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# Estimating the Benefits of Clean Energy Policies

## Quickstart Tutorial: How To Use The Co-Benefits Risk Assessment (COBRA) Screening Model

Analytical Steps and Case Studies

State and Local Climate and Energy Program

United States Environmental Protection Agency

June, 2015

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# Overview of Presentation

- How to conduct an analysis with COBRA
  - Summarizes four key analytical steps
- Two case studies illustrate how to apply these steps in two clean energy scenarios:
  1. Renewable Portfolio Standard
  2. Wind Energy Program

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# How to Conduct an Analysis with COBRA

State and Local Climate and Energy Program

Analytical Steps and Relevant Resources

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# Steps in 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

This presentation will:

- Walk you through these steps, and
- Lead you to other tools and resources that can help you develop your inputs.

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

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# 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

- Estimating what and where electricity will be displaced and emissions reduced presents challenges due to the:
  - Complex way electricity is generated and transmitted across the U.S.
  - Uncertainty about future emissions in places with market-based environmental programs, such as cap and trade
- Simplifying assumptions can be made when using COBRA but a highly sophisticated energy analysis of the impacts of a clean energy policy on a location will generate more reliable results
- For more information about the complexity of the energy system, see Chapters 3 and 4 of *Assessing the Multiple Benefits of Clean Energy: A Resource for States*, available at http://www.epa.gov/statelocalclimate/resources/benefits.html

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

- In COBRA, you can enter the emission changes as a percentage or in absolute terms
  - A **percentage** can be used when a policy is expected to reduce emissions or use of an energy source by a specific proportion
    - For example, for an increase in the use of renewable electricity generation by 20%, you could assume that the use of existing fuels for electricity generation would be reduced by 20%
  - An **absolute** number can be used for policies that do not lend themselves easily to percentage reductions or when you want to enter more specific emission changes
    - For example, 5,000 tons of sulfur dioxide

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# Resources for Calculating Emissions Reductions from Electricity-related Policies

- If you do not have absolute emission reduction estimates, you can use:
  - A basic approach or tool, such as:
    - Applying an emission factor obtained from EPA's Emissions & Generation Resource Integrated Database (eGrid) http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html, or
    - EPA's AVoided Emissions and geneRation Tool (AVERT) http://epa.gov/avert/
  - More sophisticated approaches, such as those described in EPA guides:
    - *Assessing the Multiple Benefits of Clean Energy: A Resource for States*, Chapter 4 http://www.epa.gov/statelocalclimate/documents/pdf/epa_assessing_benefits_ch4.pdf
    - *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans,* Appendix I http://www.epa.gov/airquality/eere/manual.html

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# 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 2008 NEI, see: http://www.epa.gov/ttnchie1/net/2008inventory.html

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

- Often, clean energy investments, such as those that increase the use of renewable energy or energy efficiency,  will affect the “fuel combustion from electric utilities” category
- Within each category, there are fuel choices, such as coal, gas, and oil
  - If you know the specific fuel will be affected, you may choose it
  - If not, you can use the broader category
- Enter the estimated emission reductions by the appropriate types and locations, ensuring that you save your inputs once you are finished

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# Step 3: Select a discount rate

- A discount rate is used to appropriately discount the value of future benefits
- Not all benefits occur in the year of analysis, and people are generally willing to pay more for something now than for the same thing later
- COBRA accounts for this time preference by discounting benefits received later

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# Step 3: Select a discount rate

- EPA's Guidelines for Economic Analysis recommend using both 3% and 7% discount rates to see how the conclusions of your analysis change. Both rates are available in COBRA
- The discount rate will affect the value of the benefits
  - A higher discount rate favors investments with immediate benefits and reduces the value of future benefits
  - A lower discount rate places a greater value on future benefits to society
- You can run your scenario with both rates and then evaluate the effect of the change in discount rate on the results

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# Step 4: Run the model and review the results

- Once you have completed these four 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

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# 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

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# Key Considerations when Interpreting Results

- 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

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# Key Considerations when Interpreting Results

- Emissions in some states and regions are "capped" and firms may trade emission allowances
  - If you assume an emission reduction among power plants in a state, emissions from other power plants may increase unless emission allowances are retired as part of the assumed emission reduction
    - COBRA does not automatically capture this potential effect; it would need to be calculated in another model

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# Case Study 1:
# Renewable Portfolio Standard

State and Local Climate and Energy Program

This case study illustrates how to conduct an analysis of a clean energy policy with COBRA using a renewable portfolio standard as an example.

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# Analyzing the Health Benefits of a Renewable Portfolio Standard with COBRA

- A renewable portfolio standard (RPS) requires electric utilities to switch a particular percentage of electricity generation to renewable sources
- If electricity had previously been generated with fossil fuels, the RPS will result in criteria air pollutant reductions and health benefits

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# Analyzing the Health Benefits of a Renewable Portfolio Standard with COBRA

- The next slides describe how to estimate the health and related economic benefits of a state or local RPS
  - Specifically, we assume a state (Michigan) has established an RPS requirement that 10% of electricity generation must be from renewable sources by 2015
    - We also could have looked at a county with a renewable target or requirement

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

- Select what geographic locations you expect to be affected by the emissions change
  - You can enter emissions changes at the national, regional, state or county levels
  - If you know that specific plants will be affected, you can enter emissions changes only in those counties
  - Or you could use more sophisticated energy modeling approaches or tools to identify any and all plants that may be affected by a state or local RPS and manually enter those changes for the counties with affected plants

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

- For the Michigan RPS, we assume that all emission changes will occur statewide
- In COBRA, we create a scenario for an individual state and select Michigan

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

- To determine the emissions reduced, you can:
  - Assume that a switch of 10% of electricity generation from fossil fuels to renewable sources that do not generate air pollution will reduce 10% of all pollutants,  or
  - Estimate absolute emission reductions using:
    - An emission factor approach as described earlier
    - A more sophisticated modeling approach, if available

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

- For this example, we use emissions factors from EPA's Emissions & Generation Resource Integrated Database (eGrid)* to develop an absolute estimate
  - Using "eGRID2012 year 2009 Summary Tables (PDF)," we found:
    - Net electric generation in Michigan: **88 million MWh**
    - Non-baseload output emissions rates for Michigan:

      $SO_2$: **6.6348 lbs. per MWh**

      $NO_x$: **1.9392 lbs. per MWh**
    - Percentage of electric generation that already comes from renewable sources in Michigan: **3.1%**

* eGRID is available at http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

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

- Since 3.1% of electric generation already comes from renewable sources, we assume our scenario will reduce emissions by:

  10% - 3.1% = **6.9%**

- We calculate the reduction in MWh:

  6.9% × 88 million MWh = **6 million MWh**

- Assuming the renewable energy used does not emit any air pollution, we calculate the emission reductions as:

  $SO_2$: 6 million MWh × 6.6348 per MWh = 40 million lbs.

  = **20,000 tons**

  $NO_x$: 6 million MWh × 1.9392 per MWh = 12 million lbs.

  = **6,000 tons**

[Note that 1 ton = 2,000 lbs.]

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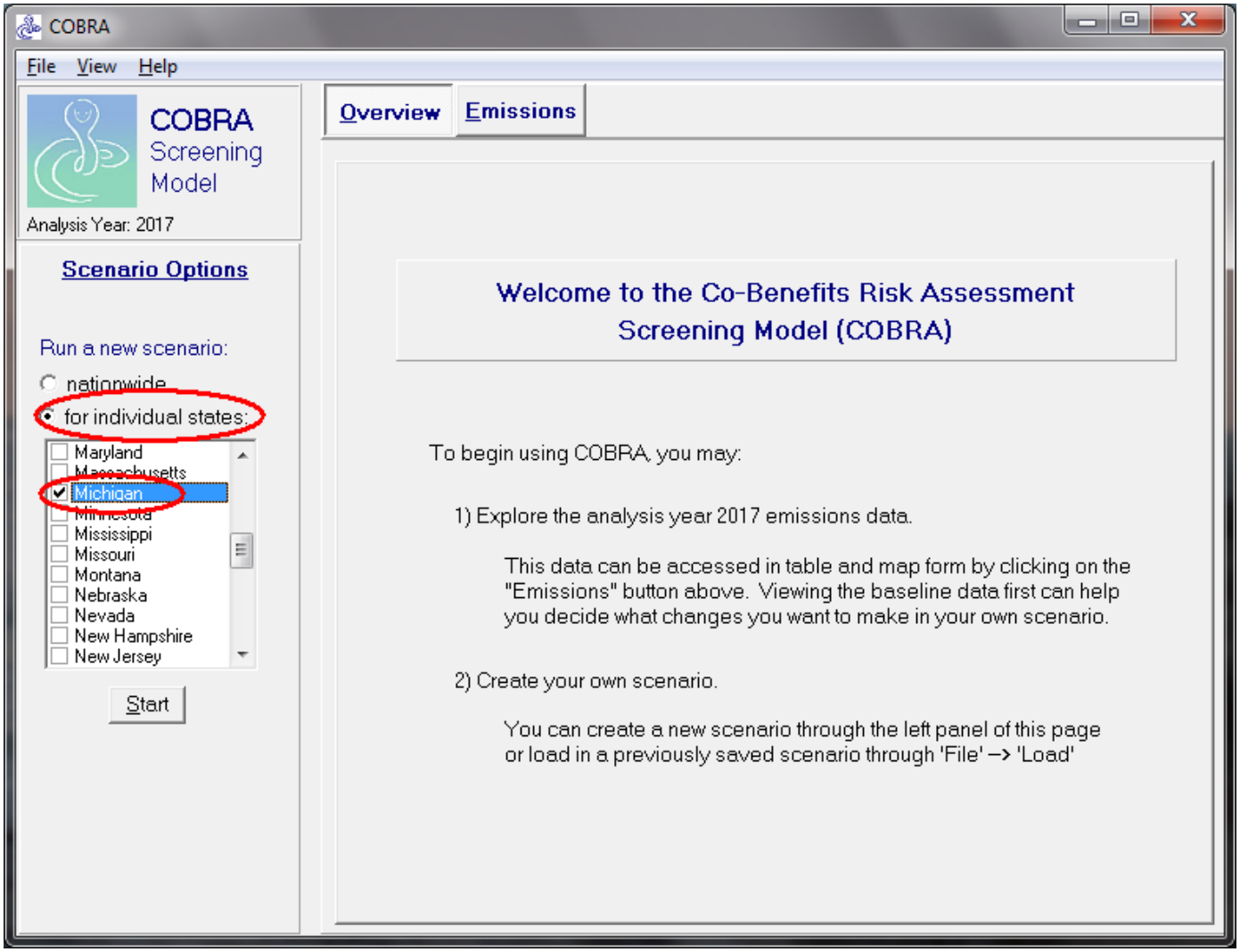
# Step 2: Set up Scenario in COBRA
# (a) Location of Emission Reductions Expected



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

- A RPS affects the fuel combustion from electricity generation category
  - These categories include fuel choices (e.g., gas, coal)
  - You can select specific fuel choices that are expected to be affected if known or assume all fuel choices are affected
- For the Michigan RPS example, we assume that all fuel sources would be affected by the RPS (i.e., not just natural gas or just coal) and select the "fuel combustion from electricity generation" category

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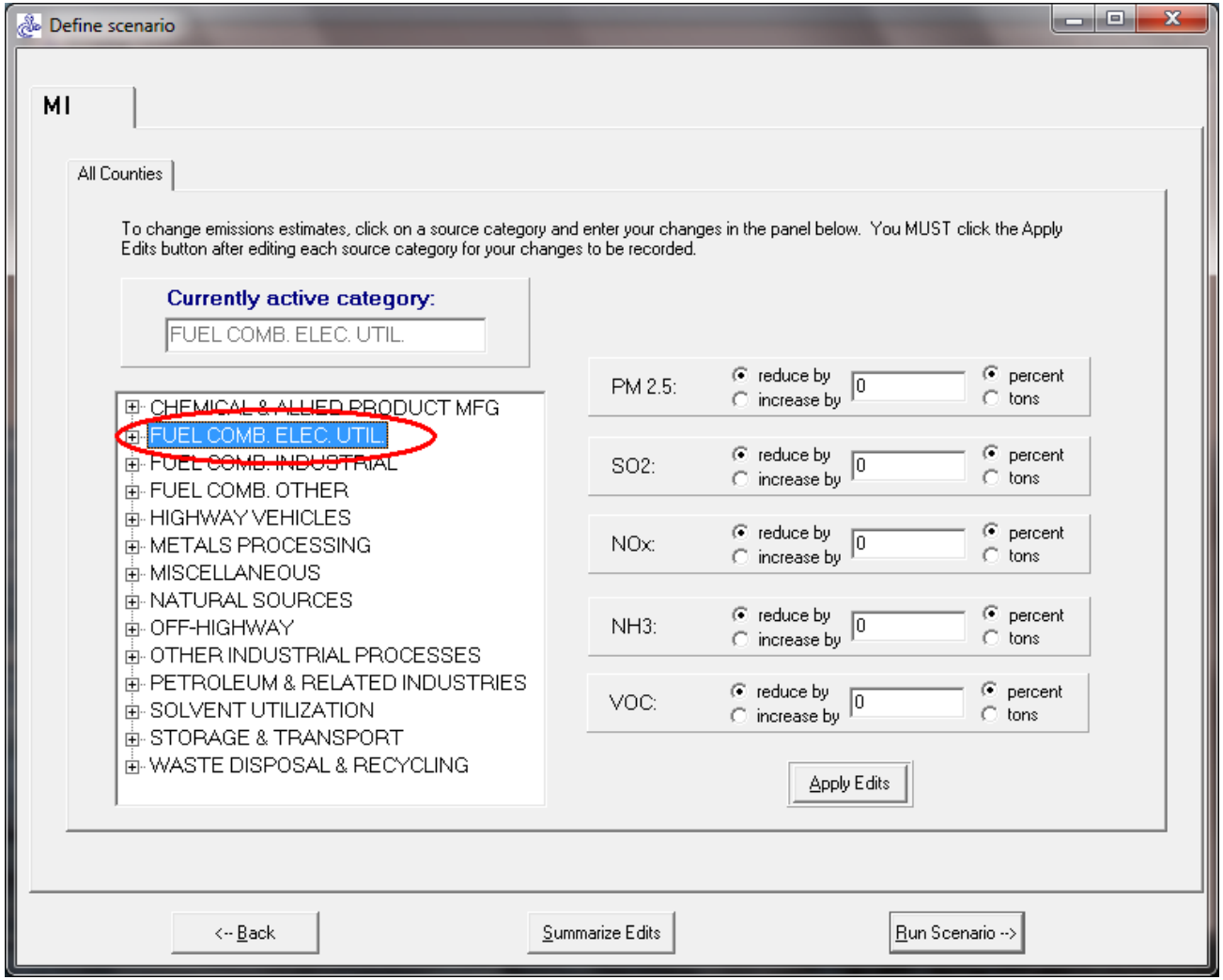
# Step 2: Set up Scenario in COBRA
# (b) Types of Emission Reductions Expected



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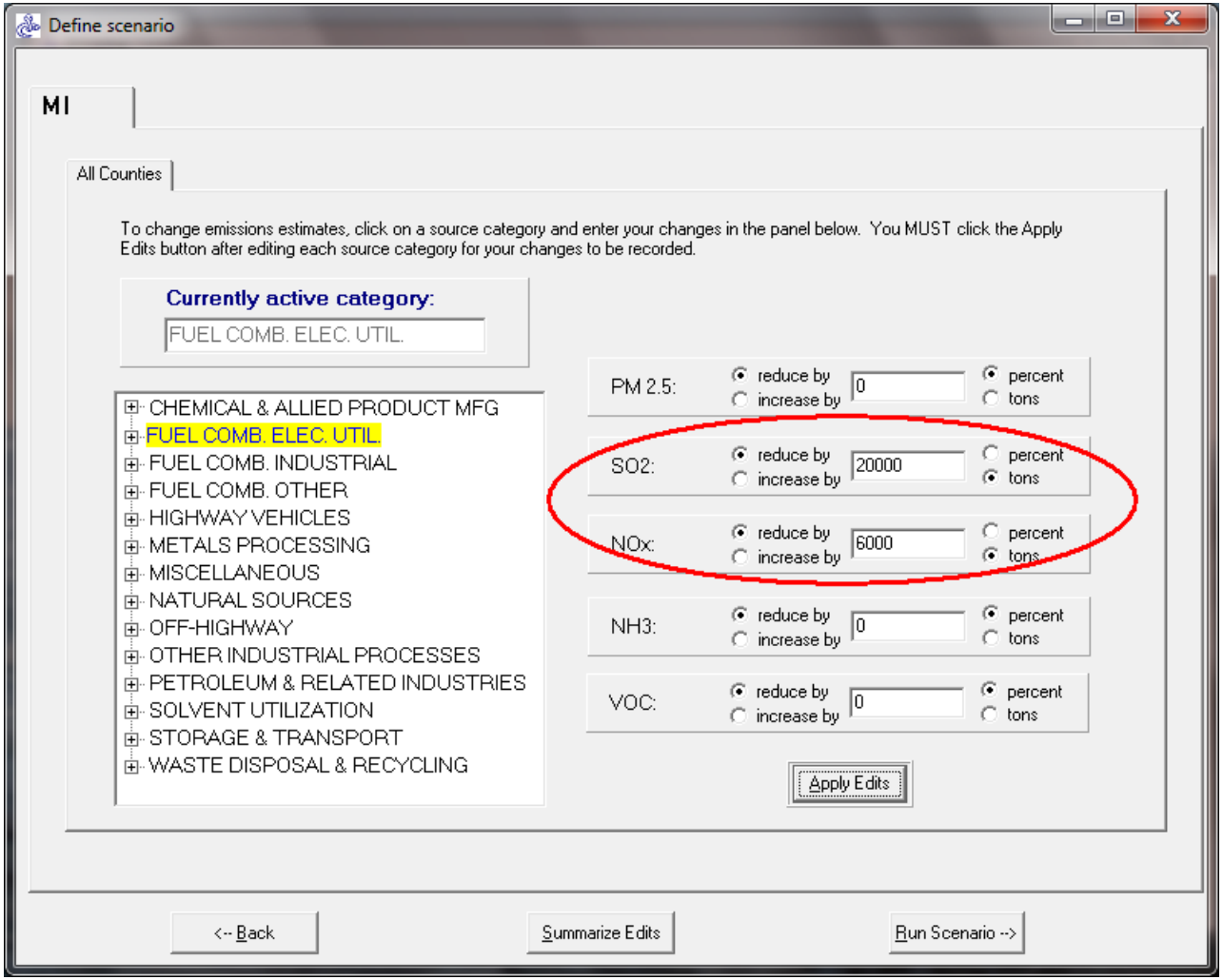
# Step 2: Set up Scenario in COBRA
# (c) Quantity of emission reductions expected



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# Step 3: Select a discount rate

- A discount rate is used to appropriately discount the value of future benefits
- In this case study, we use a 3% discount rate
- This discount rate provides an upper bound for the estimated benefits and places a greater value on future benefits to society, compared to higher discount rates

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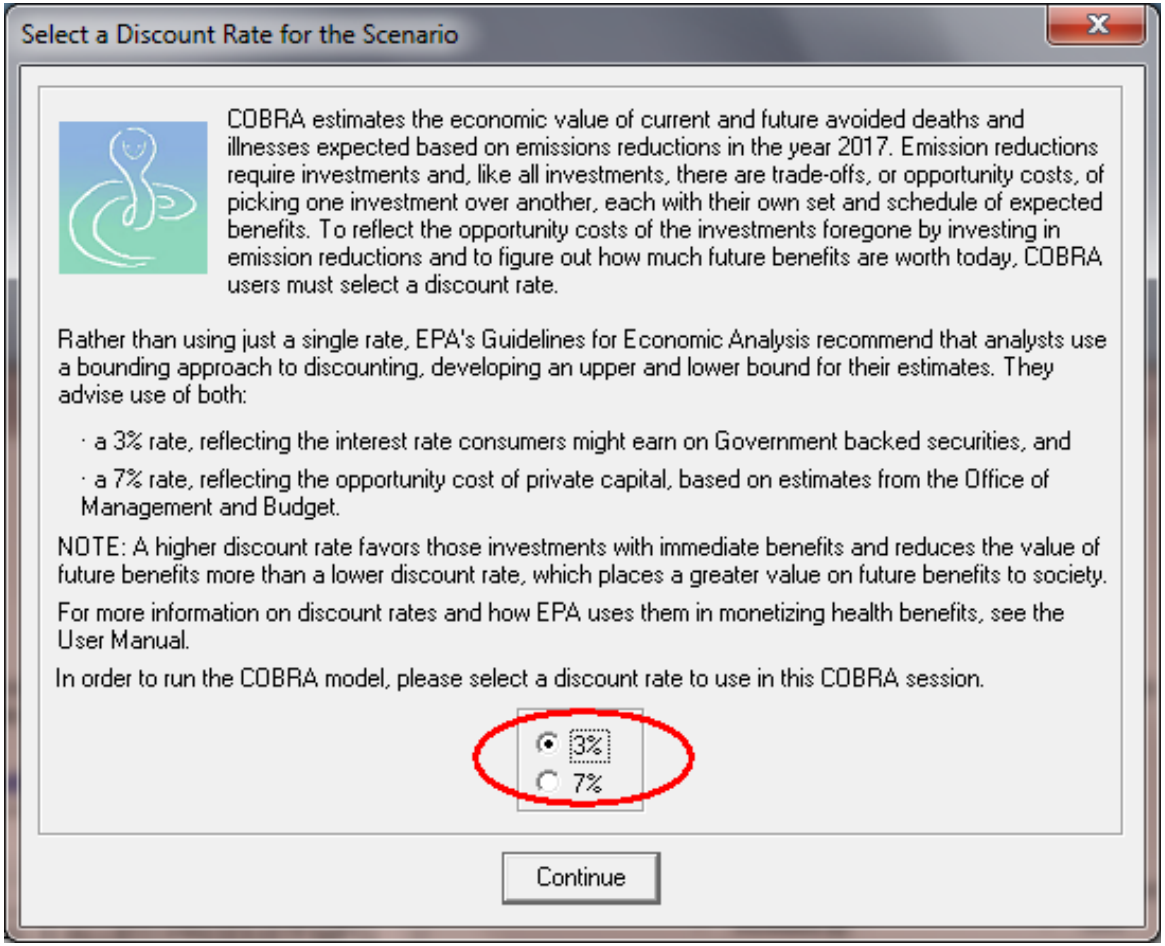
# Step 3: Select a discount rate



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# Step 4: Run the model and review the results

We calculated absolute emissions reductions of Michigan's renewable portfolio standard of 10%.

**Annual Emission Reductions (short tons)**

| Pollutant | Amount |
|---|---|
| Sulfur Dioxide ($SO_2$) | 20,000 |
| Nitrogen Oxides ($NO_x$) | 6,000 |

COBRA (1) converted emissions reductions into air quality improvements, and (2) estimated annual adverse health impacts avoided.

**Annual Adverse Health Impacts Avoided**

| Outcome | Number |
|---|---|
| Mortality | 85 - 192 |
| Asthma Exacerbations | 2,271 |
| Heart Attacks | 11 - 99 |
| Hospital Admissions | 55 |
| Acute Bronchitis | 117 |
| Respiratory Symptoms | 3,636 |
| Asthma ER Visits | 46 |
| Minor Restricted Activity Days | 61,181 |
| Work Days Lost | 10,227 |

COBRA monetized the value or benefits of the avoided adverse health effects.

**Annual Benefits (2010, $1,000s)**

| Dollar Value |
|---|
| $715,980 - $1,620,219 |
| $130 |
| $1,304 - $12,114 |
| $1,853 |
| $56 |
| $102 |
| $20 |
| $4,143 |
| $1,633 |
| *total* $725,221 - $1,640,270 |

* Don't forget to consider the caveats from slides 13 through 15

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# Case Study 2: Wind Energy Program

State and Local Climate and Energy Program

This case study illustrates how to conduct an analysis of a clean energy program with COBRA using wind energy capacity as an example.

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# Using COBRA to Evaluate the Benefits of Wind Energy Production

- Wind energy is used across the country, whether it is produced in-state or purchased from other states
- If the electricity had previously been generated with fossil fuels, wind energy production can lead to criteria air pollutant reductions and health benefits

For more details, see: the American Wind Energy Association's "The Clean Air Benefits of Wind Energy" report, available at http://awea.files.cms-plus.com/FileDownloads/pdfs/AWEA_Clean_Air_Benefits_WhitePaper%20Final.pdf.

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# Using COBRA to Evaluate Wind Energy Production

- The next slides describe how to estimate the health and related economic benefits of increasing a state's wind energy capacity
  - Specifically, we assume Texas has decided to explore the benefits associated with a new wind energy program

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

- Select what geographic locations you expect to be affected by the emissions change
  - You can enter emissions changes at the national, regional, state or county levels
  - If you know that specific plants will be affected, you can enter emissions changes only in those counties
  - Or you could use more sophisticated energy modeling approaches or tools to identify any and all plants that may be affected by a state or local wind energy program and enter those changes in manually

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

- For this example, we assume that the wind energy impacts will take place throughout Texas
- Due to the interconnectedness of the grid, these impacts will affect electricity providers and emissions beyond this state

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

- To estimate the electricity reductions expected from the program, you can either:
  - Estimate how many MW you expect to save, or
  - Find a similar program to use as a proxy
- In this hypothetical example, we estimate emissions reductions due to a 7,000 MW wind energy program in Texas
  - The American Wind Energy Association (AWEA) reported installed wind power capacity by state, with a total of 12,355 MW for Texas*
  - Another 7,000 MW of wind energy projects are currently under construction in Texas*

*Source: AWEA's "AWEA U.S. Wind Industry Fourth Quarter 2013 Market Report", available at http://www.awea.org/4q2013.

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

- To estimate the annual emissions reduced from 7,000 MW of installed wind capacity, you can use:
  - A basic tool that estimates emissions reductions from renewable energy programs
  - A more sophisticated modeling approach, if available

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

- For this example, we use EPA's AVoided Emissions and geneRation Tool (AVERT)* to:
  - Apply a 7,000 MW increase in installed wind capacity in Texas
  - Calculate the county-level emission reductions (in lbs)
  - Sum the emission reductions to state level
  - Convert emissions reductions to tons

For more details, EPA's AVERT tool and documentation are available at http://epa.gov/avert/.

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

- Annual emission reductions (in tons) from 7,000 MW wind energy program using AVERT:

| State/County | $SO_2$ | $NO_x$ |
|---|---|---|
| Texas | 31,738.6 | 12,722.9 |
| Oklahoma* | 0.75 | 64.75 |

*Note that Oklahoma also experiences emissions reductions from the wind program.

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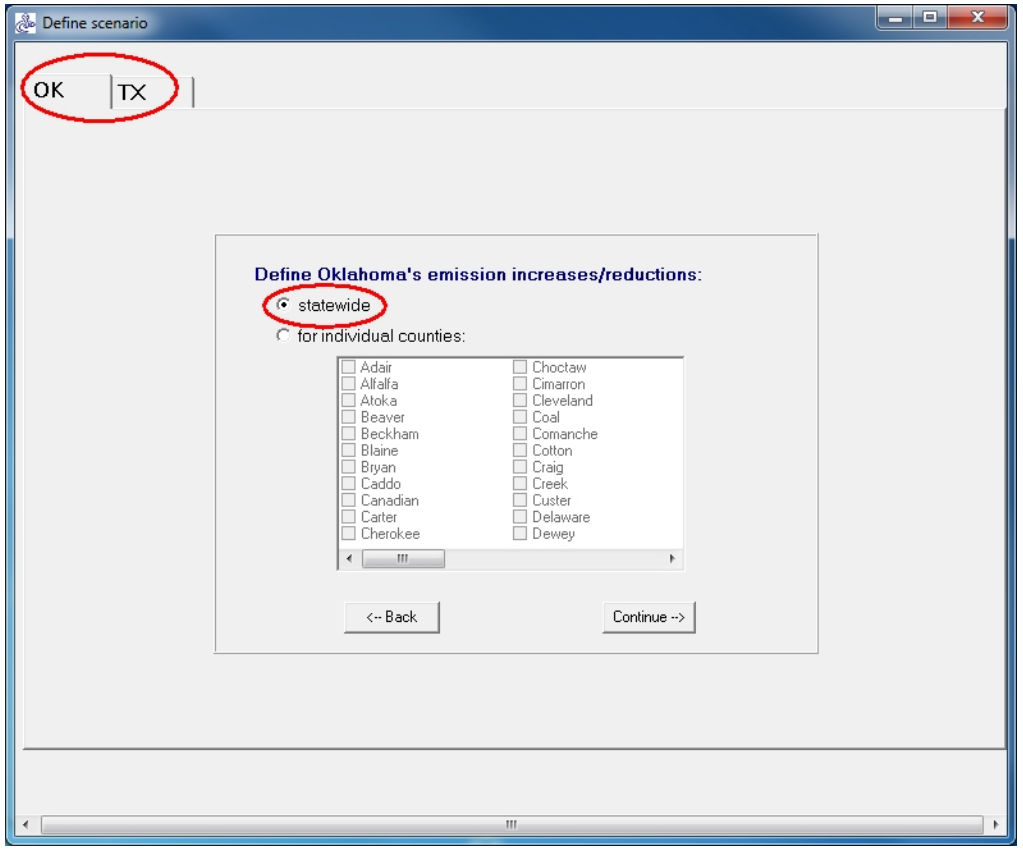
# Step 2: Set up Scenario in COBRA
# (a) Location of Emission Reductions Expected

- Emission reductions in all affected states are input at the state level



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

- Since renewable energy programs affect electricity generation, the affected emissions category is “fuel combustion from electricity generation”
- This category includes fuel choices (e.g., gas, coal)
- Since all fuel sources could be affected by the renewable energy program, select the “fuel combustion from electricity generation” category

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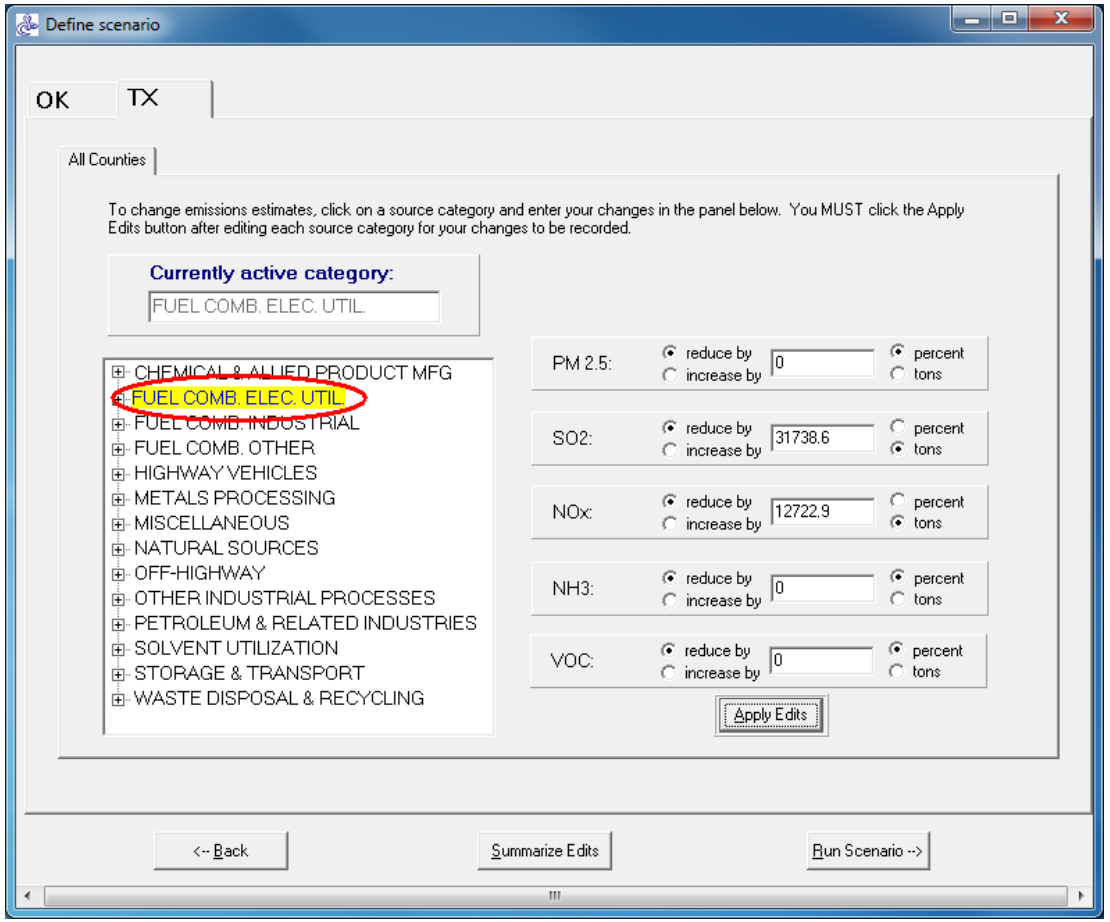
# Step 2: Set up Scenario in COBRA
# (b)Types of Emission Reductions Expected

- Select emissions category for each affected state or county



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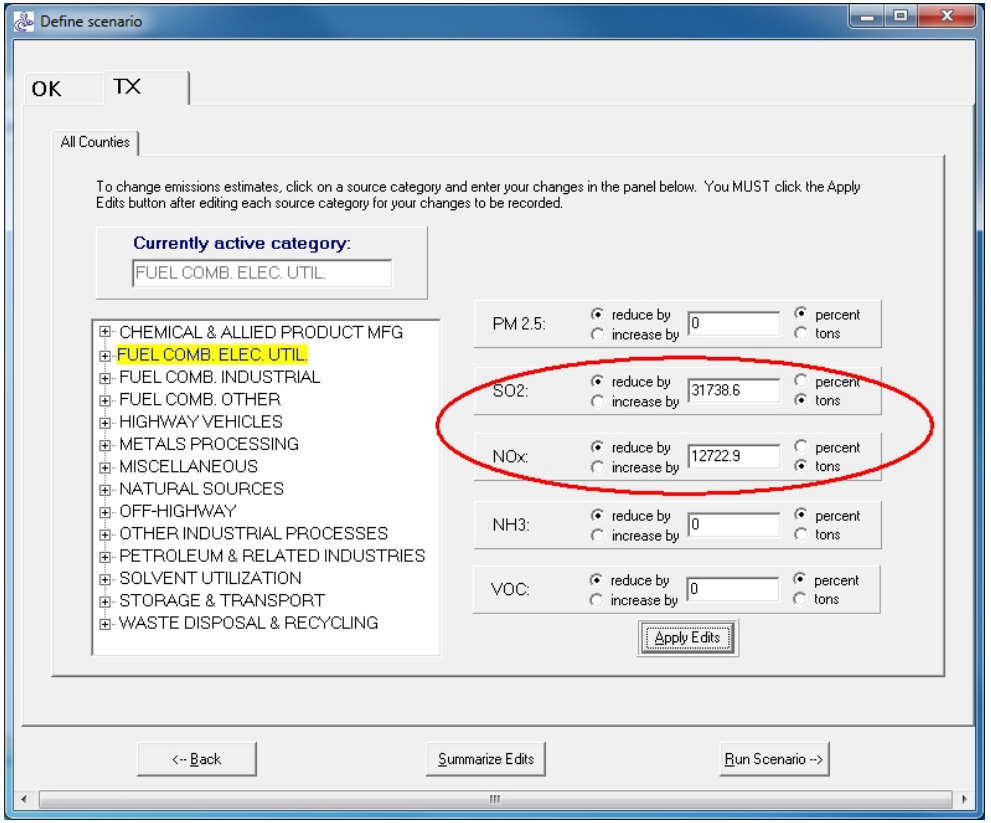
# Step 2: Set up Scenario in COBRA
# (c) Quantity of emission reductions expected

- Enter emission reductions for each affected state or county
  - Do not forget to enter and click “Apply Edits” for each state/ county



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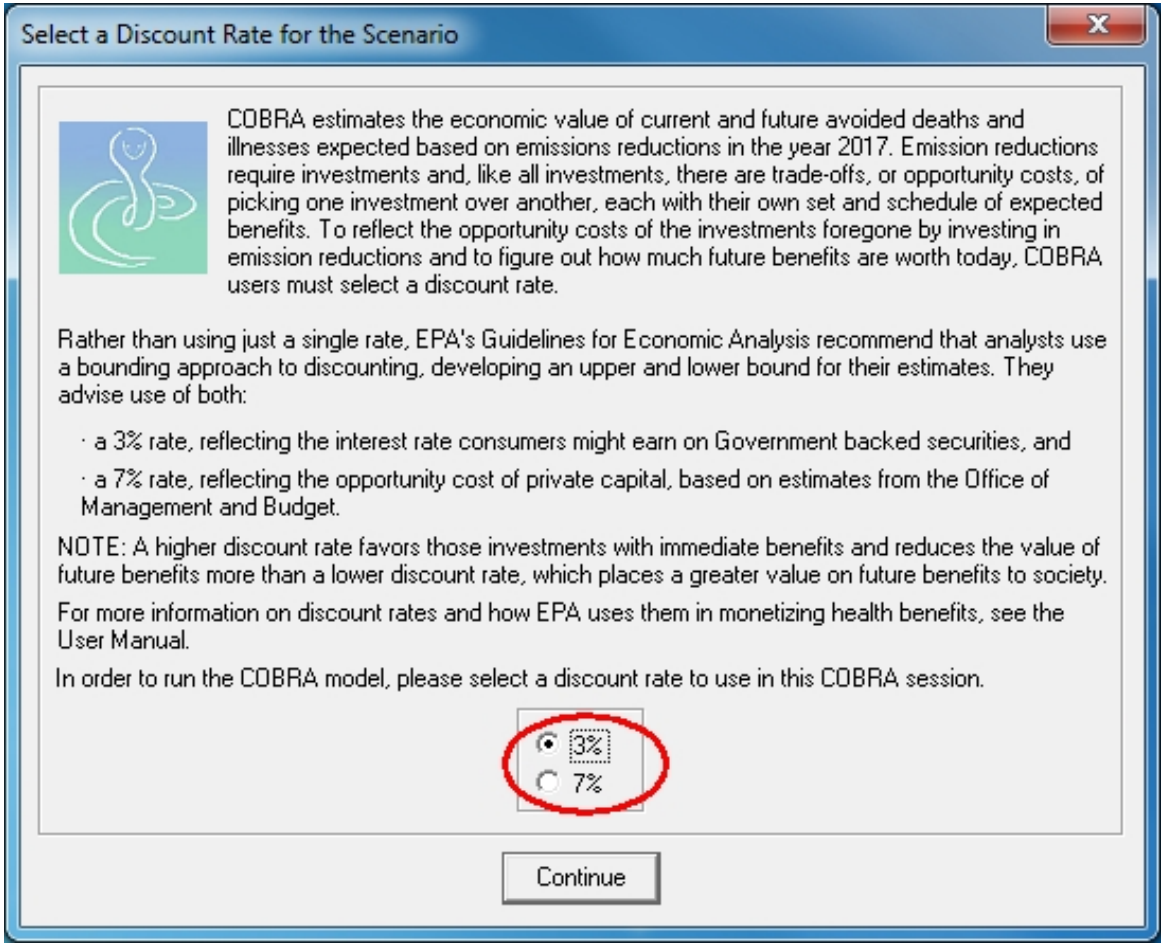

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# Step 4: Run the model and review the results

We used AVERT to calculate the emissions reductions due to an increased wind capacity of 1,000 MW.

**Annual Emission Reductions** (short tons)

| Pollutant | Amount |
|---|---|
| Sulfur Dioxide ($SO_2$) | 31,739 |
| Nitrogen Oxides ($NO_x$) | 12,788 |

Note: These reductions are aggregated across all affected states.

COBRA (1) converted emissions reductions into air quality improvements, and (2) estimated annual adverse health impacts avoided.

**Annual Adverse Health Impacts Avoided**

| Outcome | Number |
|---|---|
| Mortality | 64 - 145 |
| Asthma Exacerbations | 2,020 |
| Heart Attacks | 8 - 71 |
| Hospital Admissions | 41 |
| Acute Bronchitis | 105 |
| Respiratory Symptoms | 3,261 |
| Asthma ER Visits | 33 |
| Minor Restricted Activity Days | 50,320 |
| Work Days Lost | 8,460 |

COBRA monetized the value or benefits of the avoided adverse health effects.

**Annual Benefits** (2010, $1,000s)

| Dollar Value |
|---|
| $538,360 - $1,219,323 |
| $116 |
| $945 - $8,776 |
| $1,363 |
| $50 |
| $91 |
| $14 |
| $3,407 |
| $1,351 |
| $545,698 - $1,234,492 |

*total*

* Don't forget to consider the caveats from slides 13 through 15

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# How Can I Learn More?

## Visit Our Website:

http://www.epa.gov/statelocalclimate/resources/cobra.html

## Contact Us:

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