EPA's Control Strategy Tool (CoST)

David Misenheimer, US EPA
Larry Sorrels, US EPA
Darryl Weatherhead, US EPA

June 2010

This Presentation Covers:

- Overview of EPA's Control Strategy Tool (CoST)

Overview - Origin of CoST

- CoST was developed by:

  Air Benefit and Cost Group (ABCG)
  Health and Environmental Impacts Division (HEID)
  Office of Air Quality Planning and Standards (OAQPS)
  EPA's Office of Air and Radiation (OAR)

- CoST replaces AirControlNET
  - Both systems were designed to support the assessment of emissions reductions and engineering costs for control strategies
  - However, CoST is designed with increased transparency, flexibility, and extensibility over the older system

Some Inventory Terminology

- Base Year Inventory
  - An emissions inventory for the current year or a recent year which relies largely on reported actual emissions
- Future Year Base Case Inventory
  - An emissions inventory for a future year that includes emission projections based on forecasts of growth, impacts of rules and regulations that are final but that will be implemented over time, planned plant closures, etc. (a 'business as usual' future case)
- Future Year Control Case Inventory
  - Future year base case inventory with additional controls applied. Such inventories are projections of what is possible in order to meet the requirements of new air quality rules or regulations.

What does CoST do?

- Developed for performing large-scale national or regional level analyses - primarily Regulatory Impact Analyses (RIAs) for National Ambient Air Quality Standards (NAAQS)
- Supports preparation and analysis of future year criteria pollutant emissions control strategies for point, non-point, mobile sources

- Uses the National Emissions Inventory, projected to future yr
- Reports on emissions reductions and costs associated with:
  - target pollutant (e.g., NOx or VOC for Ozone NAAQS analyses)
  - co-impacts of the selected control measures on other criteria pollutants

What does CoST do (cntd.)?

- Calculates annual costs of the control measures for a control strategy:
  - For point sources – uses cost equations when sufficient data are available, otherwise relies on less refined cost per ton of reduction estimates
  - For mobile sources – relies on cost per ton of reduction estimates
  - For non-point sources – relies on cost per ton of reduction estimates
- CoST was NOT designed for local-scale source by source analyses, although input data, not the software, is the primary limiting factor
- Does NOT currently include control measure information for HAPs and GHGs

What questions are we trying to answer with CoST?

- Example Goal: reduce NOx emissions in 2020 for the Southeast by 100,000 tons/yr
- Use CoST to answer control questions for criteria air pollutants (CAPs) like:
  - What is the **maximum emissions reduction** achievable for NOx and what set of controls will achieve this reduction? (i.e., is my goal < maximum?)
  - What set of control measures can achieve the emissions reduction goal at the **least cost**?
  - What does the **cost curve** look like for other levels of reduction?

Questions CoST Can Answer (cntd.)

- What **emissions reductions** for the target pollutant would be achieved?
- What are the emissions reductions **or increases** for **other pollutants** of interest?
- What are the **engineering costs** of applying the controls for a specific strategy?
- What **control measures** are available for specific source categories and pollutants; how much reduction do they provide and for what cost?
- Future goal: What is the optimum method for achieving simultaneous reductions of **multiple pollutants** (e.g., PM and toxics)?

Control Strategies

- In CoST, Control Strategies are set up and run to help answer the questions posed above
- Running a control strategy causes control measures to be assigned to emissions sources via an algorithm (e.g., least cost)
- Estimates of the resulting emissions reductions (and/or increases) and costs are provided

CoST Control Measures Database (CMDB)

- The CMDB and emission inventories are the two major input data sets for CoST
- CMDB contains information about control measures, their control efficiencies, engineering costs, and the emission sources to which they apply
- Was initially populated with data from AirControlNET, but there are some additions
- Currently the CMDB has data for the criteria pollutants (PM, VOC, NOx, SO2)
- We will add control information for HAPs and GHGs in the future, as resources allow and as data are available
- Control efficiencies and costs can vary by pollutant, state and/or county, source size, and year

Data Stored for each Control Measure

Control Measure: A technology or program that reduces emissions
The CMDB: A set of related tables of control measure data

Summary Info – Describes each control measure (SCR, LNB, etc)

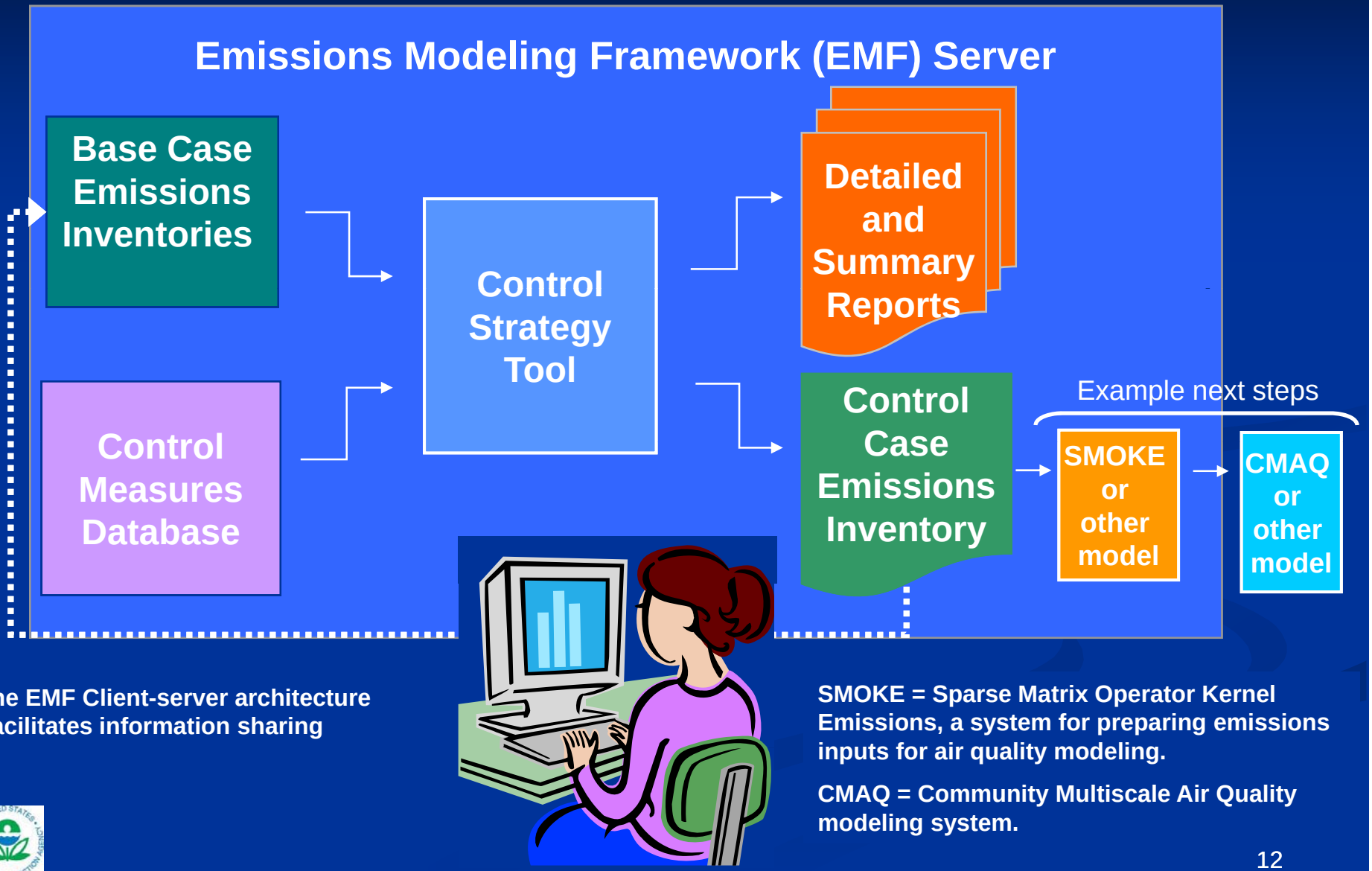
Control Efficiency & Cost Info – Varies by pollutant

Source Category Codes – Links to the inventory

Cost Equations – Compute capital and O&M costs

References – Sources of information for measures

CoST is a Client-Server System



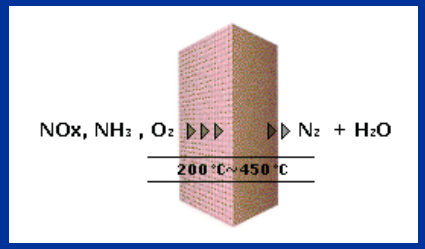
The EMF Client-server architecture facilitates information sharing

SMOKE = Sparse Matrix Operator Kernel Emissions, a system for preparing emissions inputs for air quality modeling.

CMAQ = Community Multiscale Air Quality modeling system.

Example Control Measure Application

Industrial Boiler



SCR

Plant:	International Paper
Industry:	Pulp & Paper Mill
SCC:	Indust. Boiler - Bit/Subbit Pulv Coal Dry Bottom
Pollutant:	NOx (177 tons/yr)
Control:	Selective Catalytic Redxn
CE:	75%
CPTon:	$1,319
Reduction:	133 tons/yr (.75 x 177)
Final Emis:	44 tons/yr (177 - 133)
Cost:	$175,000 (133 x 1,319)

Creation of a Control Strategy

What emissions does this produce and what measures are available to control them???

Creation of a Control Strategy

- Strategies assign measures to sources
  - Inventories are selected
  - Available measures for heavy duty trucks:

    - Truck Stop Electrification
    - Diesel Retrofits (selective catalytic reduction)
    - Engine Rebuilds

  - One or more measures can be applied to the inventory sources for HD trucks
  - Measure assignments can vary geographically
  - The cost of measure application is computed for a specified cost year, and emissions reductions

Key Steps for Running a Control Strategy

1) Input Basic Parameters (e.g.):
- Name
- Cost Year for results
- Target Pollutant

2) Select Strategy Algorithm (e.g.):
- Max Emissions Reduction
- Least Cost
- Least Cost Curve

3) Select Inventory Dataset(s):
- Sectors (ptipm, ptnonipm, nonpt, onroad, nonroad)
- Filters for specific SCCs, geographic areas, etc.

4) Select Control Measures:
- Default is to include known measures
- Can select specific technologies

5) Select Constraints (e.g.):
- Max cost/ton controls (e.g., $20K/ton)
- Min emissions reduction (e.g., 10 tpy)

6) Run Strategy Query

Outputs:

- **Detailed Pairing of Measures to Sources**
- **Control Case Emissions Inventory**
- **Summaries (Automatic and On-Demand)**

Primary Strategy Algorithms to Assign Measures to Sources

- Maximum Emissions Reduction
  - For each source, finds the single measure that results in the maximum possible reduction of the target pollutant regardless of cost
- Least Cost
  - Determines the minimum annual cost way to achieve a specified reduction of the target pollutant (e.g., 100,000 tpy) using one measure per source
- Least Cost Curve
  - Runs least annual cost analysis for a series of reductions
- Apply Measures in Series
  - Applies independent measures in the specified order (e.g., I&M, commuter progs, retrofits)

Other Algorithms

- Annotate Inventory
  - Tries to find measures that provide the control efficiencies specified in the base year inventory
  - Can help identify holes in the CMDB or unrealistic levels of control in the inventory
- Project Future Year Inventory
  - Constructs the future year base case inventory from the base year inventory and a set of control programs (e.g., plant closures, growth projections, planned controls)
  - Notes in the inventory which measures would best achieve the targeted levels of control

Properties of Algorithms

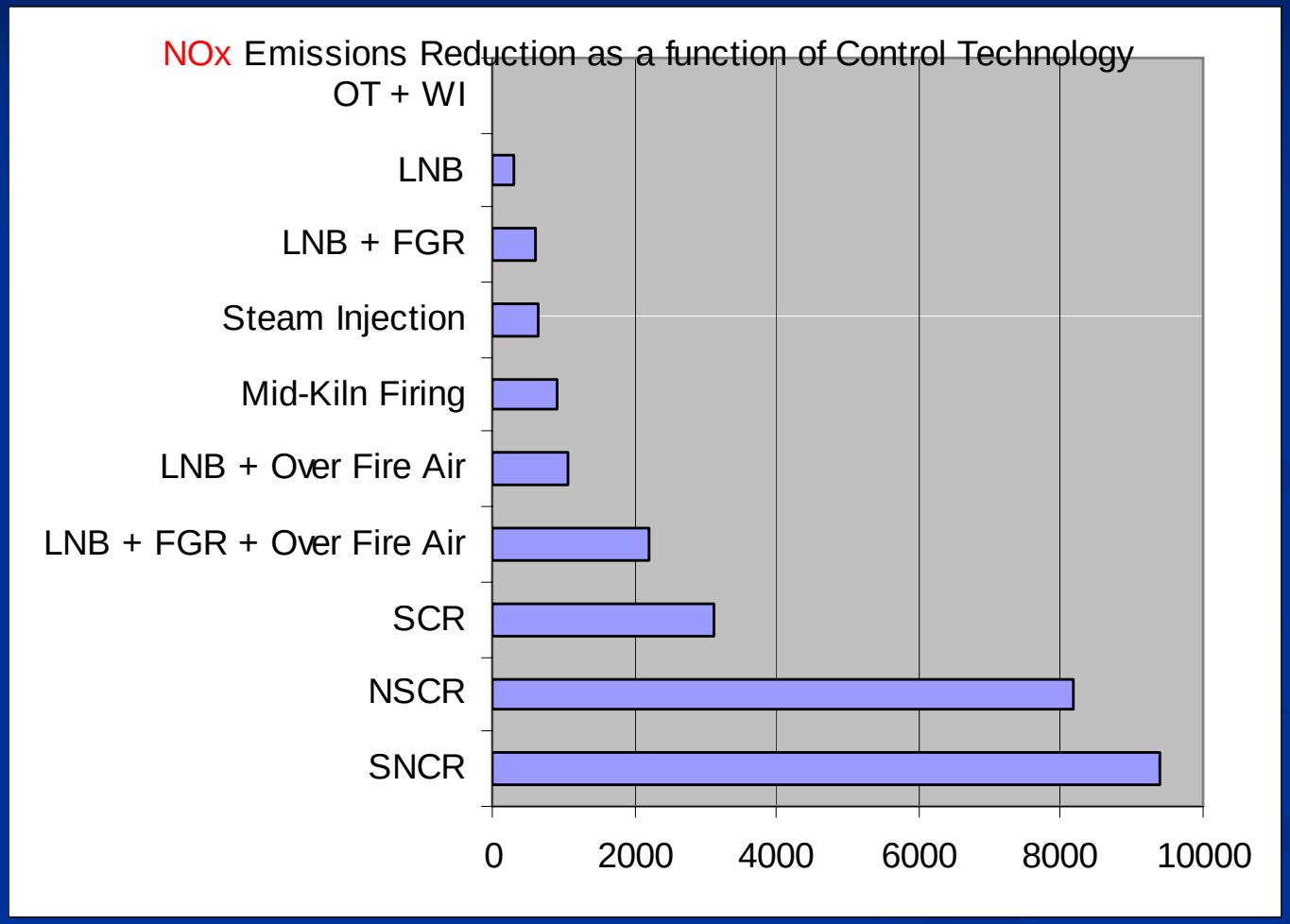
- All algorithms assign one measure for each source in each run except Apply Measures in Series
- Typically, Maximum Emissions Reduction and Least Cost are applied to point and non-point sources, while Apply Measures in Series is applied to mobile sources

Strategy Type	Multiple Inventories	Typical Sectors	Measure Assignment	Outputs
Maximum Emissions Reduction	Processed independently	nonpt, ptnonipm	One per source	Standard
Apply Measures in Series	Processed independently	onroad, nonroad	Multiple per source	Standard
Least Cost	Can be merged	nonpt, ptnonipm	One per source	Standard, Least Cost Control Measure Worksheet
Least Cost Curve	Can be merged	nonpt, ptnonipm	One per source	Standard, Least Cost Control Measure Worksheet, Least Cost Curve Summary
Annotate Inventory	Processed independently	nonpt, ptnonipm	One per source	Standard
Project Future Year Inventory	Processed independently	Any	One per source	Standard

Analyzing CoST Outputs

- CoST provides support for sorting, filtering, and summarizing outputs, and for creating some types of plots
- Output datasets can be exported to CSV files for use by spreadsheet and database software programs
- Summaries of the outputs can be exported to CSV files, Shapefiles for use in GIS/mapping tools, and .kmz files for use with Google Earth

Plot of a Summary by Control Technology



OT = Oxygen Trim

WI = Water Injection

LNB = Low NOx Burner

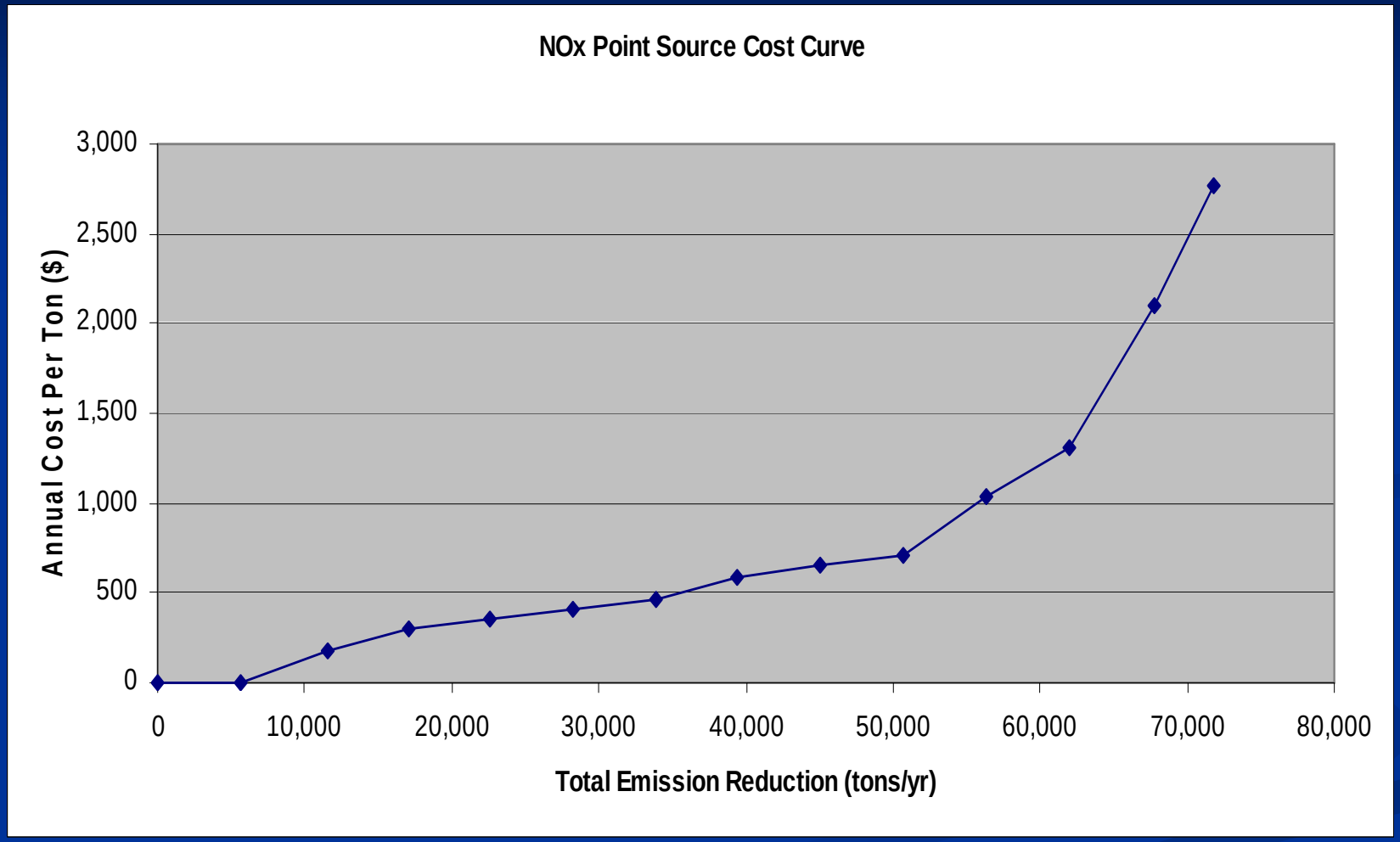
FGR = Flue Gas Recirc.

SCR = Selective Catalytic Reduction

NSCR = Nonselective Catalytic Reduction

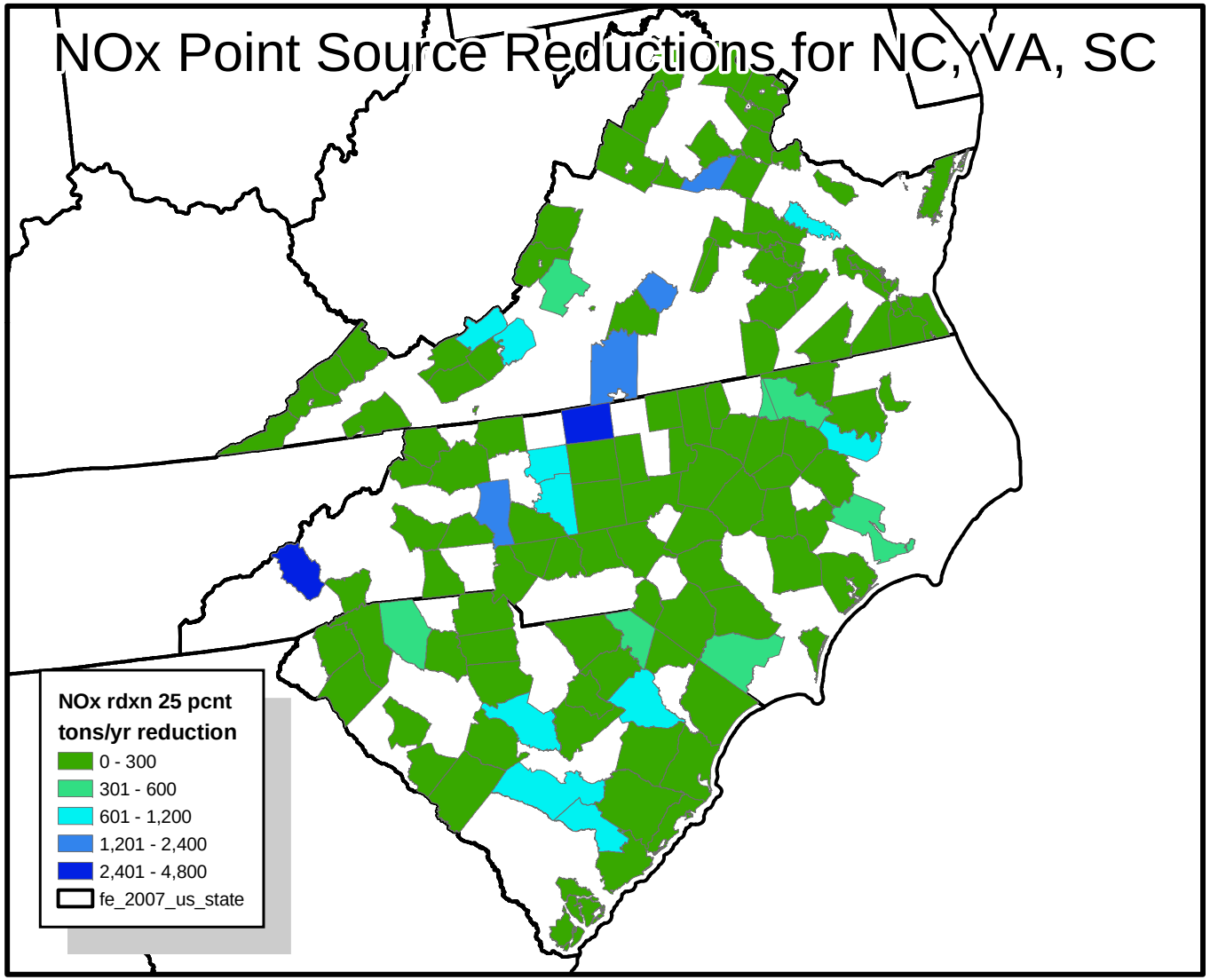
SNCR = Selective Noncatalytic Reduction

CoST per Ton Cost Curve

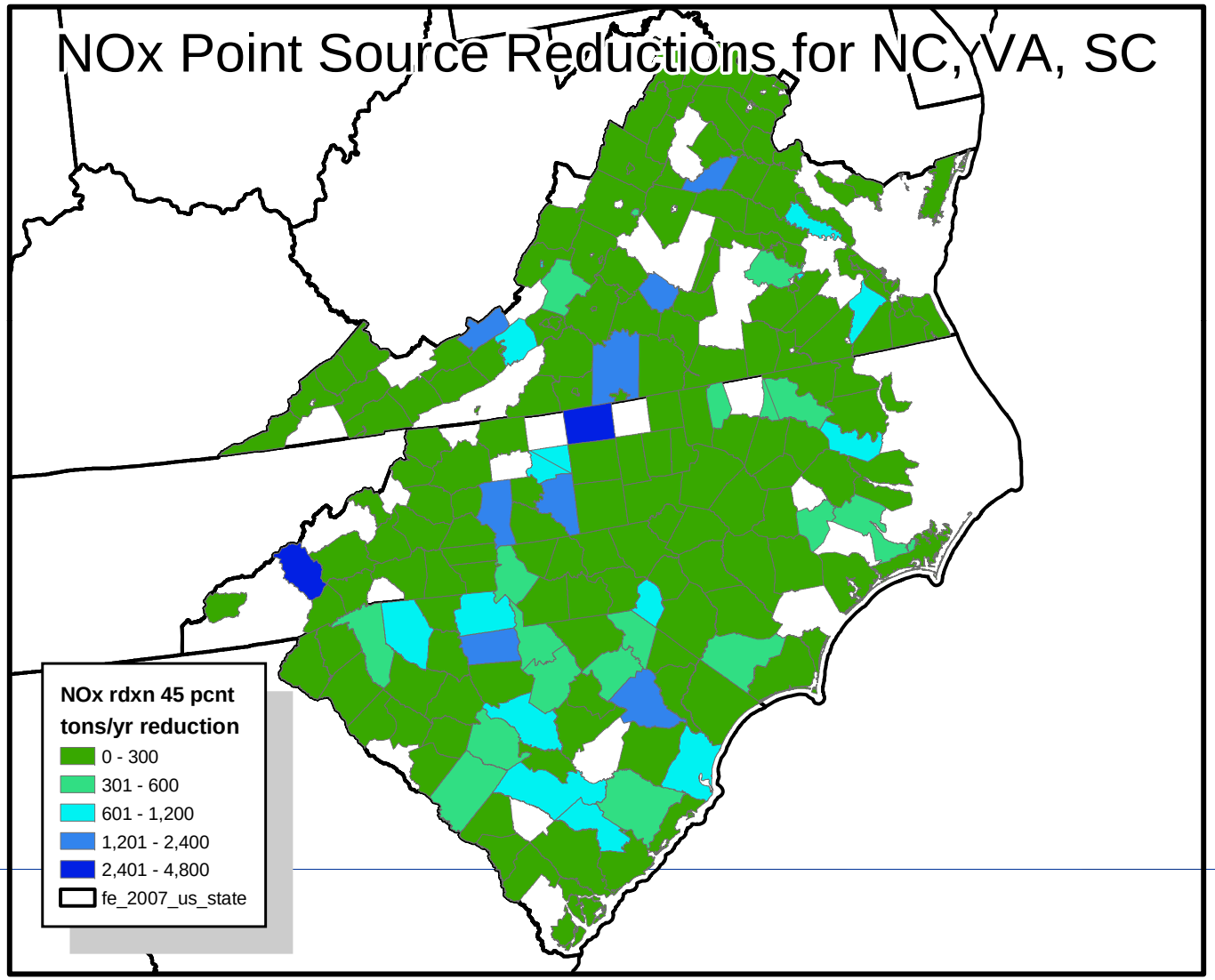


*** Data generated by CoST, but plotted with Excel**

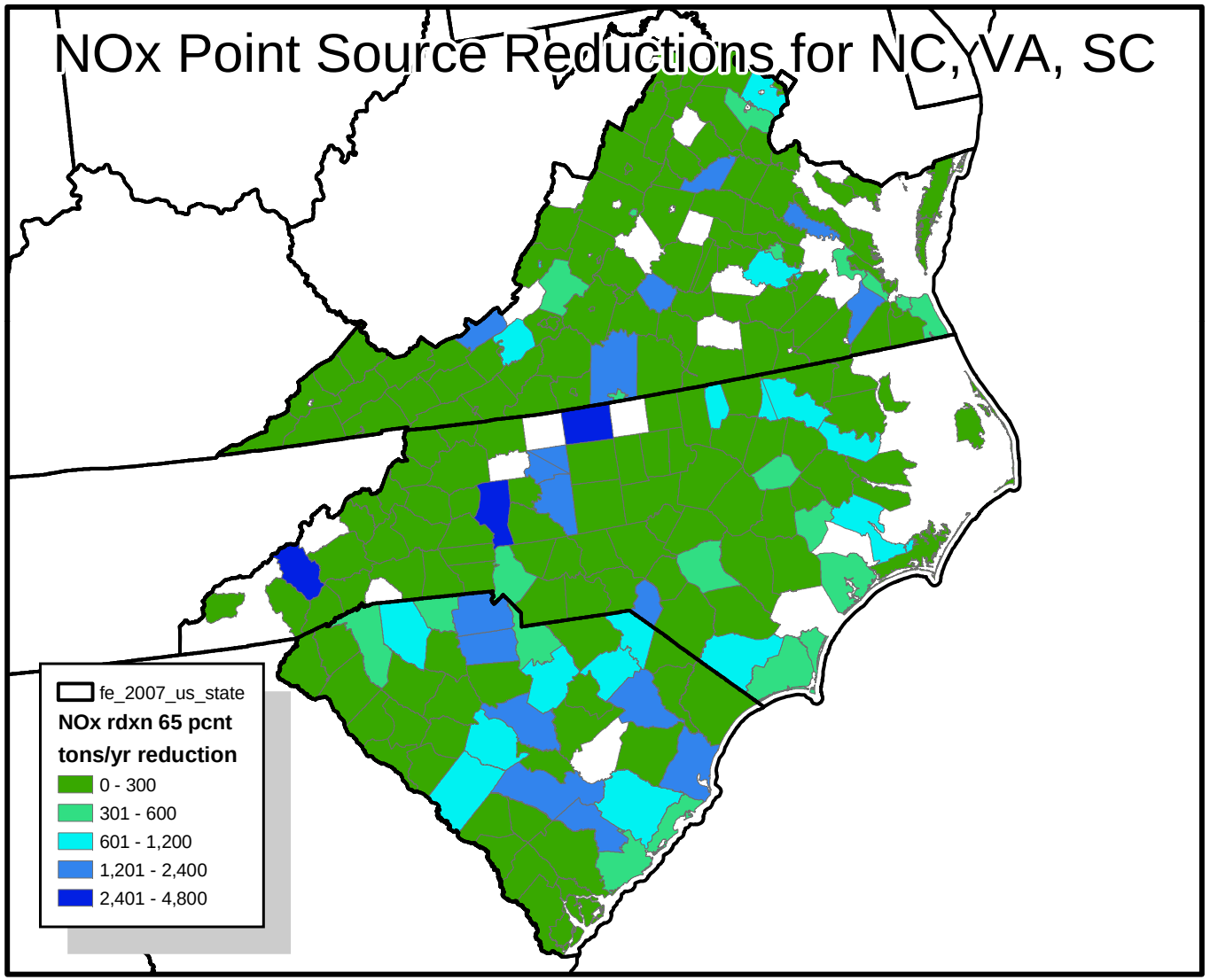
CoST Outputs: Least Cost Control Strategy with Goal of 25% Reduction of NOx

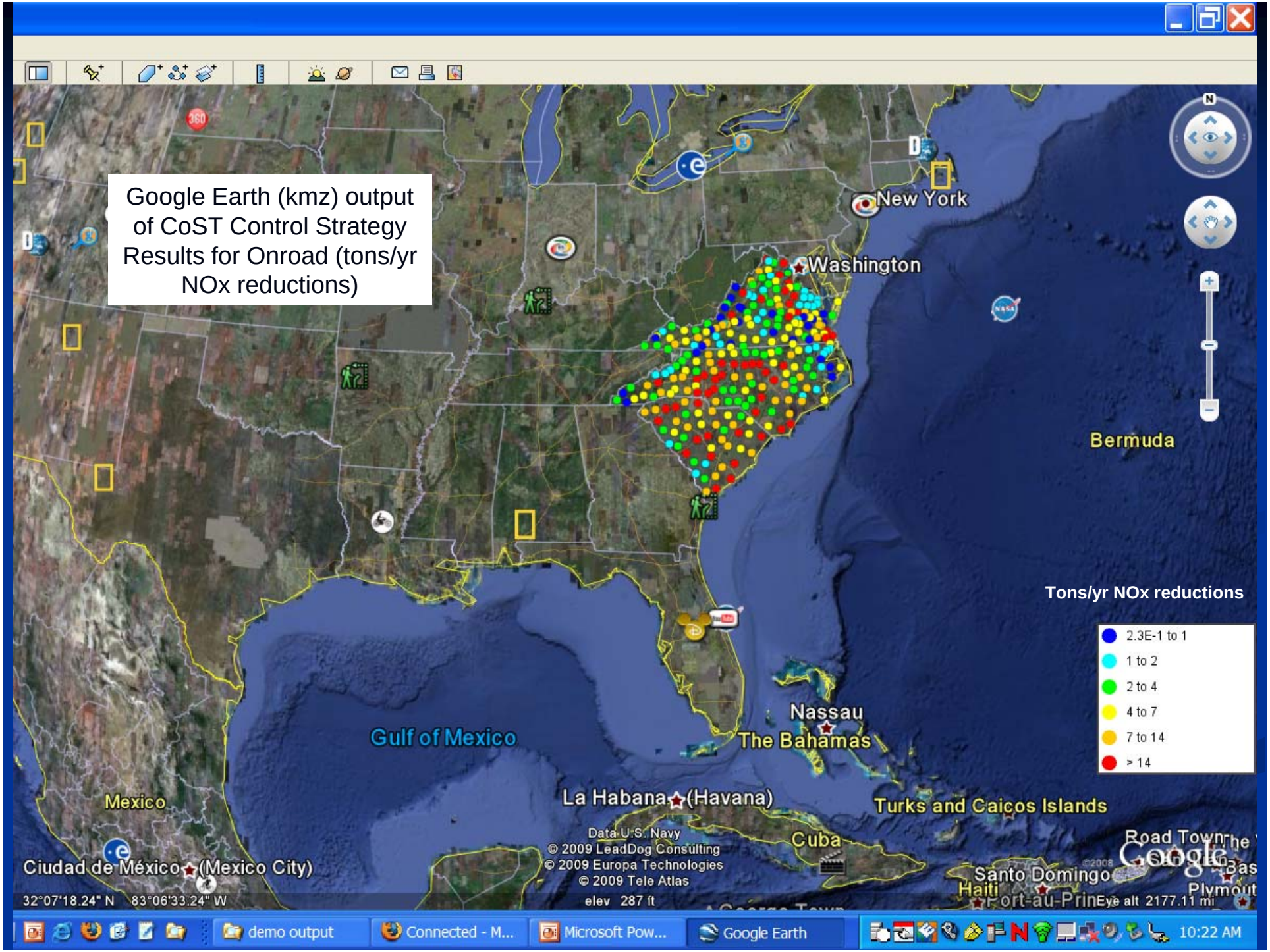


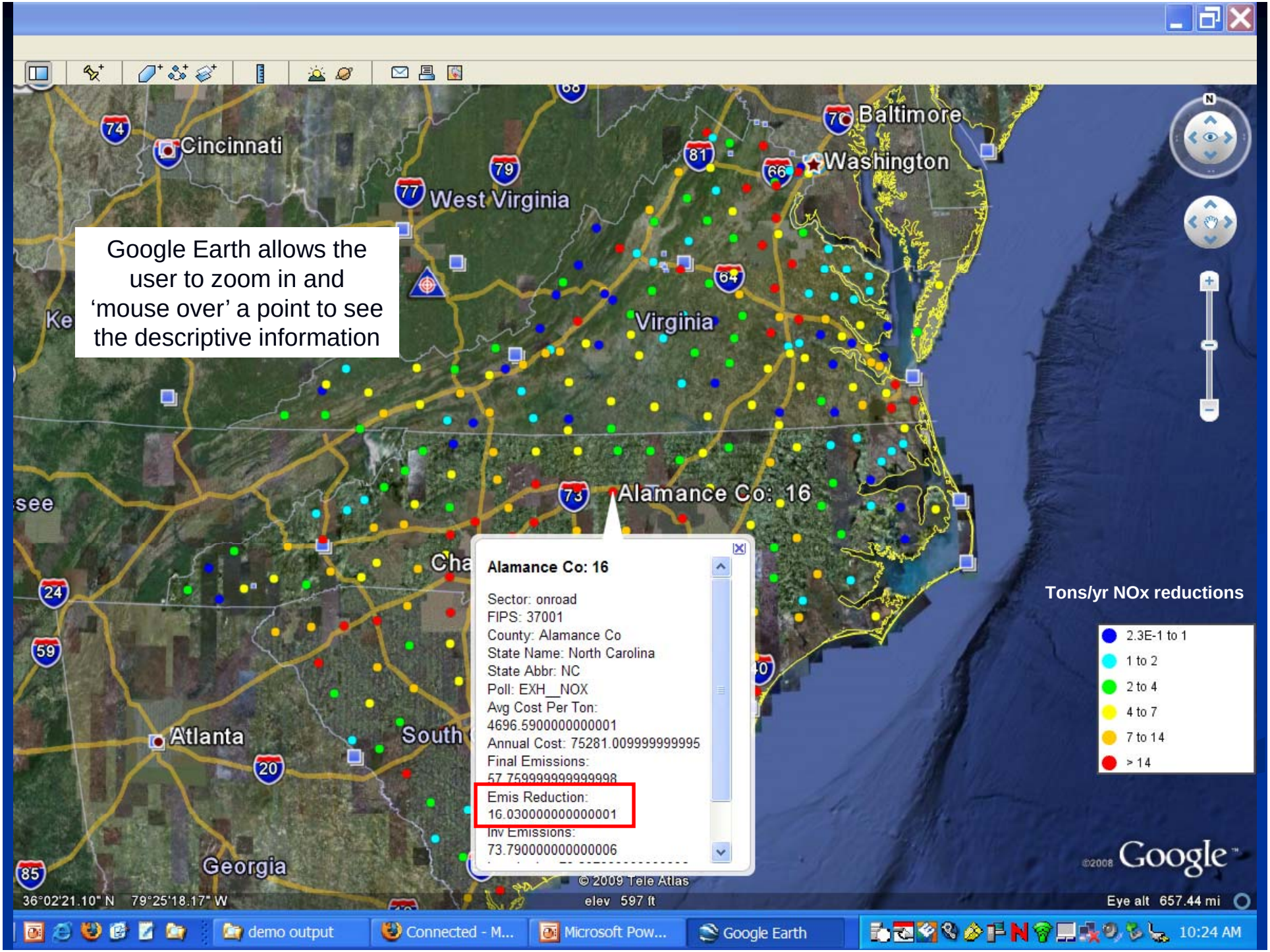
CoST Outputs: Least Cost Control Strategy with Goal of 45% Reduction of NOx



CoST Outputs: Least Cost Control Strategy with Goal of 65% Reduction of NOx




Google Earth (kmz) output of CoST Control Strategy Results for Onroad (tons/yr NOx reductions)
New York
Washington
Bermuda
Tons/yr NOx reductions
2.3E-1 to 1
1 to 2
2 to 4
4 to 7
7 to 14
> 14
Nassau
The Bahamas
Gulf of Mexico
Mexico
La Habana (Havana)
Turks and Caicos Islands
Cuba
Haiti
Santo Domingo
Ciudad de México (Mexico City)
Data U.S. Navy
© 2009 LeadDog Consulting
© 2009 Europa Technologies
© 2009 Tele Atlas
elev 287 ft
32°07'18.24" N 83°06'33.24" W
Eye alt 2177.11 mi
demo output
Connected - M...
Microsoft Pow...
Google Earth
10:22 AM


Google Earth allows the user to zoom in and 'mouse over' a point to see the descriptive information
Cincinnati
West Virginia
Baltimore
Washington
Virginia
Alamance Co: 16
Alamance Co: 16
Sector: onroad
FIPS: 37001
County: Alamance Co
State Name: North Carolina
State Abbr: NC
Poll: EXH__NOX
Avg Cost Per Ton:
4696.5900000000001
Annual Cost: 75281.009999999995
Final Emissions:
57.759999999999998
Emis Reduction:
16.030000000000001
Inv Emissions:
73.790000000000006
Atlanta
Georgia
Tons/yr NOx reductions
2.3E-1 to 1
1 to 2
2 to 4
4 to 7
7 to 14
> 14
© 2009 Tele Atlas
©2008 Google
36°02'21.10" N 79°25'18.17" W
elev 597 ft
Eye alt 657.44 mi
demo output
Connected - M...
Microsoft Pow...
Google Earth
10:24 AM

CoST Team

- David Misenheimer
- Darryl Weatherhead
- Larry Sorrels
- Alison Eyth
- Julia Gamas

Office of Air Quality Planning and Standards
US EPA, RTP, NC

- CoST was developed with support from the UNC Institute for the Environment