Recent Applications of the Control Strategy Tool (CoST) within the Emissions Modeling Framework

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Purpose of CoST

- Support the preparation and analysis of future year emission control strategies for point, area, and mobile sources
- Track information on control measures, their costs, and the emission sources to which they apply
- Facilitate multi-pollutant analyses, including criteria pollutants, HAPs, and greenhouse gases
- *Goal of this talk is to orient you to the software while discussing the recent applications*

CoST within the EMF Client-Server System

EMF Server runs the Control Strategies

NEI Data Grown by SMOKE

1

Emissions Modeling Framework Database

Future Yr. Base Emission Inventories

x

Control Measure Data

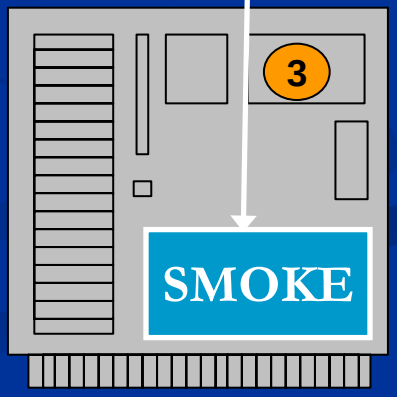
=

Future Yr. Control Case Inventories

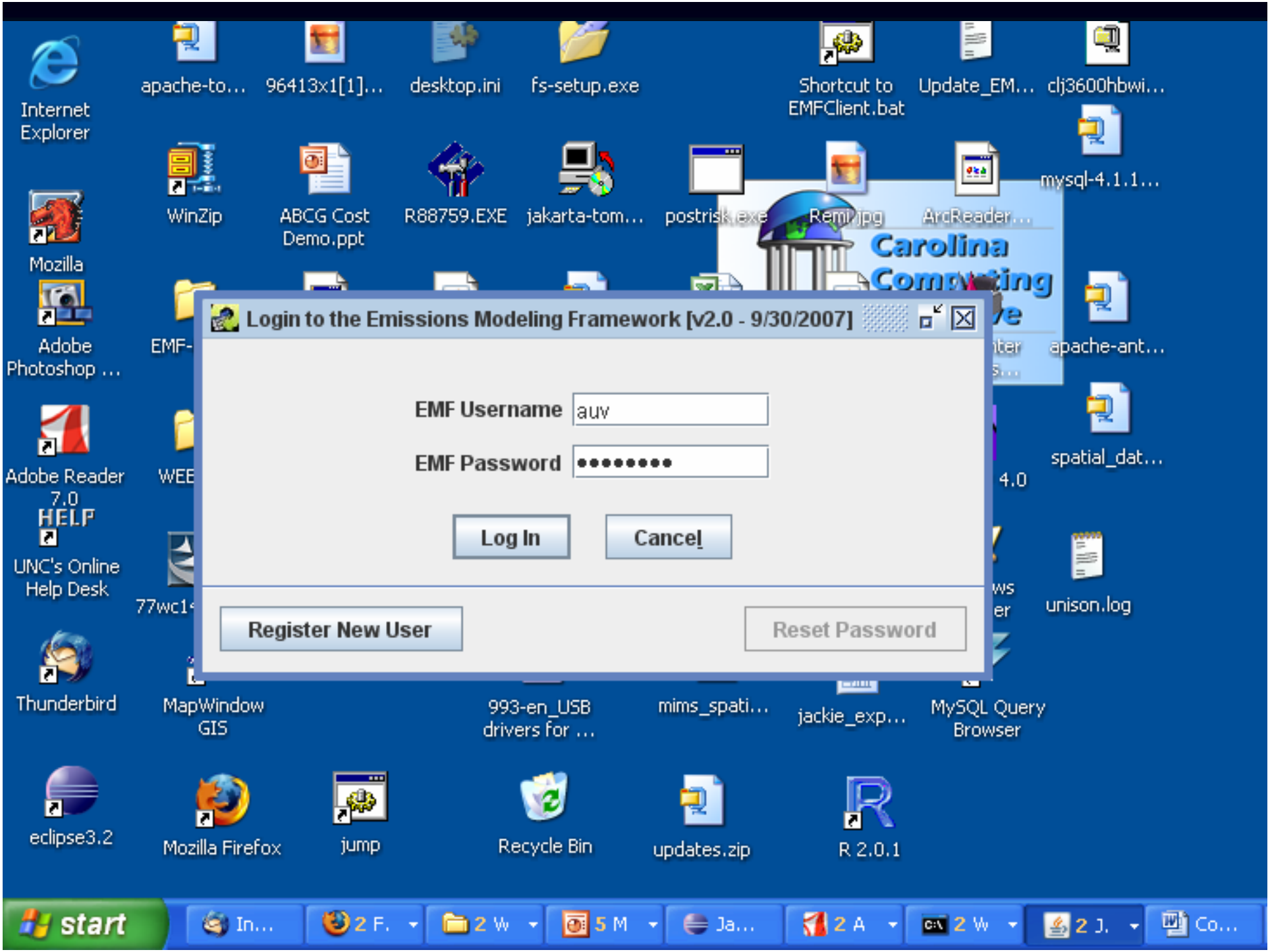
2

PC Clients

1. **Import inventories into the EMF**
2. **Create and run a Control Strategy**
3. **Export the controlled inventories for input to SMOKE**



Compute Cluster


Internet Explorer
apache-to...
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desktop.ini
fs-setup.exe
Shortcut to EMFClient.bat
Update_EM...
clj3600hbwi...
mysql-4.1.1...
WinZip
ABCG Cost Demo.ppt
R88759.EXE
jakarta-tom...
postrisk.exe
Remi.jpg
ArcReader...
Mozilla
Adobe Photoshop ...
EMF-
apache-ant...
Adobe Reader 7.0
WEE
spatial_dat...
4.0
HELP
UNC's Online Help Desk
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unison.log
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MySQL Query Browser
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Mozilla Firefox
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Login to the Emissions Modeling Framework [v2.0 - 9/30/2007]
EMF Username
auv
EMF Password
Log In
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Register New User
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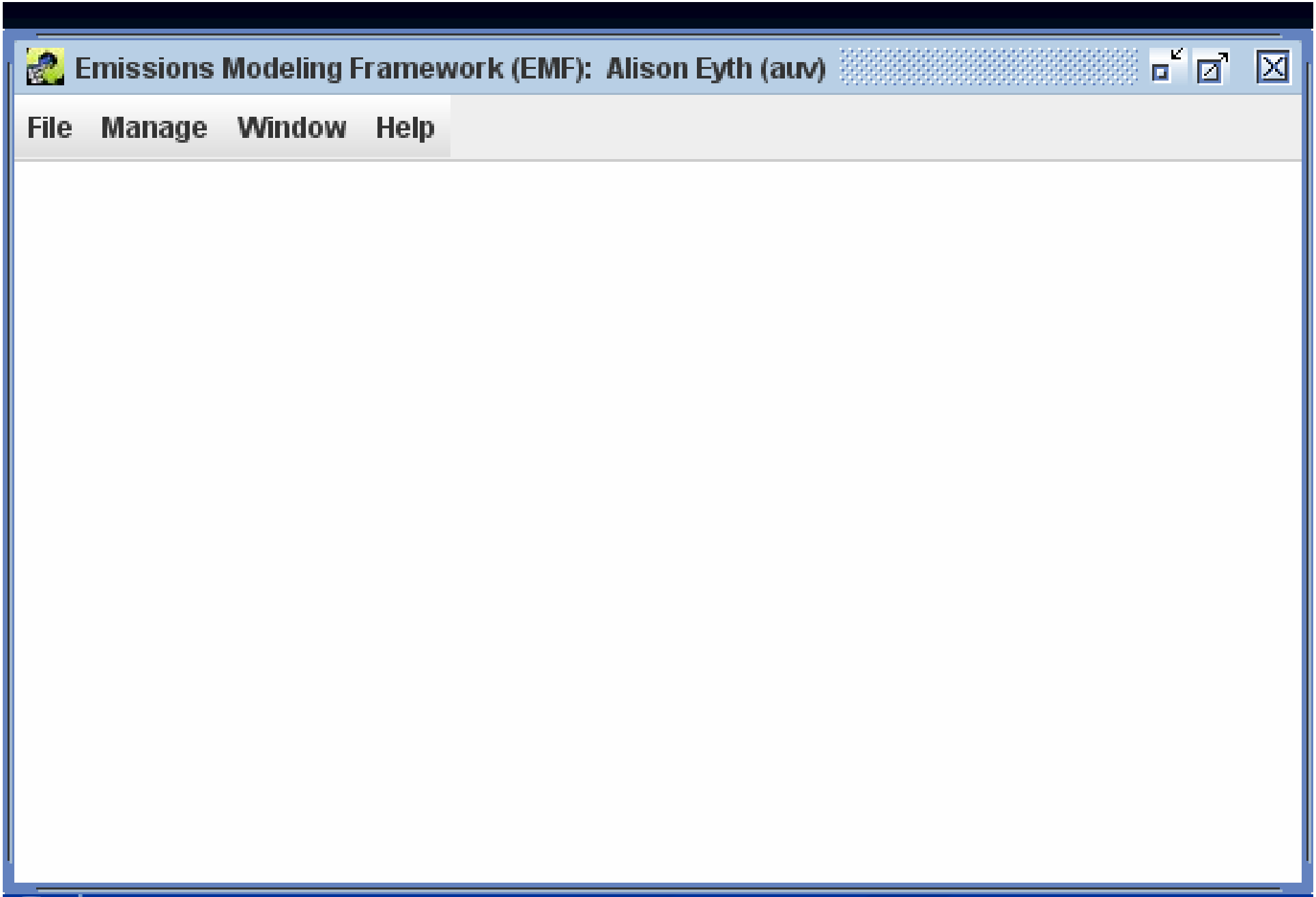
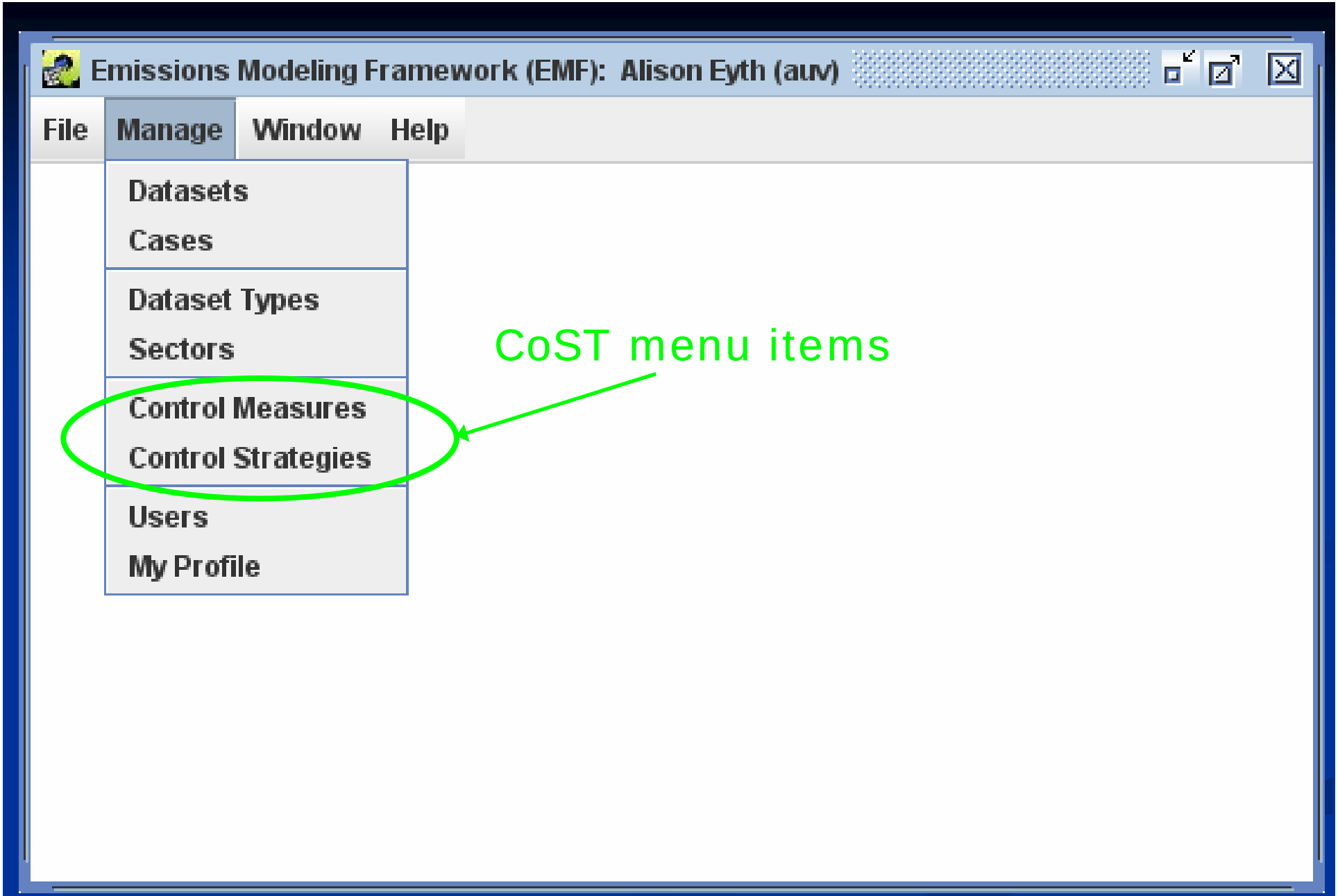
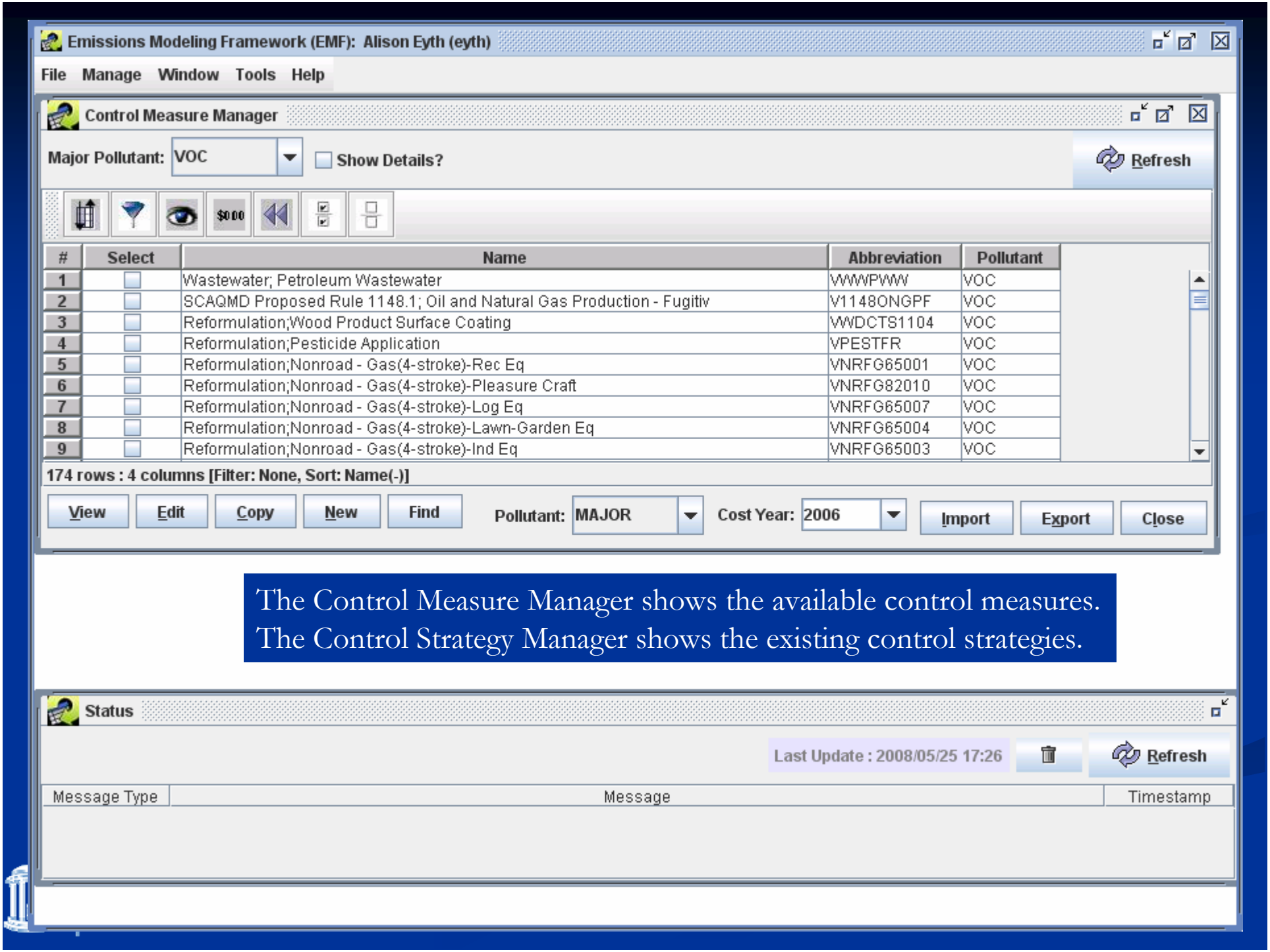

Emissions Modeling Framework (EMF): Alison Eyth (auv)
File
Manage
Window
Help


Emissions Modeling Framework (EMF): Alison Eyth (auv)
File
Manage
Window
Help
Datasets
Cases
Dataset Types
Sectors
Control Measures
Control Strategies
Users
My Profile
CoST menu items



The Control Measure Manager shows the available control measures. The Control Strategy Manager shows the existing control strategies.

Mobile Source Analysis for Ozone NAAQS RIA

- CoST reproduced results of an independent analysis
- Different than previous analyses because multiple measures were to be applied to the same source in a specified order
  - order of application impacts estimated costs, but not reductions
- Developed a new strategy analysis type to support this project
  - "Apply Measures in Series": applies all measures that are applicable to each source based on its SCC

Onroad Mobile Measures Used

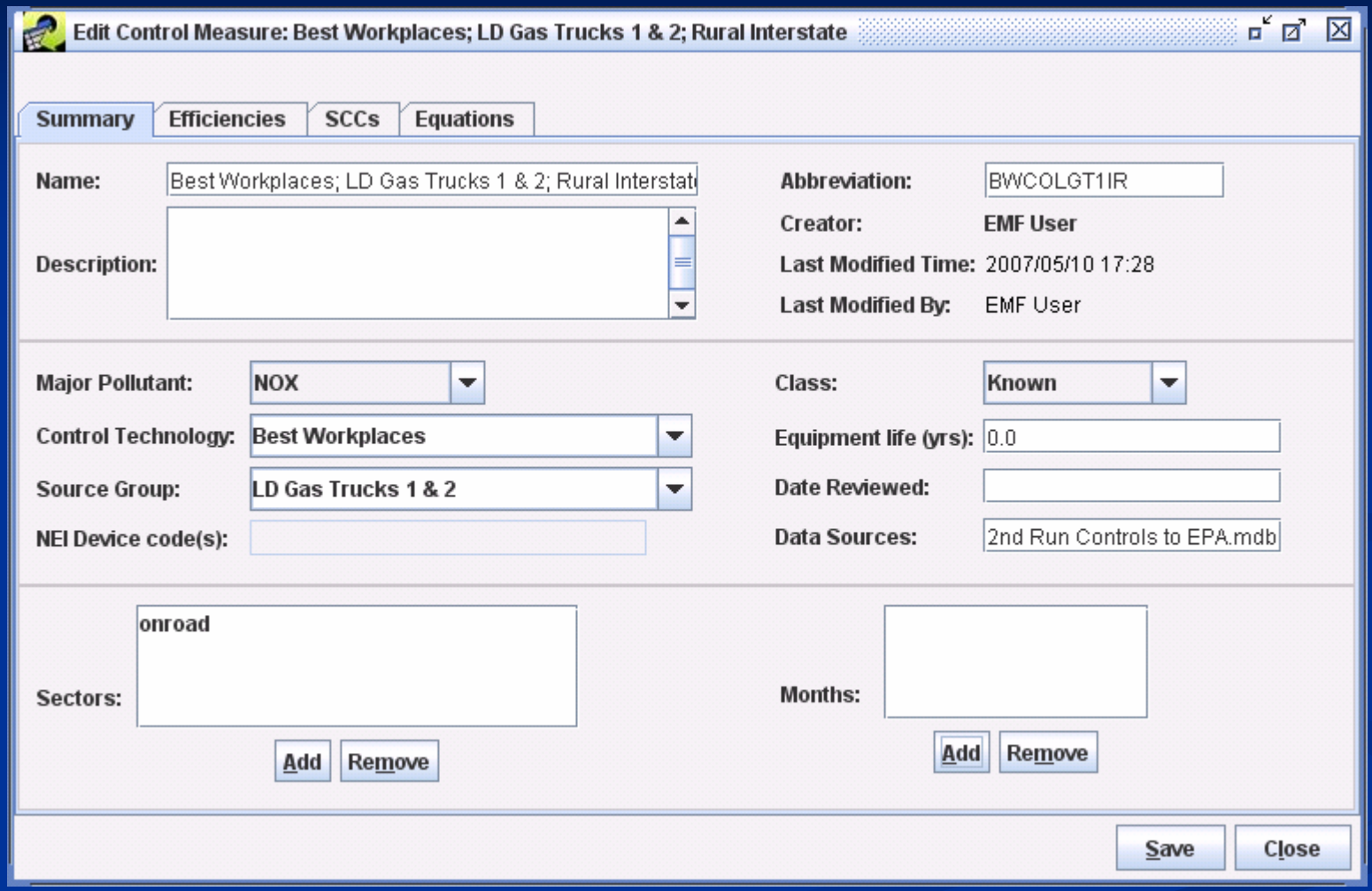
- Plug-In Hybrids
- Aftermarket Catalyst
- Eliminate Long Duration Idling
- Lower Reed Vapor Pressure (RVP)
- Onroad Scrappage and Retrofit
- Continuous Inspection and Maintenance Programs
- Best Workplaces for Commuters
- Tier 3 Standard

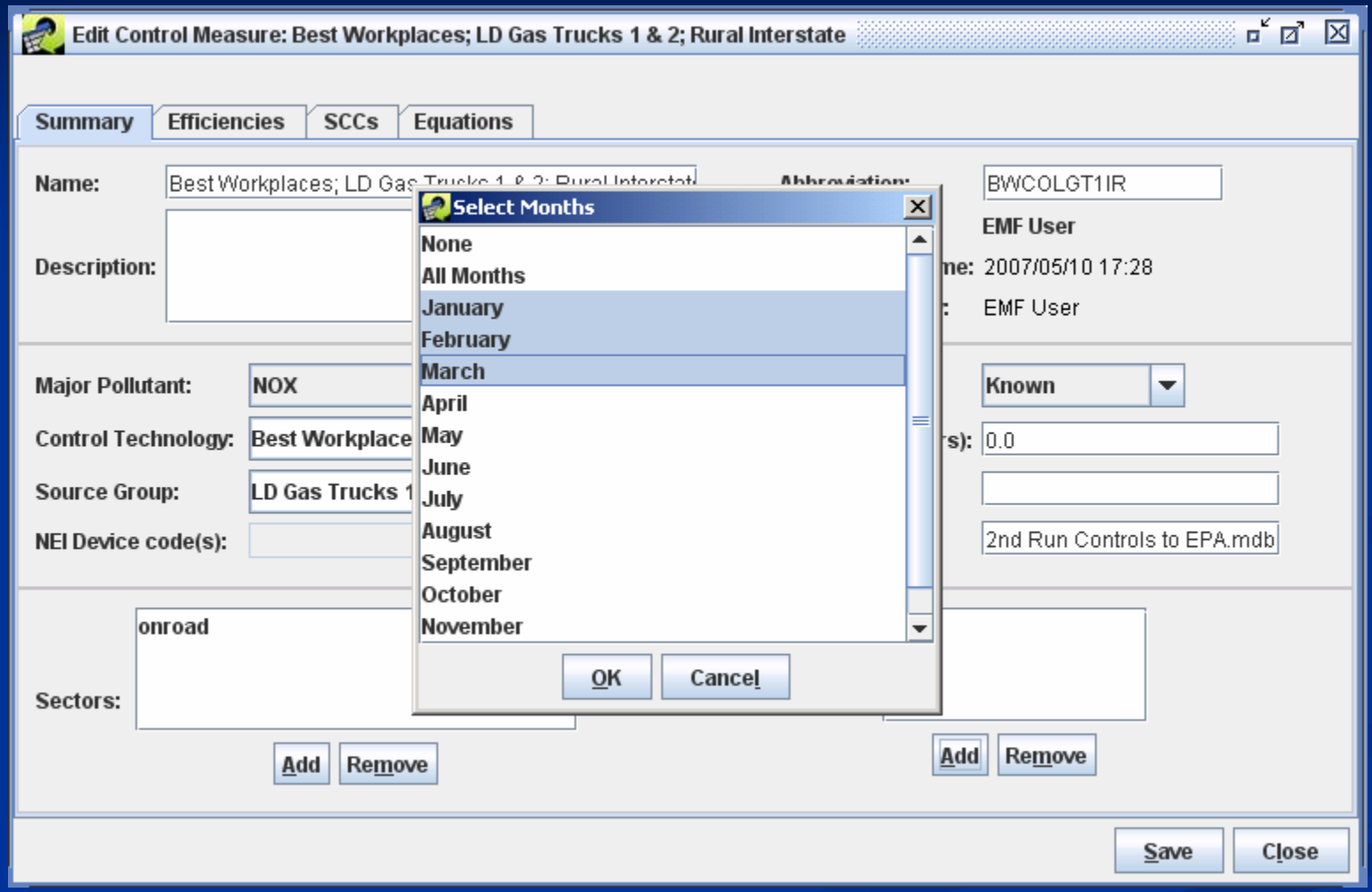
Example Nonroad Mobile Measures Used

- Lower RVP
- Bond Rule (CA and non-CA)
- Nonroad Retrofits
- Diesel Marine National Rule
- Ocean Going Vessel Standards
- Commercial Aircraft Standards
- Diesel Locomotive Standards

Control Measure Characteristics

- Measures had particular months to which they apply to emulate seasonal variations in effectiveness
- When measures affected multiple pollutants, cobenefit reductions were specified
- Costs were sometimes distributed across multiple pollutants
- County and SCC-specific measures meant large data volume:
  - Over 500,000 records each for onroad and nonroad measures
  - Inventories for each month were approx. 2 million records (onroad) and 3 million records (nonroad) and used average day values


Edit Control Measure: Best Workplaces; LD Gas Trucks 1 & 2; Rural Interstate
Summary
Efficiencies
SCCs
Equations
Name:
Best Workplaces; LD Gas Trucks 1 & 2; Rural Interstat
Abbreviation:
BWCOLGT1IR
Description:
Creator:
EMF User
Last Modified Time:
2007/05/10 17:28
Last Modified By:
EMF User
Major Pollutant:
NOX
Class:
Known
Control Technology:
Best Workplaces
Equipment life (yrs):
0.0
Source Group:
LD Gas Trucks 1 & 2
Date Reviewed:
NEI Device code(s):
Data Sources:
2nd Run Controls to EPA.mdb
Sectors:
onroad
Months:
Add
Remove
Add
Remove
Save
Close


Edit Control Measure: Best Workplaces; LD Gas Trucks 1 & 2; Rural Interstate
Summary
Efficiencies
SCCs
Equations
Name:
Best Workplaces; LD Gas Trucks 1 & 2; Rural Interstat
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EMF User
Major Pollutant:
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Control Technology:
Best Workplace
s):
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Source Group:
LD Gas Trucks 1
NEI Device code(s):
2nd Run Controls to EPA.mdb
Sectors:
onroad
Add
Remove
Add
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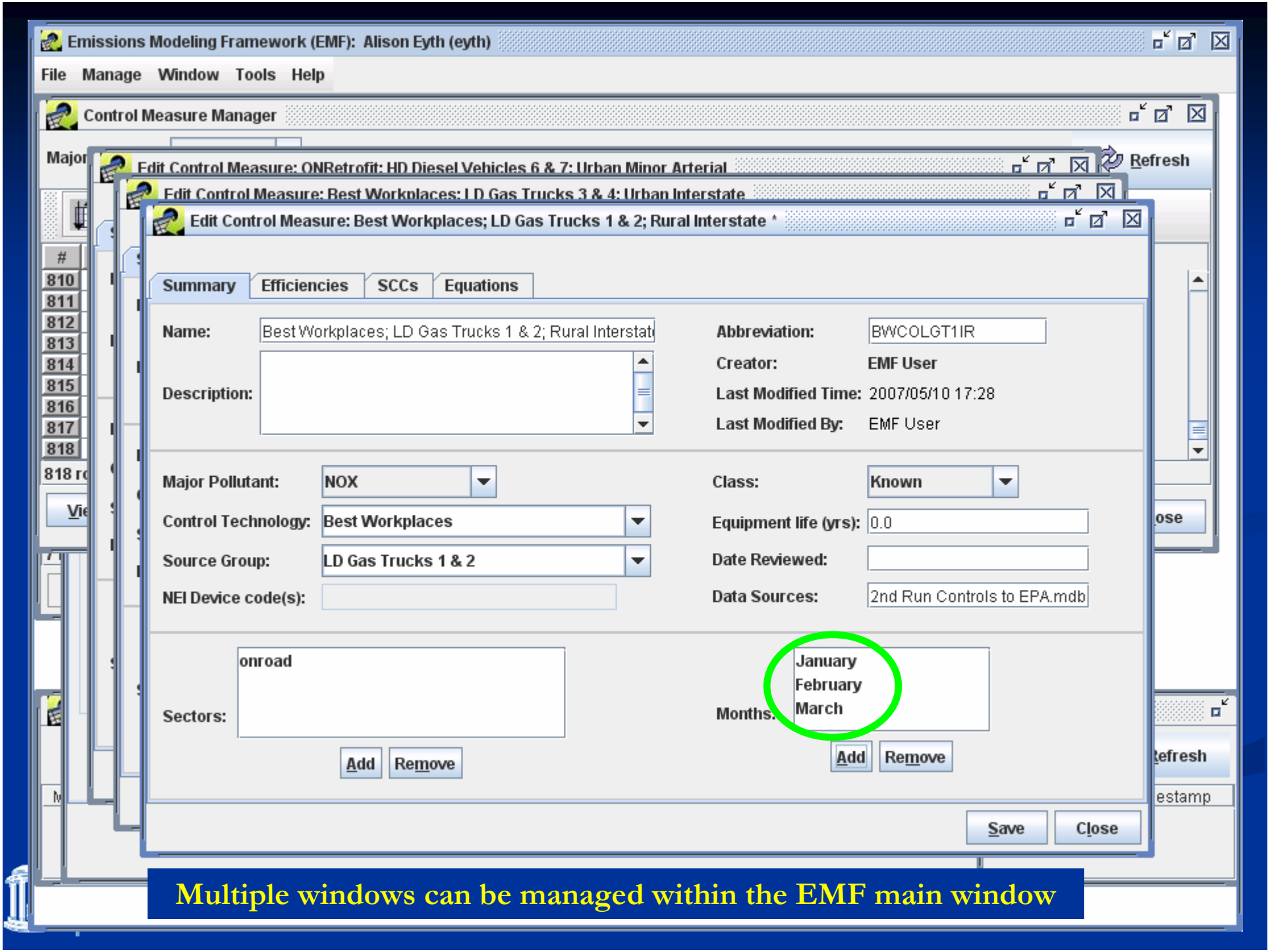
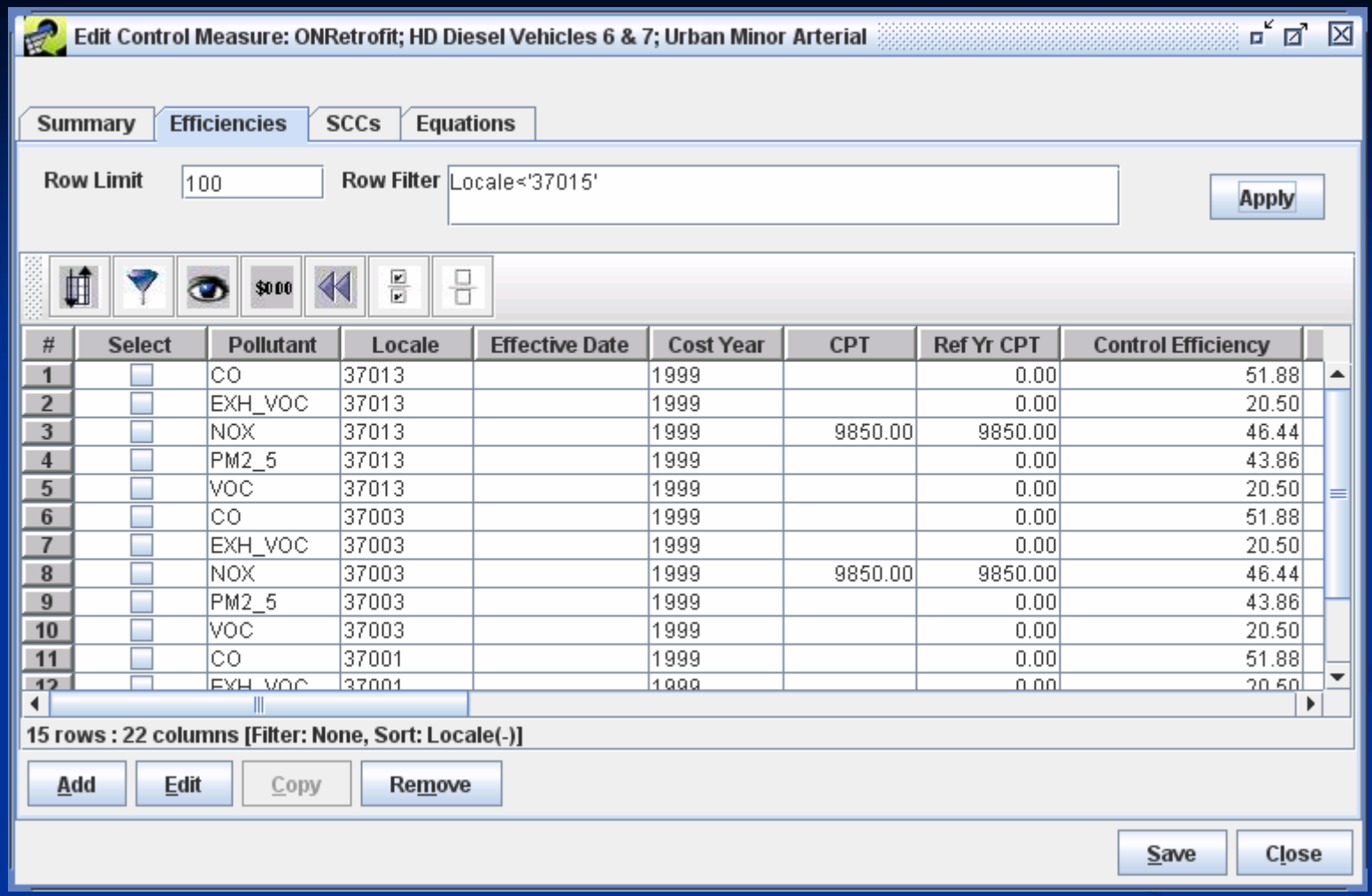
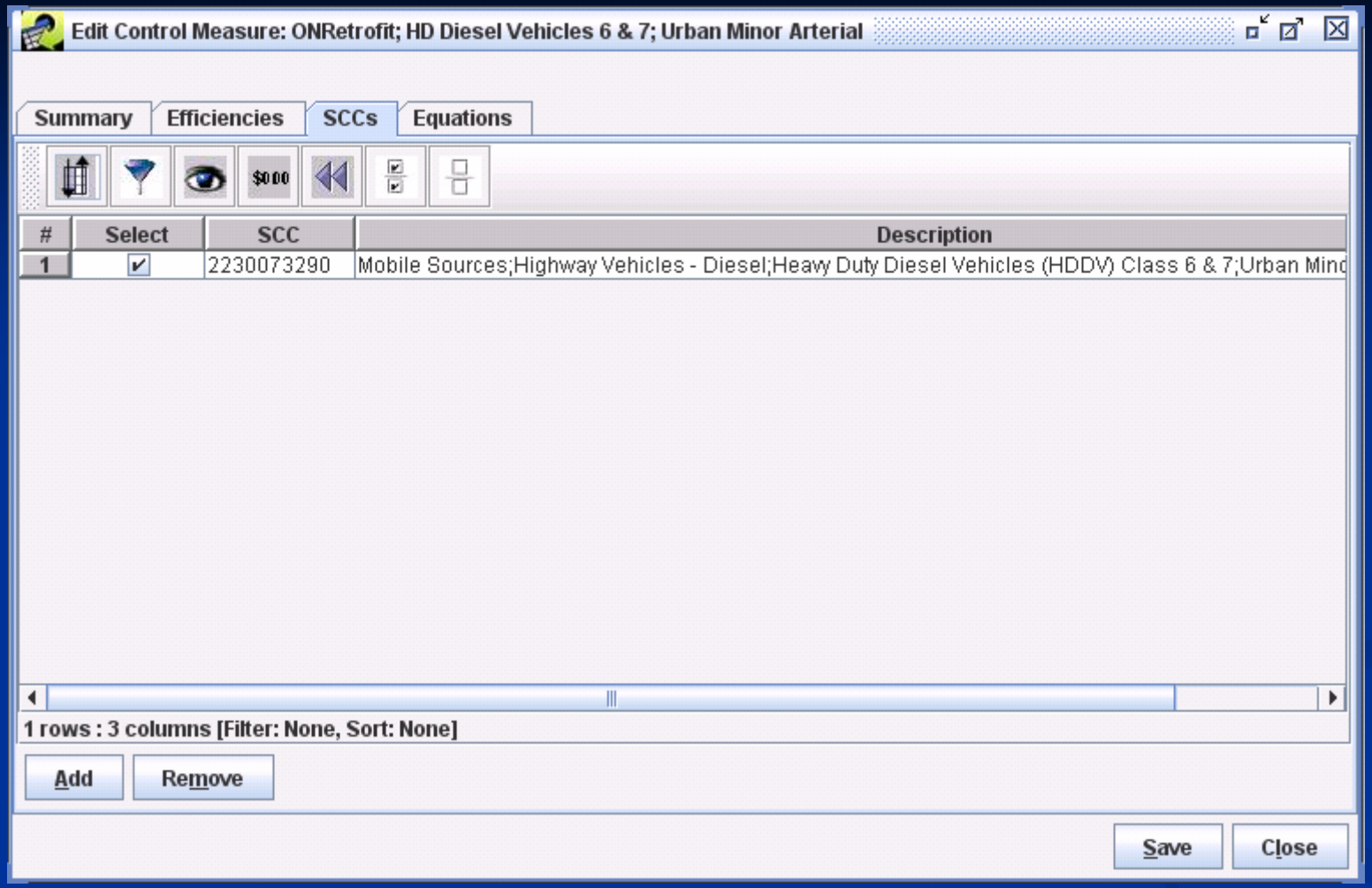
Save
Close
Select Months
None
All Months
January
February
March
April
May
June
July
August
September
October
November
OK
Cancel


Emissions Modeling Framework (EMF): Alison Eyth (eyth)
File Manage Window Tools Help
Control Measure Manager
Refresh
Edit Control Measure: ONRetrofit: HD Diesel Vehicles 6 & 7: Urban Minor Arterial
Edit Control Measure: Best Workplaces: LD Gas Trucks 3 & 4: Urban Interstate
Edit Control Measure: Best Workplaces; LD Gas Trucks 1 & 2; Rural Interstate *
Summary
Efficiencies
SCCs
Equations
Name: Best Workplaces; LD Gas Trucks 1 & 2; Rural Interstat
Abbreviation: BWCOLGT1IR
Description:
Creator: EMF User
Last Modified Time: 2007/05/10 17:28
Last Modified By: EMF User
Major Pollutant: NOX
Class: Known
Control Technology: Best Workplaces
Equipment life (yrs): 0.0
Source Group: LD Gas Trucks 1 & 2
Date Reviewed:
NEI Device code(s):
Data Sources: 2nd Run Controls to EPA.mdb
Sectors: onroad
Add Remove
Months: January February March
Add Remove
Save Close
Multiple windows can be managed within the EMF main window



- Efficiency records are available for each county for multiple pollutants with varying costs and control efficiencies

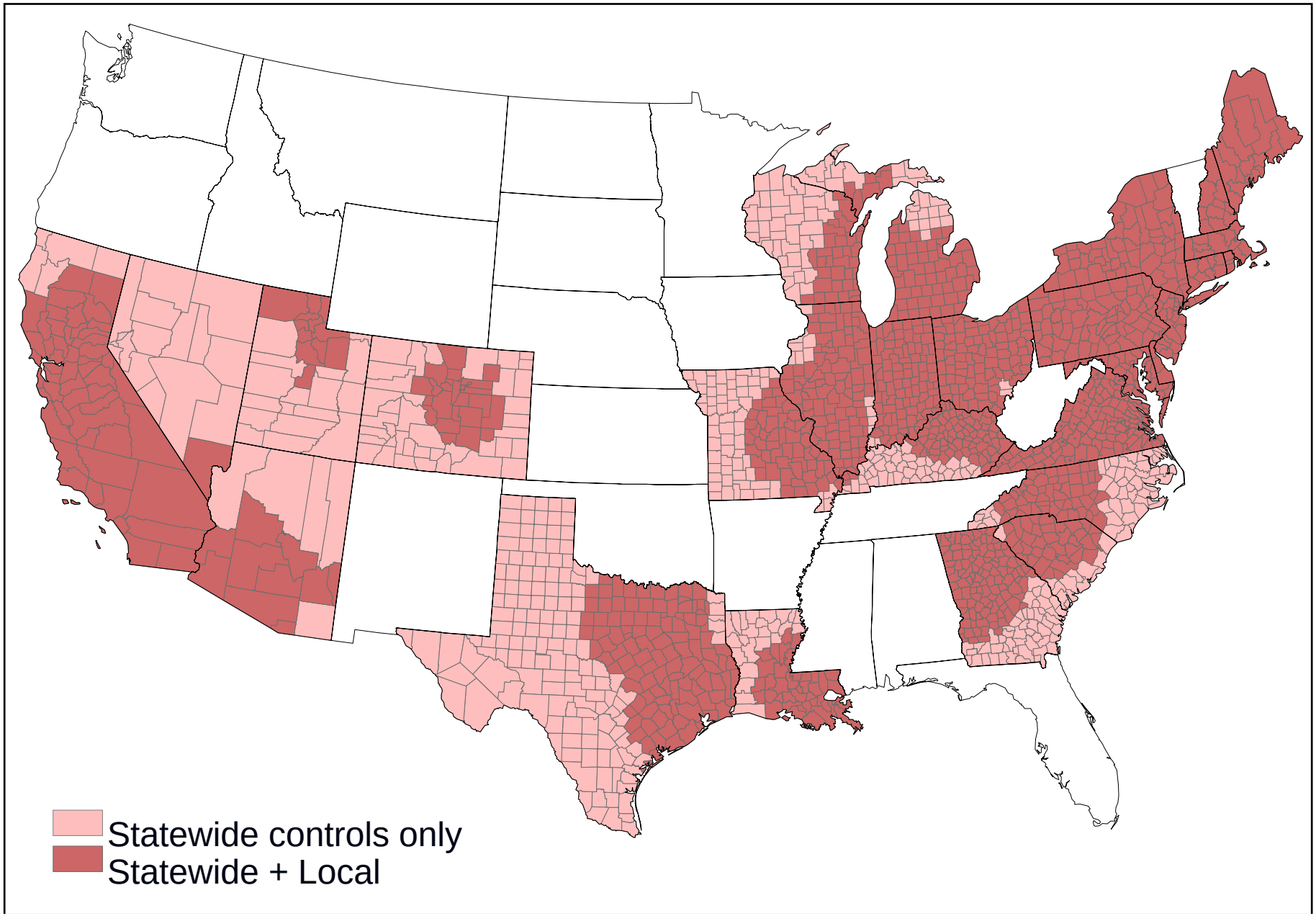


- Each mobile measure was typically applied to one SCC, but in general measures can apply to one or more SCCs

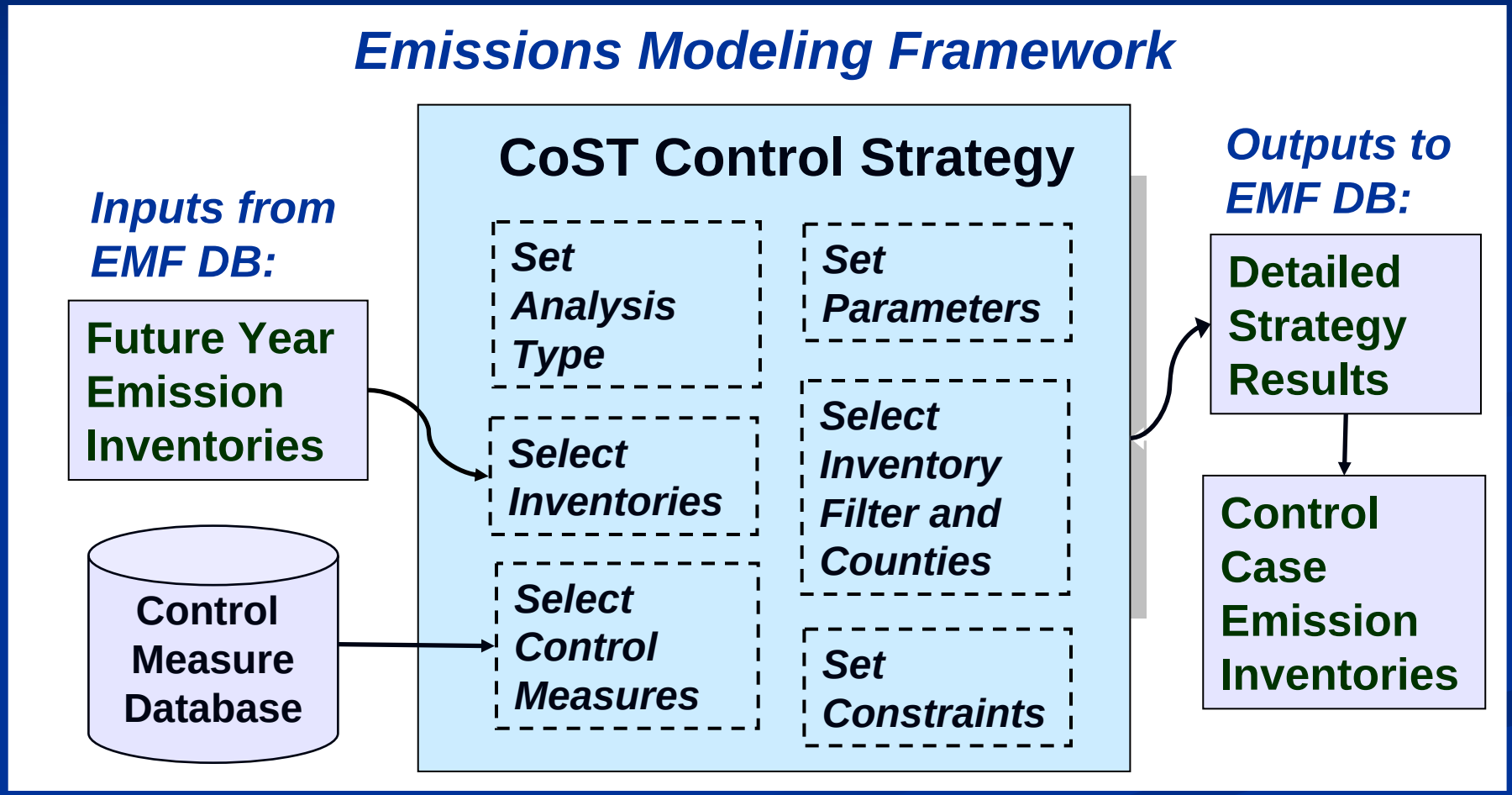
Control Strategy Challenges

- Data volume required direct SQL processing in DB instead of in Java
- Needed to specify twelve monthly average day inventories to use (not just a single annual inventory)
- Wanted to override rule effectiveness and rule penetration used by the measures for a particular run
- Needed to apply each measure in a different set of counties

Different Measures were Applied to Different Counties

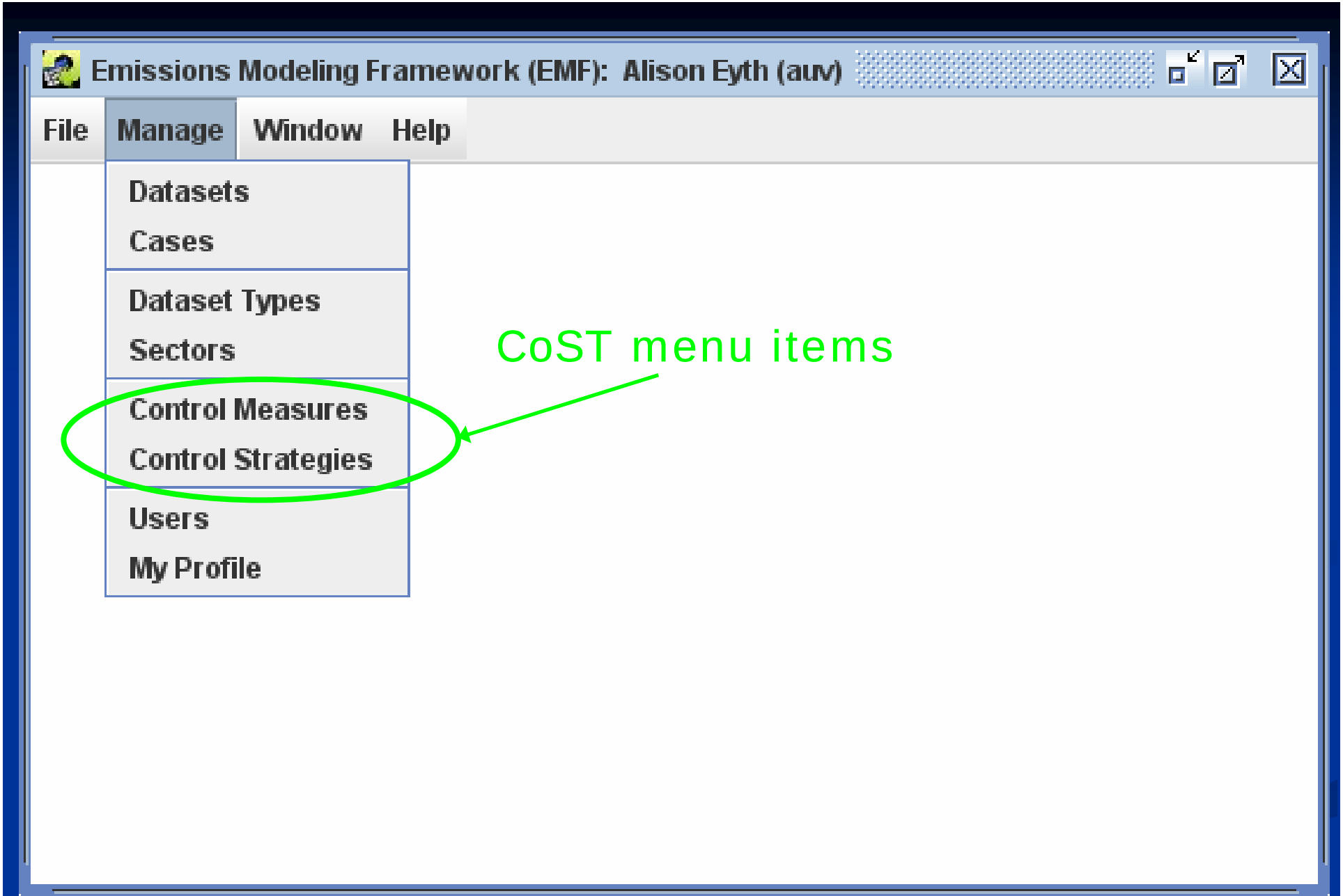


Setting up a Control Strategy



Currently Available Strategy Analysis Types

- Maximum Emissions Reduction
  - Determine the most reduction of target pollutant that is possible using the specified measures
- Least Cost
  - Determine the minimum cost way to achieve a specified reduction of the target pollutant
- Least Cost Curve
  - Runs least cost analysis for a series of reductions
- Annotate Inventory
  - Find measures that provide specified efficiencies
- Apply Measures in Series
  - Applies all specified measures in chosen order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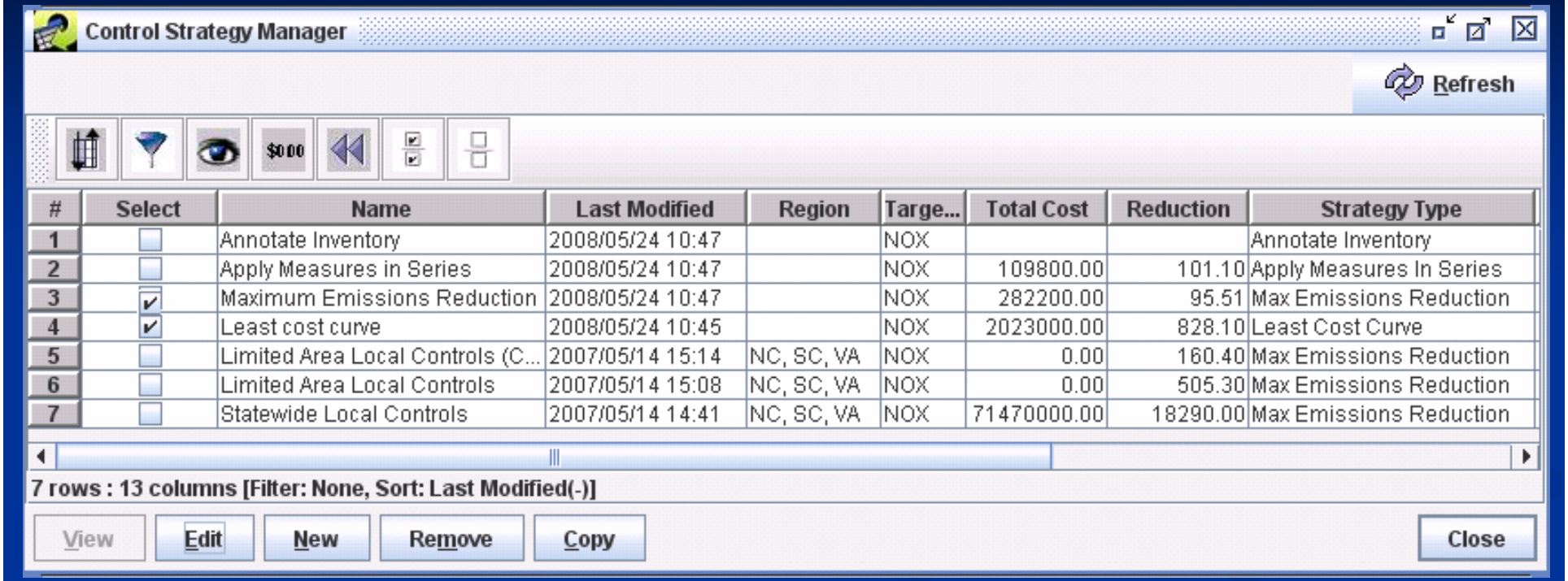
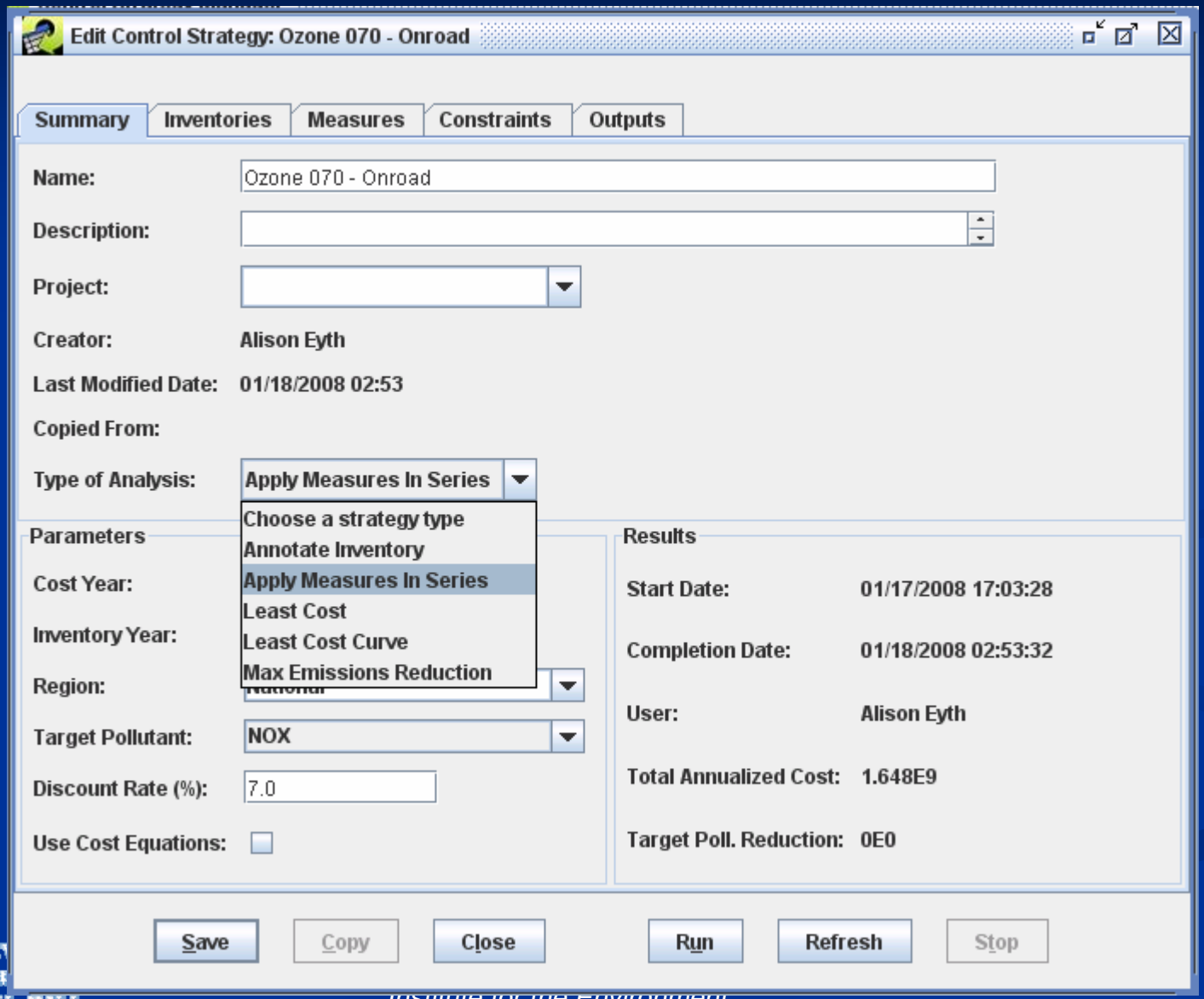
Control Strategy Manager



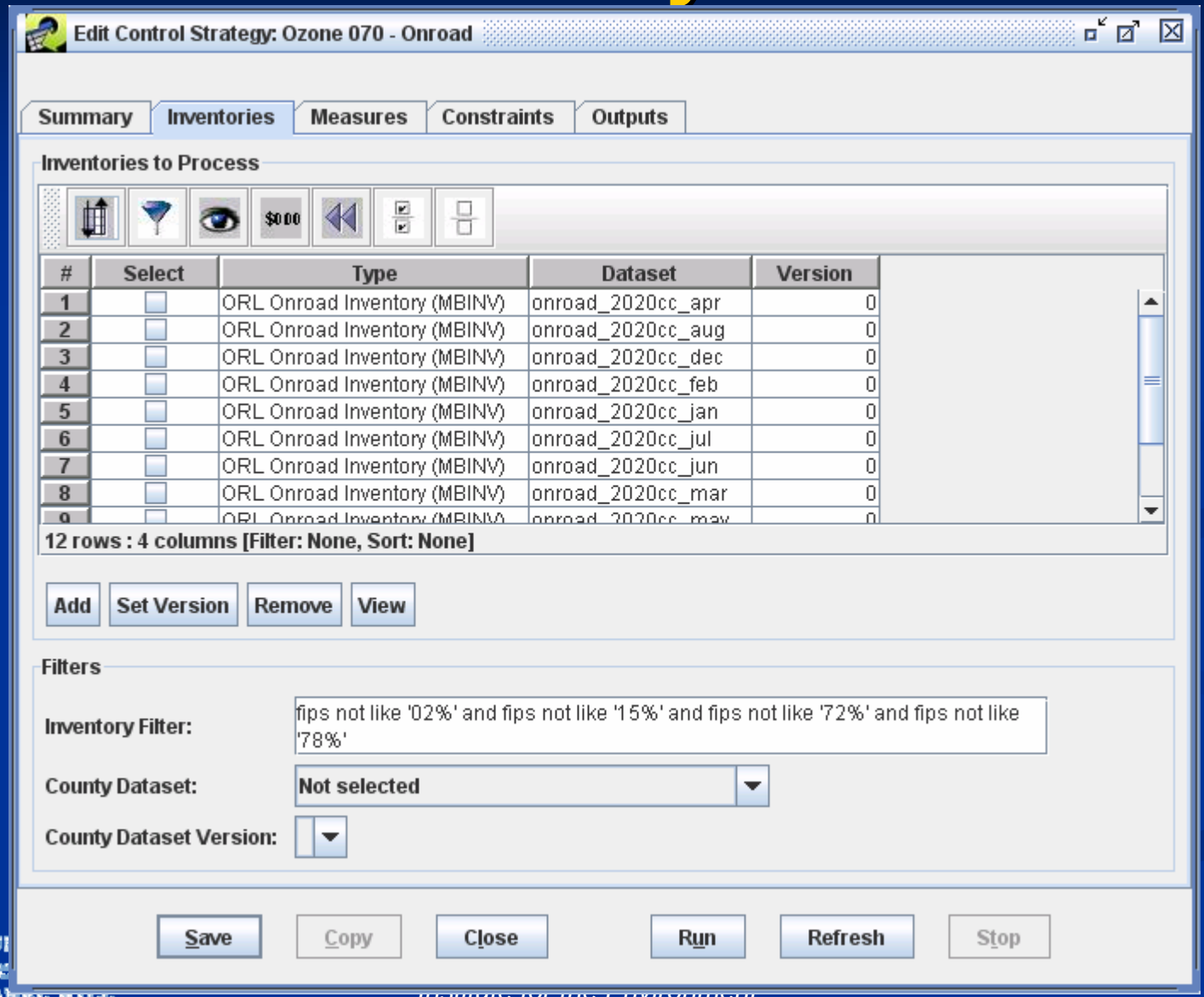
#	Select	Name	Last Modified	Region	Targe...	Total Cost	Reduction	Strategy Type
1	☐	Annotate Inventory	2008/05/24 10:47		NOX			Annotate Inventory
2	☐	Apply Measures in Series	2008/05/24 10:47		NOX	109800.00	101.10	Apply Measures In Series
3	☑	Maximum Emissions Reduction	2008/05/24 10:47		NOX	282200.00	95.51	Max Emissions Reduction
4	☑	Least cost curve	2008/05/24 10:45		NOX	2023000.00	828.10	Least Cost Curve
5	☐	Limited Area Local Controls (C...	2007/05/14 15:14	NC, SC, VA	NOX	0.00	160.40	Max Emissions Reduction
6	☐	Limited Area Local Controls	2007/05/14 15:08	NC, SC, VA	NOX	0.00	505.30	Max Emissions Reduction
7	☐	Statewide Local Controls	2007/05/14 14:41	NC, SC, VA	NOX	71470000.00	18290.00	Max Emissions Reduction

- Used to create, edit, remove, and copy strategies
- The configuration information for strategies and the run results are archived for future reference and comparison

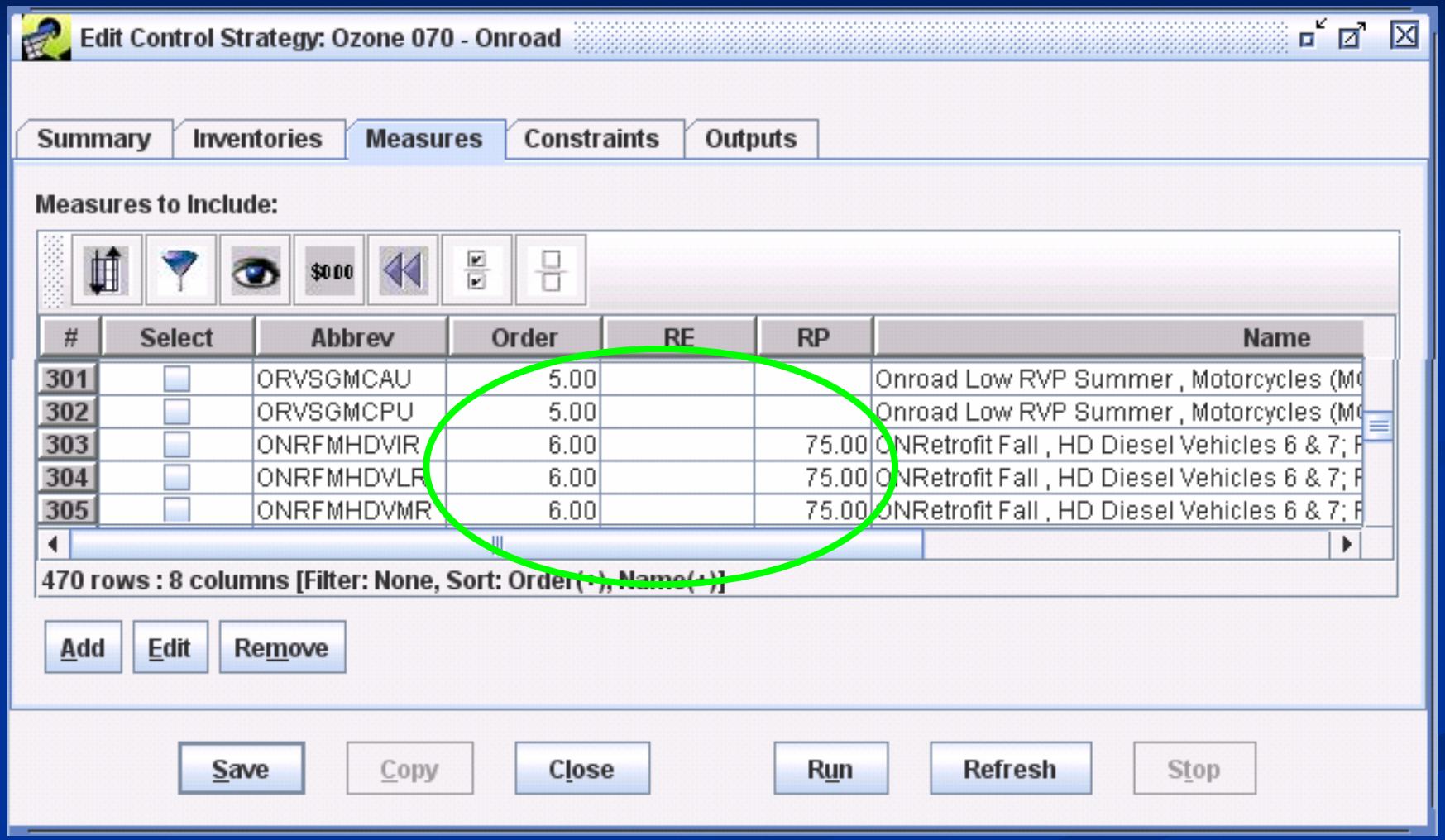
Selecting a Strategy Analysis Type



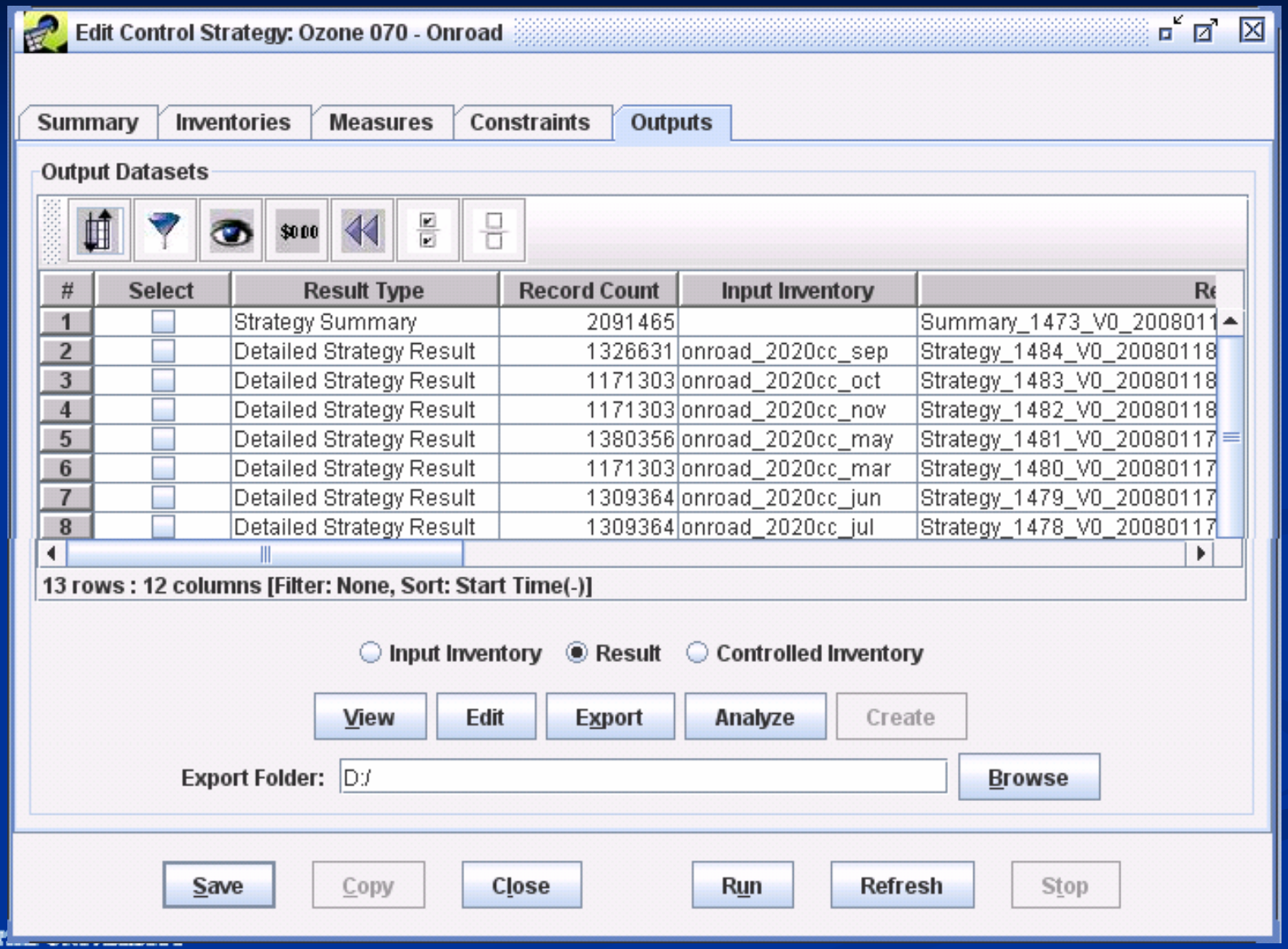
Using Monthly Inventories and Inventory Filter



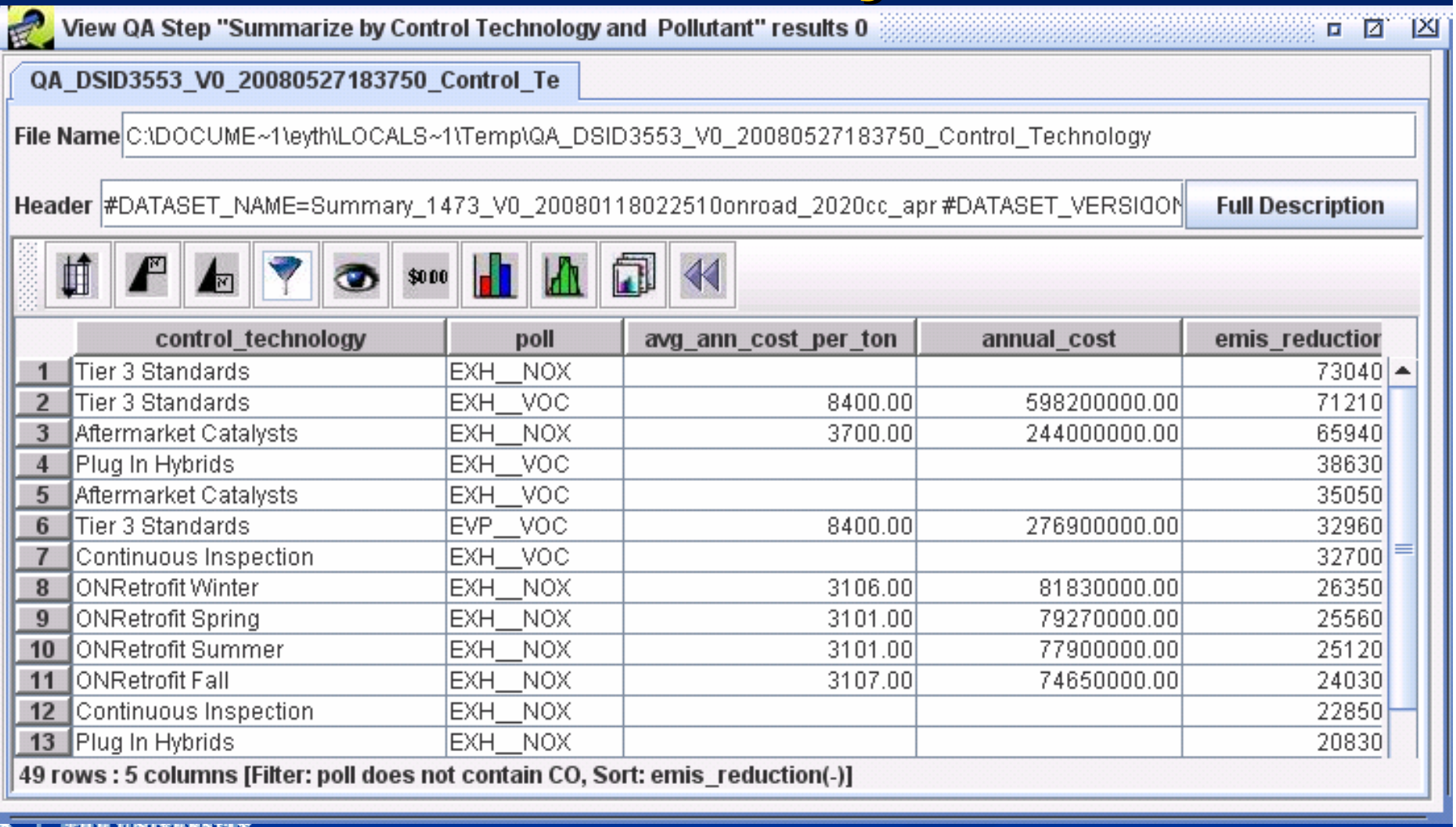
Specifying Measures with Order and RP Overrides



Mobile Strategy Outputs



Mobile Emissions Reduction Summary

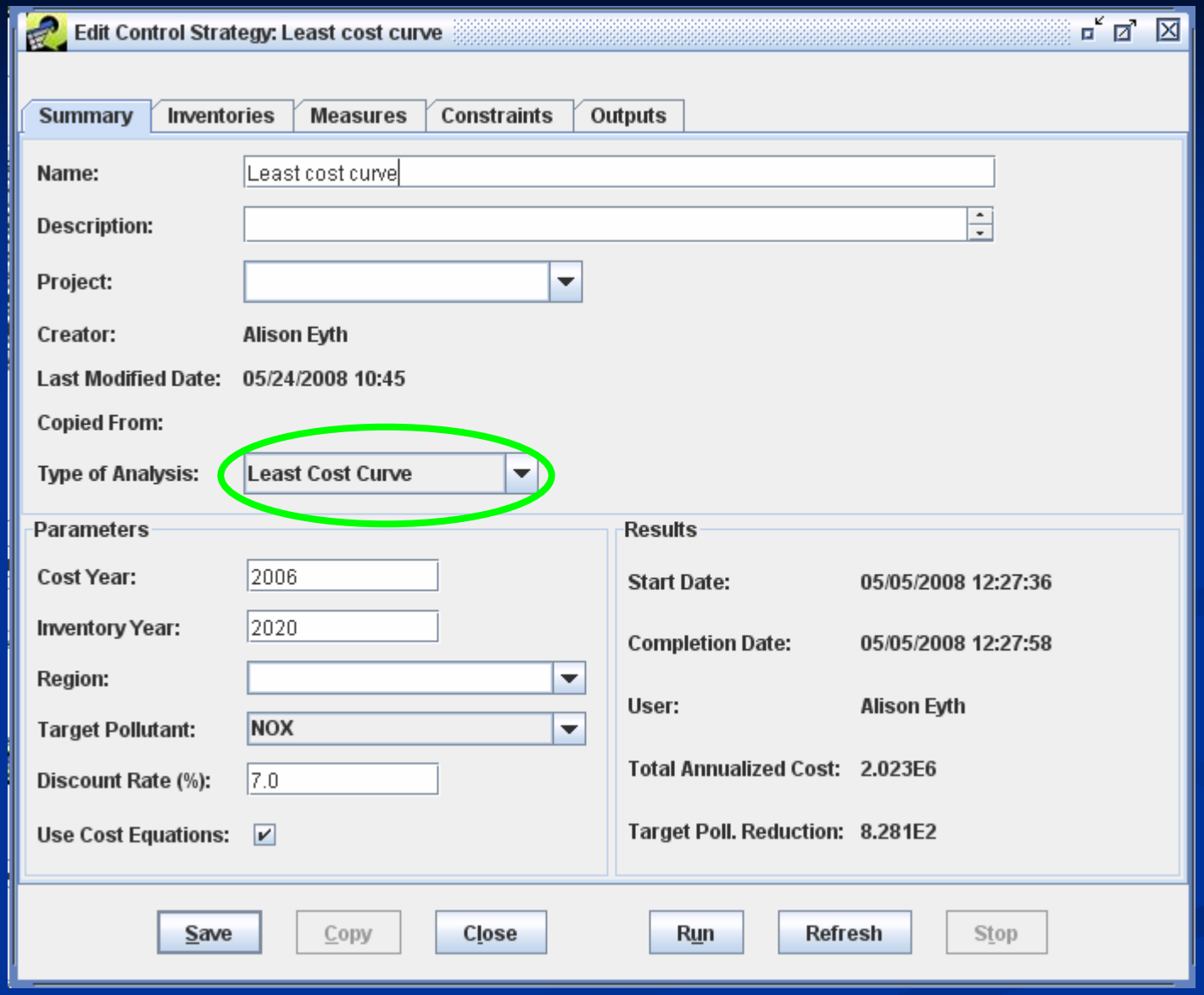


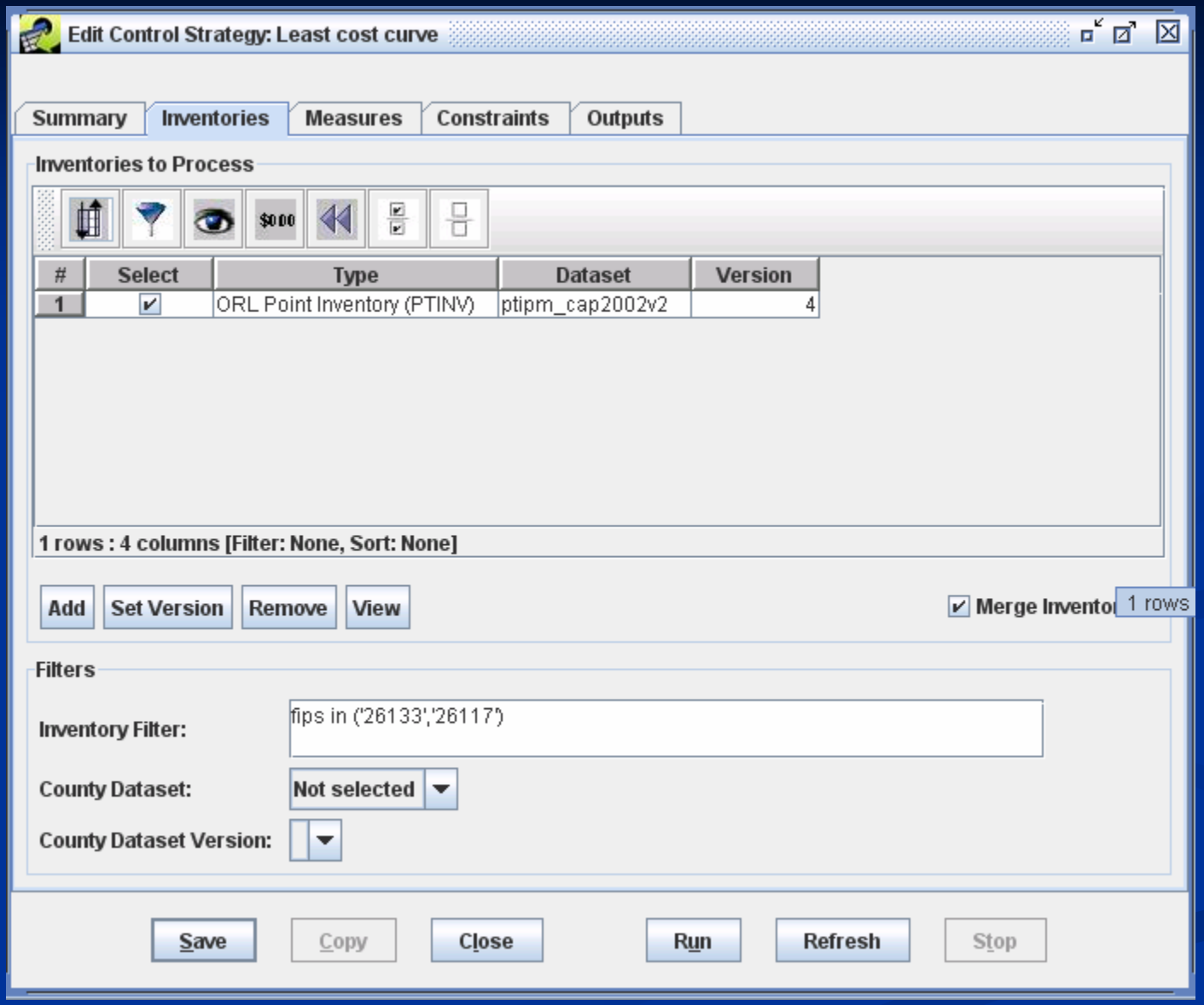
	control_technology	poll	avg_ann_cost_per_ton	annual_cost	emis_reductior
1	Tier 3 Standards	EXH__NOX			73040
2	Tier 3 Standards	EXH__VOC	8400.00	598200000.00	71210
3	Aftermarket Catalysts	EXH__NOX	3700.00	244000000.00	65940
4	Plug In Hybrids	EXH__VOC			38630
5	Aftermarket Catalysts	EXH__VOC			35050
6	Tier 3 Standards	EVP__VOC	8400.00	276900000.00	32960
7	Continuous Inspection	EXH__VOC			32700
8	ONRetrofit Winter	EXH__NOX	3106.00	81830000.00	26350
9	ONRetrofit Spring	EXH__NOX	3101.00	79270000.00	25560
10	ONRetrofit Summer	EXH__NOX	3101.00	77900000.00	25120
11	ONRetrofit Fall	EXH__NOX	3107.00	74650000.00	24030
12	Continuous Inspection	EXH__NOX			22850
13	Plug In Hybrids	EXH__NOX			20830

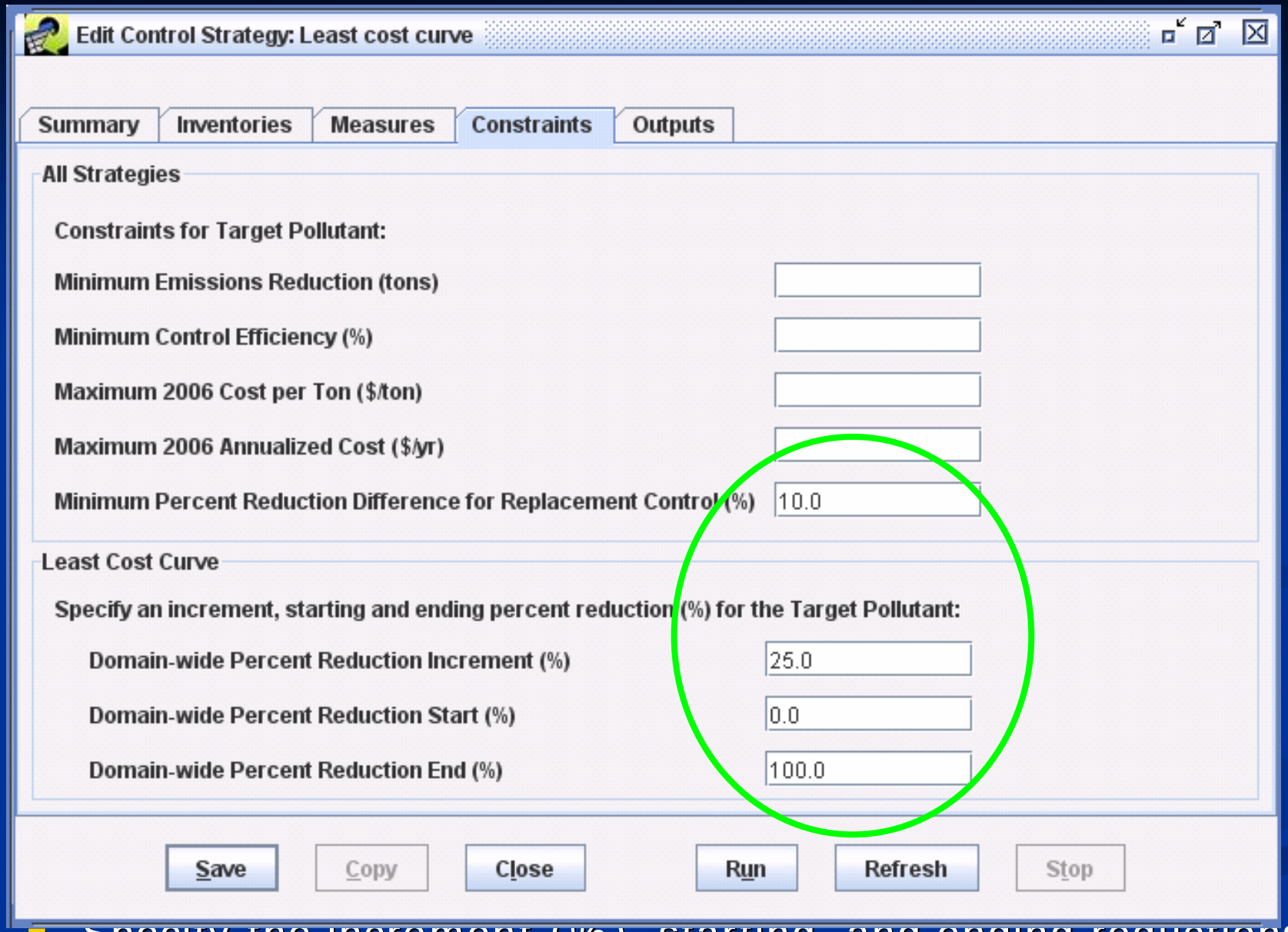
49 rows : 5 columns [Filter: poll does not contain CO, Sort: emis_reduction(-)]

New Least Cost Analyses

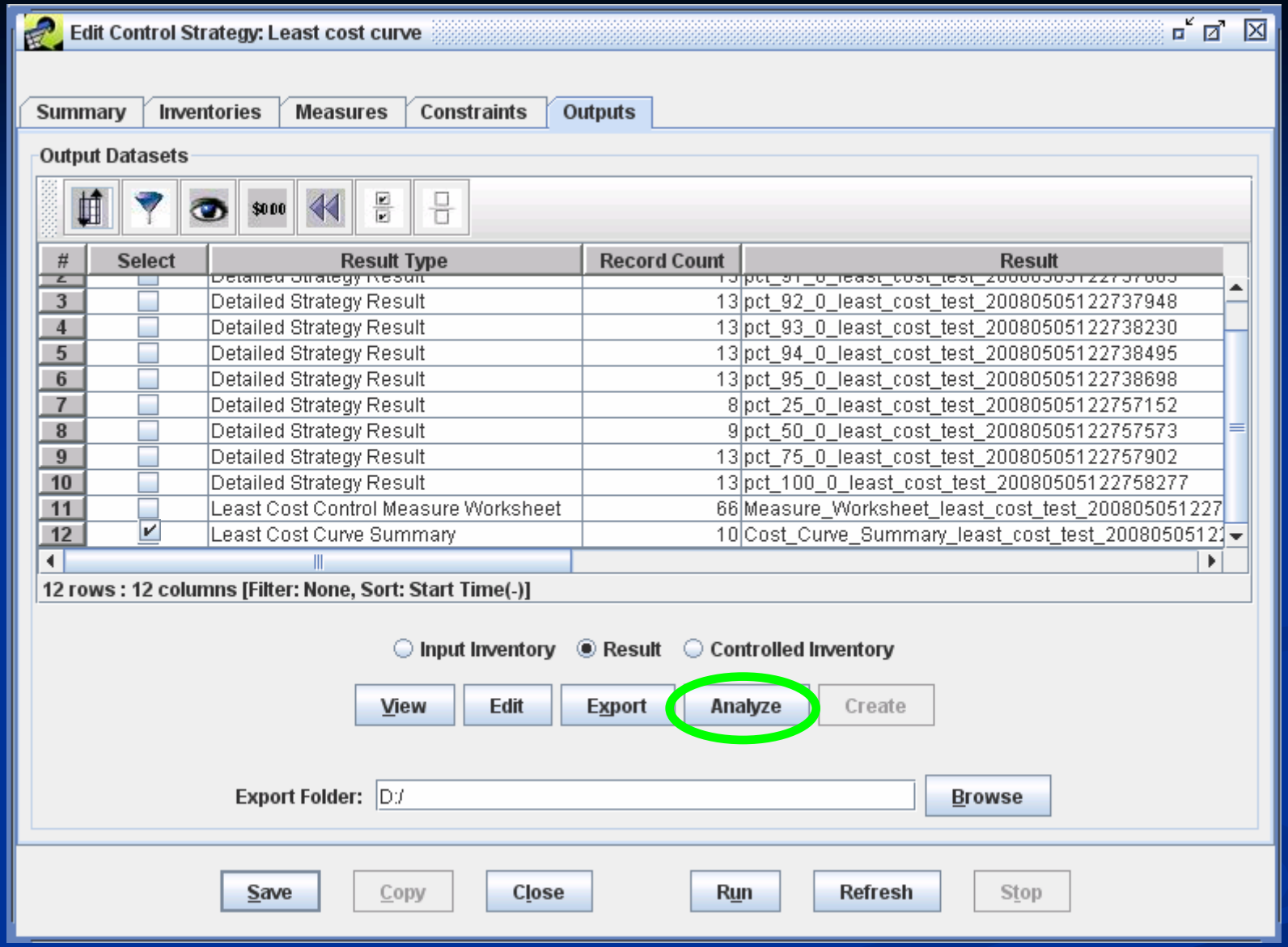
- Least cost analysis type finds 'least cost' way to reduce emissions of a pollutant within a region (algorithm is similar to that in AirControlNET)
- Inventories from multiple sectors (point, area, agricultural) can be processed together in a single least cost run
- Least cost curve strategy performs a series of least cost runs each n percentage points (e.g., 5%, 10%, 15%, …) and summarizes the results of each run


Edit Control Strategy: Least cost curve
Summary
Inventories
Measures
Constraints
Outputs
Name:
Least cost curve
Description:
Project:
Creator:
Alison Eyth
Last Modified Date:
05/24/2008 10:45
Copied From:
Type of Analysis:
Least Cost Curve
Parameters
Cost Year:
2006
Inventory Year:
2020
Region:
Target Pollutant:
NOX
Discount Rate (%):
7.0
Use Cost Equations:
Results
Start Date:
05/05/2008 12:27:36
Completion Date:
05/05/2008 12:27:58
User:
Alison Eyth
Total Annualized Cost:
2.023E6
Target Poll. Reduction:
8.281E2
Save
Copy
Close
Run
Refresh
Stop

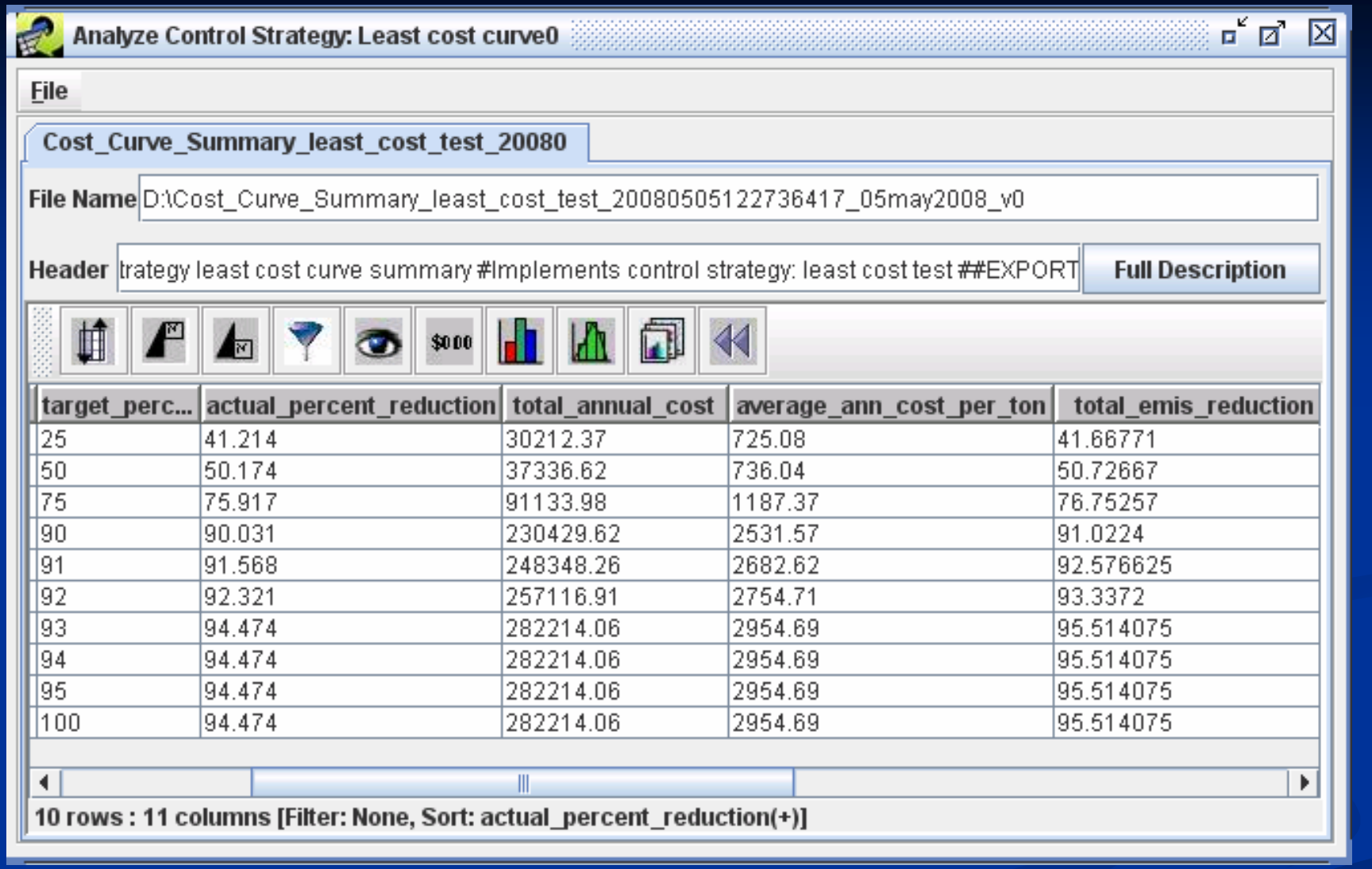

Edit Control Strategy: Least cost curve
Summary
Inventories
Measures
Constraints
Outputs
Inventories to Process
$000
| Select | Type | Dataset | Version
1 | ✔ | ORL Point Inventory (PTINV) | ptipm_cap2002v2 | 4
1 rows : 4 columns [Filter: None, Sort: None]
Add
Set Version
Remove
View
Merge Invento
1 rows
Filters
Inventory Filter:
fips in ('26133','26117')
County Dataset:
Not selected
County Dataset Version:
Save
Copy
Close
Run
Refresh
Stop



- Specify the increment (%), starting, and ending reductions

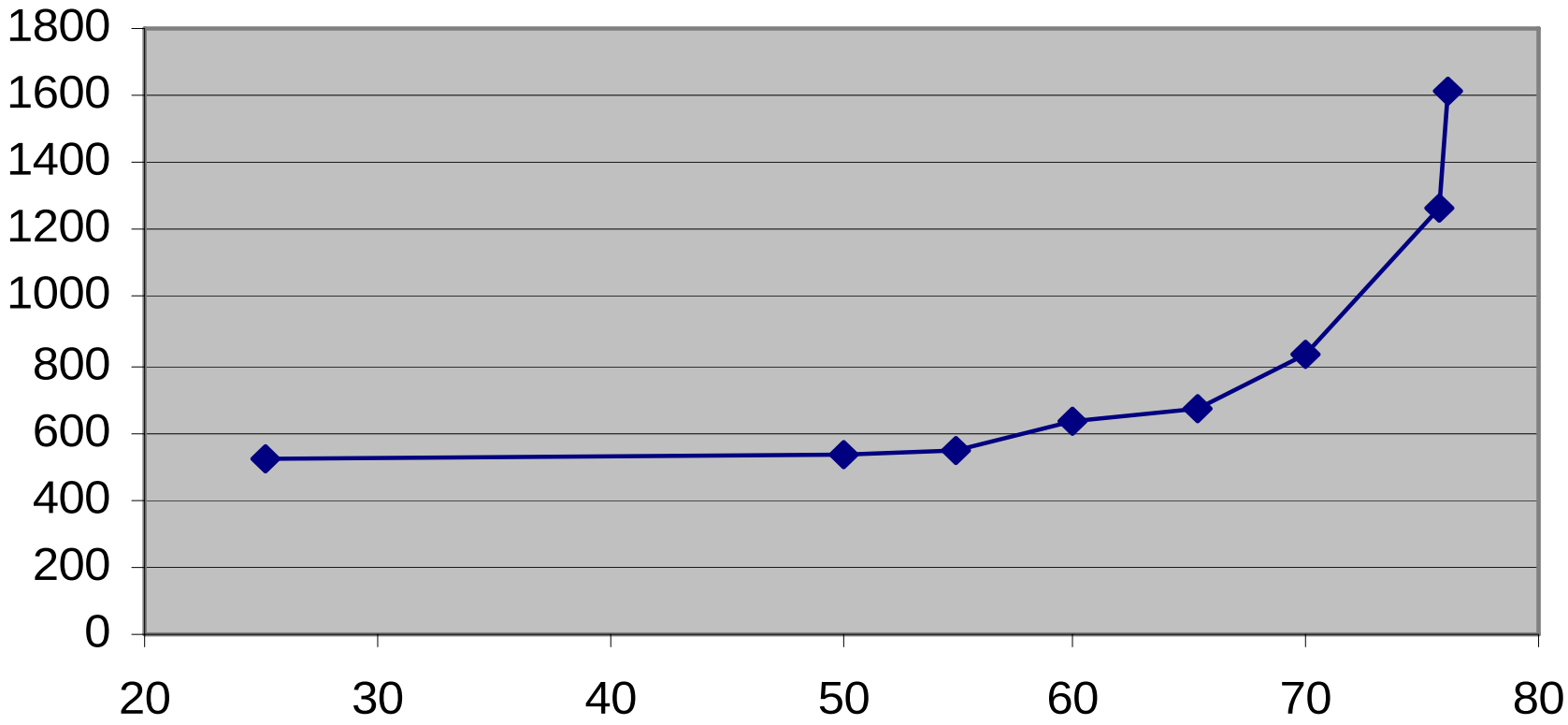


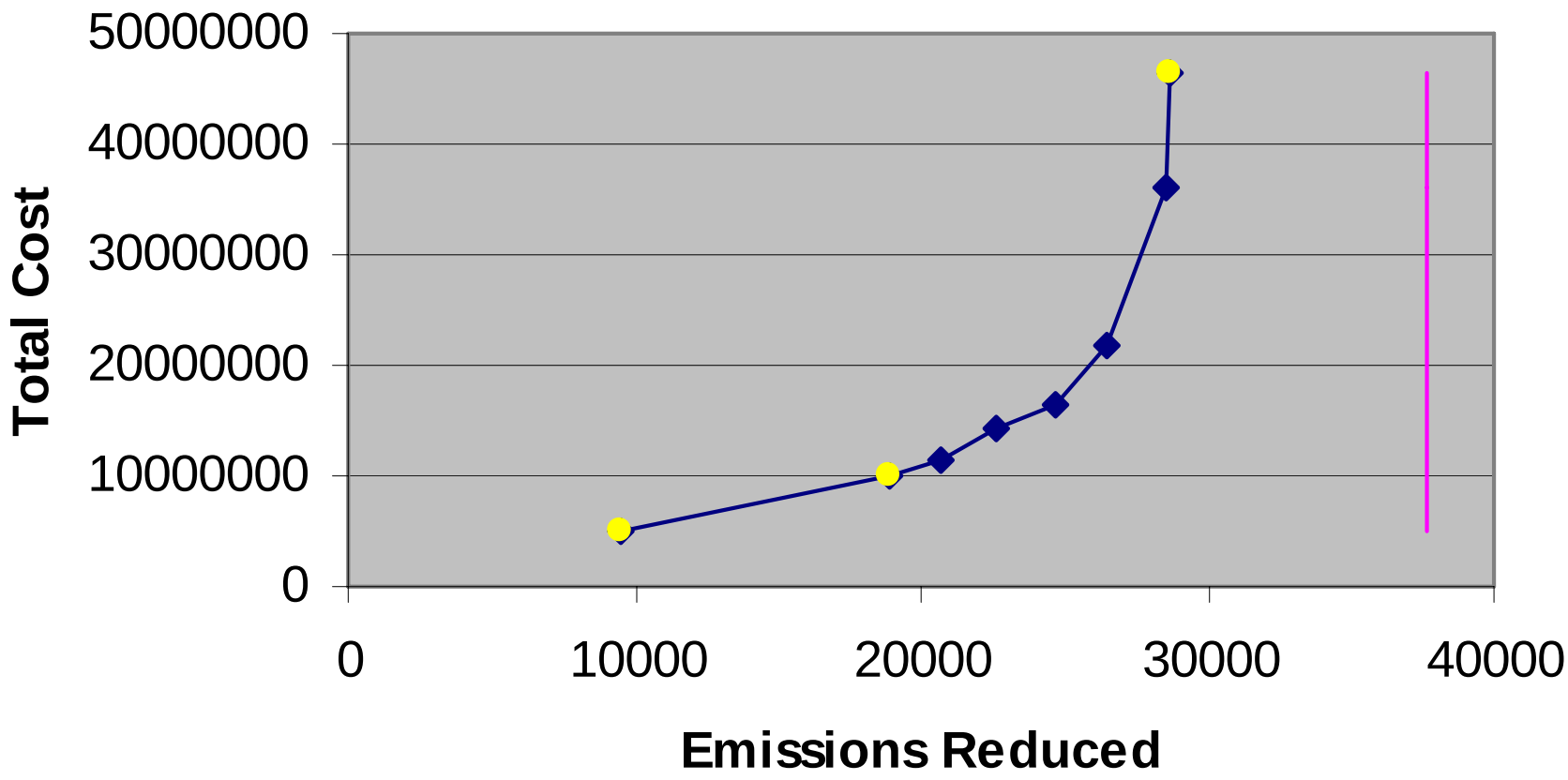
- Individual and summary results are generated



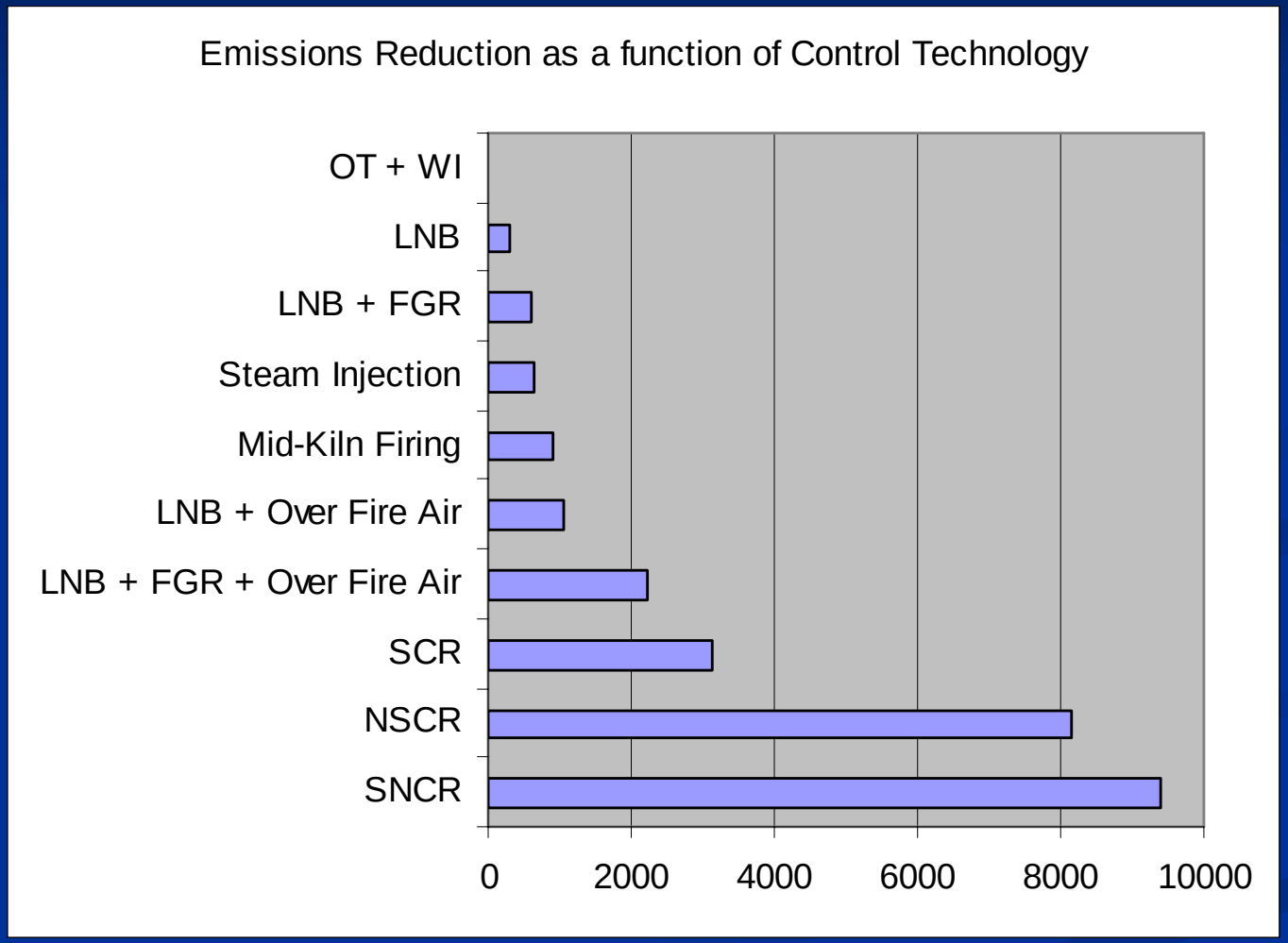
- Cost curve summary shows results for all runs

Cost per ton as a function of percent reduction (EGU sector)




EGU Sector Total Cost as f(Emissions Reduced)
Total Cost
50000000
40000000
30000000
20000000
10000000
0
0
10000
20000
30000
40000
Emissions Reduced

Technologies used by a Least Cost Run



Ongoing Work: Annotate Inventory

- New strategy analysis type that associates available measures with inventories based on control efficiency in the inventory
- Really need for inventory providers to fill in the control efficiency (ceff) and control device code whenever possible
- This prevents improper application of additional controls to already controlled sources
- Applying this has helped identify additional needs for control measure data

Annotation Results

measure_abbre	inv_ceff	measure_ceff	ceff_abs_diff	pri_control_device	measure_name
NSTINGTNG	79.99	80	0.01	STEAM OR WATER INJECTION	Steam Injection; Gas Turbines - Natural Gas
NLNC3UBCT2	69.99	58.3	11.69	MISCELLANEOUS CONTROL DEVICES	LNC3; Utility Boiler - Subbit Coal/Tangential
NLNC3UBCT2	69.99	58.3	11.69	MISCELLANEOUS CONTROL DEVICES	LNC3; Utility Boiler - Subbit Coal/Tangential
NLNBUGTNG	54.99	68	13.01	STEAM OR WATER INJECTION	LNB; Gas Turbines - Natural Gas
NLNC3UBCT2	89.99	58.3	31.69	STAGED COMBUSTION	LNC3; Utility Boiler - Subbit Coal/Tangential
NNGRECBNG2	84.99	50	34.99	CONTROL OF % O2 IN COMBUSTION AIR (OFF STOICHIOMETRIC FIRING)	NGR; External Combustion Boilers, Elec Gen, Nat Gas (2)
NNGRECBNG2	84.99	50	34.99	CONTROL OF % O2 IN COMBUSTION AIR (OFF STOICHIOMETRIC FIRING)	NGR; External Combustion Boilers, Elec Gen, Nat Gas (2)
	97.99			WET SCRUBBER - HIGH EFFICIENCY	
	94.6			DRY LIMESTONE INJECTION	

Ongoing Work: Control Programs

- Control Program information is needed to project base year inventories to future years
  - Once complete, this will allow users to apply projection and control factors to project inventories to a specified future year
- Control programs can list preferred control measures or technologies to use
  - If unspecified, CoST will give a best guess or leave blank if none are close enough
- Control program information from states would be helpful for improved accuracy

Types of Control Programs

- Plant closures
- Planned reductions at specific plants
- Planned growth at specific plants
- Caps on emissions at existing plants
- SCC-based reduction programs
- Commuter programs
- Estimated growth for specific sectors

Ongoing work: GHG Study for Cement Plants

- A preliminary application for the greenhouse pollutant Elemental Carbon was performed last year
- This year we are performing an analysis of CO2 targeting the cement sector
- CO2 control measure data is being added for cement sources (via EPA summer intern)
- Developing a CO2+criteria pollutant inventory for cement plants that will be usable in CoST
- GHG Analyses would be SO MUCH easier if a detailed (unit level) inventory was available!

Other Recent Enhancements

- Support cost equations for point sources so that cost can be represented in a way other than a simple cost/ton (approx. 8 types are available)
- New detailed result summaries are available (e.g., state+scc+control technology)
- Creates controlled ORL format inventories that specify which control measures have been applied to each source
- Find Measures for SCCs feature

Other Priorities for Summer '08

- Examining ways to perform least cost optimization for multiple target pollutants (e.g., NOx + SOx)
- Facilitate uncertainty and sensitivity analyses in control strategies

Acknowledgments

- This work was funded by the Air Benefit and Cost Group of the Health and Environmental Impacts Division of U.S. EPA's Office of Air Quality Planning and Standards
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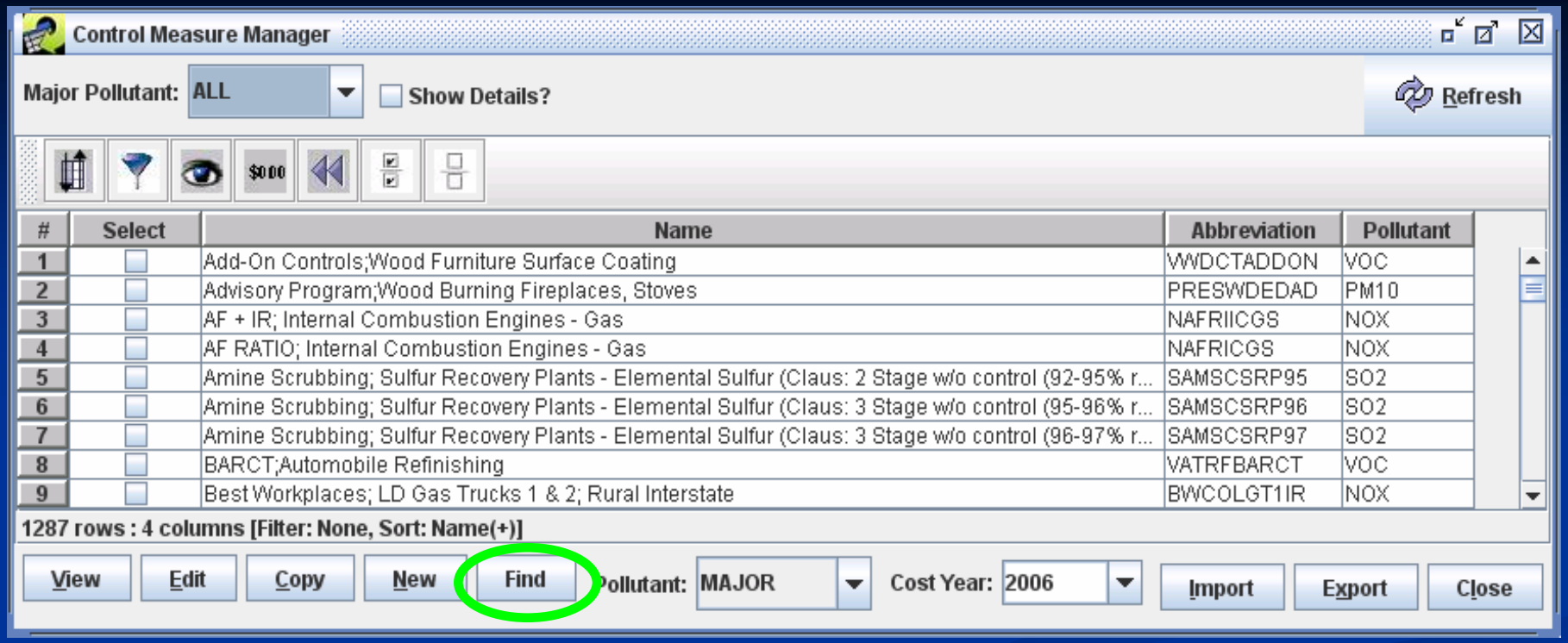
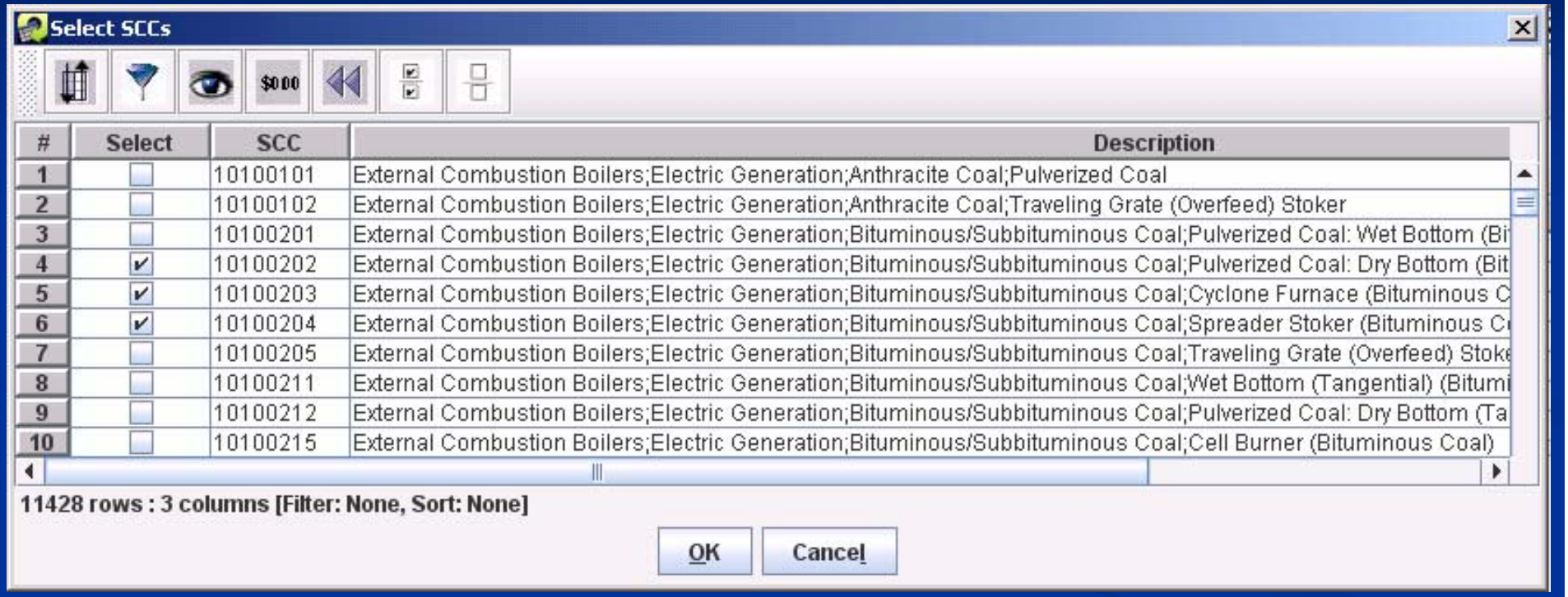
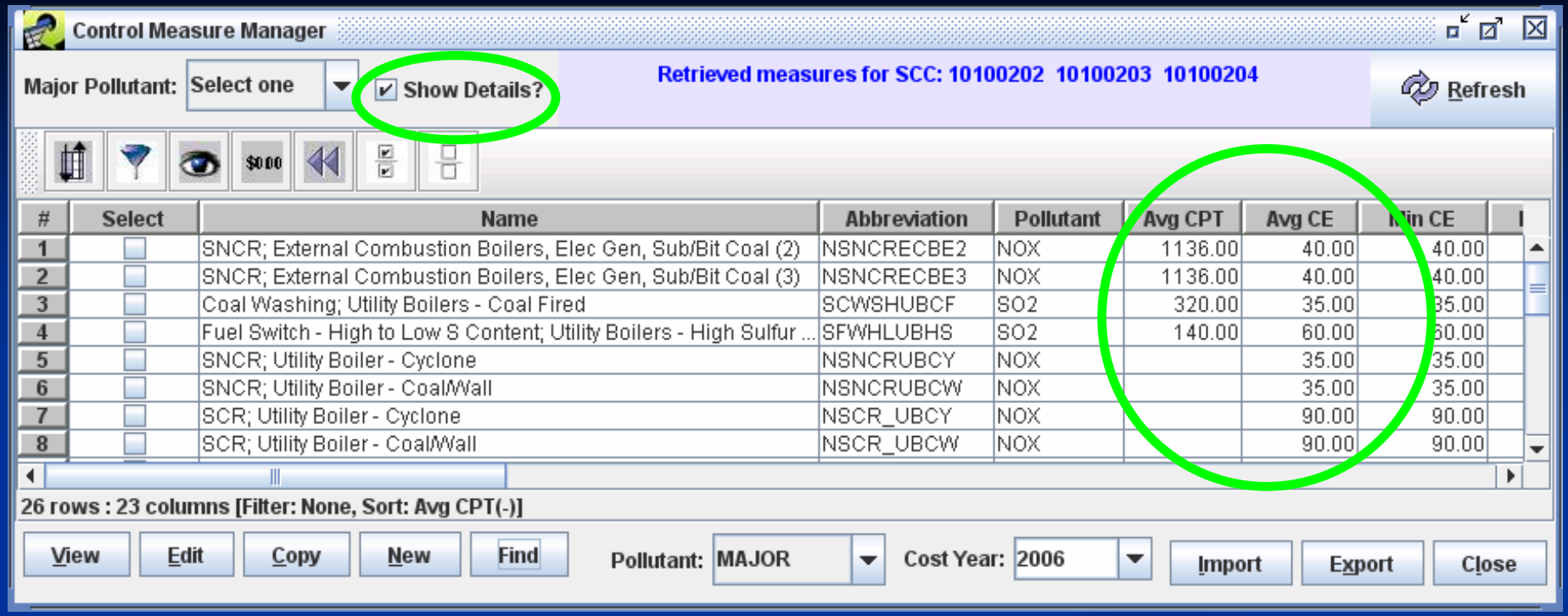


- A need for a new feature was identified: Find Control Measures that apply to sources with particular SCCs

Select the SCCs of Interest



- Can select manually or use a filter on SCC and/or Description to select all from a group



- Control Measures that can apply to the selected SCCs are shown
- Clicking Show Details causes manager to show average cost per ton, min/max/avg control efficiency, etc.