State and Local Climate and Energy Program

# U.S. Environmental Protection Agency's (EPA's) CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool

February 22, 2022 | 3 PM Eastern

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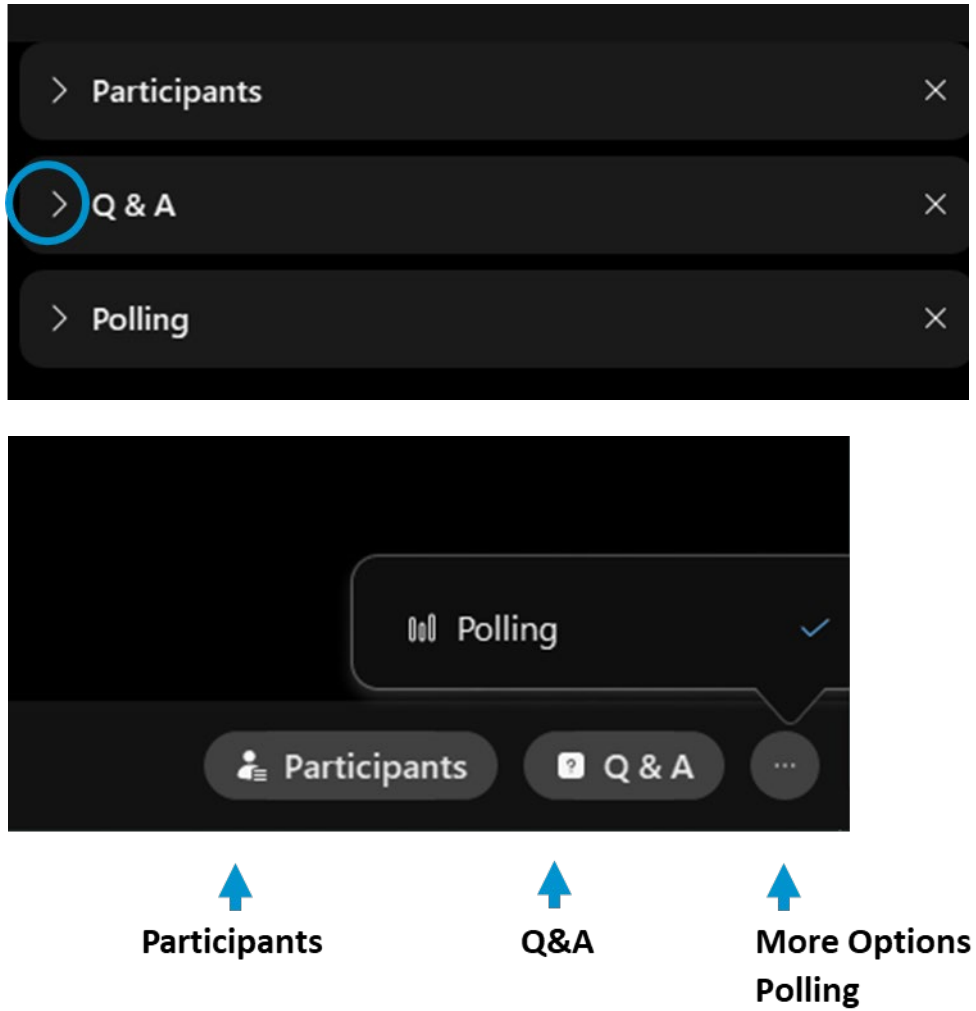
# Webinar Panels

We'll use three panels

- Participants, Polling, and Question & Answer (Q&A)
- Use the arrow to expand or collapse the panels

Adding Panels

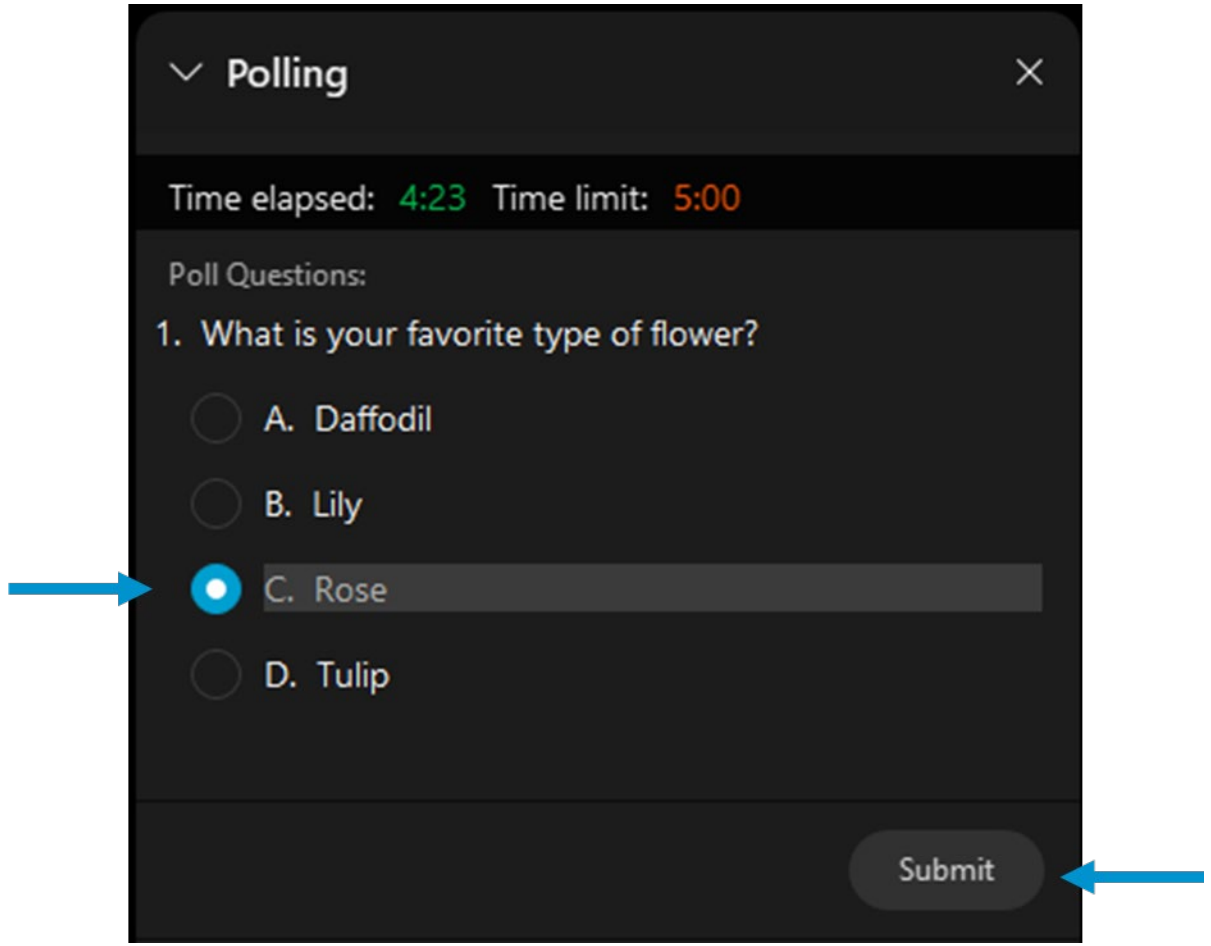
- If some panels don't appear, hover over the bottom of the screen and select the desired panels
- Select More Options (…) for additional panels
- Highlighted backgrounds indicate active panels



# Polling and Feedback

## Polling

- We'll ask several poll questions during the webinar
- The polling panel will appear when we open the first poll
- Select your desired response and hit "Submit"




## Webinar Feedback

- A feedback form will pop-up when you exit today's webinar

# Q&A

- Participants are muted
- Questions will be moderated at the end
- To ask a question:
  1. Select “All Panelists” from the drop-down menu
  2. Enter your question in the Q&A box
  3. Hit “Enter”


- EPA will post final materials on the Webinar Series page: www.epa.gov/statelocalenergy/state-local-and-tribal-webinar-series

# Today's Speakers

**Emma Zinsmeister**

Master of Public Health (MPH)

Senior Health Analyst

U.S. EPA

**David Cooley**

Master of Environmental Management (MEM)

Senior Associate

Abt Associates

- Welcome to COBRA (25 mins)
  - How COBRA works
  - Comparison of Desktop and Web Edition
  - How COBRA has been used
- Live demonstration (15 mins)
  - 100-megawatt (MW) utility solar in Tennessee
- Questions and discussion (15 mins)

- Appendix A: Web Edition step-by-step
- Appendix B: Desktop Edition step-by-step

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

GHG: Greenhouse gas
$CO_2$: Carbon dioxide

State and Local Climate and Energy Program

# Our Tools and Resources Support State, Local and Tribal Stakeholders on Climate and Energy

## Develop Inventories and Set Goals


**State Inventory and Projection Tool**
Develop and update inventories for 11 sectors. Forecast emissions through 2050

**Local Inventory Tool**
Develop community-wide inventories or inventories of local government operations only

**Tribal Inventory Tool**
Develop community-wide inventories or inventories of tribal government operations only

## Design, Compare, or Evaluate Policy

AVERT

**AVoided Emissions and geneRation Tool**
Evaluate changes in power plant emissions from energy policy

COBRA

**Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool**
Quantify and monetize health impacts of reducing emissions

HEALTH $ BENEFITS per kilowatt-hour

**Health Benefits per kWh**
Estimate the health benefits per kWh of clean energy

ESIST Energy Savings and Impacts Scenario Tool

**Energy Savings and Impacts Scenario Tool**
Analyze energy savings, costs, and multiple benefits from energy efficiency programs

## Communicate and Support Policy Implementation

$CO_2$ Greenhouse Gas Equivalencies CALCULATOR

**Greenhouse Gas Equivalencies Calculator**
Convert a unit of energy to the equivalent amount of $CO_2$ emissions from using that amount

HEAT ISLAND REDUCTION PROGRAM

**Heat Island Reduction Program**
Resources to implement heat island mitigation policies and projects

**Technical Support**
Provide 1-1 technical support for state, local and tribal stakeholders

**Convene Stakeholders**
Engage state, local and tribal decision-makers

**Local Action Framework:**
A Guide to Help Communities Achieve Energy and Environmental Goals

**Energy and Environment Guide to Action:** State Policies and Best Practices for Advancing Energy Efficiency, Renewable Energy, and Combined Heat and Power

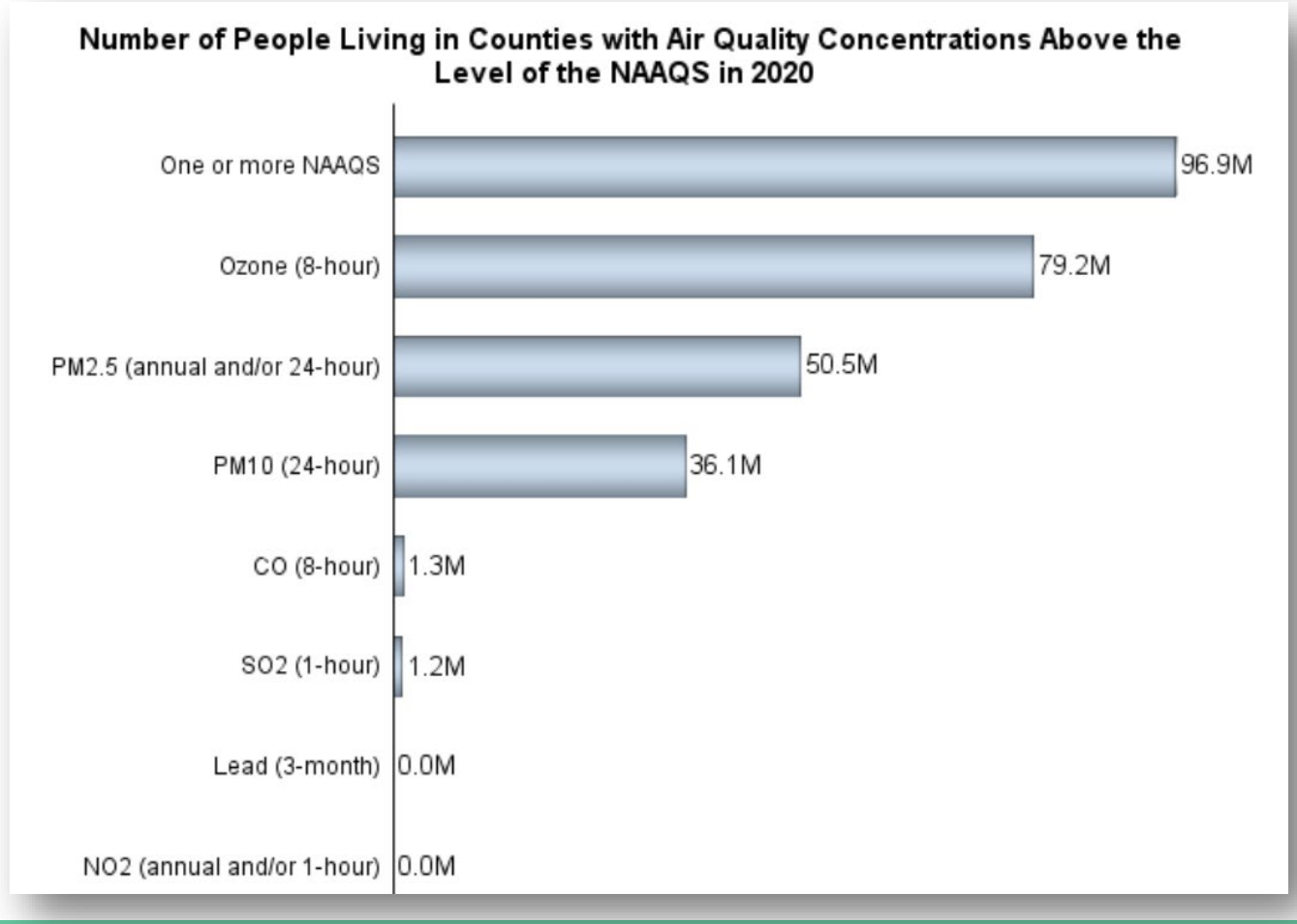
**Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy:**
A Guide for State and Local Governments

**Local Government Climate and Energy Strategy Series:**
A Guide to Developing and Implementing Greenhouse Gas Reduction Programs

State and Local Climate and Energy Program

# Welcome to COBRA

# Air pollution remains a concern across the United States

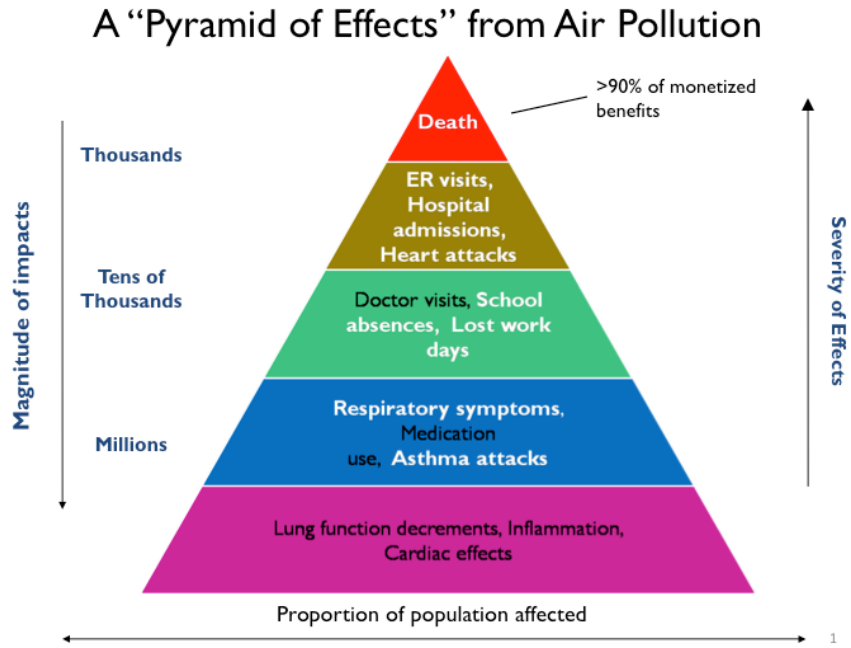



NAAQS: National Ambient Air Quality Standards
$PM_{2.5}$: Particulate matter 2.5
$PM_{10}$: Particulate matter 10
CO: Carbon monoxide
$SO_2$: Sulfur dioxide
$NO_2$: Nitrogen dioxide

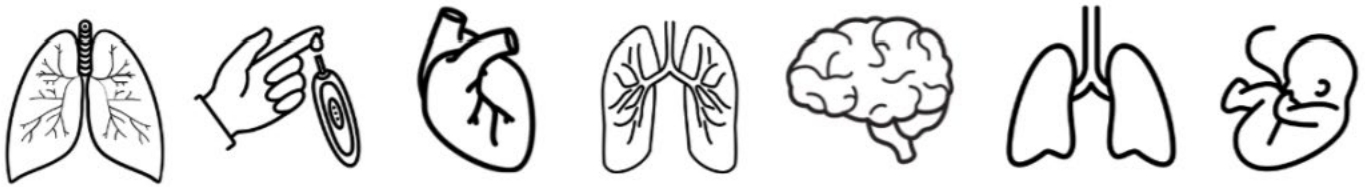
# Health effects of air pollution

**61,000 deaths** attributed to air pollution in the United States (2019)

48,000 from $PM_{2.5}$ exposure
13,000 from ozone ($O_3$) exposure




***Percentage of Deaths (by Cause) Attributed to Air Pollution in the United States in 2019***



**10 percent** of COPD deaths

**6 percent** of diabetes deaths

**3 percent** of ischemic heart disease deaths

**4 percent** of lung cancer deaths

**3 percent** of stroke deaths

**3 percent** of lower-respiratory infection deaths

**4 percent** of neonatal deaths

COPD: Chronic obstructive pulmonary disease

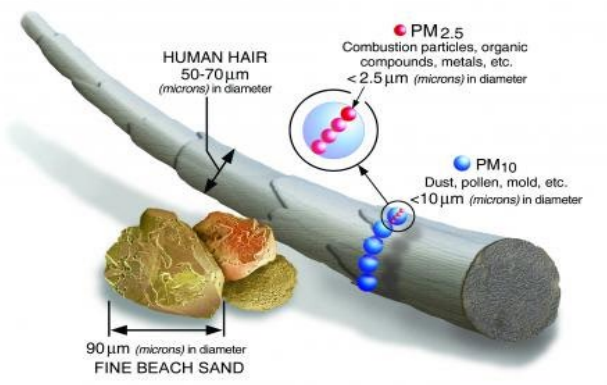
# Fine PM 2.5

**Primary $PM_{2.5}$**

- Emitted directly into the atmosphere
- Sources:
  - Smokestacks
  - Construction sites
  - Unpaved roads
  - Fields
  - Fires

**Secondary $PM_{2.5}$**

- Formed through complex atmospheric reactions of
  - $SO_2$
  - Nitrogen oxides ($NO_x$)
  - Ammonia ($NH_3$)
  - Volatile organic compounds (VOCs)
- Sources:
  - Pollutants emitted from power plants, industries and automobiles



# Energy choices matter

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

Energy Efficiency, Renewable Energy, Low Emission Fuels

Reduce Emissions

- Reduces air pollution
- Improves air quality and human health
- Reduces premature death and illnesses

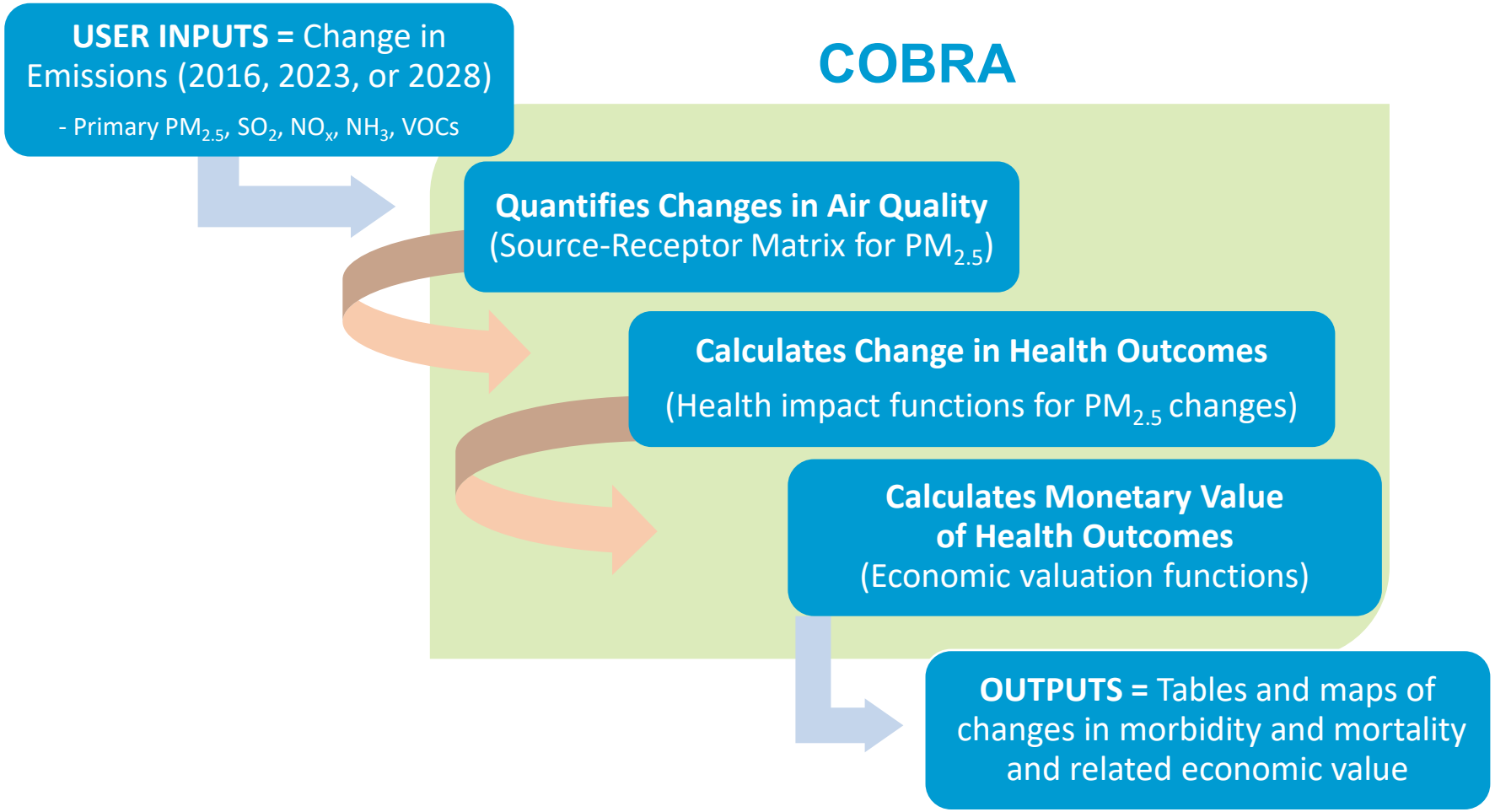
- People avoid costly illnesses
- Businesses benefit from increased worker productivity, fewer employee absences
- Children miss fewer school days

Deliver Societal Benefits

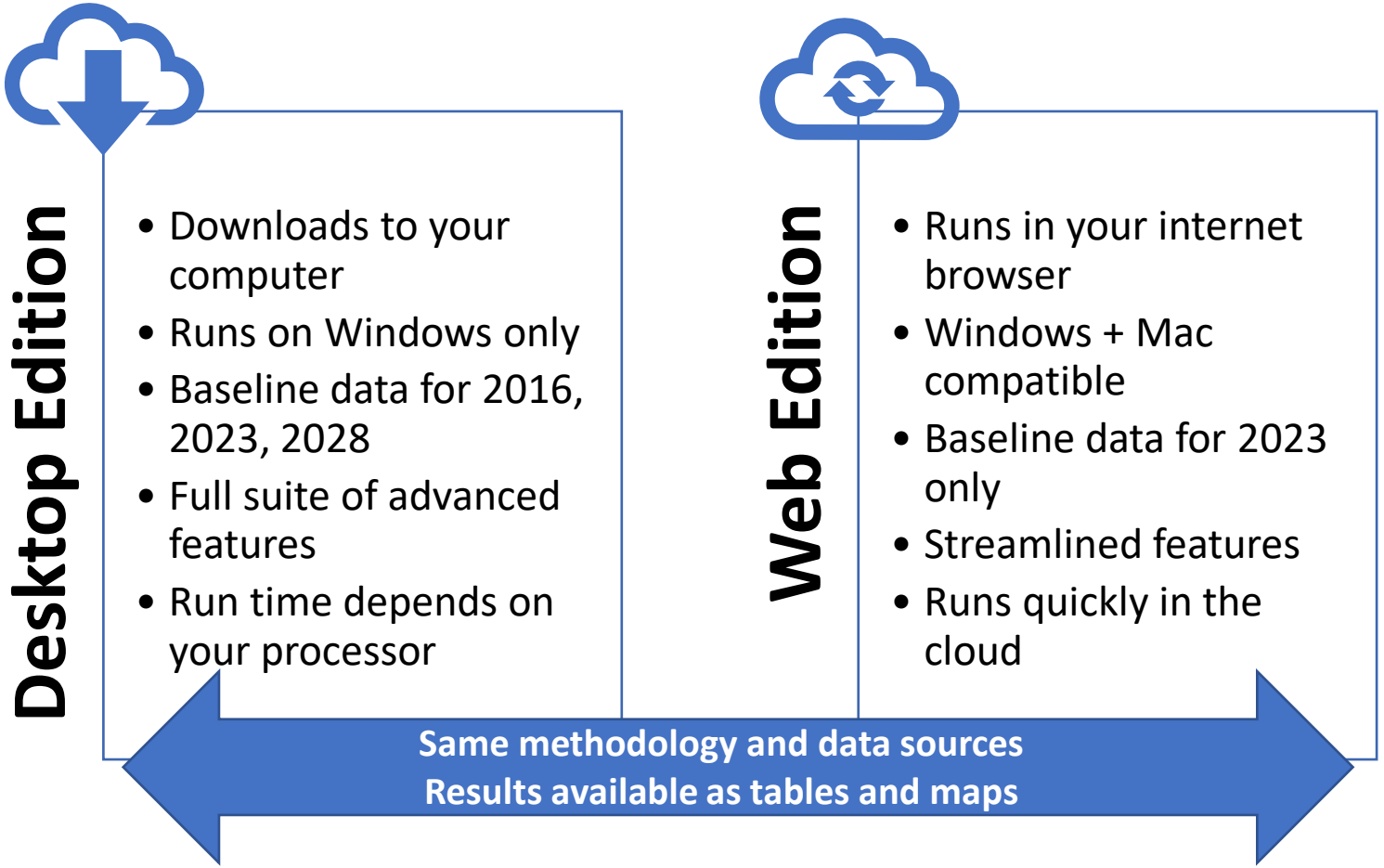
# What is COBRA?

- COBRA is a free, easy-to-use, peer reviewed screening model that quickly:
  - Estimates county-level **health impacts** from changes in criteria air pollutants that affect $PM_{2.5}$ concentrations;
  - Monetizes the **economic value** of those benefits; and
  - Presents results via **tables and maps** that facilitate visualization of the results.
- COBRA uses approaches and assumptions consistent with EPA's standard practices.
- It is intended to enrich the discussion of co-benefits and foster balanced decision-making that considers both the costs and health benefits of policy choices, especially related to energy.

# How does COBRA work?



# What are the options for running COBRA?



# Where do the emissions baseline data come from?

- COBRA contains detailed emissions inventories for the years 2016 and 2023, and 2028 derived from EPA's 2016v1 Air Emissions Modeling Platform.
  - Reflect federal and state measures (promulgated or under reconsideration) as of May 2018.

- The 2016, 2023, and 2028 base cases include:
  - Electrical generating unit emissions (reflecting the implementation of the Cross State Air Pollution Rule Update);
  - The Mercury and Air Toxics Rule (MATS);
  - The Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources;
  - Mobile emissions (reflecting changes in activity data and the impacts the Tier 3 Motor Vehicle Emission and Fuel Standards Rule and local inspection and maintenance programs); and
  - Base year-specific fire data for 2016.

# How does COBRA quantify $PM_{2.5}$-related air quality changes?

- COBRA translates air pollution emissions changes into changes in **ambient $PM_{2.5}$** using a reduced form air quality model, the Source-Receptor (S-R) Matrix.
- The **S-R Matrix 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.
- Since the S-R Matrix is not a sophisticated model, COBRA is most appropriately used as a **screening tool**.

# What human health effects are included?

- COBRA estimates the number of health incidences avoided AND the related economic value for:

| | | | |
|---|---|---|---|
| **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 does COBRA quantify and monetize health impacts?

- Uses a range of health impact functions to translate changes in ambient $PM_{2.5}$ into health incidences.
- Includes estimates of baseline incidence rates and prevalence rates for the health effects.
- Uses population and income projections based on U.S. Census of Population & Housing and forecasting models developed by Woods & Poole.
- Applies economic valuation functions and discount rates to develop dollar estimates.

# Which epidemiological studies are used to estimate adverse health impacts of $PM_{2.5}$?

| 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 |



For full citations see the COBRA user manual at www.epa.gov/cobra.

# What are the unit values of the health effects estimated in COBRA?

| Health Incidence Avoided | Economic Value in 2023 (2017$) | |
|---|---|---|
| | 3% discount rate | 7% discount rate |
| Adult Mortality* | $9,748,682 | $8,682,996 |
| Infant Mortality | $10,866,012 | $10,866,012 |
| Non-Fatal Heart Attacks* | $39,174 - $309,825 | $37,038 - $297,494 |
| Hospital Admissions | $17,655 - $47,581 | $17,655 - $47,581 |
| Asthma ER Visits | $457 - $547 | $457 - $547 |
| Acute Bronchitis | $550 | $550 |
| Respiratory Symptoms (upper + lower) | $24 - $38 | $24 - $38 |
| Asthma Exacerbations | $66 | $66 |
| Minor Restricted Activity Days | $78 | $78 |
| Work Loss Days | $178 | $178 |

*Discounted due to time lag between $PM_{2.5}$ exposure and health outcome; low and high values based on assumptions of how sensitive outcomes are to unit change in $PM_{2.5}$ exposure

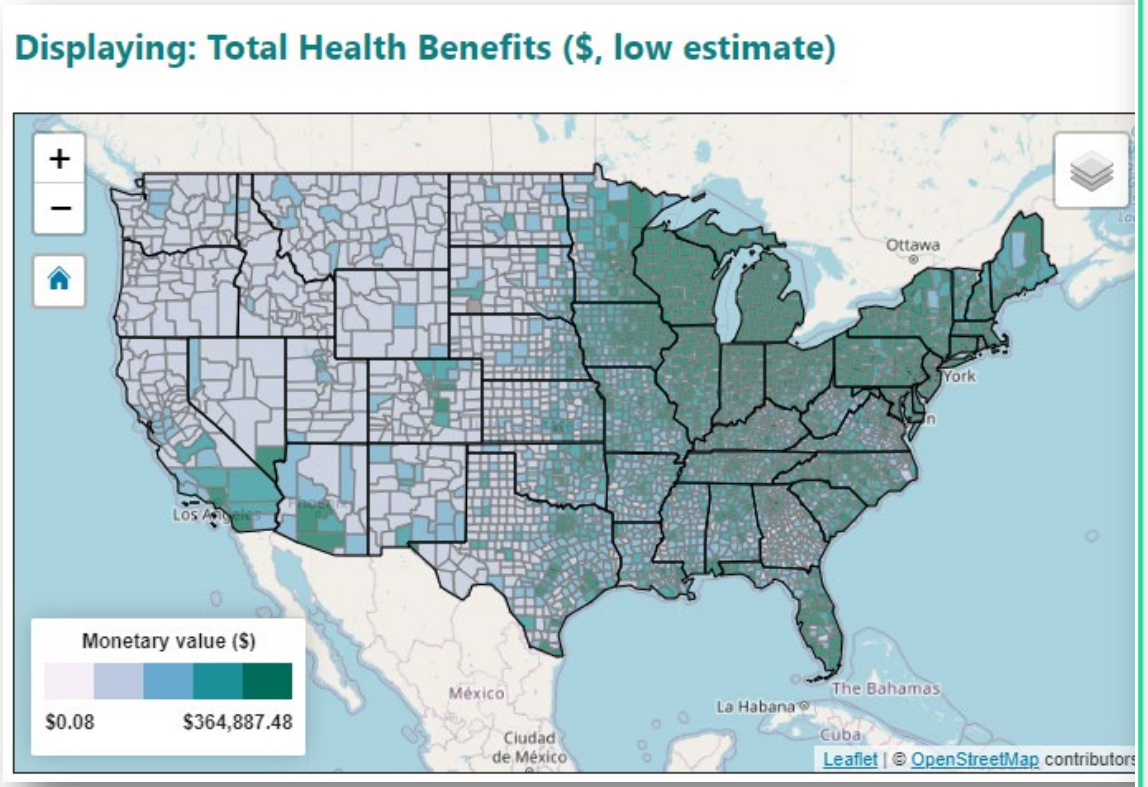
# What methods are used to determine the economic value of different health effects?

| 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 Emergency Room 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: www.epa.gov/environmental-economics/mortality-risk-valuation.

# How are results displayed?

## Tables & maps




(screenshots from Web Edition)

**Step 3: View Results** BUILD NEW SCENARIO

### A. Summary of Health Effects Results

Below is a table with the health effects results based on your scenario.

You are viewing results for all contiguous U.S. states. This is because changes in air quality can impact health endpoints in multiple locations due to the transportation of emissions across state and county lines.

**Use the filters below to see health effects for a specific state or county.**

**1. Filter by state:** All contiguous U.S. states

**2. Filter by county: (optional)** All counties

### Results for: All Contiguous U.S. States

Export: All results | Current filter

| Health Endpoint | Change in Incidence (cases, annual) | | Monetary Value (dollars, annual) | |
|---|---|---|---|---|
| | Low | High | Low | High |
| Mortality * | 0.435 | 0.984 | $4,757,095 | $10,765,302 |
| Nonfatal Heart Attacks * | 0.045 | 0.415 | $7,136 | $66,308 |
| Infant Mortality | 0.002 | 0.002 | $24,826 | $24,826 |
| Hospital Admits, All Respiratory | 0.084 | 0.084 | $4,806 | $4,806 |
| Hospital Admits, Cardiovascular ** | 0.094 | 0.094 | $3,395 | $3,395 |
| Acute Bronchitis | 0.550 | 0.550 | $339 | $339 |
| Upper Respiratory Symptoms | 9.930 | 9.930 | $424 | $424 |
| Lower Respiratory Symptoms | 6.985 | 6.985 | $189 | $189 |
| Emergency Room Visits, Asthma | 0.189 | 0.189 | $107 | $107 |
| Asthma Exacerbation | 10.375 | 10.375 | $770 | $770 |
| Minor Restricted Activity Days | 292.579 | 292.579 | $25,649 | $25,649 |
| Work Loss Days | 49.376 | 49.376 | $9,885 | $9,885 |
| **Total Health Effects** | | | **$4,834,620** | **$10,901,999** |

* The Low and High values represent differences in the methods used to estimate some of the health impacts in COBRA. For example, high and low results for avoided premature mortality are based on two different epidemiological studies of the impacts of PM2.5 on mortality in the United States

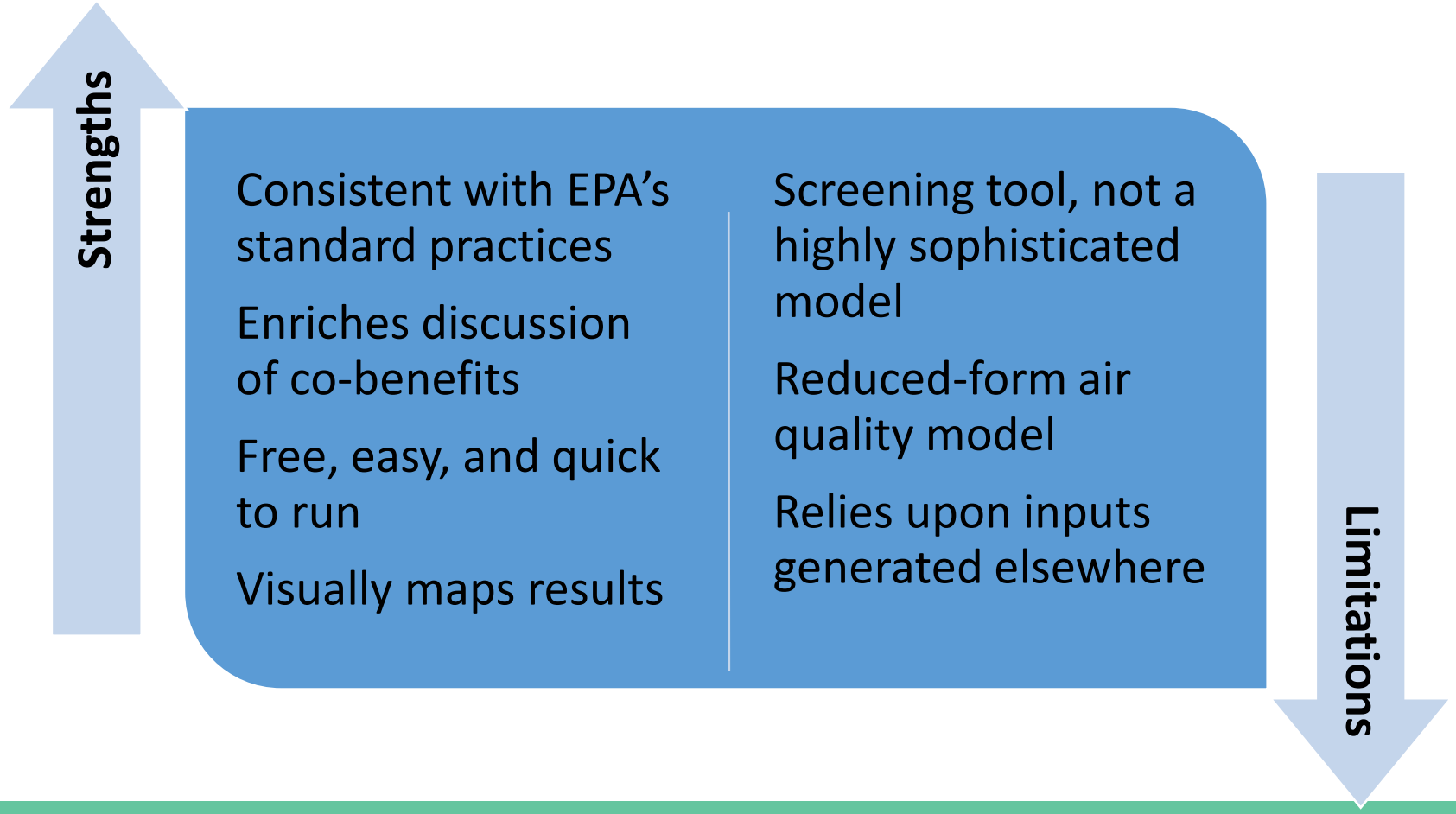
# What do the results represent?

- Results represent the **annual change** in average $PM_{2.5}$ microgram per cubic meter ($\mu g/m^3$) concentration, health incidence, and monetary value (2017 $) for the year of analysis (2016, 2023, or 2028).
- Incidence refers to the number of new cases of a health outcome over a specified time period. The change in incidence is not necessarily a whole number because COBRA calculates small **statistical risk reductions** that are then aggregated over the entire population.

# What do the results represent?

- COBRA calculates **low and high values** because two different sets of health impact functions are used to estimate adult mortality and non-fatal heart attacks based on assumptions of the sensitivity of these outcomes to $PM_{2.5}$ concentrations.
- COBRA uses a **discount rate** to express future economic values in present terms because not all health effects and associated economic values occur in the year of analysis. COBRA assumes changes in adult mortality and non-fatal heart attacks occur over a 20-year period.

# What should you keep in mind when using either the Desktop or Web Edition?



# How has COBRA been used?

## *State-level Climate Action Plans*

- Maryland, New York, and Oregon

## *Renewable energy policies and programs*

- Renewable policies in Illinois
- Solar installations in Long Island, NY

## *Energy efficiency policies and programs*

- North Carolina's Clean Energy Plan
- Illinois Energy Efficiency Portfolio Standard

## *Transportation policies*

- Analysis of reduced vehicle trips in Utah
- Public transit program in Nevada

## *Other analyses*

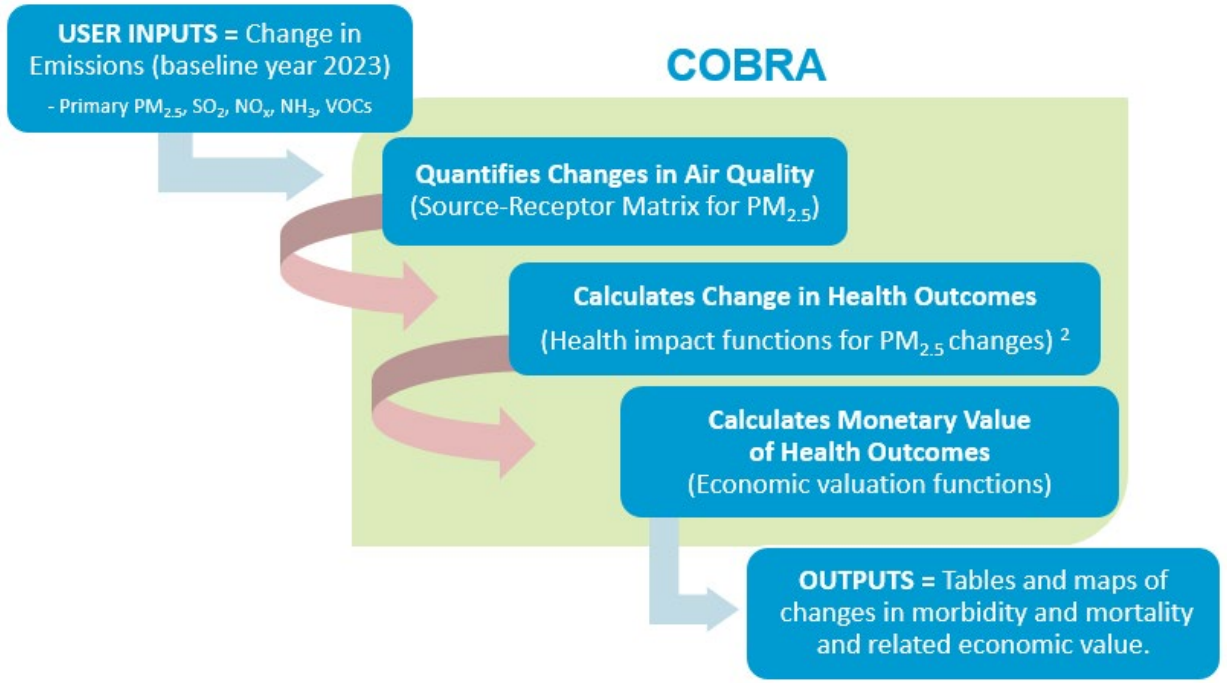
- Impacts of prescribed fires
- Benefits of urban tree planting

**More than 130** citations as of February 2022

# Pop Quiz

## Q: What makes COBRA a screening-level tool?

a) The source-receptor matrix for $PM_{2.5}$
b) The health impact functions
c) The economic valuation functions
d) All the above



State and Local Climate and Energy Program

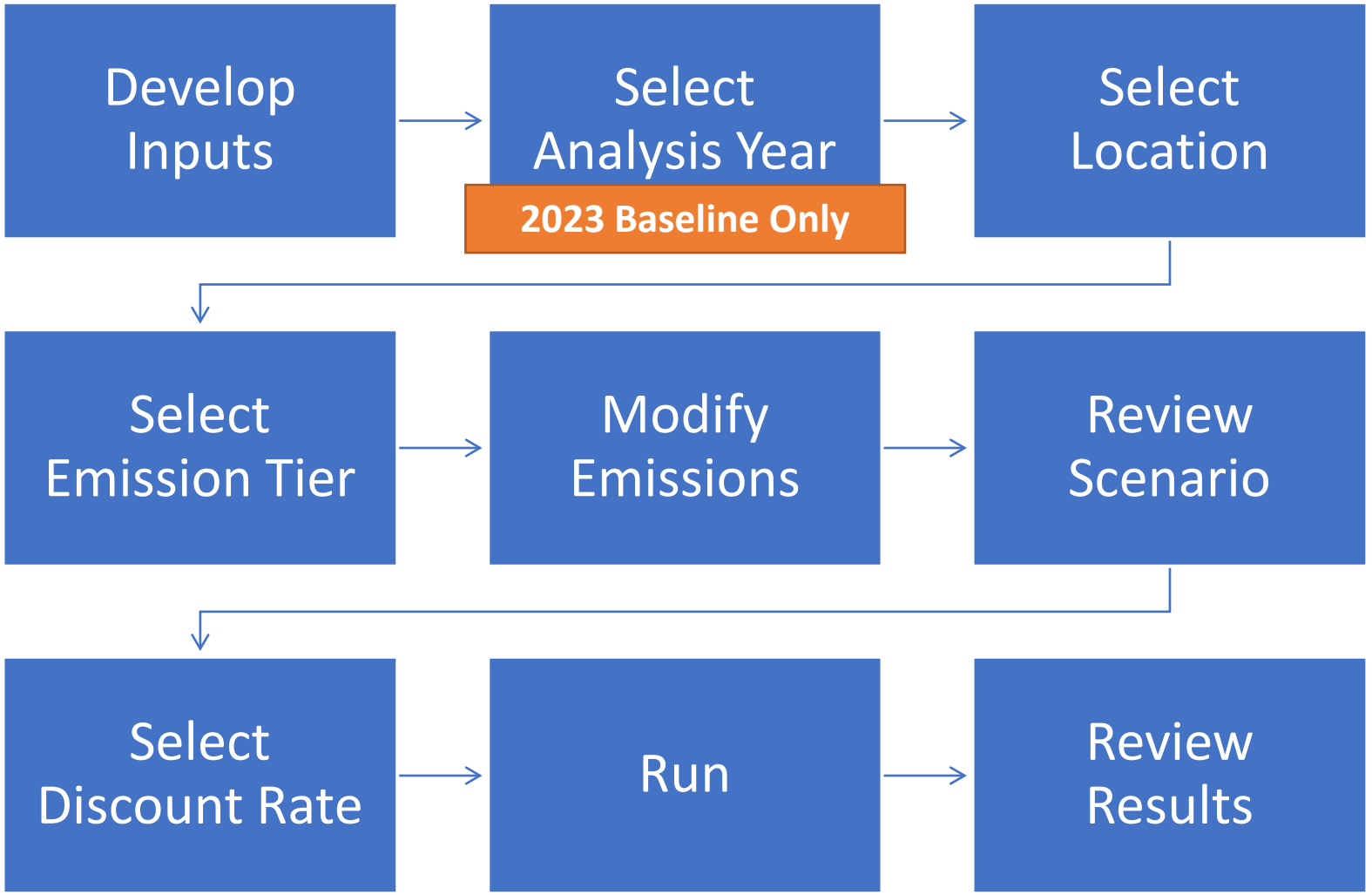
# Live Demonstration

www.epa.gov/cobra

# Demo: Assessed with COBRA Web Edition

What are the air quality and health impacts of a **100 MW utility solar** installation in **Nashville, Tennessee**?

# How do you run the COBRA Web Edition?



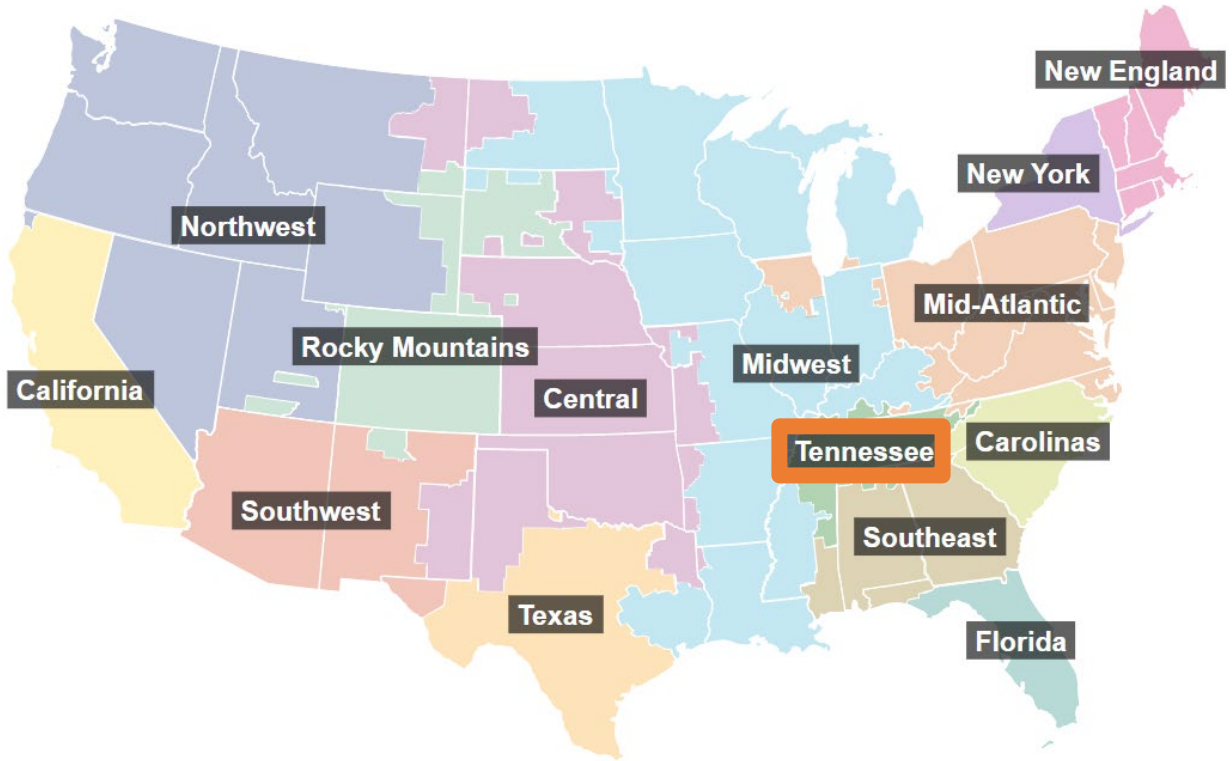
# Develop Inputs

- When are the emissions changes taking place?
- Where are the emissions changes occurring?
- What is the source of the emissions?
- What emissions are changing and by how much?

# Generate emissions inputs

100 MW Utility Solar in Tennessee

AVERT
AVoided Emissions and geneRation Tool
www.epa.gov/avert




Select “Tennessee” region

# Emissions estimates from AVERT

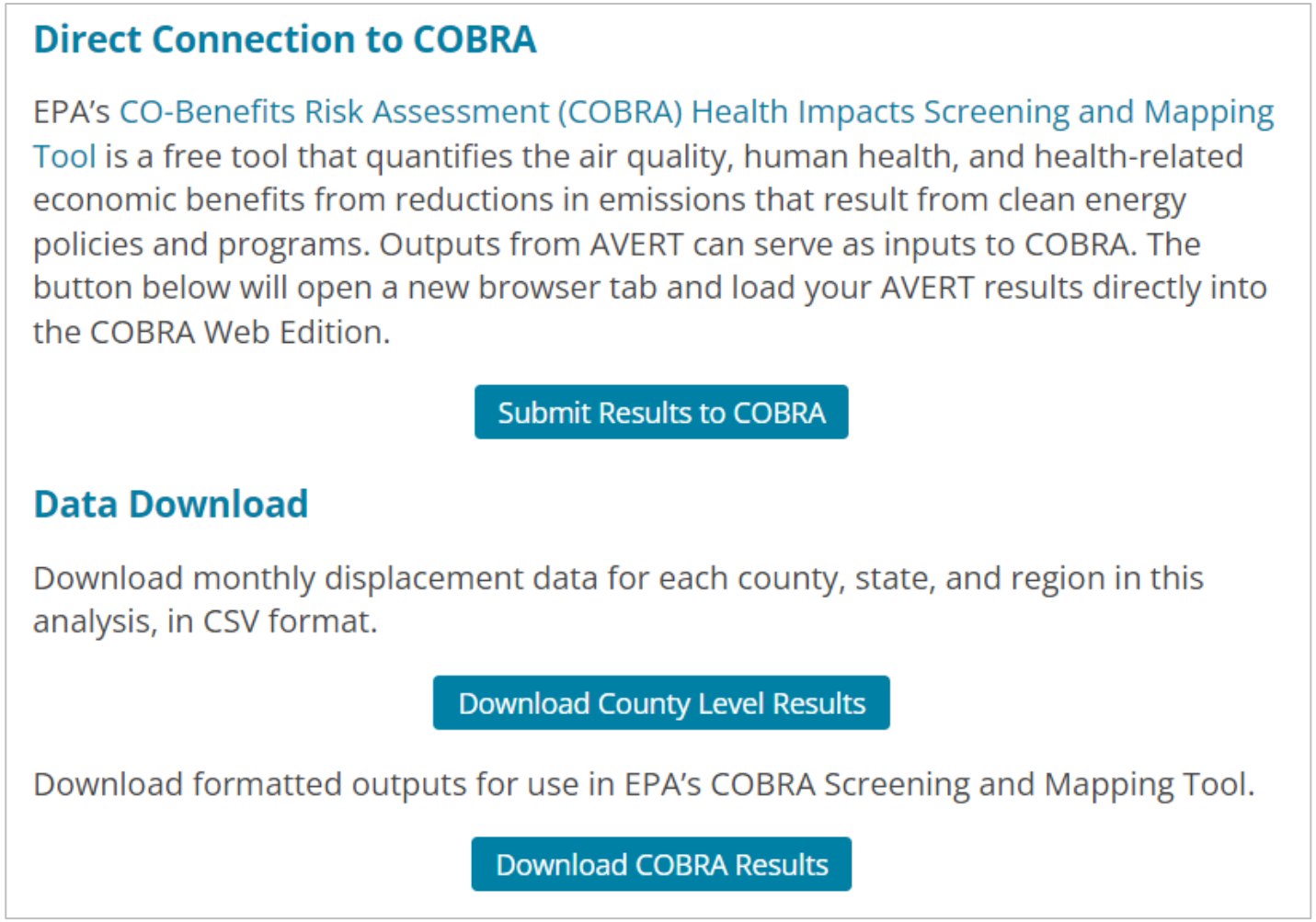
## Annual State Emission Changes:
### Tennessee Region

| State | $SO_2$ (lb) | $NO_X$ (lb) | $CO_2$ (tons) | $PM_{2.5}$ (lb) | VOCs (lb) | $NH_3$ (lb) |
|---|---|---|---|---|---|---|
| Alabama | -90 | -1,400 | -10,010 | -390 | -130 | -750 |
| Kentucky | -59,240 | -43,600 | -26,250 | -3,140 | -1,000 | -510 |
| Mississippi | -230 | -6,000 | -24,400 | -2,760 | -980 | -2,600 |
| Tennessee | -82,440 | -53,870 | -83,620 | -14,400 | -3,340 | -3,780 |

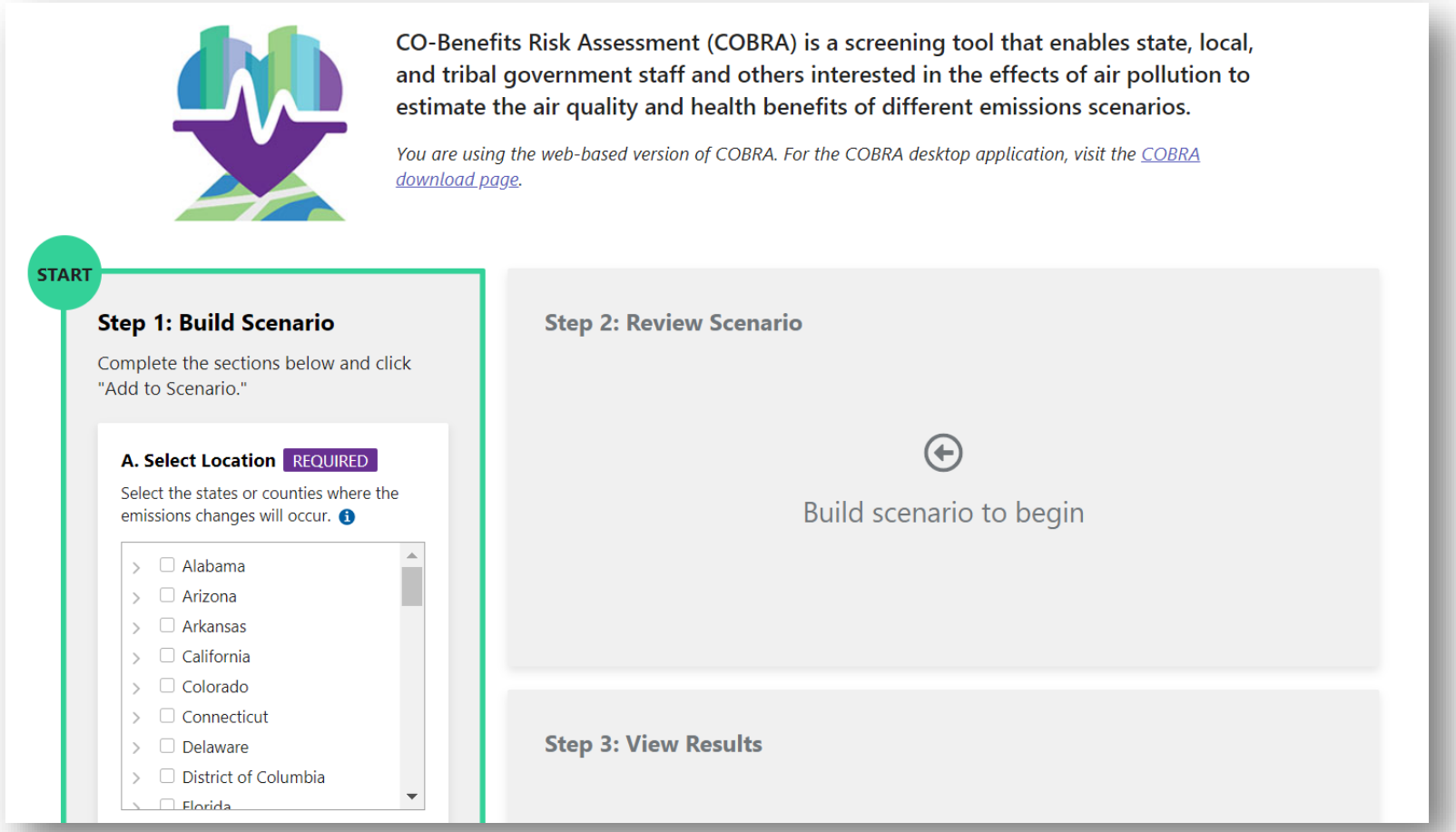
Convert from pounds (lbs) to tons (2,000 lbs = 1 ton)

| State | $SO_2$ (tons) | $NO_x$ (tons) | $PM_{2.5}$ (tons) | VOCs (tons) | $NH_3$ (tons) |
|---|---|---|---|---|---|
| Alabama | -0.05 | -0.7 | -0.2 | -0.07 | -0.38 |
| Kentucky | -29.62 | -21.8 | -1.57 | -0.5 | -0.26 |
| Mississippi | -0.12 | -3 | -1.38 | -0.49 | -1.3 |
| Tennessee | -41.22 | -26.94 | -7.2 | -1.67 | -1.89 |

# AVoided Emissions and geneRation Tool (AVERT) – COBRA connection

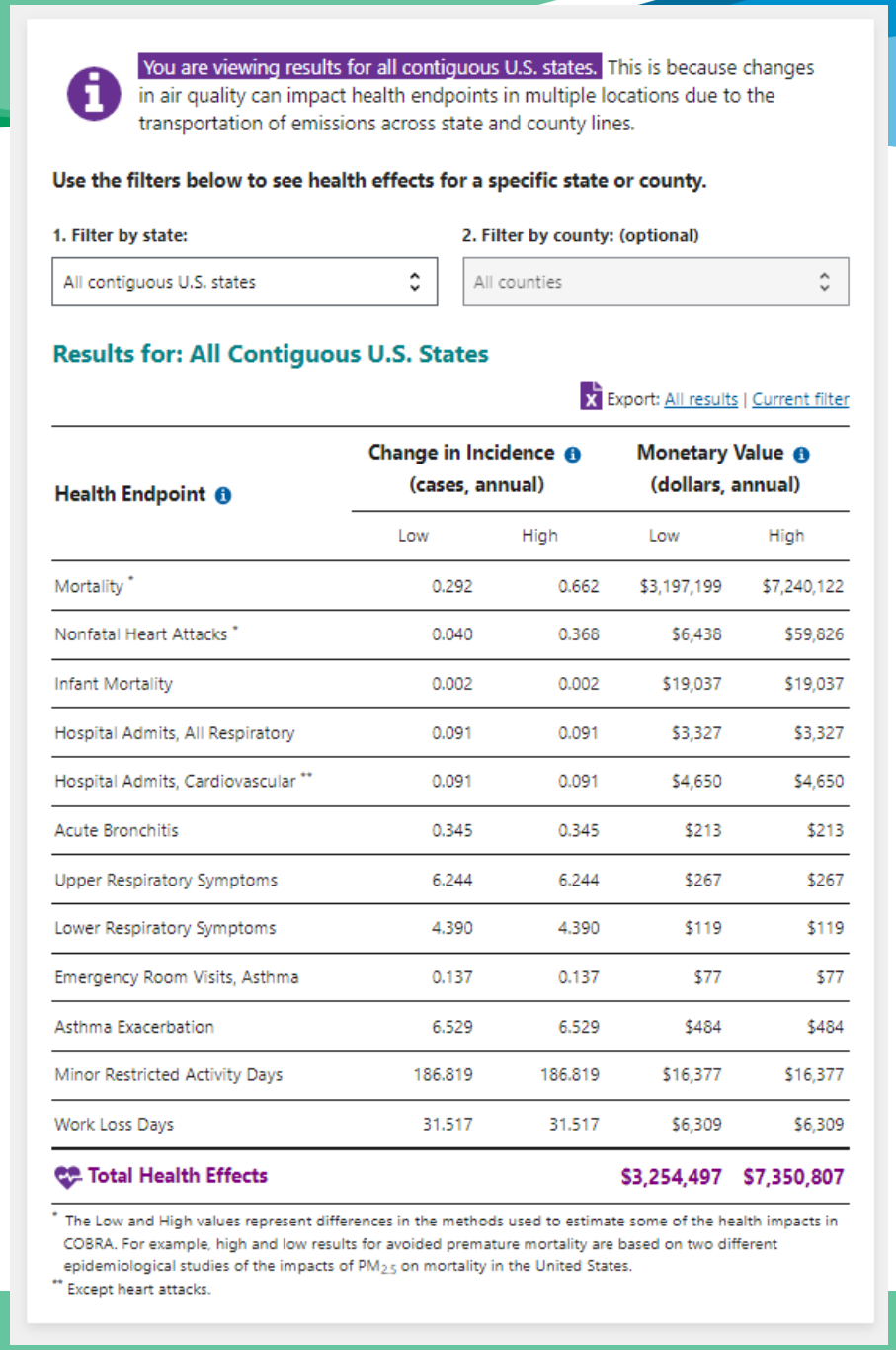


# Demo of COBRA Web Edition



# Results

| Total Health Benefits | Low, 3% (2017$) | High, 3% (2017$) |
|---|---|---|
| Nationwide | 3,254,497 | 7,350,807 |
| Alabama | 103,466 | 233,807 |
| Kentucky | 169,617 | 383,457 |
| Mississippi | 68,497 | 154,562 |
| Tennessee | 532,747 | 1,211,078 |
| **Davidson County** | **13,815** | **31,358** |



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2. Filter by county: (optional) All counties

**Results for: All Contiguous U.S. States**

Export: All results | Current filter

| Health Endpoint | Change in Incidence (cases, annual) | | Monetary Value (dollars, annual) | |
|---|---|---|---|---|
| | Low | High | Low | High |
| Mortality * | 0.292 | 0.662 | $3,197,199 | $7,240,122 |
| Nonfatal Heart Attacks * | 0.040 | 0.368 | $6,438 | $59,826 |
| Infant Mortality | 0.002 | 0.002 | $19,037 | $19,037 |
| Hospital Admits, All Respiratory | 0.091 | 0.091 | $3,327 | $3,327 |
| Hospital Admits, Cardiovascular ** | 0.091 | 0.091 | $4,650 | $4,650 |
| Acute Bronchitis | 0.345 | 0.345 | $213 | $213 |
| Upper Respiratory Symptoms | 6.244 | 6.244 | $267 | $267 |
| Lower Respiratory Symptoms | 4.390 | 4.390 | $119 | $119 |
| Emergency Room Visits, Asthma | 0.137 | 0.137 | $77 | $77 |
| Asthma Exacerbation | 6.529 | 6.529 | $484 | $484 |
| Minor Restricted Activity Days | 186.819 | 186.819 | $16,377 | $16,377 |
| Work Loss Days | 31.517 | 31.517 | $6,309 | $6,309 |
| **Total Health Effects** | | | **$3,254,497** | **$7,350,807** |

* The Low and High values represent differences in the methods used to estimate some of the health impacts in COBRA. For example, high and low results for avoided premature mortality are based on two different epidemiological studies of the impacts of $PM_{2.5}$ on mortality in the United States.

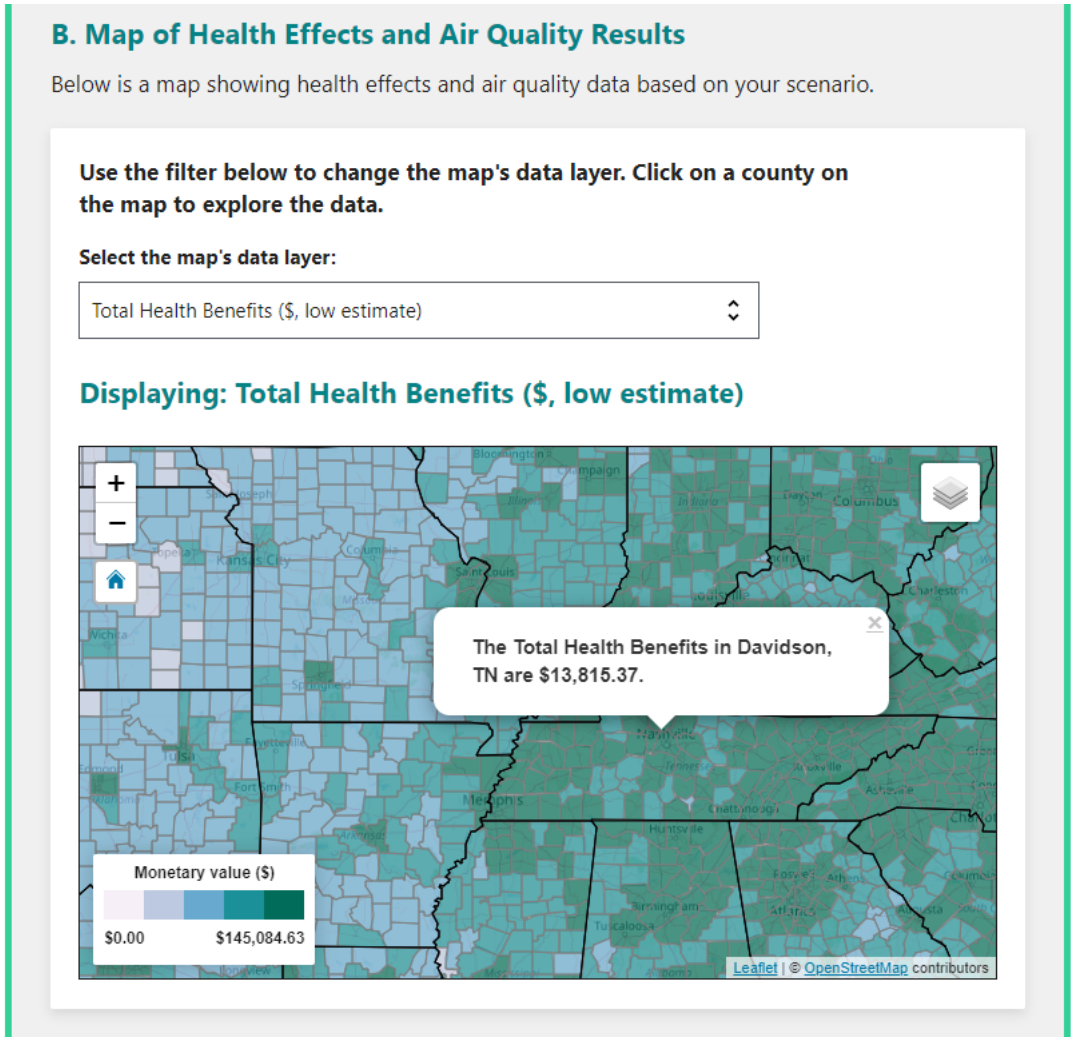
** Except heart attacks.

# Results

**How to get a screen capture:**

**Ctrl+PrtSc**
(Windows)

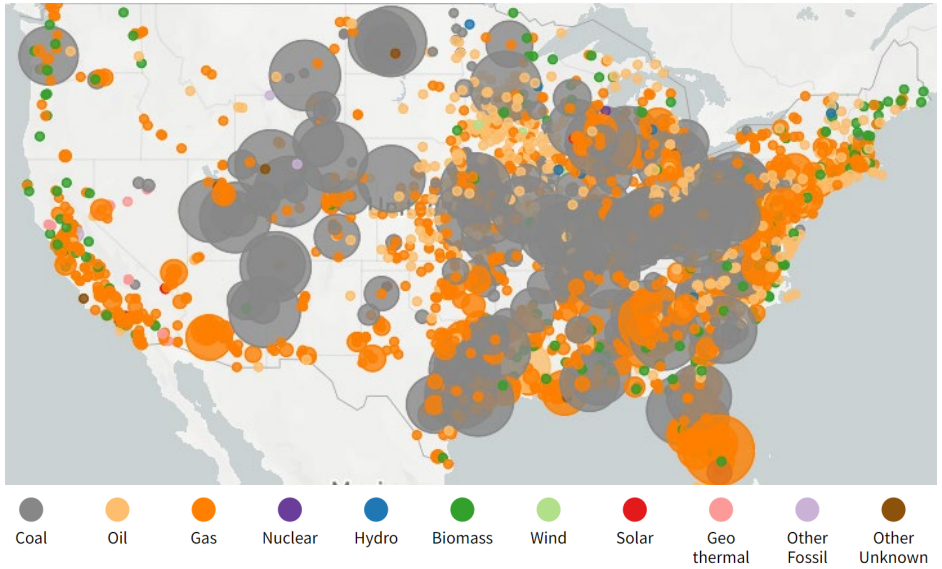
**Shift+Command+3**
(Mac)



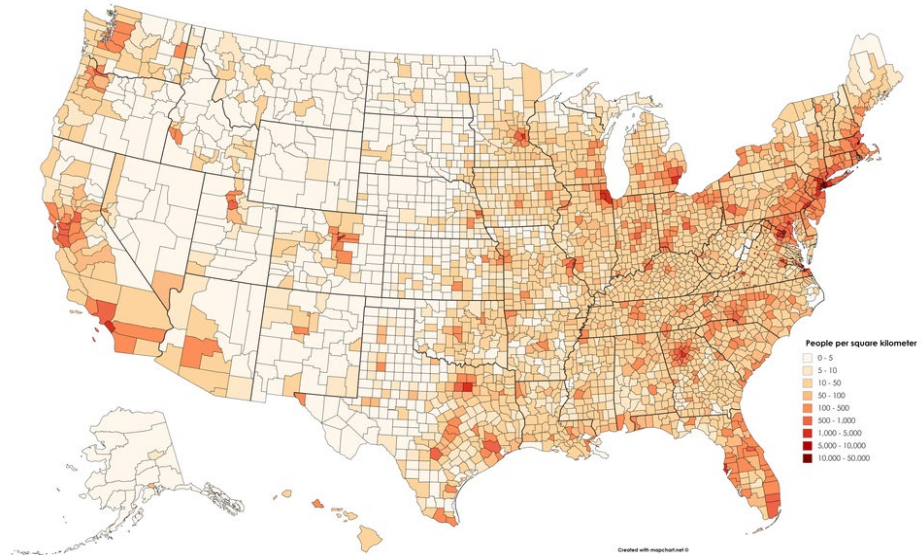
# What's driving the results?

- Regional emissions sources & changes
- Airshed dynamics
- Population density
- Population proximity to emissions sources
- Sensitivity of health outcomes to emissions changes
- Other factors?

**U.S. Power Plant Emissions by Source, 2020**




**2020 Population Distribution in The United States**



# Poll Question

- What types of policies or programs do you plan to analyze using COBRA? (select all that apply)
  - GHG mitigation / climate action plans
  - Renewable energy
  - Energy efficiency
  - Vehicle electrification
  - Building electrification
  - Waste sector
  - Industrial sector
  - Wildfire emissions

State and Local Climate and Energy Program

# COBRA

epa.gov/cobra

## Co-Benefits Risk Assessment

### Health Impacts Screening and Mapping Tool

**Contact us: cobra@epa.gov**

**Join our Office Hours: Feb. 24, 2-3pm (ET)**

**Register at epa.gov/statelocalenergy/state-local-and-tribal-webinar-series**

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Slide 6

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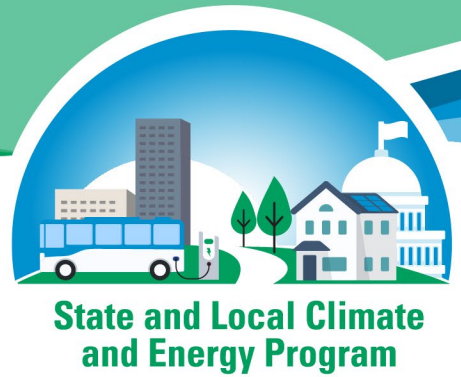



# Appendix A

COBRA Web Edition Step-by-Step

# Step 0. Develop Your Inputs

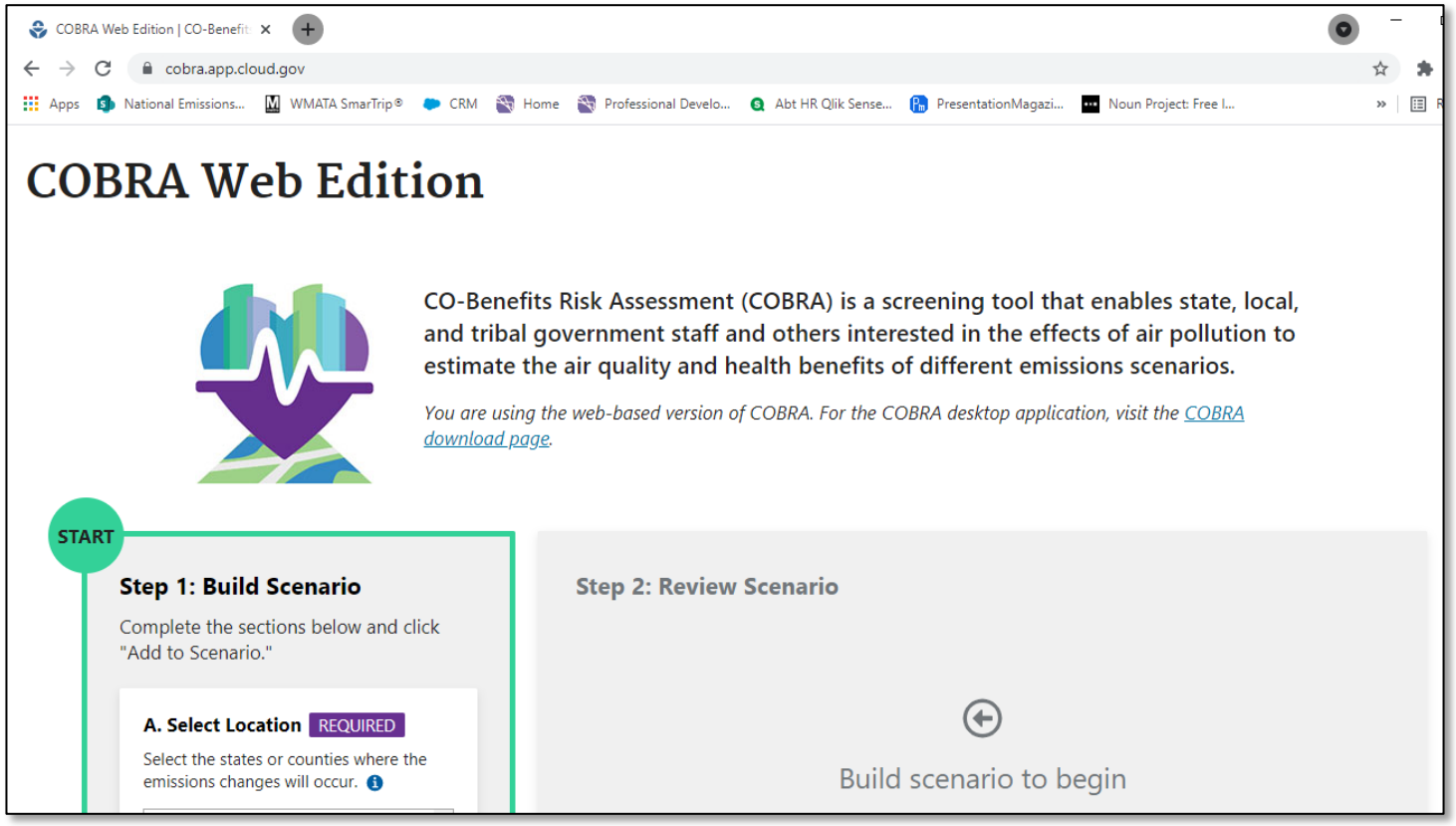
| Part 1: Woodstove Changeouts |
| --- |
| Location: Wisconsin |
| Sector: Fuel Combustion Other; Residential Wood; Woodstoves |
| Emissions Changes:<br>- $PM_{2.5}$: Reduce by 31.5 tons<br>- VOCs: Reduce by 80.7 tons |
| Discount Rate: 3% |

| Part 2: 440 kW Solar Photovoltaic (PV) |
| --- |
| Location: Wisconsin |
| Sector: Fuel Combustion Electric Utility |
| Emissions Changes:<br>- $PM_{2.5}$: Reduce by 1.7 tons<br>- $SO_2$: Reduce by 9.2 tons<br>- $NO_X$: Reduce by 6.5 tons<br>- VOCs: Reduce by 1.2 tons |
| Discount Rate: 3% |

Target completion date: 2024

kW: Kilowatt

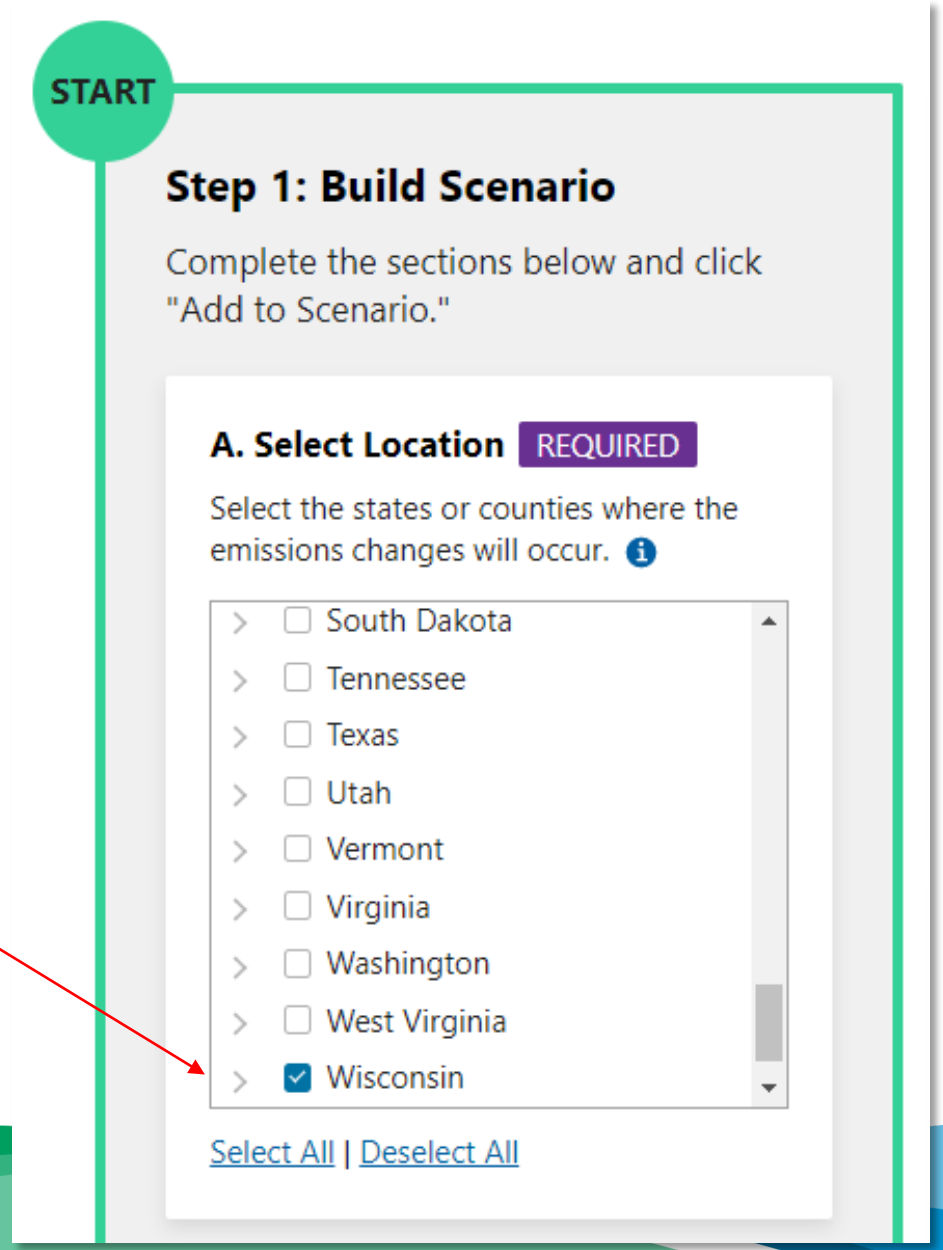
# Step 1. Access COBRA




The new COBRA Web Edition can be accessed at: www.epa.gov/cobra

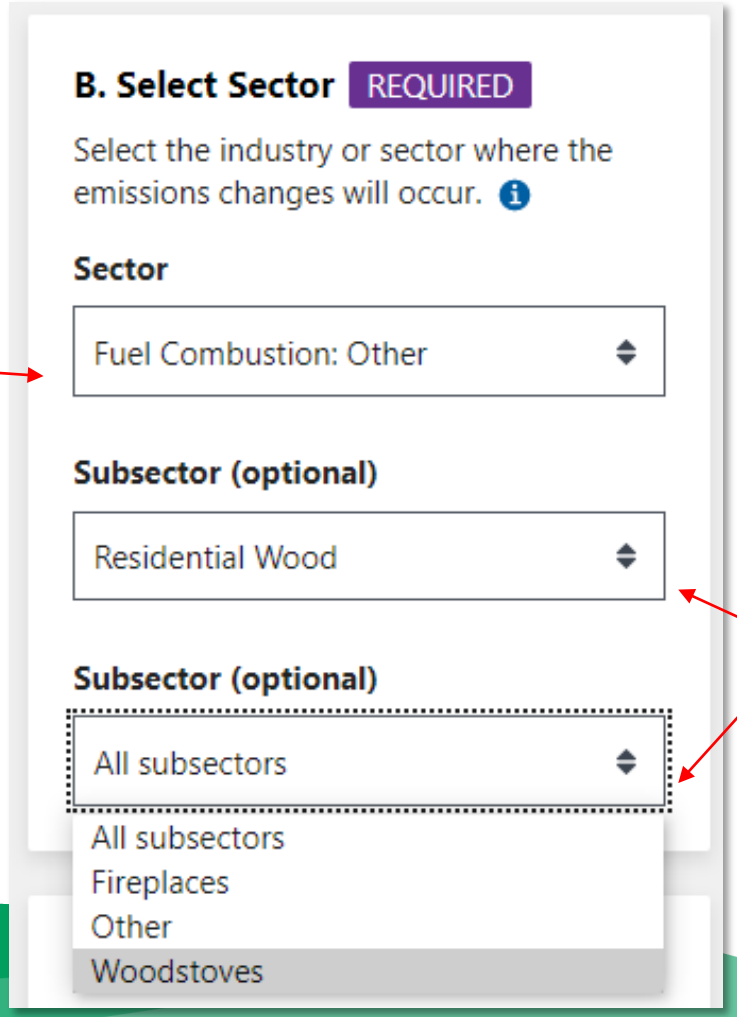
# Step 2. Select Location

Scroll through the list of locations to select the one you are interested in. Check the box to make a selection.



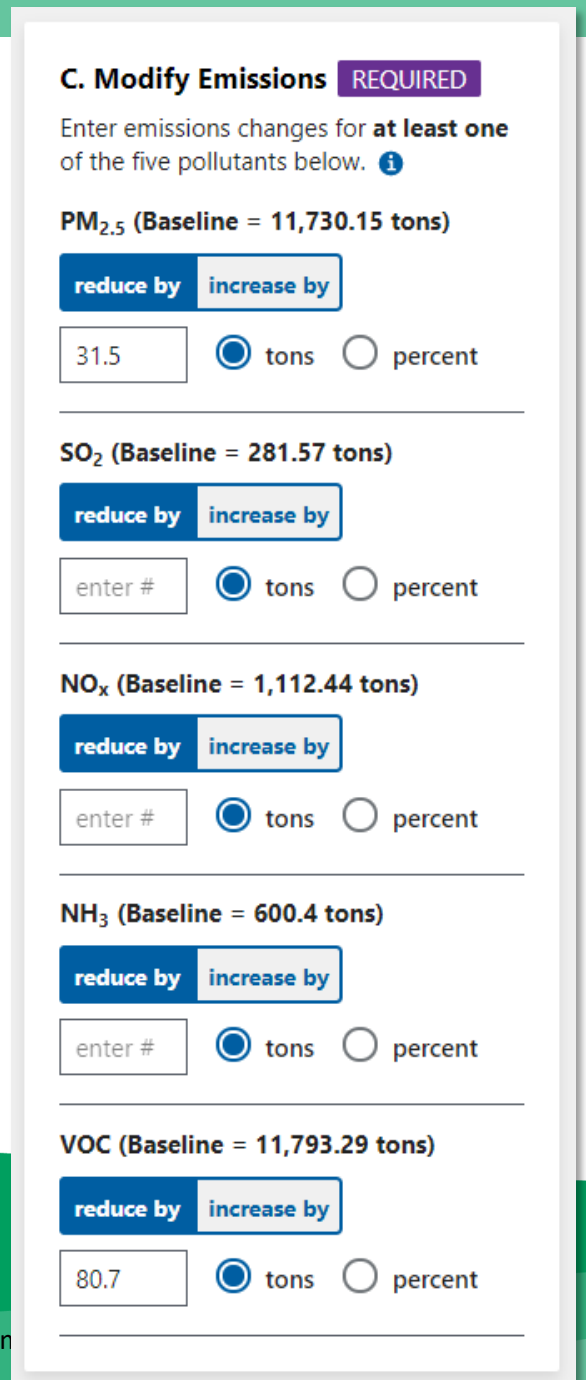
# Step 3. Select Sector

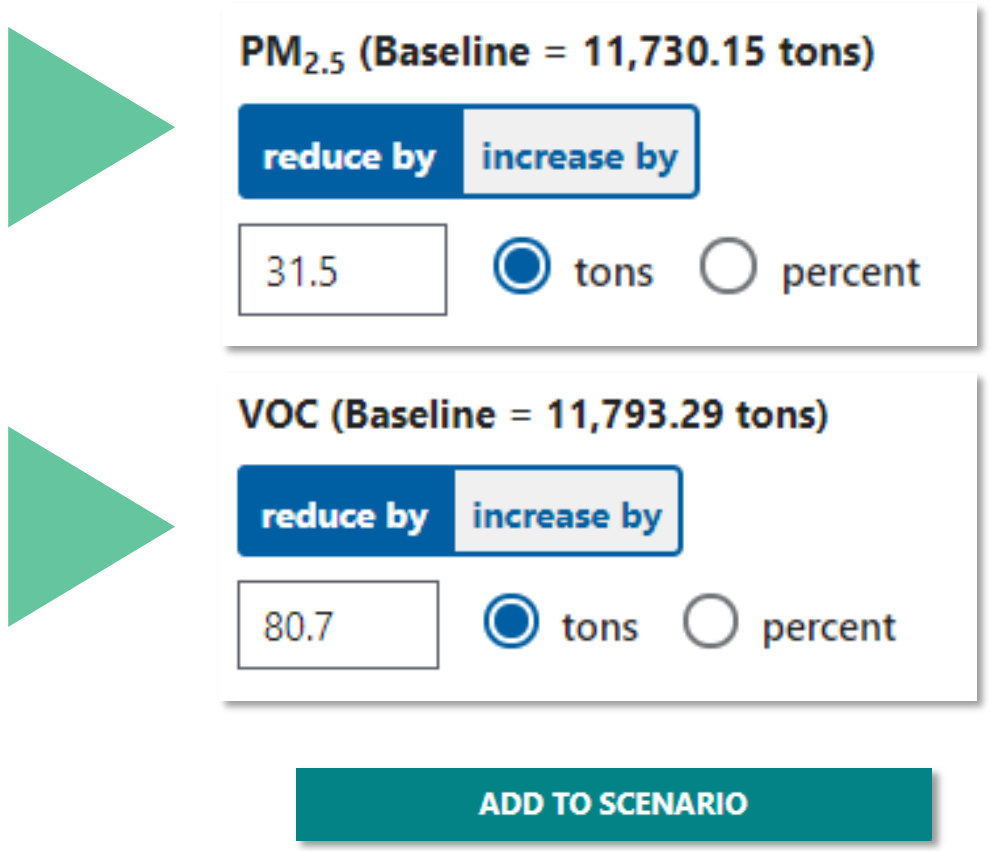
Select the sector you are interested in from the dropdown menu.




Select any subsectors you are interested in from the dropdown menus.

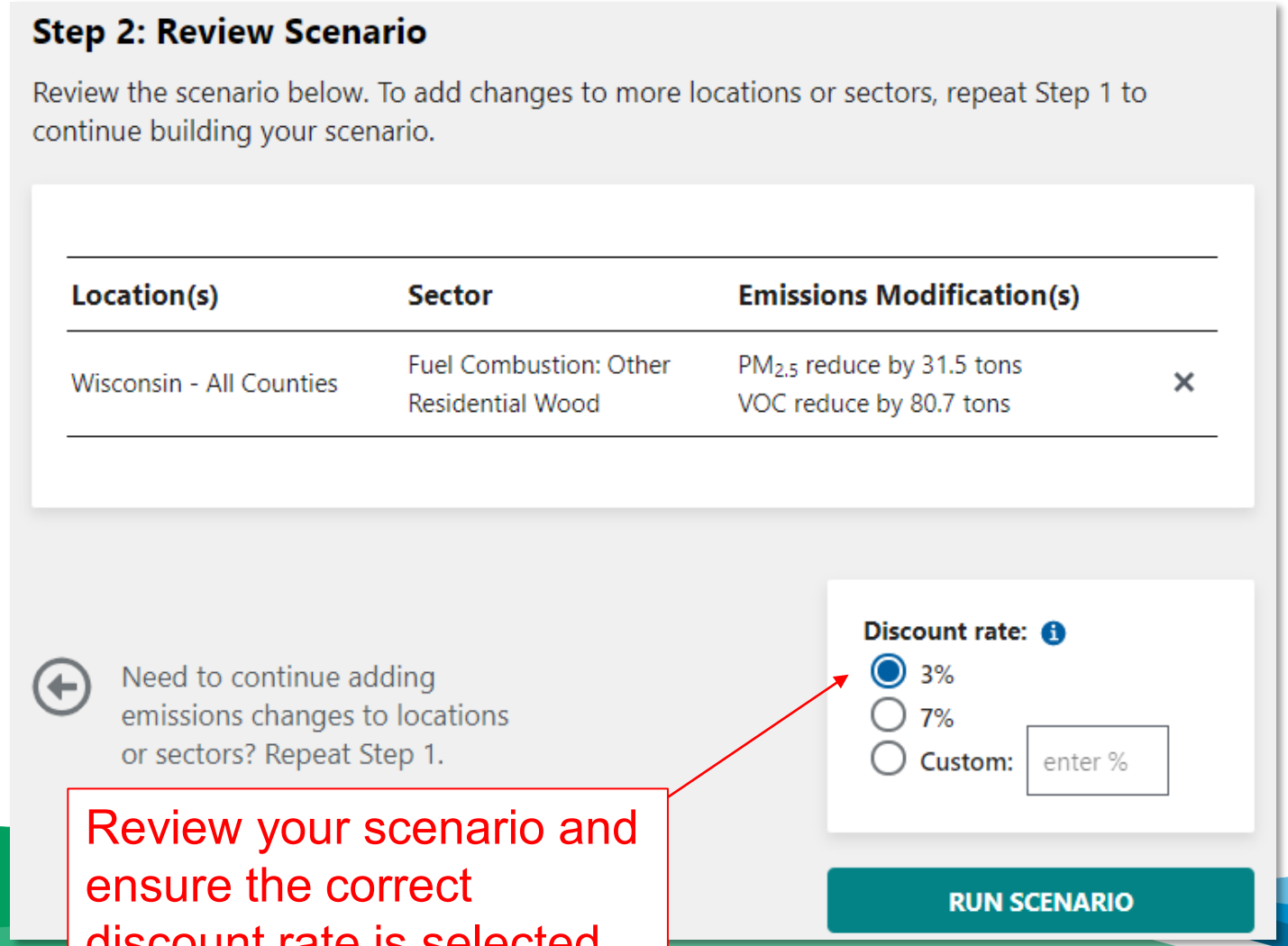
# Step 4. Modify Emissions




Enter your emissions information and select ADD TO SCENARIO.

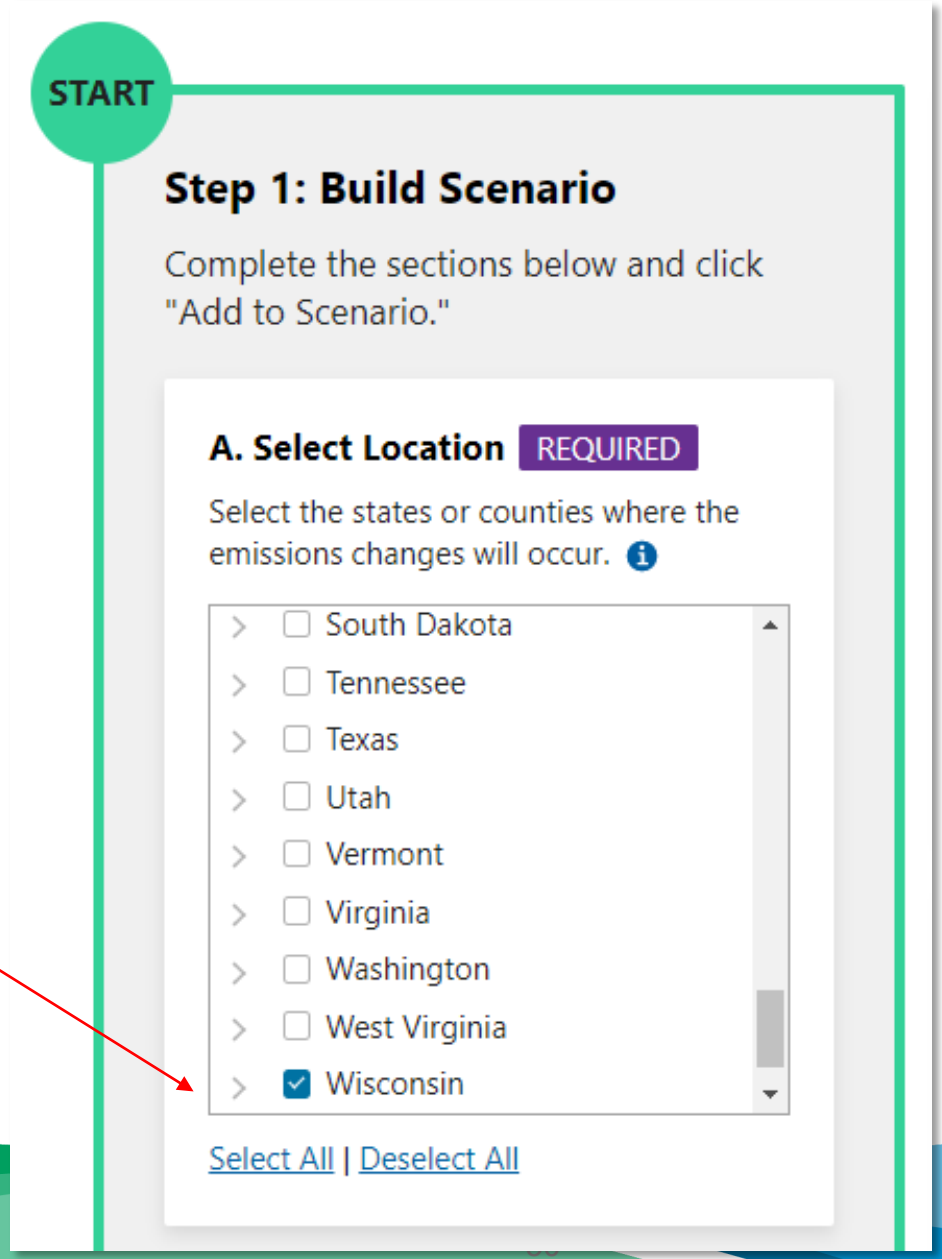
# Step 5. Review Scenario




Review your scenario and ensure the correct discount rate is selected.

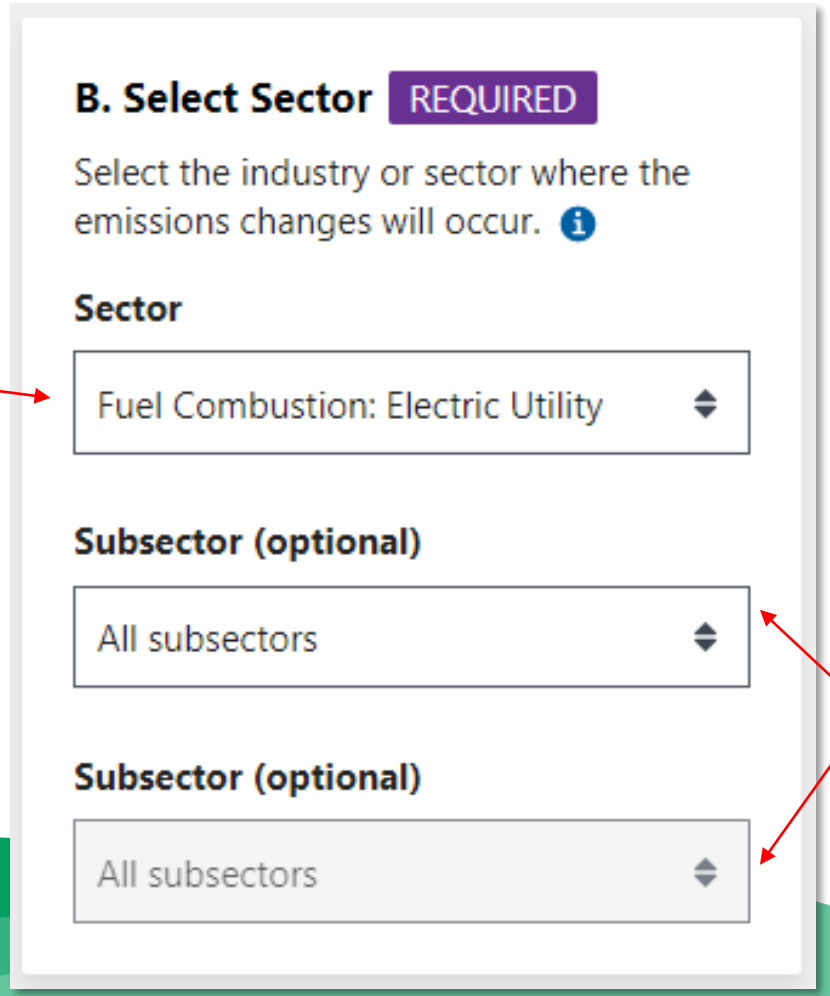
# Step 6. Add Additional Location Information

Scroll through the list of locations to select the one you are interested in. Check the box to make a selection.



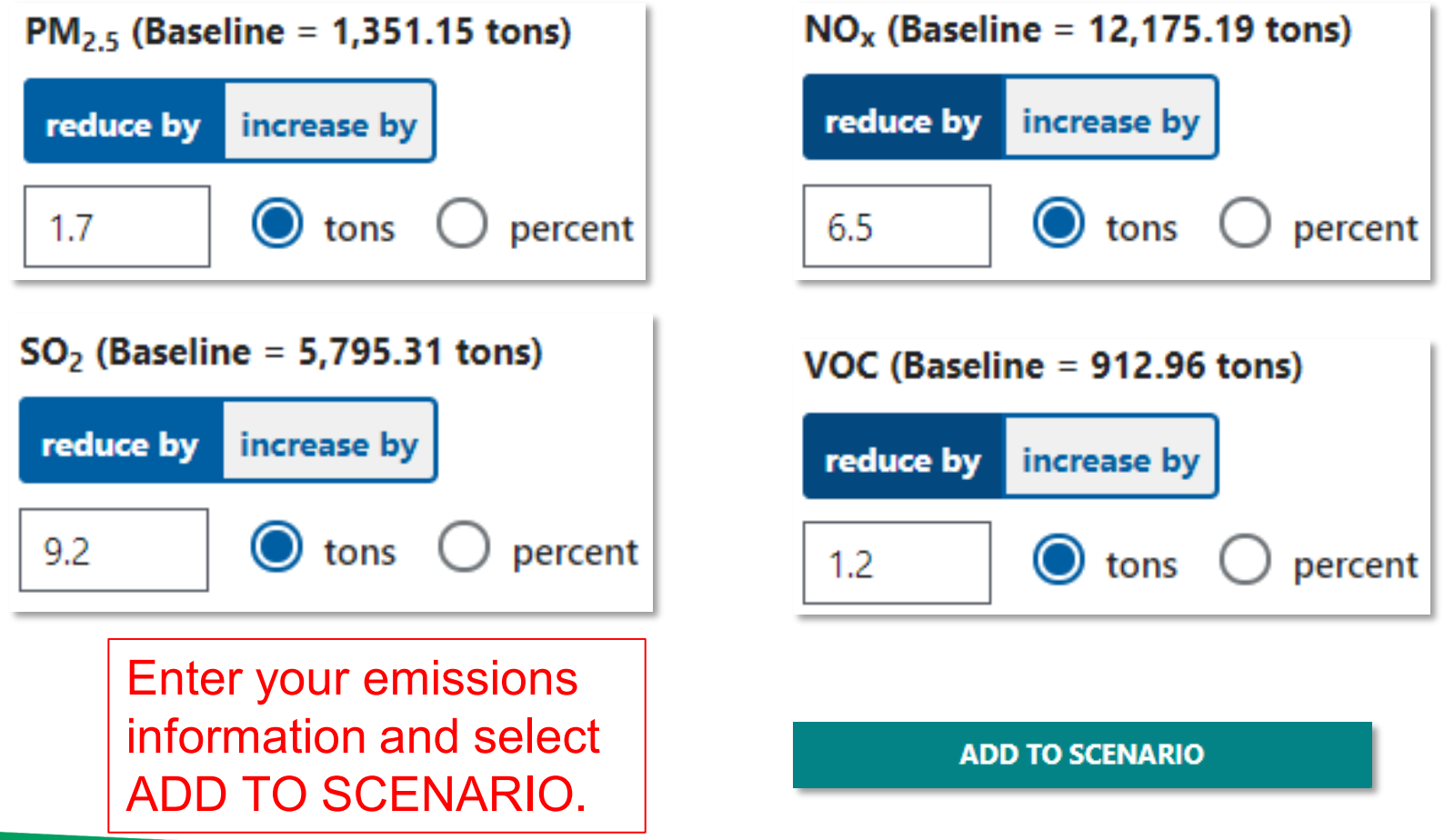
# Step 7. Add Additional Sector Information

Select the sector you are interested in from the dropdown menu.

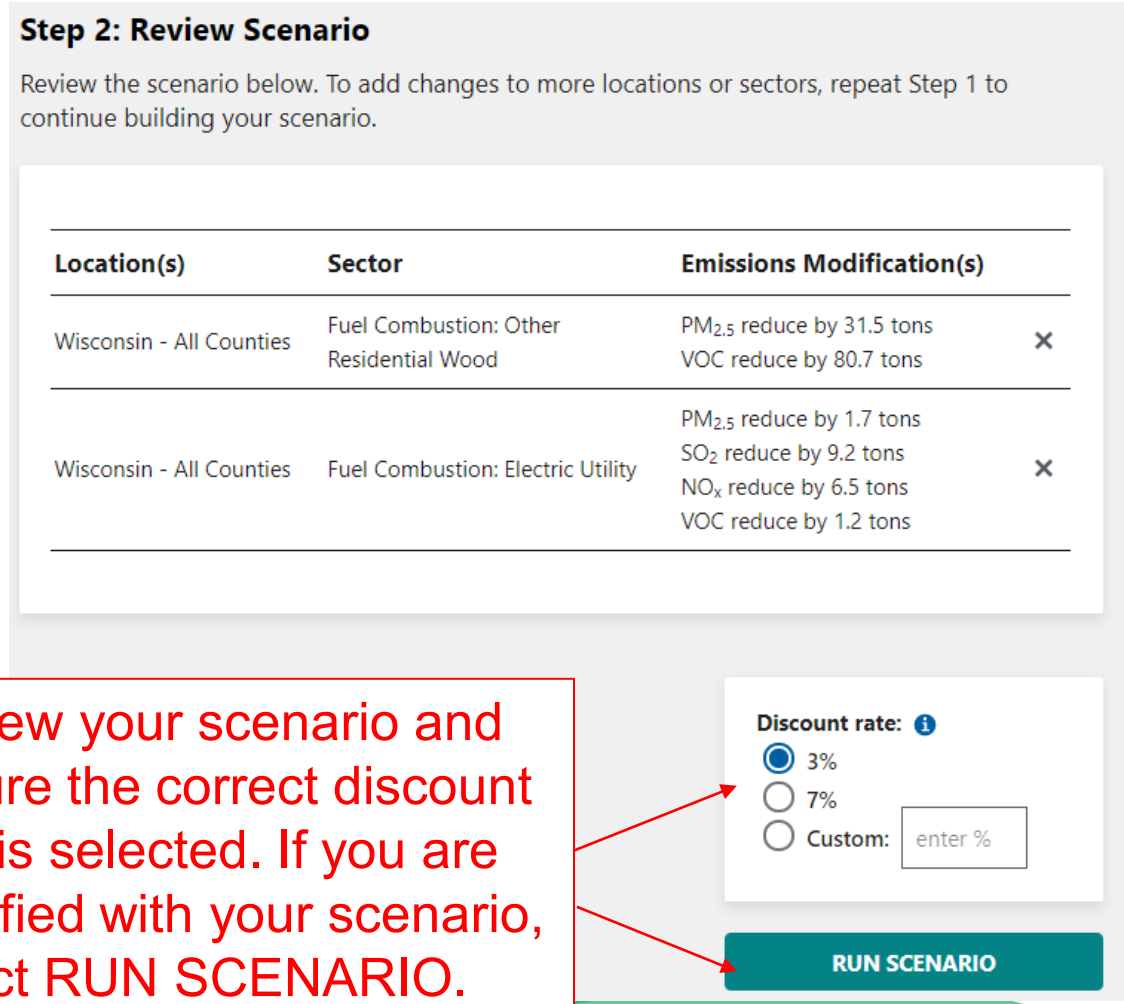



Select any subsectors you are interested in from the dropdown menus.

# Step 8. Add Additional Emissions Information

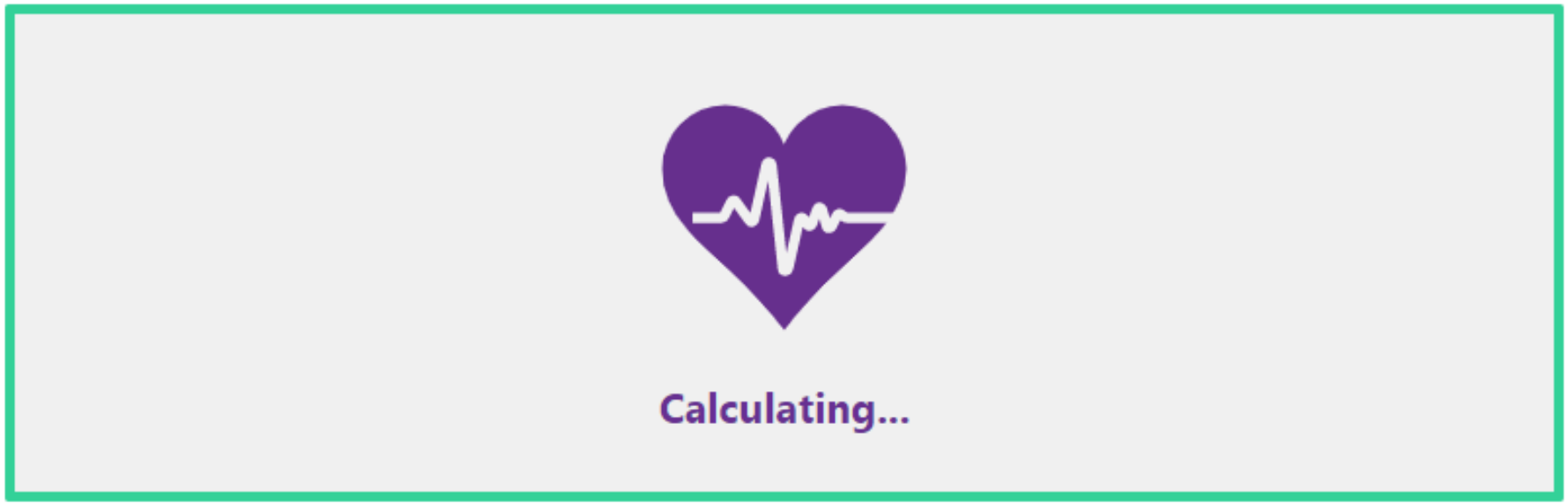


# Step 9. Review Scenario



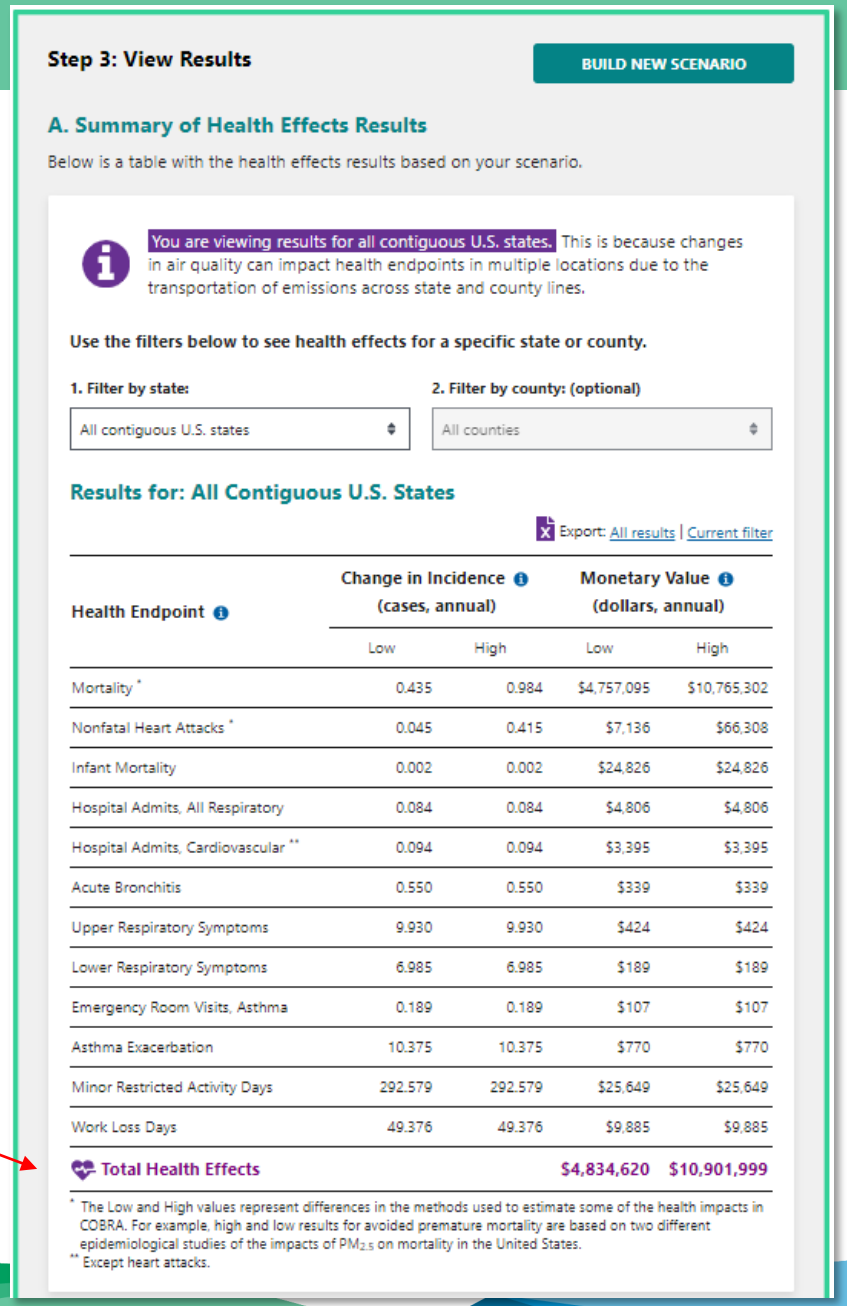

Review your scenario and ensure the correct discount rate is selected. If you are satisfied with your scenario, select RUN SCENARIO.

# You will see the following screen as your results are calculating…



# Step 10. View Results

View the Summary of Health Effects Results. Look to the bottom of the chart to find the Total Health Effects.



**Step 3: View Results** BUILD NEW SCENARIO

**A. Summary of Health Effects Results**

Below is a table with the health effects results based on your scenario.

You are viewing results for all contiguous U.S. states. This is because changes in air quality can impact health endpoints in multiple locations due to the transportation of emissions across state and county lines.

**Use the filters below to see health effects for a specific state or county.**

1. Filter by state: All contiguous U.S. states
2. Filter by county: (optional) All counties

**Results for: All Contiguous U.S. States**

Export: All results | Current filter

| Health Endpoint | Change in Incidence (cases, annual) | | Monetary Value (dollars, annual) | |
|---|---|---|---|---|
| | Low | High | Low | High |
| Mortality * | 0.435 | 0.984 | $4,757,095 | $10,765,302 |
| Nonfatal Heart Attacks * | 0.045 | 0.415 | $7,136 | $66,308 |
| Infant Mortality | 0.002 | 0.002 | $24,826 | $24,826 |
| Hospital Admits, All Respiratory | 0.084 | 0.084 | $4,806 | $4,806 |
| Hospital Admits, Cardiovascular ** | 0.094 | 0.094 | $3,395 | $3,395 |
| Acute Bronchitis | 0.550 | 0.550 | $339 | $339 |
| Upper Respiratory Symptoms | 9.930 | 9.930 | $424 | $424 |
| Lower Respiratory Symptoms | 6.985 | 6.985 | $189 | $189 |
| Emergency Room Visits, Asthma | 0.189 | 0.189 | $107 | $107 |
| Asthma Exacerbation | 10.375 | 10.375 | $770 | $770 |
| Minor Restricted Activity Days | 292.579 | 292.579 | $25,649 | $25,649 |
| Work Loss Days | 49.376 | 49.376 | $9,885 | $9,885 |
| **Total Health Effects** | | | **$4,834,620** | **$10,901,999** |

* The Low and High values represent differences in the methods used to estimate some of the health impacts in COBRA. For example, high and low results for avoided premature mortality are based on two different epidemiological studies of the impacts of $PM_{2.5}$ on mortality in the United States.

** Except heart attacks.

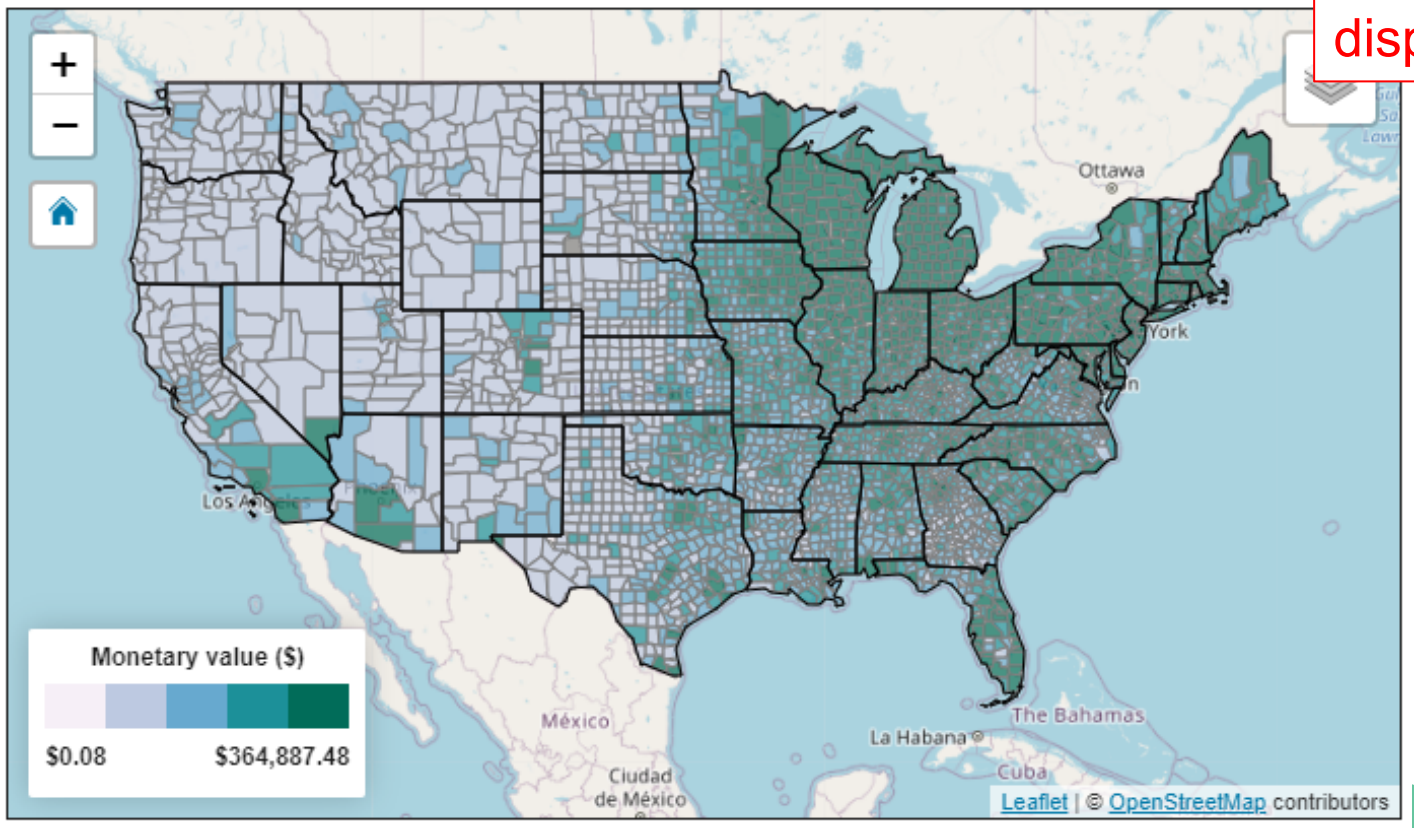
**Total Health Effects** $4,834,620 $10,901,999

# Step 10. View Results (continued)

**Select the map's data layer:**

Total Health Benefits ($, low estimate)

**Displaying: Total Health Benefits ($, low estimate)**




You can also view your results on a map. Use the filter to see other data displayed.

State and Local Climate and Energy Program

# Appendix B

COBRA Desktop Edition Step-by-Step

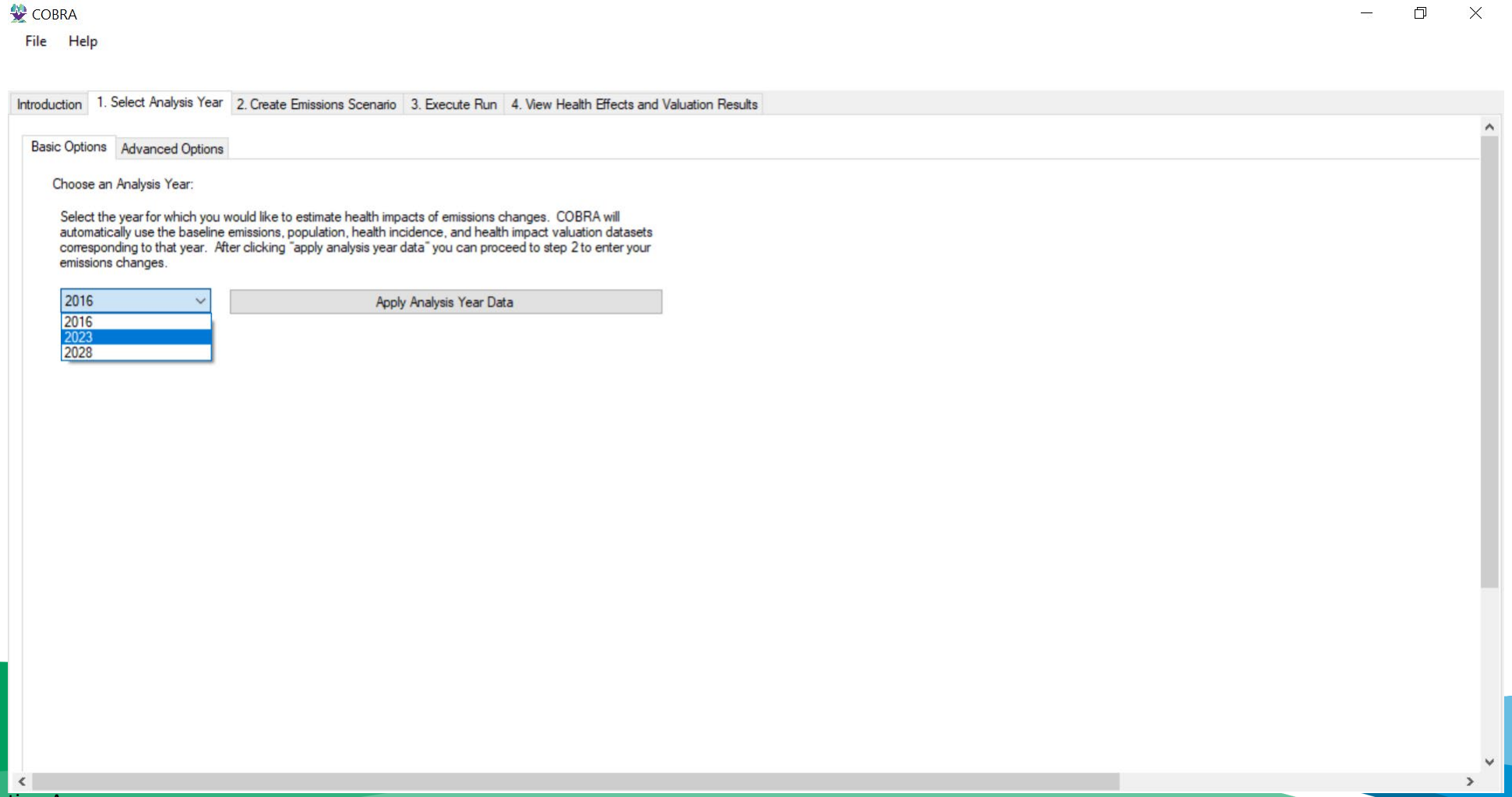
# Step 0. Develop Your Inputs

| Part 1: Woodstove Changeouts |
| --- |
| Location: Wisconsin |
| Sector: Fuel Combustion Other; Residential Wood; Woodstoves |
| Emissions Changes:<br>- $PM_{2.5}$: Reduce by 31.5 tons<br>- VOCs: Reduce by 80.7 tons |
| Discount Rate: 3% |

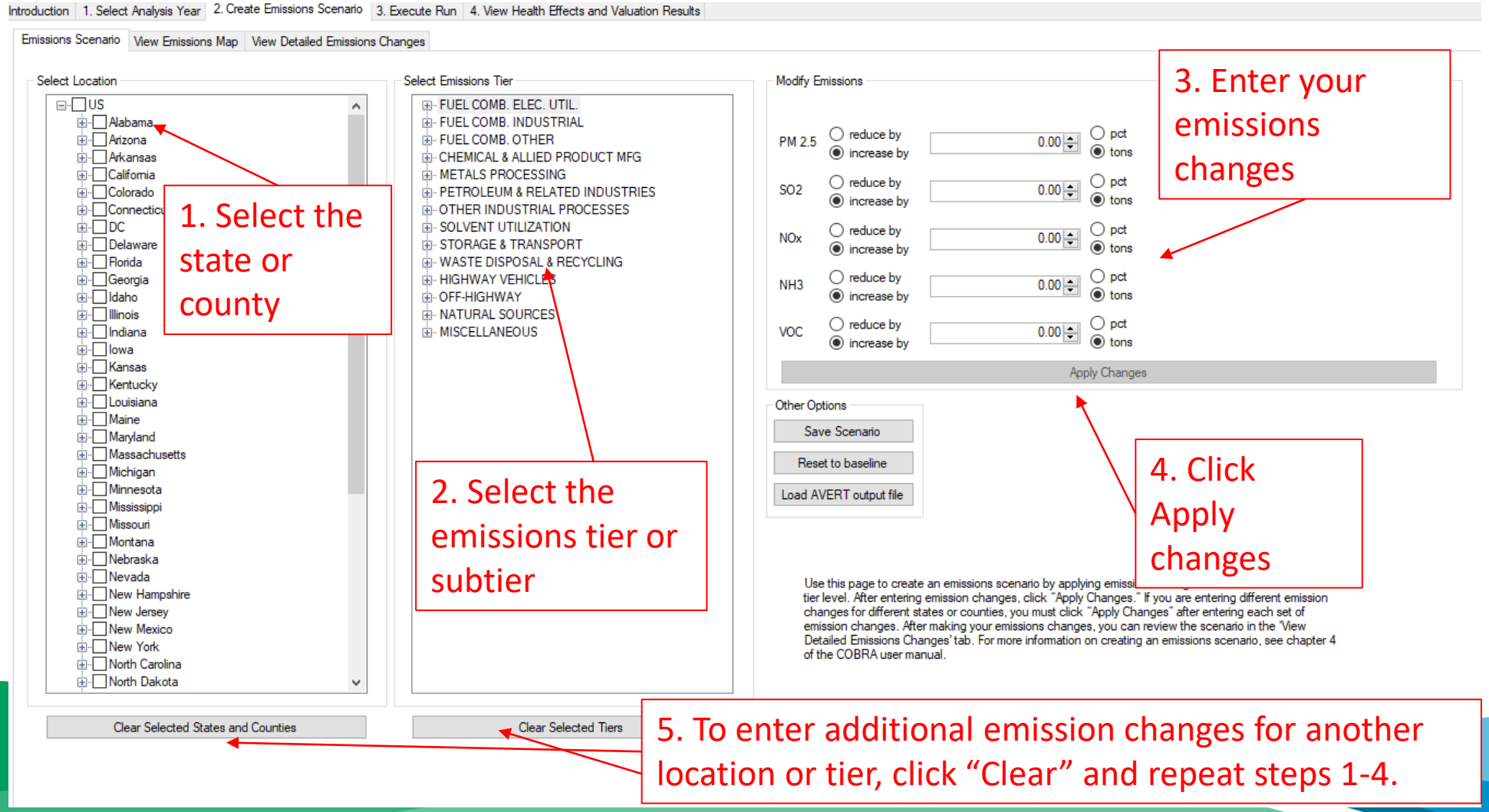
| Part 2: 440 kW Solar PV |
| --- |
| Location: Wisconsin |
| Sector: Fuel Combustion Electric Utility |
| Emissions Changes:<br>- $PM_{2.5}$: Reduce by 1.7 tons<br>- $SO_2$: Reduce by 9.2 tons<br>- $NO_X$: Reduce by 6.5 tons<br>- VOCs: Reduce by 1.2 tons |
| Discount Rate: 3% |

Target completion date: 2024

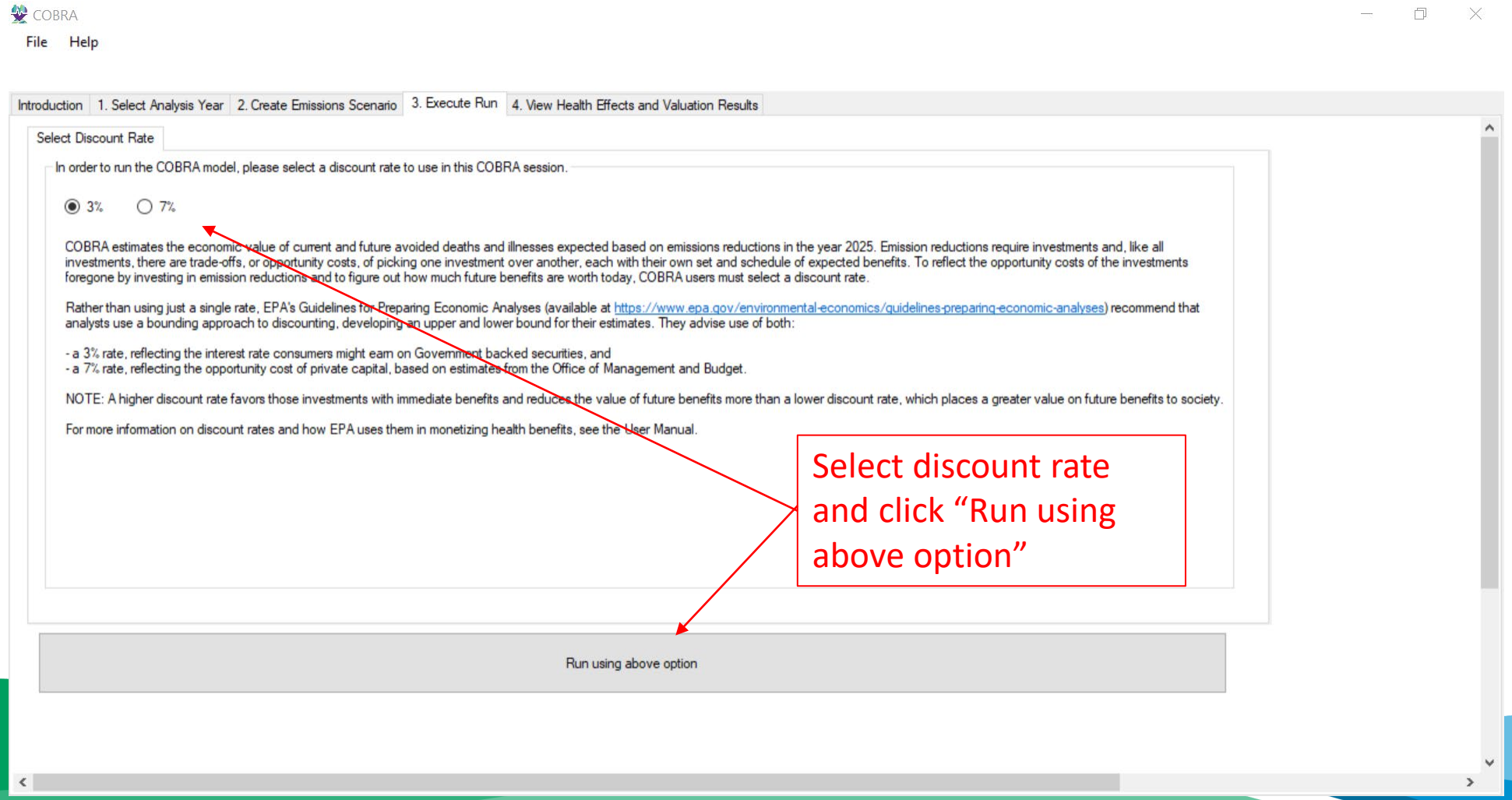
# Step 1. Apply Analysis Year



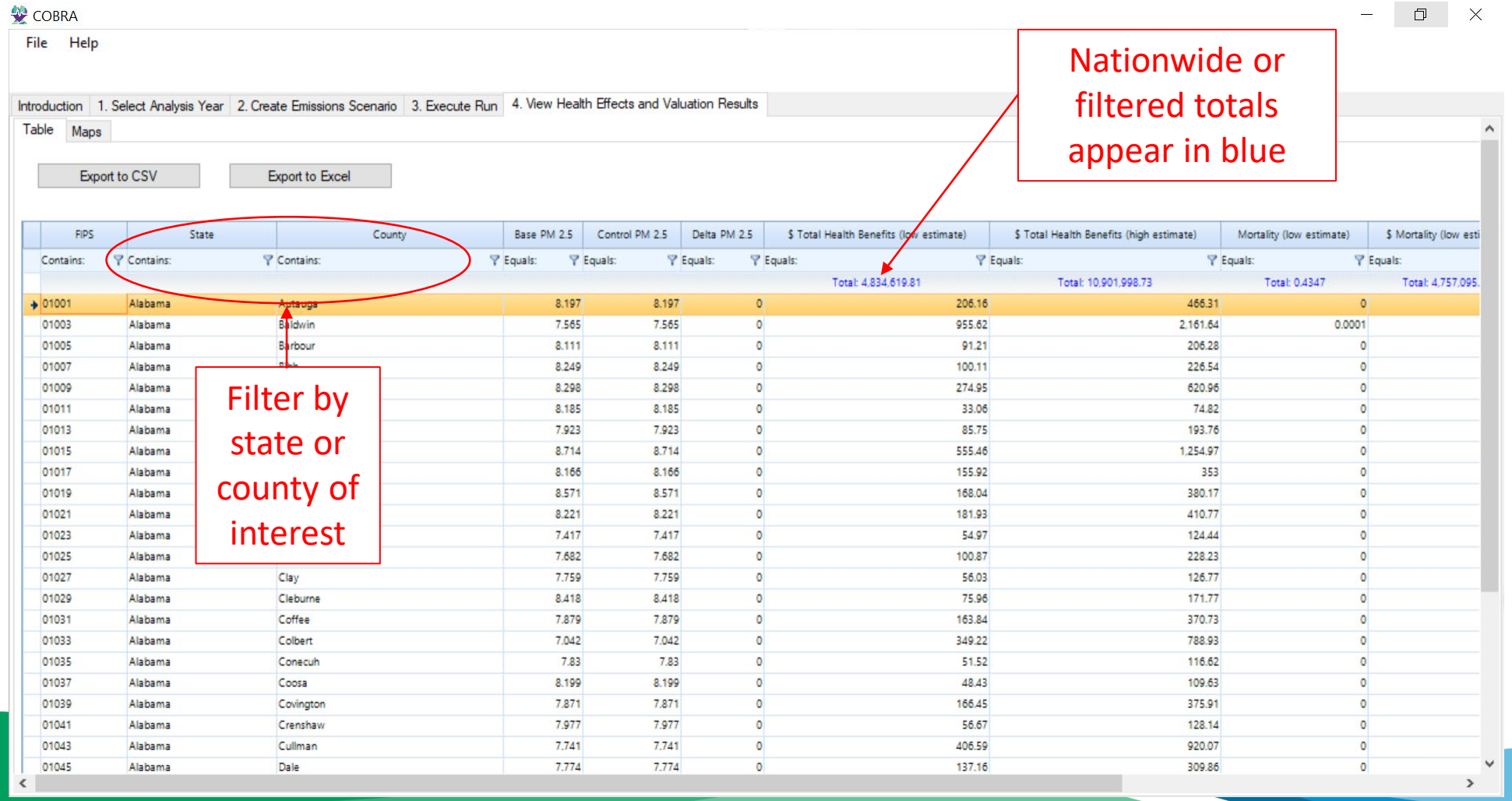
# Step 2. Create Emissions Scenario



# Step 3. Execute Run

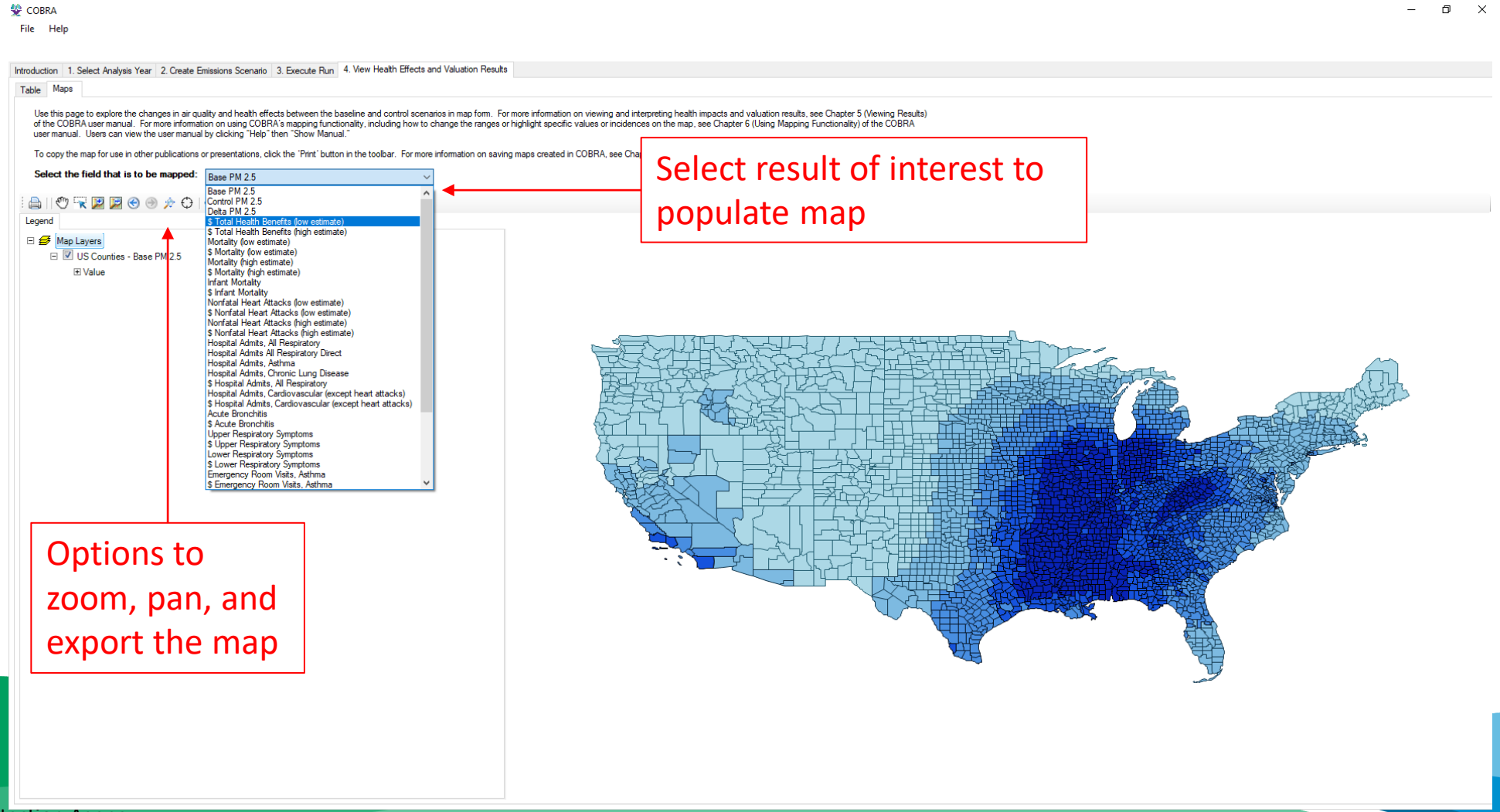


# Step 4. View Health Effects and Valuation Results

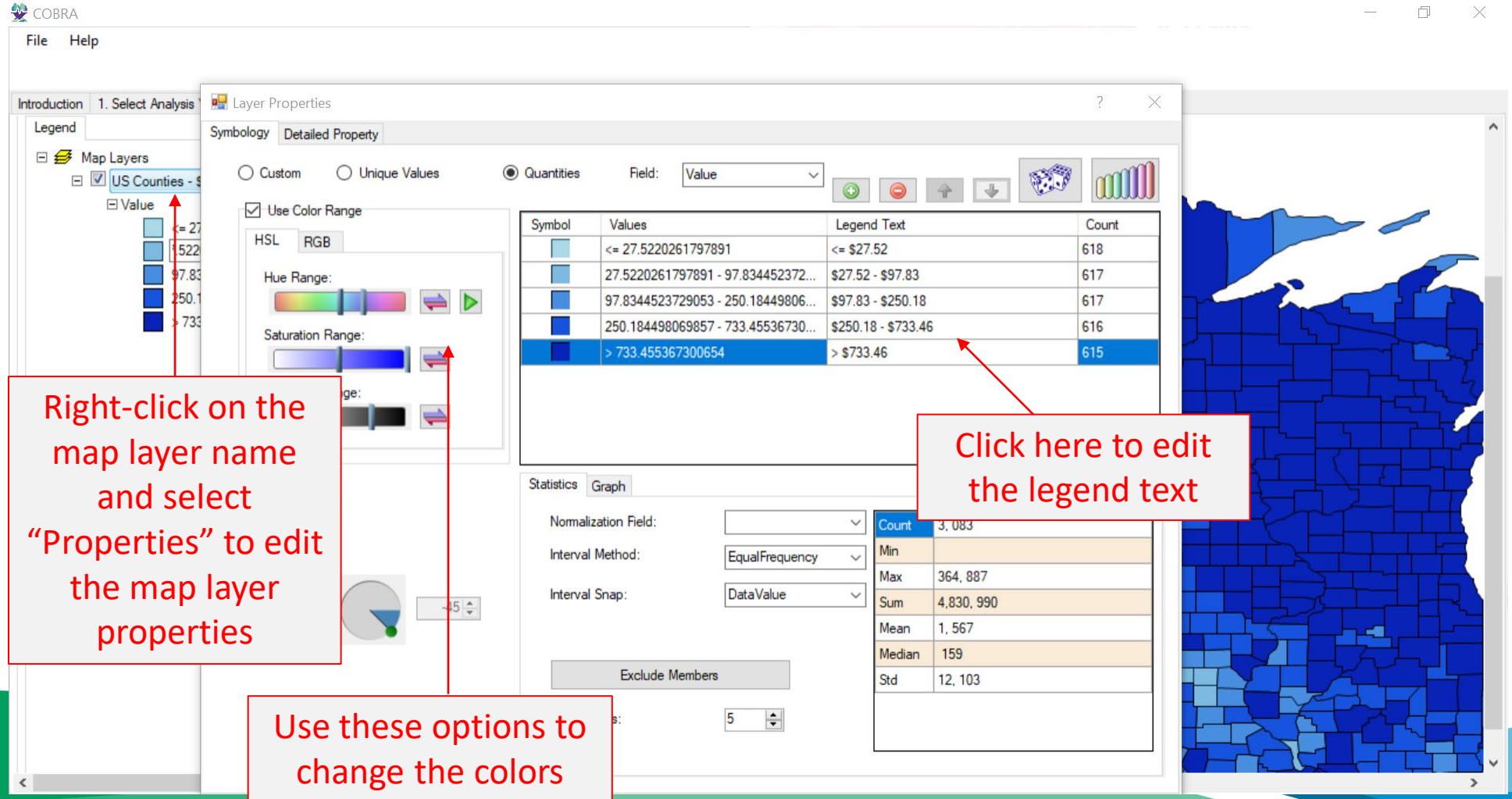



| FIPS | State | County | Base PM 2.5 | Control PM 2.5 | Delta PM 2.5 | $ Total Health Benefits (low estimate) | $ Total Health Benefits (high estimate) | Mortality (low estimate) | $ Mortality (low esti |
|---|---|---|---|---|---|---|---|---|---|
| Contains: | Contains: | Contains: | Equals: | Equals: | Equals: | Equals: | Equals: | Equals: | Equals: |
| | | | | | | Total: 4,834,619.81 | Total: 10,901,998.73 | Total: 0.4347 | Total: 4,757,095. |
| 01001 | Alabama | Autauga | 8.197 | 8.197 | 0 | 206.16 | 466.31 | 0 | |
| 01003 | Alabama | Baldwin | 7.565 | 7.565 | 0 | 955.62 | 2,161.64 | 0.0001 | |
| 01005 | Alabama | Barbour | 8.111 | 8.111 | 0 | 91.21 | 206.28 | 0 | |
| 01007 | Alabama | [illegible] | 8.249 | 8.249 | 0 | 100.11 | 226.54 | 0 | |
| 01009 | Alabama | | 8.298 | 8.298 | 0 | 274.95 | 620.96 | 0 | |
| 01011 | Alabama | | 8.185 | 8.185 | 0 | 33.06 | 74.82 | 0 | |
| 01013 | Alabama | | 7.923 | 7.923 | 0 | 85.75 | 193.76 | 0 | |
| 01015 | Alabama | | 8.714 | 8.714 | 0 | 555.46 | 1,254.97 | 0 | |
| 01017 | Alabama | | 8.166 | 8.166 | 0 | 155.92 | 353 | 0 | |
| 01019 | Alabama | | 8.571 | 8.571 | 0 | 168.04 | 380.17 | 0 | |
| 01021 | Alabama | | 8.221 | 8.221 | 0 | 181.93 | 410.77 | 0 | |
| 01023 | Alabama | | 7.417 | 7.417 | 0 | 54.97 | 124.44 | 0 | |
| 01025 | Alabama | | 7.682 | 7.682 | 0 | 100.87 | 228.23 | 0 | |
| 01027 | Alabama | Clay | 7.759 | 7.759 | 0 | 56.03 | 126.77 | 0 | |
| 01029 | Alabama | Cleburne | 8.418 | 8.418 | 0 | 75.96 | 171.77 | 0 | |
| 01031 | Alabama | Coffee | 7.879 | 7.879 | 0 | 163.84 | 370.73 | 0 | |
| 01033 | Alabama | Colbert | 7.042 | 7.042 | 0 | 349.22 | 788.93 | 0 | |
| 01035 | Alabama | Conecuh | 7.83 | 7.83 | 0 | 51.52 | 116.62 | 0 | |
| 01037 | Alabama | Coosa | 8.199 | 8.199 | 0 | 48.43 | 109.63 | 0 | |
| 01039 | Alabama | Covington | 7.871 | 7.871 | 0 | 166.45 | 375.91 | 0 | |
| 01041 | Alabama | Crenshaw | 7.977 | 7.977 | 0 | 56.67 | 128.14 | 0 | |
| 01043 | Alabama | Cullman | 7.741 | 7.741 | 0 | 406.59 | 920.07 | 0 | |
| 01045 | Alabama | Dale | 7.774 | 7.774 | 0 | 137.16 | 309.86 | 0 | |

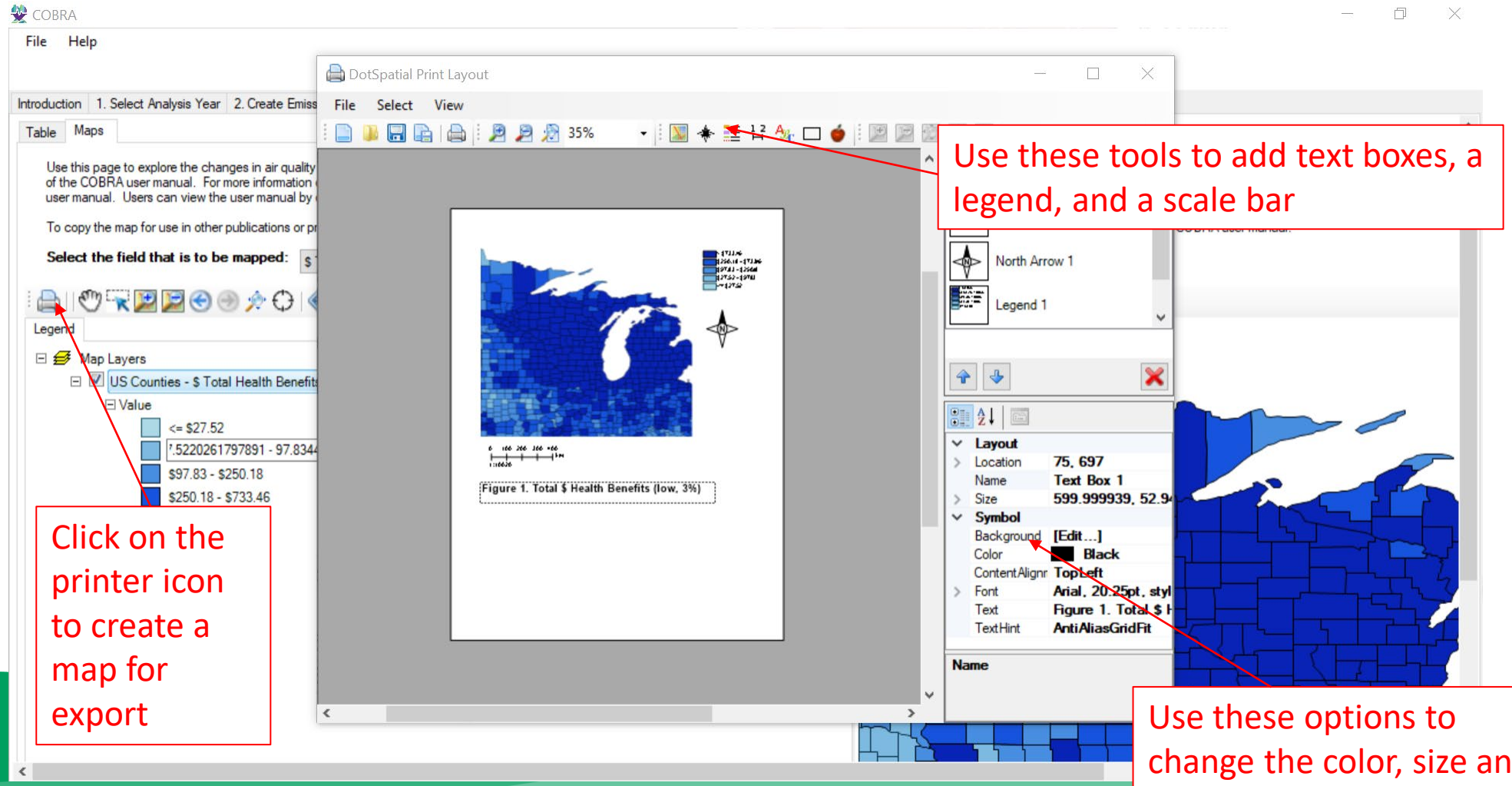
# Step 4. View Health Effects and Valuation Results (continued)



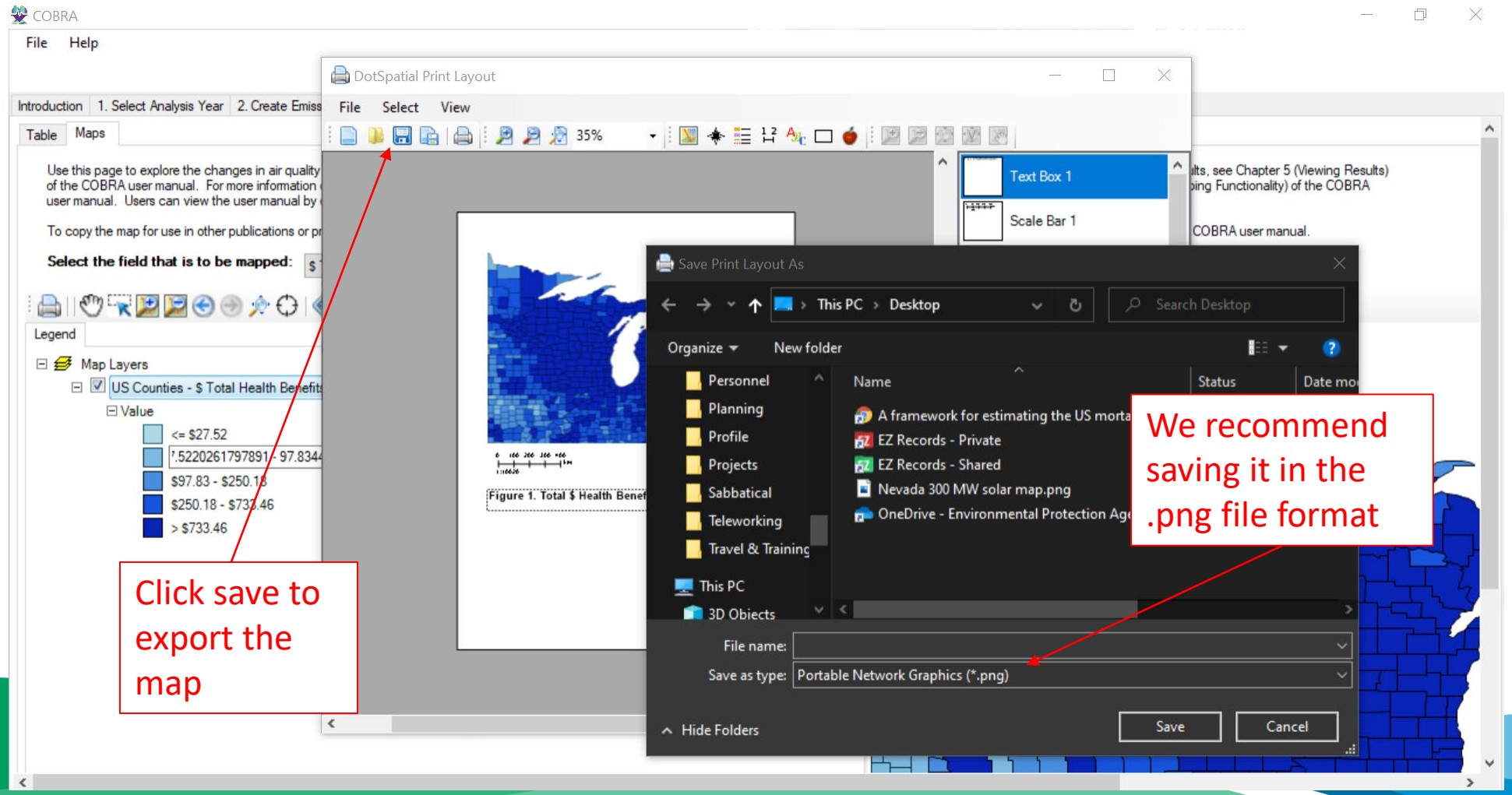
# Step 4. View Health Effects and Valuation Results (continued)



# Step 4. View Health Effects and Valuation Results (continued)



# Step 4. View Health Effects and Valuation Results (continued)



# Final Results

**Table 1. Estimated health benefits of woodstove changeouts and 440 kW solar PV in Wisconsin**

| Total Health Benefits | Low, 3% (2017$) | High, 3% (2017$) |
|---|---|---|
| Nationwide | $4,834,620 | $10,901,999 |
| Nevada | $2,365,991 | $5,335,684 |

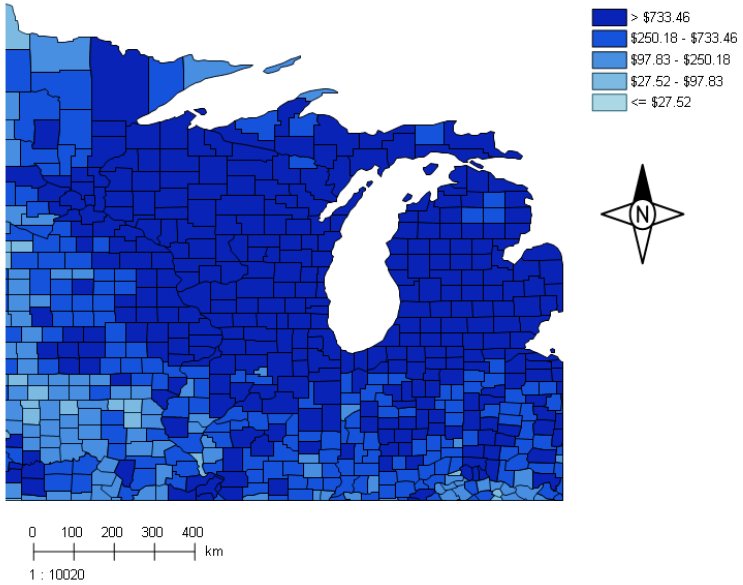



**Figure 1. Total $ Health Benefits (low, 3%)**