999\$)

FOM Cost by Region	Base Case		CAIR Case	
	2009	2018	2009	2018
AZNM	999.8	1,173.9	999.8	1,173.9
CALI	1,399.3	1,767.7	1,397.1	1,767.6
DSNY	554.3	365.1	559.0	386.4
ECAO	3,163.2	3,282.9	3,310.1	3,583.2
ENTG	1,172.8	1,351.0	1,177.5	1,361.8
ERCT	1,905.2	2,084.9	1,905.2	2,097.9
FRCC	1,500.1	1,570.0	1,504.2	1,595.8
LILC	71.1	89.7	79.1	92.5
MACE	1,712.7	1,859.8	1,698.8	1,850.0
MACS	474.3	504.5	503.3	548.3
MACW	843.0	961.8	849.6	989.5
MANO	2,462.9	2,942.4	2,466.9	2,949.6
MAPP	1,282.3	1,352.2	1,276.4	1,347.3
MECS	525.5	625.8	525.5	631.5
NENG	1,230.3	1,246.7	1,233.3	1,247.1
NWPE	512.5	539.5	518.4	545.3
NYC	145.0	162.1	145.0	167.5
PNW	906.4	988.3	906.4	988.1
RMPA	295.2	305.0	295.5	305.3
SOU	1,490.9	1,674.5	1,510.6	1,777.1
SPPN	477.7	564.3	477.7	566.9
SPPS	651.9	715.0	656.3	722.2
TVA	1,380.2	1,469.9	1,384.2	1,508.4
UPNY	726.7	792.6	713.3	782.1
VACA	2,764.7	3,099.6	2,756.4	3,096.6
WUMS	461.8	494.1	461.8	495.5
National Total	29,109.7	31,983.2	29,311.5	32,577.6

Table A18 VOM Cost by IPM Model Region (Million 1999\$)

VOM Cost by Region	Base Case		CAIR Case	
	2009	2018	2009	2018
AZNM	301.4	349.7	301.3	349.7
CALI	525.1	677.9	523.7	677.6
DSNY	41.0	34.1	41.4	51.4
ECAO	1,218.5	1,316.6	1,378.1	1,883.4
ENTG	158.6	195.1	170.2	228.0
ERCT	493.4	602.5	492.9	621.6
FRCC	303.2	404.1	307.8	466.1
LILC	24.9	39.5	24.4	33.6
MACE	140.5	166.4	137.6	174.4
MACS	70.6	83.1	97.8	141.1
MACW	188.1	203.1	226.7	300.4
MANO	313.9	359.5	335.8	408.4
MAPP	306.1	337.8	309.5	353.1
MECS	146.3	181.0	145.8	211.6
NENG	174.5	205.0	176.8	205.3
NWPE	235.2	249.6	236.7	252.7
NYC	12.1	25.5	12.1	30.0
PNW	93.3	126.3	93.3	126.0
RMPA	117.5	128.0	117.2	127.9
SOU	409.5	512.1	431.8	720.1
SPPN	147.0	158.1	147.4	161.5
SPPS	201.2	231.2	204.0	242.3
TVA	286.2	312.0	290.1	400.3
UPNY	81.8	90.4	85.0	91.1
VACA	570.6	679.9	602.2	720.4
WUMS	110.0	138.3	111.4	143.2
National Total	6,670.4	7,807.0	7,001.0	9,121.3

Table A19 Fuel Cost by IPM Model Region (Million 1999\$)

Fuel Cost by Region	Base Case		CAIR Case	
	2009	2018	2009	2018
AZNM	2,231.5	2,884.8	2,296.0	2,912.2
CALI	3,804.4	5,249.7	3,883.0	5,266.9
DSNY	512.8	531.4	537.3	642.6
ECAO	5,452.7	6,207.7	5,346.3	5,844.2
ENTG	1,700.8	2,398.6	1,817.2	2,388.2
ERCT	4,950.1	5,835.0	5,121.9	5,812.3
FRCC	2,979.2	4,480.9	3,045.0	4,282.9
LILC	400.7	530.3	407.5	454.6
MACE	1,106.4	1,453.7	1,195.5	1,461.6
MACS	528.2	599.7	502.4	599.4
MACW	1,039.5	1,258.4	1,039.9	1,176.8
MANO	2,073.1	2,192.0	2,133.0	2,158.4
MAPP	1,560.0	1,666.6	1,561.8	1,676.2
MECS	1,070.6	1,322.5	1,075.2	1,434.1
NENG	1,868.1	2,291.3	1,915.8	2,297.8
NWPE	679.2	643.8	687.8	659.6
NYC	313.2	459.5	326.0	512.2
PNW	1,078.6	1,326.2	1,126.8	1,333.3
RMPA	429.3	596.2	426.8	595.4
SOU	3,933.6	5,195.6	4,146.3	5,399.1
SPPN	678.0	731.7	683.1	726.5
SPPS	1,908.5	2,197.0	1,952.0	2,287.2
TVA	1,633.0	1,868.4	1,675.8	1,972.9
UPNY	599.3	758.0	655.3	703.8
VACA	3,057.0	3,800.8	3,135.3	3,928.7
WUMS	625.4	748.5	632.9	732.9
National Total	46,213.0	57,228.2	47,325.9	57,259.8

Table A20 Capital Cost by IPM Model Region (Million 1999\$)

Capital Cost by Region	Base Case		CAIR Case	
	2009	2018	2009	2018
AZNM	0.0	114.8	0.0	114.8
CALI	375.3	1287.1	454.1	1290.4
DSNY	0.0	0.7	0.0	73.3
ECAO	97.2	226.9	505.9	1164.9
ENTG	3.3	4.4	10.3	36.7
ERCT	0.9	978.4	0.6	1029.3
FRCC	13.3	455.4	25.2	540.3
LILC	54.0	167.9	62.4	143.9
MACE	4.2	22.1	4.2	33.8
MACS	18.2	134.0	94.7	261.9
MACW	0.0	0.3	80.9	162.8
MANO	2.7	21.6	35.4	71.3
MAPP	52.9	52.9	52.9	68.7
MECS	0.0	212.4	0.0	237.9
NENG	76.3	160.0	87.3	163.9
NWPE	0.0	23.0	0.0	23.0
NYC	0.0	103.9	0.0	137.1
PNW	5.5	183.8	5.5	182.2
RMPA	0.0	0.0	0.0	0.0
SOU	4.6	412.9	55.5	770.0
SPPN	5.3	28.0	5.3	51.0
SPPS	0.0	142.9	12.2	171.8
TVA	0.0	10.4	11.8	135.2
UPNY	0.0	4.1	11.6	23.2
VACA	232.6	647.5	221.1	667.1
WUMS	10.3	138.8	10.2	149.8
National Total	956.6	5,534.2	1,747.2	7,704.1