Developing Southern Company Emissions and Flue Gas Characteristics for VISTAS Regional Haze Modeling

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http://www.southerncompany.com/
Outline

• Background & Objective
• Methodology: Emissions, Flue Gas Characteristics
  – 2002 Base Year
  – 2002 Typical Year
  – 2009, 2018 Future Years
• Emission Summary for Southern Company EGU’s
• Conclusion
Background

- VISTAS – Visibility Improvement State and Tribal Association of Southeast
- VISTAS is developing common set of emission inventories for regional haze regulatory process in southeast
  - 2002 Base Year
  - 2002 Typical Year
  - 2009, 2018 Projection Years
    - OTB (On-The-Books)
    - OTW (On-The-Way)/CAIR
- Emission inventories developed with input from states and stakeholders
- Southern Company provided hourly, unit specific emissions ($\text{SO}_2, \text{NO}_x, \text{CO}, \text{VOC}, \text{PM-FIL}, \text{NH}_3$) and flue gas characteristics (temperature and flow rate) for all its EGU’s for VISTAS emission scenarios in NIF v3.0 format
Objective

• Describe the methodology used to create Southern Company emissions and flue gas characteristics for VISTAS scenarios
  – Coal/Oil/Gas fired units
  – Units with and without CEMS
  – Generic future units for projection years

• Caveat:
  – VISTAS decided to use Southern Company developed emissions only for the following scenarios
    • Base year 2002, not including Southern Company units located in Georgia with CEMS
    • Typical year 2002
    • Future year 2009 and 2018 for Southern Company EGU’s located in Mississippi
Methodology - 2002 Base Year

- **2002 Net Generation (MWh)**
  - EGU, Hour Specific

- **Station Service EGU Specific**

- **2002 Gross Generation (MWh)**
  - EGU, Hour Specific

- **Heat Rate Equation EGU Specific**

- **Flue Gas Temperature, Flow Rate (Deg. F, ACFH) 50% & 100% EGU Specific Load**

- **If Gross MWh > 50% of Max load**
  - No
  - Flow @ 50% load Temp @ 50% load EGU, Hour Specific
  - Yes
  - Linear interpolation of Flow, Temp between 50% & 100% load EGU, Hour Specific

- **2002 Heat Input (MMBTU/hr)**
  - EGU, Hour Specific

- **2002 SO₂, NOₓ, VOC, CO, PM-FIL, NH₃ Emissions (lb/hr)**
  - EGU, Hour Specific

- **Monthly Averaged SO₂ & NOₓ rates**
  - CO, VOC, PM-FIL, NH₃ rates (lb/MMBTU) EGU Specific

- **2002 BASE YEAR**
  - EGU Specific NOₓ, SO₂, VOC, CO, NH₃, Emissions (Tons/hr)
  - EGU Specific Flue Gas Flow Rate (ACF/hr)
  - EGU Specific Flue Gas Temperature (Deg. F/hr)

- **NIF v 3.0 Identifiers**
  - EGU Specific
Methodology - 2002 Base Year

- 2002 net generation obtained from Energy Management Systems (EMS) database
- Station Service, Heat Rate Equation
  - Operational data and plant tests
- Emission Factors
  - NOx, SO2: Monthly Averaged CEMS data, Permit limits, AP-42 Factor Handbook
  - VOC, CO: Permit limits, AP-42 Factor
  - PM-FIL: Stack test, Permit limits, AP-42 Factor
  - NH₃: Ammonia slip at units operating an SCR
  - Emission rates checked for reasonableness
- Flue Gas Temperature and Flow rate
  - Equipment manufacturers specification
- This approach provides consistency across all Southern Company units with and without CEMS
- Eliminates biases associated with CEMS regulatory reporting requirements. May not be suitable for modeling.
Methodology -2002 Typical

PROSYM (2002 Energy Budget)
2002 Typical Net Generation (MWh)
Weekly Profile/Every Month

Station Service EGU Specific

2002 Typical Gross Generation (MWh)
EGU, Hour Specific

Flue Gas Temperature, Flow Rate
(Deg. F, ACFH)
50% & 100% EGU Specific Load

If Gross MWh > 50% of Max load

Flow @ 50% load
Temp @ 50% load
EGU, Hour Specific

Linear interpolation of Flow, Temp
between 50% & 100% load
EGU, Hour Specific

2002 Typical Heat Input (MMBTU/hr)
EGU, Hour Specific

2002 Typical Heat Input (MMBTU/hr)
EGU, Hour Specific

2002 Typical SO₂, NOₓ, VOC, CO,
PM-FIL, NH₃ Emissions (lb/hr)
EGU, Hour Specific

2002 Typical SO₂ & NOₓ rates
CO, VOC, PM-FIL, NH₃ rates
(lb/MMBTU)
EGU Specific

NIF v 3.0 Identifiers
EGU Specific

2002 Monthly Averaged
SO₂ & NOₓ rates
CO, VOC, PM-FIL, NH₃ rates
(lb/MMBTU)
EGU Specific

2002 Typical
EGU Specific NOₓ, SO₂, VOC, CO, NH₃, Emissions (Tons/hr)
TYPICAL YEAR
EGU Specific Flue Gas Flow Rate (ACF/hr)

EGU Specific Flue Gas Temperature (Deg. F/hr)
Methodology - 2002 Typical Year

• PROSYM: Chronological Production Modeling System
  – 2002 Energy Budget load forecasts, plant efficiency, off-system sale, and fuel costs
  – Weekly profile of Generation and Heat Input for each existing and planned “generic” units – Operation of an EGU at “Typical Conditions”
  – Forced outages (EFOR), Planned outages (PO) and retirements.
  – Obtained from System Planning

• Emission Factors
  – Same as in 2002 Base Year

• Flue Gas Temperature and Flow rate
  – Equipment manufacturer’s specification

• EFOR’s and PO’s are part of EGU’s “typical” operation and it would be unrealistic force “no outages” for an entire year in the PROSYM model.
Methodology - 2009 & 2018 Future Years

**PROSYM (2004 Energy Budget)**
- 2009 & 2018 Net Generation (MWh)
- Weekly Profile/Every Month

**Station Service**
- EGU Specific

**2009 & 2018**
- Gross Generation (MWh)
- EGU, Hour Specific

**If Gross MWh > 50% of Max load**

**Flow @ 50% load**
- Temp @ 50% load
- EGU, Hour Specific

**Linear interpolation of Flow, Temp between 50% & 100% load**
- EGU, Hour Specific

**2009 & 2018**
- Heat Input (MMBTU/hr)
- EGU, Hour Specific

**2009 & 2018**
- Heat Input (MMBTU)
- Weekly Profile/Every Month

**[OTB & CAIR]**
- SO₂ & NOₓ rates Seasonal/Year Around
- CO, VOC, PM-FIL, NH₃ rates
- (lb/MMBTU)
- EGU Specific

**2009 & 2018**
- EGU Specific NOₓ, SO₂, VOC, CO, NH₃, Emissions (Tons/hr)
- EGU Specific Flue Gas Flow Rate (ACF/hr)
- EGU Specific Flue Gas Temperature (Deg. F/hr)

**NIF v 3.0 Identifiers**
- EGU Specific

**Generic Unit Identifiers**

**2009 & 2018**
- Future Year [OTB, CAIR]

**Flow Input Temperature, Flow Rate**
- (Deg. F, ACFH)
- 50% & 100% EGU Specific Load

**No**

**Yes**

**Flow @ 50% load**
- Temp @ 50% load
- EGU, Hour Specific
Methodology - 2009 & 2018 Future Years

Contd.

• PROSYM: Chronological Production Modeling System
  – 2004 Energy Budget
  – Enforced outage (EFOR), Planned outage (PO) from 2002 Typical were applied to 2009 and 2018 projections to maintain consistency and remove operational discrepancies.

• Emission Factors
  – Southern Company compliance strategy (2003 version)
    • OTB & Anticipated controls to be in compliance with CAIR
  – Future generic unit emission rates based on existing similar units or latest equipment vendor specifications
  – Seasonal and year around controls considered

• Flue Gas Temperature and Flow rate
  – Equipment manufacturer’s specification

• Future generic units
  – Proximity to existing similar units, load centers of availability of transmission and fuel supply infrastructure
  – Unique identifiers used for easy incorporation in to the SMOKE model
Methodology: General

• QA/QC at every step
• Unit specific information used
• Consistent methodology used to generate 2002 Base Year, 2002 Typical and 2009 & 2018 OTB, OTW/CAIR
• Emissions and flue gas characteristics processed using perl scripts.
~ 70 % reduction in NOₓ from 2002 to the 2018 CAIR case
~ 75 % reduction in SO2 from 2002 to the 2018 CAIR case
Southern Company CO & VOC Emissions

CO, VOC (Tons/Year)

Scenarios

Southern Company PM-FIL & NH$_3$ Emissions

PM-FIL, NH$_3$ (Tons/Year)

Scenarios:
- 2002 CEMS
- 2002 BASE
- 2002 TYPICAL
- 2009 OTB (CAIR)
- 2009 OTW (CAIR)
- 2018 OTB
- 2018 OTW (CAIR)
Conclusion

• Hourly unit specific emissions and flue gas characteristics developed for all Southern Company EGU’s under VISTAS scenarios.

• Consistent and realistic methodology used across the VISTAS scenarios incorporating
  – EGU specific data: Emission factors, Operational, Stack test
  – Region specific energy forecast (It’s our business, areas we know the best)

• Such consistency in emission development methodology is highly desired when air quality modeling results are used in a relative sense
Thanks!

Questions?