Co-Benefits Risk Assessment (COBRA) Health Impact Screening and Mapping Model

Training at the 2017 International Emissions Inventory Conference

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August 15, 2017

State and Local Energy and Environment Program

EPA United States Environmental Protection Agency

Overview of COBRA Training

- What is the **COB**enefits **R**isk **A**ssessment (COBRA) Heath Impacts Screening and Mapping Tool?
- Who can use COBRA and why?
- How does it work?
  - Structurally
  - What underlying data does COBRA rely upon?
- How do I use COBRA?
  - Hands-on practice with COBRA
- What's coming soon for COBRA?

What is COBRA?

- COBRA is a free, easy-to-use, peer reviewed screening model that quickly:
  - Converts changes in criteria air pollutants ($PM_{2.5}$, SO_2, NO_X, NH_3, VOCs) into changes in ambient air quality for a given year,
  - Estimates the number of cases of illness and death avoided based on changes in $PM_{2.5}$ (not ozone),
  - Monetizes the economic value of those benefits, and
  - Presents county-level results via tables and maps that facilitate visualization of the results.
- COBRA uses approaches and "canned" assumptions consistent with those in EPA Regulatory Impact Analyses
- COBRA is intended to enrich the discussion of co-benefits, fostering balanced decision-making that considers both the costs and health benefits of policy choices, especially related to energy.

Energy Choices Matter

Energy from Fossil Fuels

In 2014, 82 percent of the energy consumed in the U.S. was produced through the combustion of fossil fuels such as coal, natural gas, and petroleum.

Burning fossil fuels causes emission of air pollutants like particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides. Fossil fuel is also the largest source of CO_2 and of overall greenhouse gas emissions.

Major Source of Air Pollution

Harms Health

- Air pollution decreases the quality of air and increases:
  - Respiratory and cardiovascular illnesses, such as asthma, chronic bronchitis, and heart attacks; and
  - Premature death.
- Children and the elderly are most vulnerable.

- These health effects result in:
  - Work days lost due to illness of employee or family member;
  - School days lost;
  - Medical bills; and
  - Pain and suffering.

Societal Costs

Source: EIA 2015, EPA 2016

Energy Choices Matter

Clean Energy

- Reduces total electricity demand
- Reduces demand for transportation-related fossil fuels.
- Displaces (or replaces) fossil fuel electricity sources with clean distributed generation or renewable energy sources
- Displaces (or replaces) fossil fuel transportation sources with renewable energy sources or low emission sources

Energy Efficiency, Renewable Energy, Low Emission Fuels

Reduces Emissions

- Improves air quality.
- Reduces premature death.
- Improves human health.

Societal Benefits

- People avoid costly illnesses.
- Businesses benefit from increased worker productivity.
- Children miss fewer school days.

Who can use COBRA and why?

- Analysts, planners, and officials from environmental, health, energy, transportation, and economic development agencies can use COBRA to:

Quickly and inexpensively compare different clean energy policies and identify those that:

- Are likely to result in the greatest health benefits
- Are expected to reduce health risks in the most cost-effective manner

Estimate and promote improvements in air quality and economic value of associated human health benefits of:

- Clean and/or renewable energy projects
- Other types of projects, such as transportation or municipal waste

Visually convey - using COBRA's mapping capabilities - how clean energy benefits can go beyond a single county and impact people at the state, regional, and national levels

Recent Reports Using COBRA

- Current users include federal, state and local energy and environment officials, public health officials, consultants, academics and advocates
- Recent reports cover an array of topics, including:
  - Staff White Paper on Benefit-Cost Analysis in the **Reforming Energy Vision** Proceeding (New York Department of Public Service. July 2015)
  - Controlling Episodic Air Pollution with a **Seasonal Gas Tax**: The Case of Cache Valley, Utah (Environmental and Resource Economics, 2015)
  - Analyzing the health co-benefits of **renewable energy deployment** in the United States (In 2015 APHA Annual Meeting & Expo, 2015).
  - Comments on B21-0650 – **Renewable Portfolio Standard** Expansion Amendment Act of 2016 (Chesapeake Climate Action Network testimony to the DC Transportation and Environment Committee, 2016).
  - Public Health Impact and **Economic Costs of Volkswagen'**s Lack of Compliance with the United States' Emission Standards (International Journal of Environmental Resources and Public Health. 13(9): 891. 2016)
  - "Standardized **Regulatory Impact Assessment**: Computers, Computer Monitors, and Signage Displays" (Prepared for California Energy Commission, June 2016)
  - The **Clean Power Plan** in Ohio: Analyzing power generation for health and equity. (PSE Healthy Energy. July 2016)
  - The **Clean Power Plan** in Pennsylvania: Analyzing power generation for health and equity. (PSE Healthy Energy. July 2016)
  - Analysis of the Public Health Impacts of the **Regional Greenhouse Gas Initiative** (Abt Associates, 2017).

How Does COBRA Work?

USER INPUTS= Change in 2017 Emissions

- PM2.5, SO2, NOx, NH3, VOCs

COBRA[1]

Quantifies Changes in Air Quality

(Specifically, particulate matter)

Calculates Change in Health Outcomes

(Resulting from particulate matter changes) [2]

Calculates Monetary Value of Health Outcomes

OUTPUTS = Tables and maps of illness cases and deaths avoided as well as the related economic value.

[1]COBRA is a peer-reviewed screening model that based on rigorous methods used by EPA health benefits assessments as described in the User Manual.

[2] COBRA estimates only particulate matter-related benefits and may be conservative in that respect.

Where does COBRA get its baseline emissions inventory?

- COBRA contains detailed emissions estimates for the year 2017, developed for the Mercury and Air Toxics Standards (MATS) Final Rule (77 FR 9304-9513), which limits mercury and other toxic air pollution from coal- and oil-fired power plants.
  - The air quality modeling platform for MATS is based on emissions data, meteorology, initial conditions, and boundary conditions from 2005 and uses 2017 as the future year of analysis.
- COBRA uses the 2017 "control case" developed by EPA for the MATS Rule, which includes:
  - electrical generating unit emissions (reflecting the implementation of both MATS and the Cross-State Air Pollution Rule),
  - mobile emissions (reflecting the impacts of implementation of the Energy Independence and Security Act of 2007 and the Energy Policy Act of 2005 on mobile source fuels), and
  - average year fire data.

How COBRA Quantifies AQ Changes

- COBRA uses a reduced form air quality model, the Source-Receptor (S-R) Matrix, to translate air pollution emissions changes into changes in ambient PM2.5
  - Consists of fixed transfer coefficients that reflect the relationship between annual average $PM_{2.5}$ concentration values at a single receptor in each county and the contribution by $PM_{2.5}$ species to this concentration from each emission source (EH Pechan & Associates, Inc 1994).
- A review of an earlier version of the S-R matrix found that it predicted public health benefits that were similar to those predicted by CALPUFF, a sophisticated AQ model (Levy et al 2003).

Human Health Effects in COBRA

- COBRA estimates the number of health incidences avoided AND the related economic value for the following:
  - Adult Mortality,
  - Infant Mortality,
  - Non-fatal Heart Attacks,
  - Respiratory Hospital Admissions,
  - Cardiovascular-related Hospital Admissions,
  - Acute Bronchitis,
  - Upper Respiratory Symptoms,
  - Lower Respiratory Symptoms,
  - Asthma Exacerbations (attacks, shortness of breath, & wheezing),
  - Asthma Emergency Room visits,
  - Minor Restricted Activity Days,
  - Work Loss Days

How COBRA Quantifies Health Impacts

- COBRA
  - uses a range of health impact (i.e. concentration response or C-R) functions to translate changes in ambient $PM_{2.5}$ into changes in the incidences of human health effects
  - includes estimates of baseline incidence rates and prevalence (percentage of population with a given ailment) rates for the health effects
  - uses population (and income) projections based on US Census of Population & Housing and forecasting models developed by Woods & Poole (2011)
- Approach and assumptions are generally consistent with approach and assumptions used in EPA Regulatory Impact Analyses
- Detailed information about specific assumptions and sources are in the User Manual Appendices

Epidemiological Studies Used to Estimate Adverse Health Impacts of $PM_{2.5}$ via COBRA

Endpoint	Author	Age
Mortality, All Cause	Krewski et al. (2009)	30-99
Mortality, All Cause	Lepeule et al. (2012)	25-99
Mortality, All Cause	Woodruff et al. (1997)	Infant
Acute Myocardial Infarction, Nonfatal	Peters et al. (2001)	18-99
Acute Myocardial Infarction, Nonfatal	Pope et al. (2006)	18-99
Acute Myocardial Infarction, Nonfatal	Sullivan et al. (2005)	18-99
Acute Myocardial Infarction, Nonfatal	Zanobetti and Schwartz (2006)	18-99
Acute Myocardial Infarction, Nonfatal	Zanobetti et al. (2009)	18-99
HA, All Cardiovascular (less Myocardial Infarctions)	Bell et al. (2008)	65-99
HA, All Cardiovascular (less Myocardial Infarctions)	Moolgavkar (2000b)	18-64
HA, All Cardiovascular (less Myocardial Infarctions)	Peng et al. (2008)	65-99
HA, All Cardiovascular (less Myocardial Infarctions)	Peng et al. (2009)	65-99
HA, All Cardiovascular (less Myocardial Infarctions)	Zanobetti et al. (2009)	65-99
HA, All Respiratory	Zanobetti et al. (2009)	65-99
HA, All Respiratory	Kloog et al. (2012)	65-99
HA, Asthma	Babin et al. (2007)	0-17
HA, Asthma	Sheppard (2003)	0-17
HA, Chronic Lung Disease	Moolgavkar (2000a)	18-64
Emergency Room Visits, Asthma	Mar et al. (2010)	0-99
Emergency Room Visits, Asthma	Slaughter et al. (2005)	0-99
Emergency Room Visits, Asthma	Glad et al. (2012)	0-99
Acute Bronchitis	Dockery et al. (1996)	8-12
Asthma Exacerbation, Cough	Mar et al. (2004)	6-18
Asthma Exacerbation, Cough	Ostro et al. (2001)	6-18
Asthma Exacerbation, Shortness of Breath	Mar et al. (2004)	6-18
Asthma Exacerbation, Shortness of Breath	Ostro et al. (2001)	6-18
Asthma Exacerbation, Wheeze	Ostro et al. (2001)	6-18
Minor Restricted Activity Days	Ostro and Rothschild (1989)	18-64
Lower Respiratory Symptoms	Schwartz and Neas (2000)	7-14
Upper Respiratory Symptoms	Pope et al. (1991)	9-11
Work Loss Days	Ostro (1987)	18-64

How COBRA Estimates Economic Values of Effects: Unit Values

Health Incident Avoided	Economic Value ($2010)	
	3% discount rate	7% discount rate
Adult Mortality	$8,434,924	$7,512,853
Infant Mortality	$9,401,680	$9,401,680
Non-Fatal Heart Attacks	$33,259 - $263,795	$31,446 - $253,247
Hospital Admissions	$15,430 - $41,002	$15,430 - $41,002
Asthma ER Visits	$388 - $464	$388 - $464
Acute Bronchitis	$477	$477
Respiratory Symptoms	$21 - $33	$21 - $33
Asthma Exacerbations	$57	$57
Minor Restricted Activity Days	$68	$68
Work Loss Days	$160	$160

Economic Values of Effects: Sources

Health Incident Avoided	Source of Value
Adult Mortality	Value of a statistical life (VSL)*
Infant Mortality	VSL*
Non-Fatal Heart Attacks	Cost of Illness (COI) = Direct medical costs, opportunity cost (OC)
Hospital Admissions	COI = Hospital charges, OC
Asthma ER Visits	COI = Costs to the hospital
Acute Bronchitis	Willingness To Pay (WTP) = Coughing and chest tightness (CT) or restricted activity day
Respiratory Symptoms	WTP = Symptoms such as coughing, head/sinus congestion, eye irritation, CT, coughing up phlegm, and/or wheeze
Asthma Exacerbations	WTP = Bad asthma day
Minor Restricted Activity Days	WTP = Combination of coughing, throat congestion, and sinusitis
Work Loss Days	WTP = Median annual earnings divided by (5 × 52)

* For more background on the VSL, see: https://www.epa.gov/environmental-economics/mortality-risk-valuation.

Outputs: Easy-to-Read Maps and Tables

Strengths & Limitations of COBRA

STRENGTHS

- Enriches discussion of co-benefits
  - Supports a balanced decision-making process that considers both the potential costs and benefits of policy choices.
- Easy-to-Use screening tool
- Flexible for User
- Inexpensive (free!) compared to rigorous air quality models
- Quick to generate results
- Mapping of results facilitates visualization of impacts

LIMITATIONS

- COBRA is a free, screening tool not a highly sophisticated model.
  - Air Quality (AQ) model is reduced form, “quick and dirty”
  - Relies upon inputs generated elsewhere
- While there are limitations that users should understand, technical peer reviewers found COBRA to be “a valuable model that produces a screening tool that can contribute to policy analysis and public dialogue.”

Steps in a COBRA Analysis

1. Estimate where (e.g., in one or more counties or states, regionally, nationally) and what emission reductions will take place
2. Enter the location, types, and quantity of emission reductions expected from the policy or activity in COBRA
3. Select a discount rate in COBRA to appropriately discount the value of future benefits
4. Run the model and review the results

COBRA uses your inputs to estimate the air quality, health, and related economic impacts of the scenario

Step 1: Estimate where and what emissions reductions will take place

- Decide on the geographic area where emissions are expected to change
- COBRA can assess actions that affect emissions in:
  - a single county or state,
  - groups of counties and states (contiguous or otherwise), or
  - the entire nation
- COBRA allows you to vary the types and amounts of emissions changes expected to occur in different locations

Resources for Calculating Emissions Reductions from Electricity-related Policies

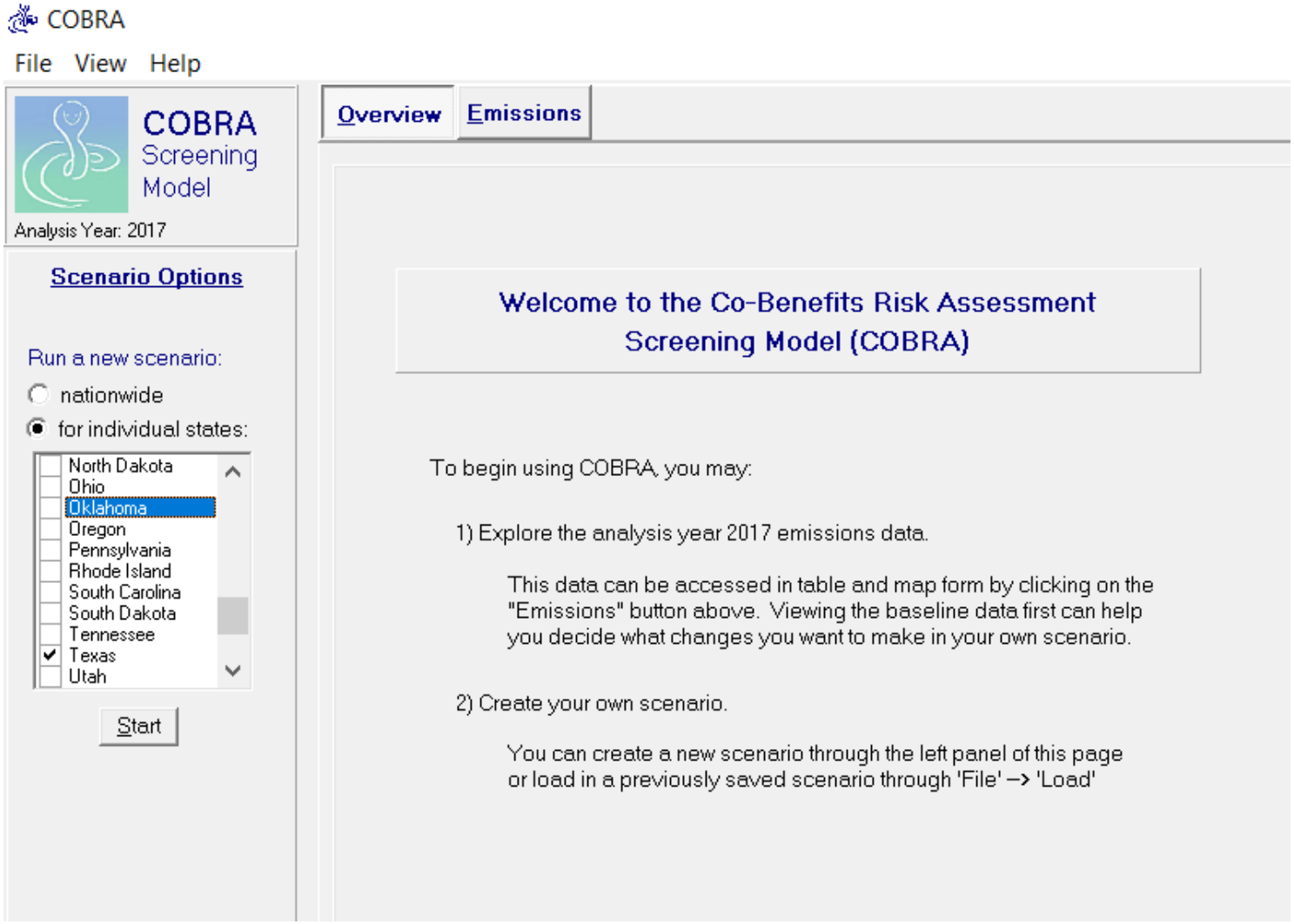
- If you do not have absolute emission reduction estimates, you can use:
  - A basic to intermediate approach or tool, such as:
    - Applying an emission factor obtained from EPA's Emissions & Generation Resource Integrated Database (eGrid) https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid, or
    - EPA's AVoided Emissions and geneRation Tool (AVERT) https://www.epa.gov/statelocalenergy/avoided-emissions-and-generation-tool-avert
    - More sophisticated approaches, such as those described in EPA guides:
    - *Assessing the Multiple Benefits of Clean Energy: A Resource for States*, Chapter 4 https://www.epa.gov/statelocalenergy/assessing-multiple-benefits-clean-energy-resource-states
    - *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans,* Appendix I https://www.epa.gov/energy-efficiency-and-renewable-energy-sips-and-tips/roadmap-incorporating-energy

Step 2: Select and enter the types, location and quantity of emission reductions expected

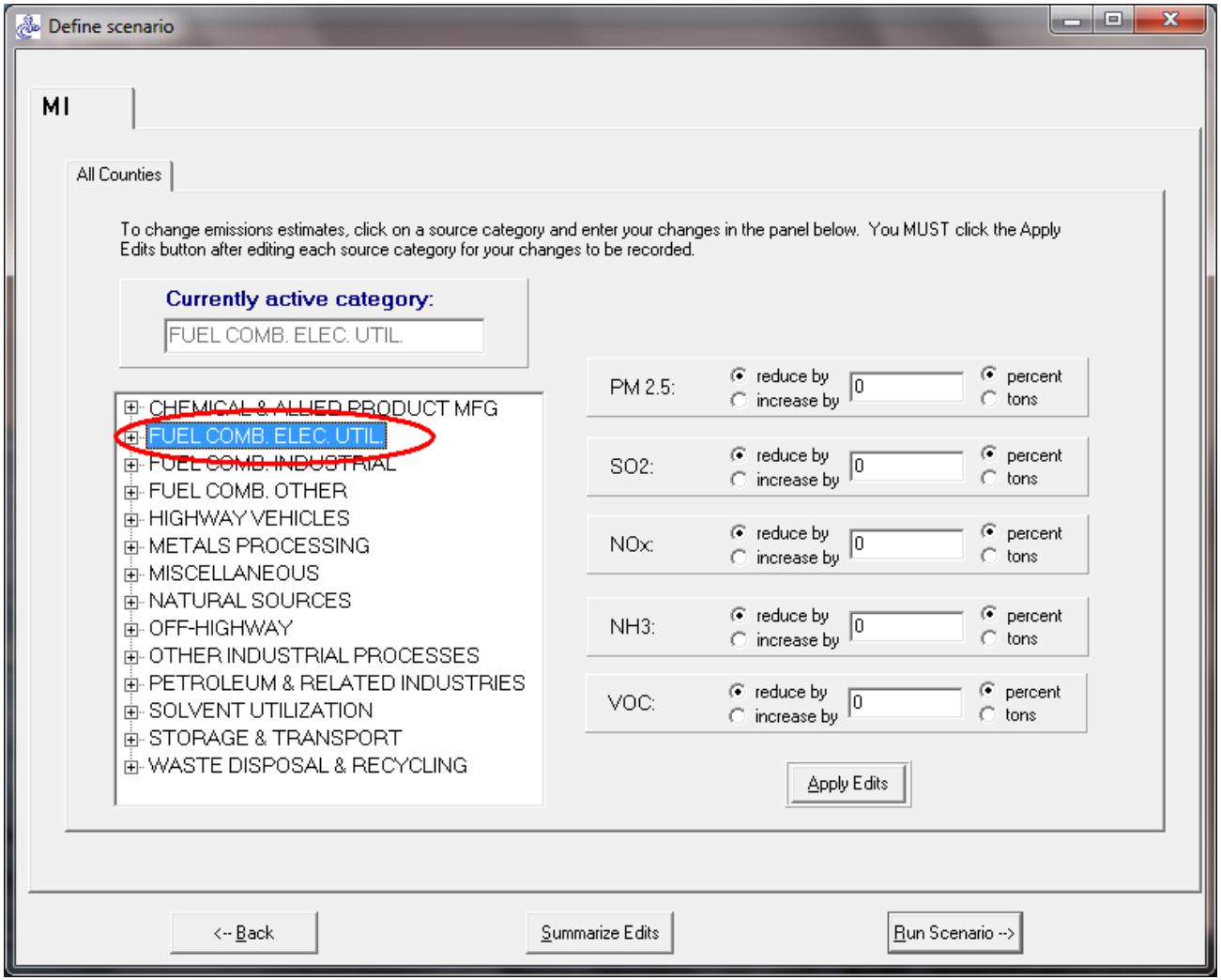
- You will need to know what source categories of emissions will be affected by the policy
- The emissions inventory in COBRA includes the 14 major emissions source categories (i.e., "tiers") of criteria pollutants included in the National Emissions Inventory (NEI):*
  - Chemical and Allied Product Manufacturing
  - Fuel Combustion - Electric Utility
  - Fuel Combustion - Industry
  - Fuel Combustion - Other
  - Highway Vehicles
  - Metal Processing
  - Miscellaneous
  - Natural Sources (Biogenics)
  - Off-Highway
  - Other Industrial Processes
  - Petroleum & Related Industries
  - Solvent Utilization
  - Storage & Transport
  - Waste Disposal & Recycling

*For more on the NEI, see: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

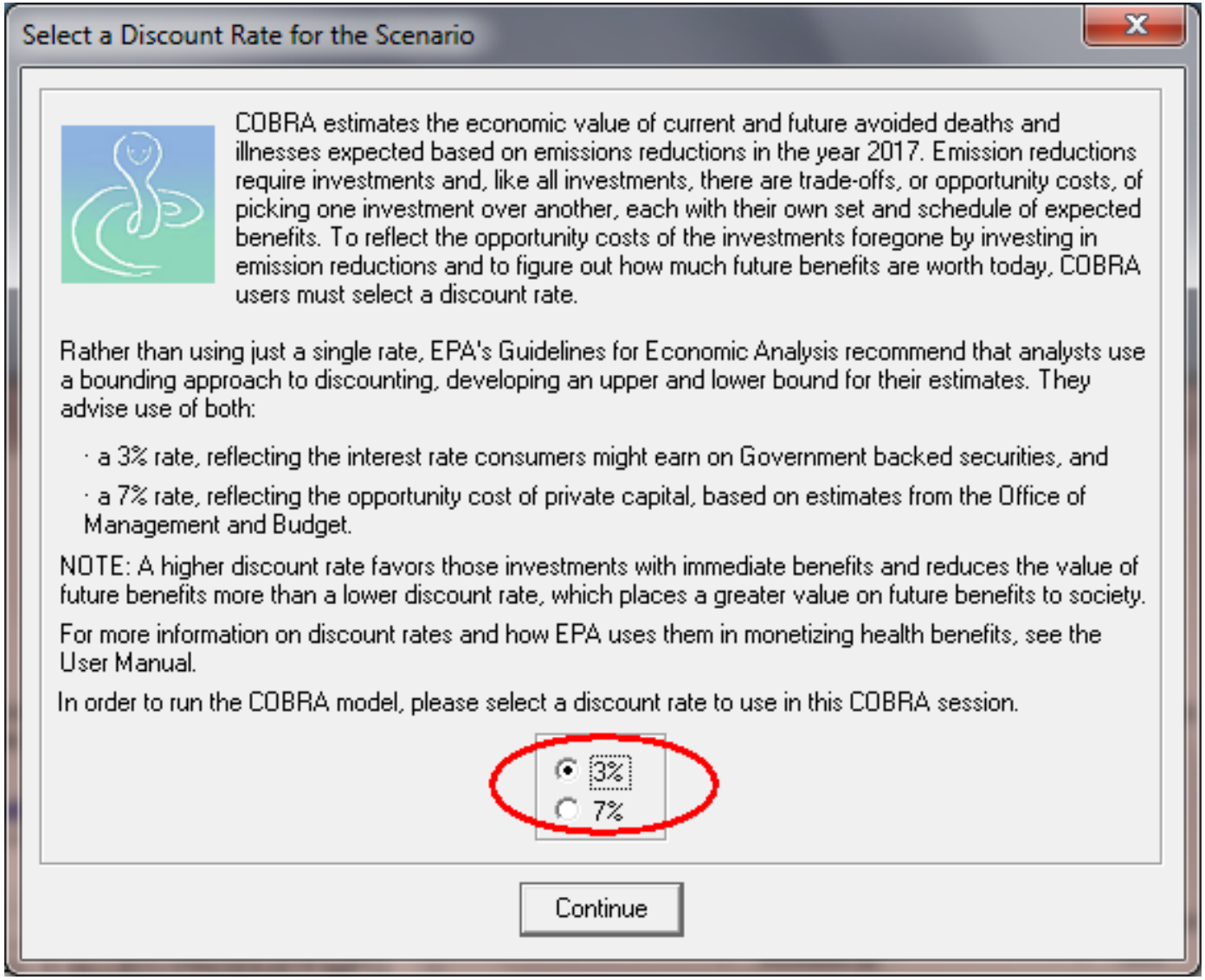
Step 2: Set up Scenario in COBRA
(a) Location of Emission Reductions Expected



Step 2: Set up Scenario in COBRA
(b) Types of Emission Reductions Expected

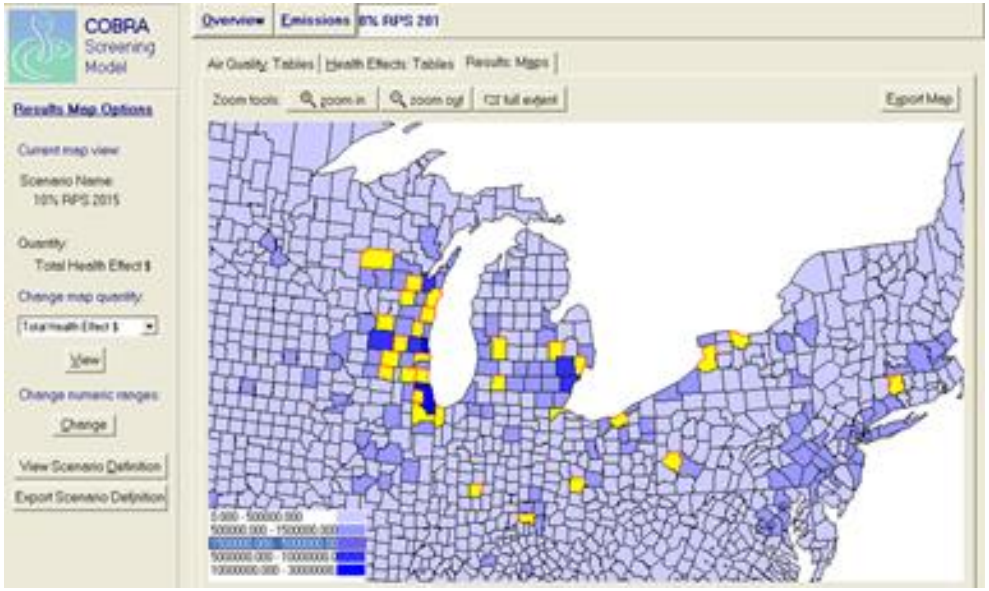


Step 3: Select a discount rate



Step 4: Run the model and review the results

- Once you have completed these steps, you are ready to run the model, which will take a few minutes depending on the speed of your computer
- You can view the results for the changes in air quality, health effects, and related economic value in table and map forms



- You can export results as tables and copy/paste screenshots into reports and presentations

Key Considerations when Interpreting Results

- COBRA is intended as a screening tool
  - COBRA does not predict the future but can be used to obtain ballpark health benefits estimates and to compare or rank options
  - When more detailed analyses are required, consider using more sophisticated modeling approaches
- There is uncertainty surrounding the values of key assumptions embedded in COBRA (i.e., emissions inventory, health impact functions, and economic values)
  - You should review the limitations and assumptions described in the COBRA User Manual

State and Local
Energy and Environment Program

Hands-On Activity:
Conduct an Analysis with COBRA

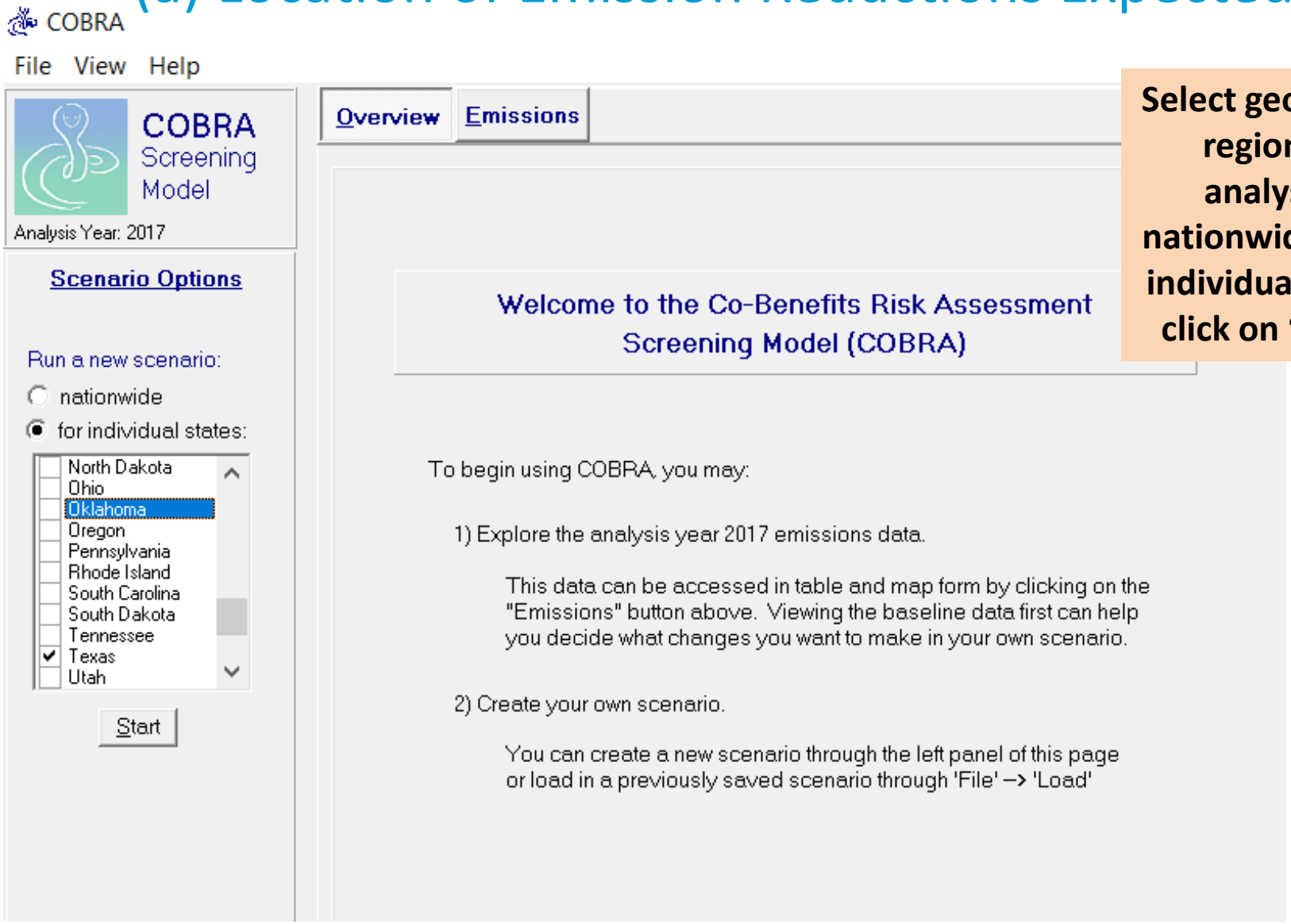
EPA United States Environmental Protection Agency

Step 1: Estimate where and what emissions reductions will take place

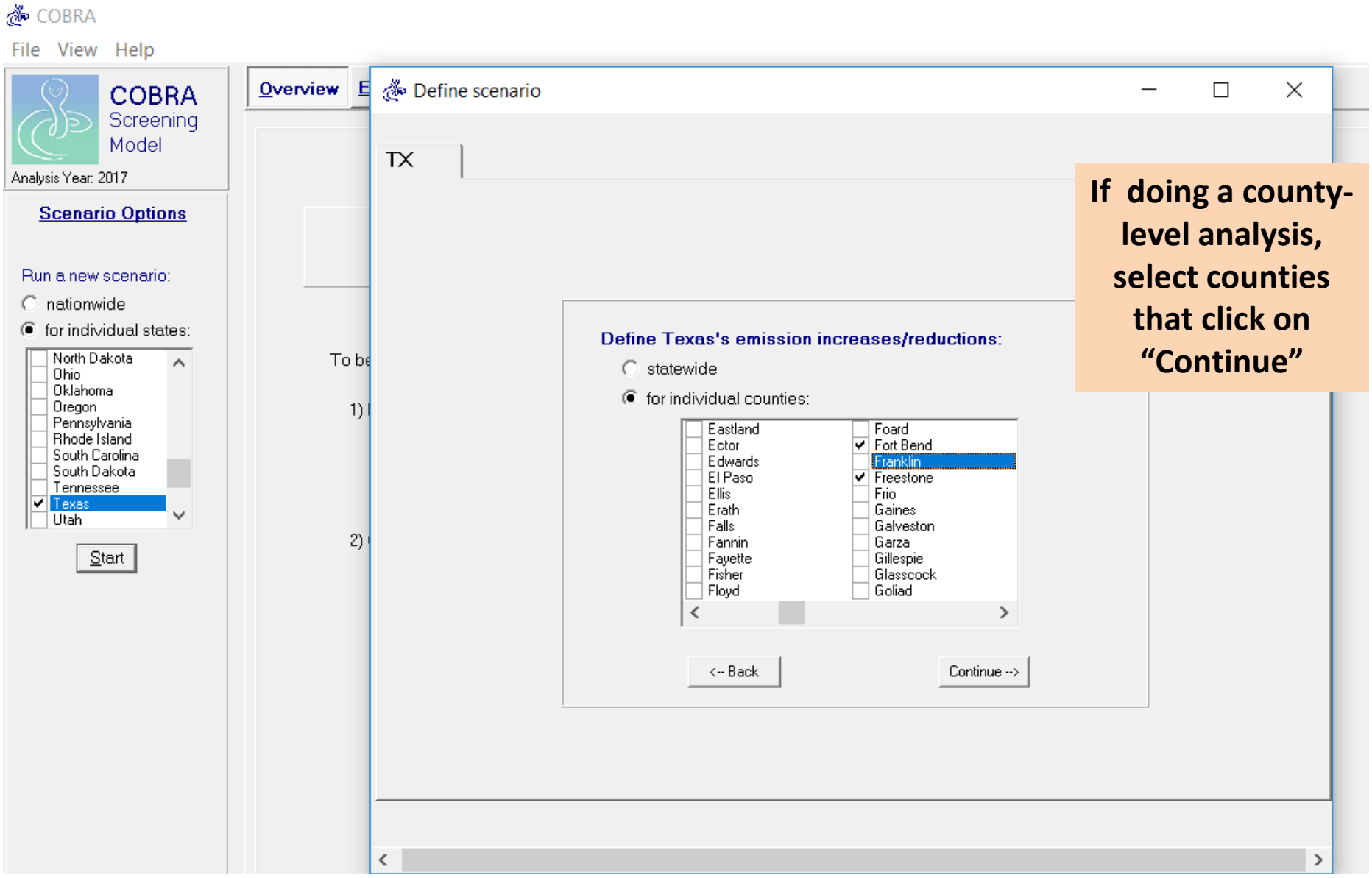
- Convert outputs from AVERT (lbs) into short tons
- To save time, let's look at the eight counties with highest impact

State	County	Annual Displaced SO_2 (tons)	Annual displaced NO_X (tons)	Annual Displaced $PM_{2.5}$ (tons)
TX	Bexar	-451	-263	-13.975
TX	Fort Bend	-1,319	-215	-53.435
TX	Freestone	-1,144	-179	-32.475
TX	Limestone	-463	-172	-12.01
TX	Milam	-179	-45	-19.265
TX	Robertson	-164	-72	-16.13
TX	Rusk	-962	-335	-32.69
TX	Titus	-1,056	-211	-23.065

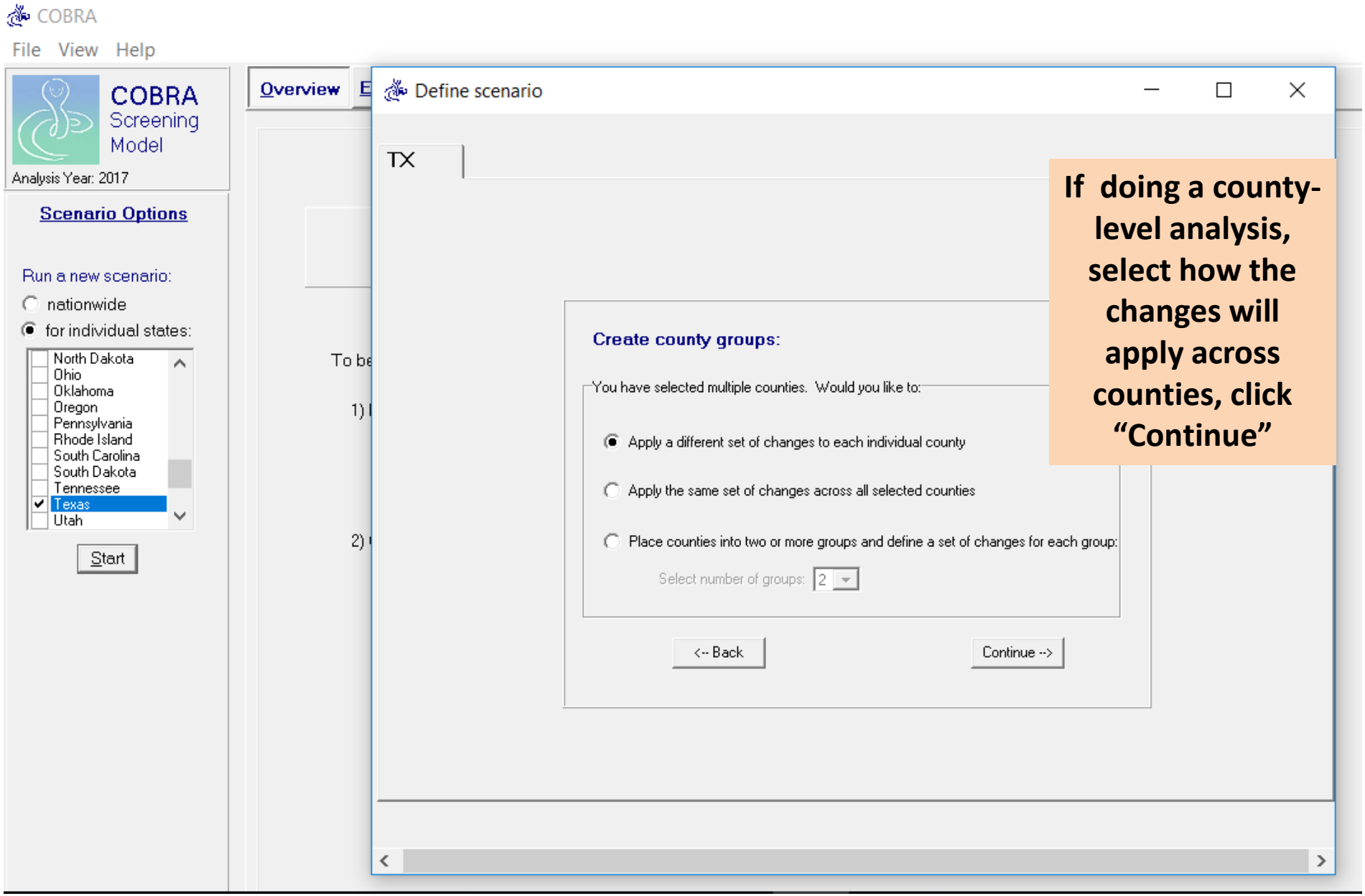
Step 2: Set up Scenario in COBRA
(a) Location of Emission Reductions Expected



Select geographic region for analysis – nationwide or for individual states, click on "Start"

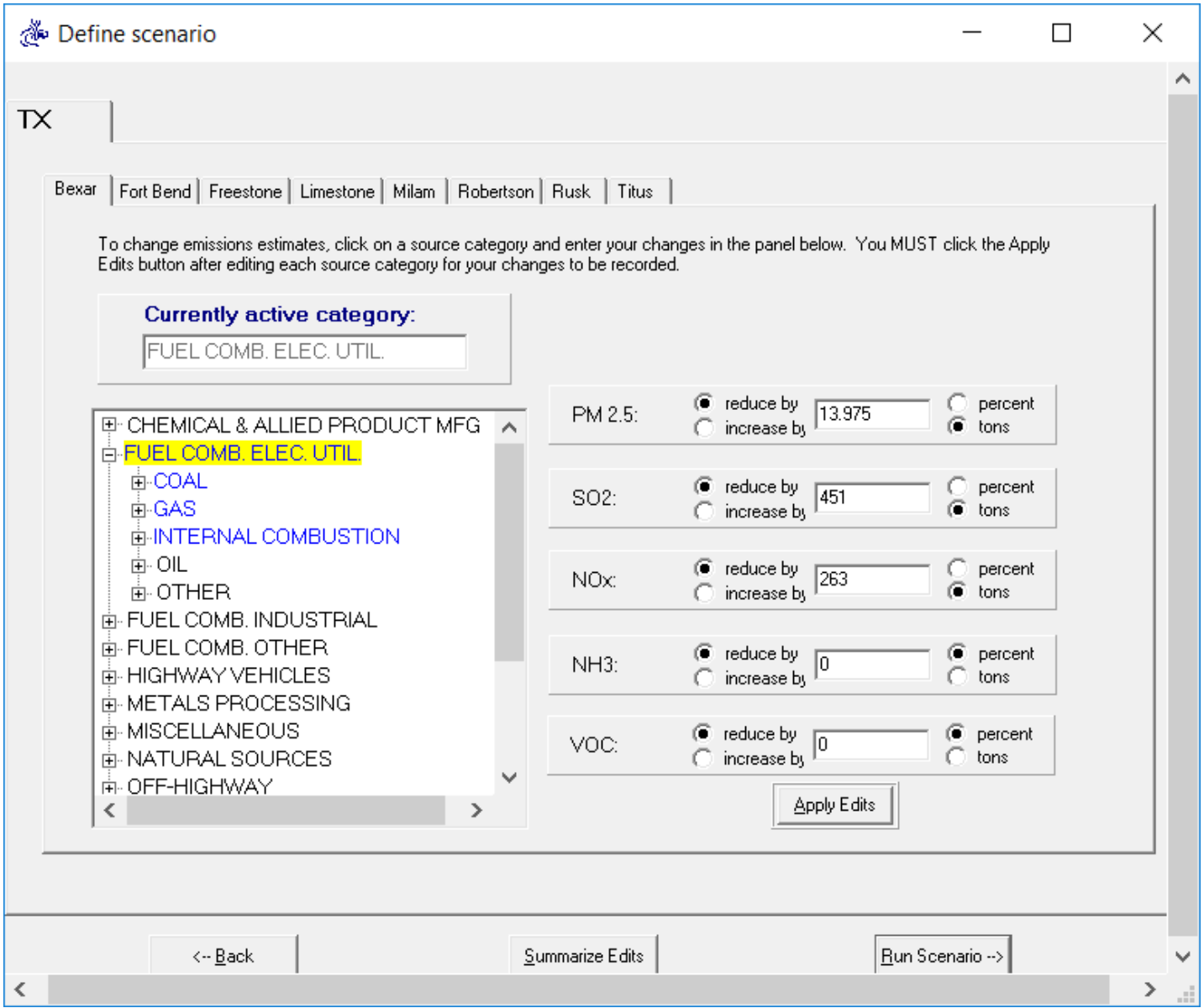


If doing a county-level analysis, select counties that click on "Continue"



If doing a county-level analysis, select how the changes will apply across counties, click "Continue"

Step 2: Set up Scenario in COBRA
(b) Type/Amount of Emission Reductions Expected



For each county:

- Select category,
- Enter tons,
- Select “Apply Edits”
- Category will turn yellow

When finished:

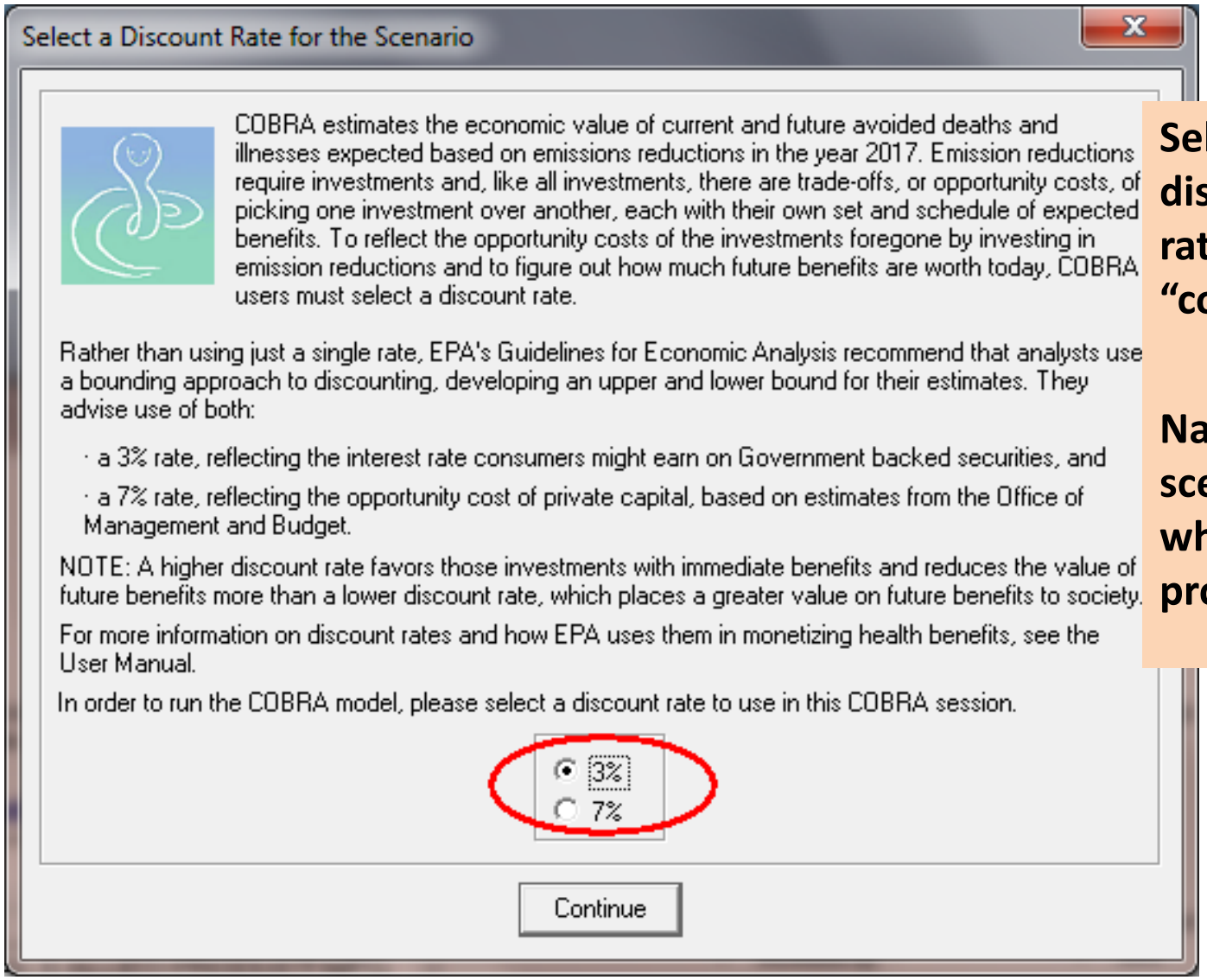
- Select “Summarize Edits” to review

Review edits made… then select “Run Scenario”

Summary of Edits to Base Emissions Data

State	County	Tier1	Tier2	Tier3	Pollutant	Change	Value	Unit	StateFIPS	CountyFIPS
TX	Limestone	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	PM 2.5	Reduce	10.5588905616111	Tons	48	293
TX	Limestone	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	SO2	Reduce	424.965038206435	Tons	48	293
TX	Limestone	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	NOx	Reduce	122.120000024757	Tons	48	293
TX	Limestone	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	PM 2.5	Reduce	1.45110943838892	Tons	48	293
TX	Limestone	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	SO2	Reduce	38.034961793565	Tons	48	293
TX	Limestone	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	NOx	Reduce	49.8799999752433	Tons	48	293
TX	Milam	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	PM 2.5	Reduce	17.6265443958489	Tons	48	331
TX	Milam	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	SO2	Reduce	168.420664874742	Tons	48	331
TX	Milam	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	NOx	Reduce	41.6141050499968	Tons	48	331
TX	Milam	FUEL COMB. ELEC. UTIL.	OTHER	OTHER	PM 2.5	Reduce	1.63845560415109	Tons	48	331
TX	Milam	FUEL COMB. ELEC. UTIL.	OTHER	OTHER	SO2	Reduce	10.5793351252582	Tons	48	331
TX	Milam	FUEL COMB. ELEC. UTIL.	OTHER	OTHER	NOx	Reduce	3.38589495000319	Tons	48	331
TX	Robertson	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	PM 2.5	Reduce	16.13	Tons	48	395
TX	Robertson	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	SO2	Reduce	164	Tons	48	395
TX	Robertson	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	NOx	Reduce	72	Tons	48	395
TX	Rusk	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	PM 2.5	Reduce	32.6697256605699	Tons	48	401
TX	Rusk	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	SO2	Reduce	962	Tons	48	401
TX	Rusk	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	NOx	Reduce	330.065618634272	Tons	48	401
TX	Rusk	FUEL COMB. ELEC. UTIL.	INTERNAL C	OTHER	PM 2.5	Reduce	.0202743394300657	Tons	48	401
TX	Rusk	FUEL COMB. ELEC. UTIL.	INTERNAL C	OTHER	NOx	Reduce	4.93438136572763	Tons	48	401
TX	Titus	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	PM 2.5	Reduce	5.23220038779929	Tons	48	449
TX	Titus	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	SO2	Reduce	133.723084874354	Tons	48	449
TX	Titus	FUEL COMB. ELEC. UTIL.	COAL	ANTHRACITE & LIGNITE	NOx	Reduce	28.3715948357528	Tons	48	449
TX	Titus	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	PM 2.5	Reduce	17.8327996122007	Tons	48	449
TX	Titus	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	SO2	Reduce	922.276915125645	Tons	48	449
TX	Titus	FUEL COMB. ELEC. UTIL.	COAL	SUBBITUMINOUS	NOx	Reduce	182.628405164247	Tons	48	449

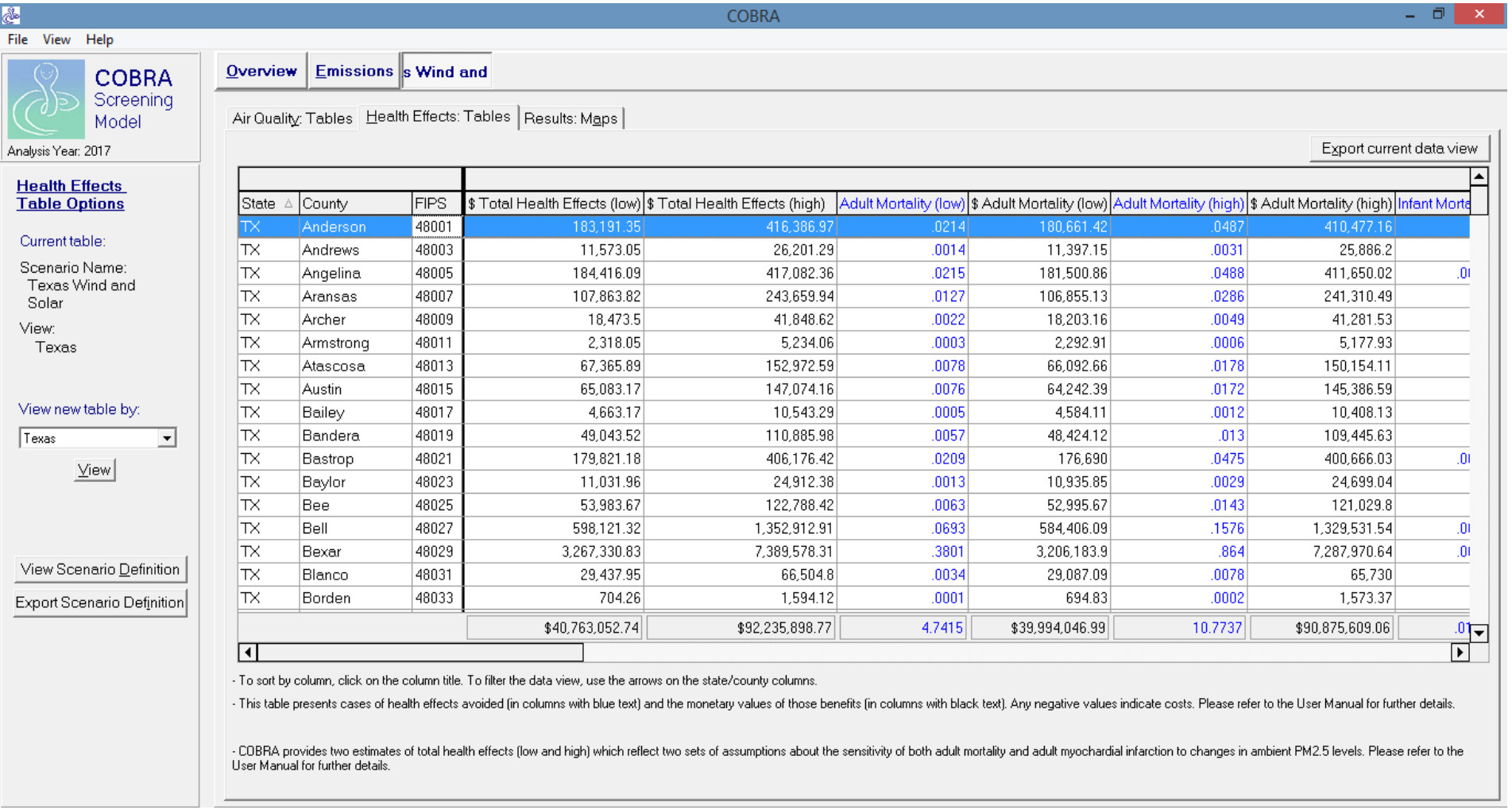
Step 3: Select a discount rate



Select a discount rate, click "continue;"

Name the scenario when prompted

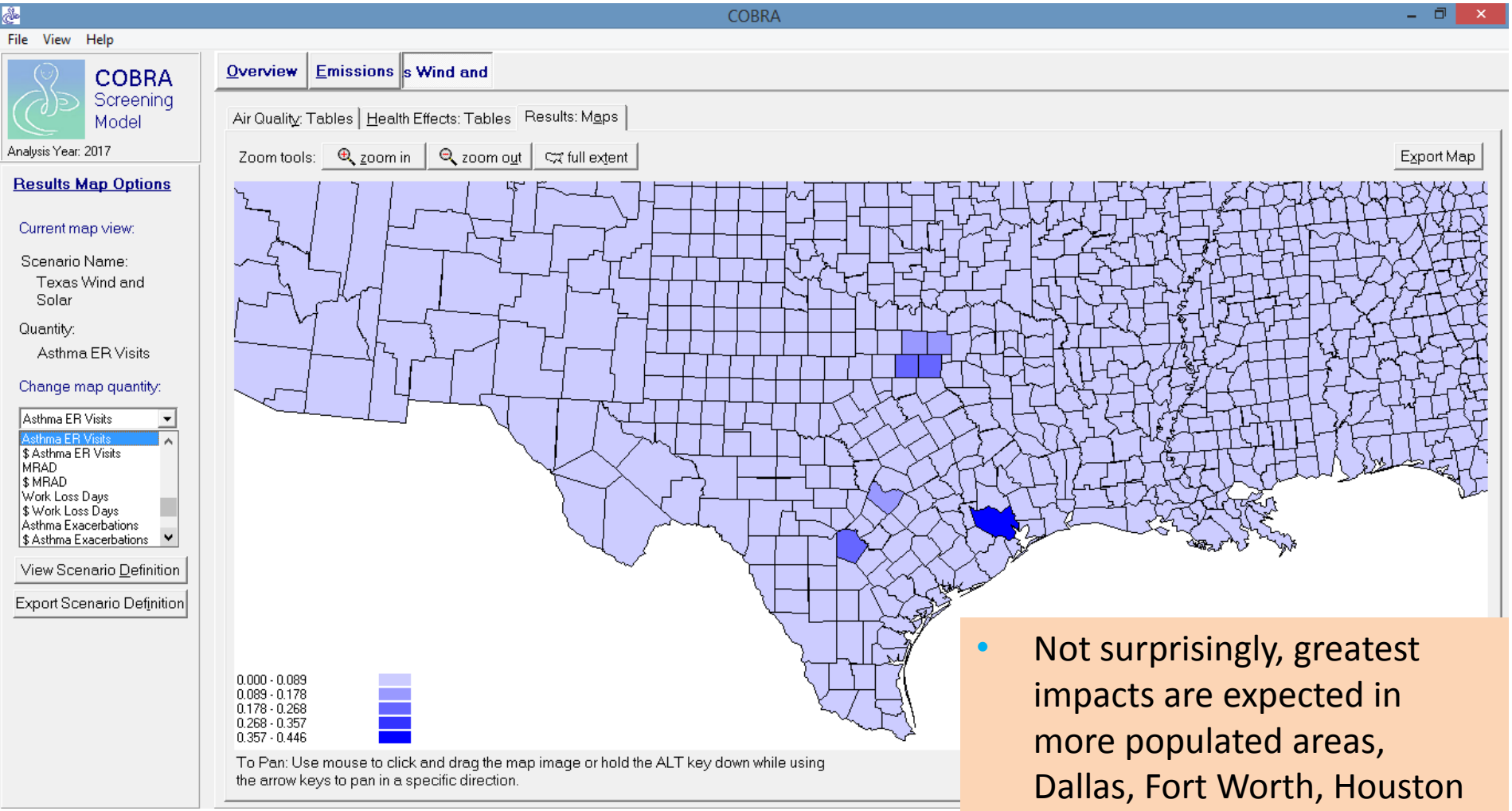
Step 4: Run the model and review the results



State	County	FIPS	$ Total Health Effects (low)	$ Total Health Effects (high)	Adult Mortality (low)	$ Adult Mortality (low)	Adult Mortality (high)	$ Adult Mortality (high)	Infant Morte
TX	Anderson	48001	183,191.35	416,386.97	.0214	180,661.42	.0487	410,477.16	
TX	Andrews	48003	11,573.05	26,201.29	.0014	11,397.15	.0031	25,886.2	
TX	Angelina	48005	184,416.09	417,082.36	.0215	181,500.86	.0488	411,650.02	.0
TX	Aransas	48007	107,863.82	243,659.94	.0127	106,855.13	.0286	241,310.49	
TX	Archer	48009	18,473.5	41,848.62	.0022	18,203.16	.0049	41,281.53	
TX	Armstrong	48011	2,318.05	5,234.06	.0003	2,292.91	.0006	5,177.93	
TX	Atascosa	48013	67,365.89	152,972.59	.0078	66,092.66	.0178	150,154.11	
TX	Austin	48015	65,083.17	147,074.16	.0076	64,242.39	.0172	145,386.59	
TX	Bailey	48017	4,663.17	10,543.29	.0005	4,584.11	.0012	10,408.13	
TX	Bandera	48019	49,043.52	110,885.98	.0057	48,424.12	.013	109,445.63	
TX	Bastrop	48021	179,821.18	406,176.42	.0209	176,690	.0475	400,666.03	.0
TX	Baylor	48023	11,031.96	24,912.38	.0013	10,935.85	.0029	24,699.04	
TX	Bee	48025	53,983.67	122,788.42	.0063	52,995.67	.0143	121,029.8	
TX	Bell	48027	598,121.32	1,352,912.91	.0693	584,406.09	.1576	1,329,531.54	.0
TX	Bexar	48029	3,267,330.83	7,389,578.31	.3801	3,206,183.9	.864	7,287,970.64	.0
TX	Blanco	48031	29,437.95	66,504.8	.0034	29,087.09	.0078	65,730	
TX	Borden	48033	704.26	1,594.12	.0001	694.83	.0002	1,573.37	
			$40,763,052.74	$92,235,898.77	4.7415	$39,994,046.99	10.7737	$90,875,609.06	.0

- To sort by column, click on the column title. To filter the data view, use the arrows on the state/county columns.
- This table presents cases of health effects avoided (in columns with blue text) and the monetary values of those benefits (in columns with black text). Any negative values indicate costs. Please refer to the User Manual for further details.
- COBRA provides two estimates of total health effects (low and high) which reflect two sets of assumptions about the sensitivity of both adult mortality and adult myocardial infarction to changes in ambient PM2.5 levels. Please refer to the User Manual for further details.

Examine the results in maps



- Not surprisingly, greatest impacts are expected in more populated areas, Dallas, Fort Worth, Houston and San Antonio

COBRA 3.0 - Coming Soon!

- Routine technical updates include:
  - Latest projection of U.S. emissions baseline (2025)
  - Recalibration of Source-receptor matrix
  - Updated population data and alignment of data
  - Alignment with latest EPA OAQPS health impact functions and dollar values
  - Most recent health baseline incidence and prevalence rates
  - User manual
- Enhancements in response to user feedback include:
  - Migration to open source platform enabling code sharing
  - Options for more sophisticated users to import/choose own baseline, population numbers, health impacts functions, economic values

How can I learn more and get a copy of COBRA?

Visit EPA's Website:

- https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-screening-model

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COBRA
Co-Benefits Risk Assessment
Health Impacts Screening and Mapping Tool

State and Local
Energy and Environment Program