US EPA ARCHIVE DOCUMENT

Estimating the Co-Benefits of Clean Energy Policies

The Co-Benefits Risk Assessment (COBRA) Screening Model

Air Quality | Human Health | Societal Benefits

State and Local Climate and Energy Program

EPA United States Environmental Protection Agency

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What is COBRA?

- The Co-Benefits Risk Assessment (COBRA) model is a peer reviewed screening tool that inexpensively and quickly estimates the air quality, human health, and associated economic impacts – the benefits - of various state and county level emission reduction scenarios.
  - The model presents the health effects and related economic value of the effects in tables and maps by county for state, region, U.S.

- COBRA enables users to obtain a first order approximation of benefits so that they can:
  - understand and communicate the potential for health and related economic benefits of clean energy
  - compare benefits to the costs of different policy scenarios
  - determine what options warrant further analysis or consideration based on their potential health benefits

How Does COBRA Work?

Users enter emissions change(s) and discount rate for 2017

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

COBRA:

Quantifies Changes in Air Quality

- Uses a simple air quality model, the Source Receptor (S-R) Matrix, to estimate effects of changes on ambient particulate matter.

Calculates Change in Health Outcomes

- Uses "canned" concentration response functions to link the changes in particulate matter to epidemiological studies[1]

Calculates Monetary Value

- Uses "canned" values based on willingness-to-pay, cost of illnesses , value of a statistical life and direct medical costs.

Outputs = Tables and maps of illnesses and deaths avoided and the related economic value.

[1] COBRA excludes benefits beyond particulate matter-related ones and may be conservative in that respect.

Human Health Effects and Their Related Economic Values 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

Strengths of COBRA

- Enriches discussion of co-benefits and supports a balanced decision-making process that considers both the potential costs and benefits of policy choices.
- Easy-to-Use screening tool
  - Requires minimal inputs
  - Includes “canned” equations and approaches generally consistent with EPA practices
  - Detailed User’s Guide describes all assumptions and equations
- Flexible for User
  - Can enter data for a single county, group of counties, statewide, outside of state, and/or group of states
  - Can enter reductions in absolute terms or as percentage change
- Inexpensive (free!) compared to rigorous air quality models
  - Results from COBRA approach have fared well in informal comparisons;
  - Enables analysts to narrow a list of options at no/low cost and then devote resources to analyzing only those options with the best prospects using more expensive air quality models.
- Quick to generate results
- Mapping of results facilitates visualization of impacts
  - Provides very localized health effects and valuations: county level

Limitations of COBRA

- EPA is a free, screening tool not a highly sophisticated model.
  - Air Quality (AQ) model is "quick and dirty"
    - COBRA is best used as screening tool, followed up with comprehensive AQ analysis and health impact assessment
  - Somewhat inflexible and simple
    - Limited timeframe for analysis (currently 2017 only)
    - Inability to import own baseline
    - Must use "canned" equations (C-R functions, economic values)
    - Does not address cap issues
  - Relies upon inputs generated elsewhere
    - Assumptions about statewide % reductions may be an oversimplification
- 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 for Running An Analysis With COBRA

1. Estimate what and where (e.g., in one or more counties or states, regionally, nationally) emission reductions will occur
   - COBRA uses **your** emission inputs to estimate the air quality, health, and health-related economic impacts of the scenario
   - We provide tips on our website as to what tools and approaches (e.g. emissions factors from eGRID*, sophisticated models) you can use to estimate the emission reductions
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

* e-GRID is available at http://www.epa.gov/cleanenergy/energy-resources/egrid/

Example: Evaluate 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
- A state or local government can use COBRA to come up with a rough estimate of the health and related economic benefits of a state or local renewable energy standard
  - Let's assume this illustrative scenario: Suppose a state (Michigan) has established an RPS requirement that 10% of electricity generation must be from renewable sources by 2015
    - NOTE: We also could have looked at a county with a renewable target or requirement

Step 1: Estimate what and where 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
- For the Michigan RPS, we assume that all emission changes will occur statewide

Step 1: Estimate what and where 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

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

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.

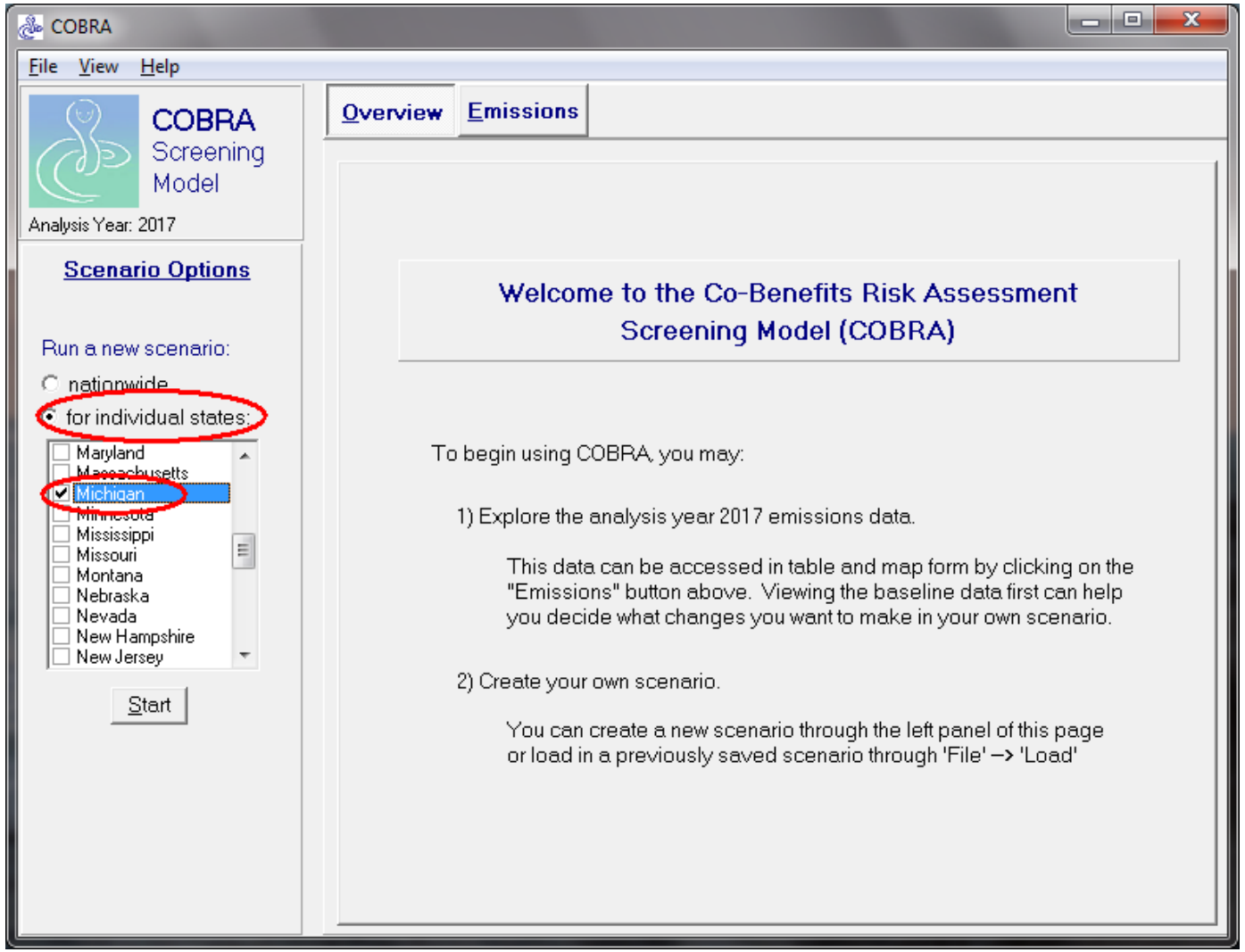
  = **20,000 tons**

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

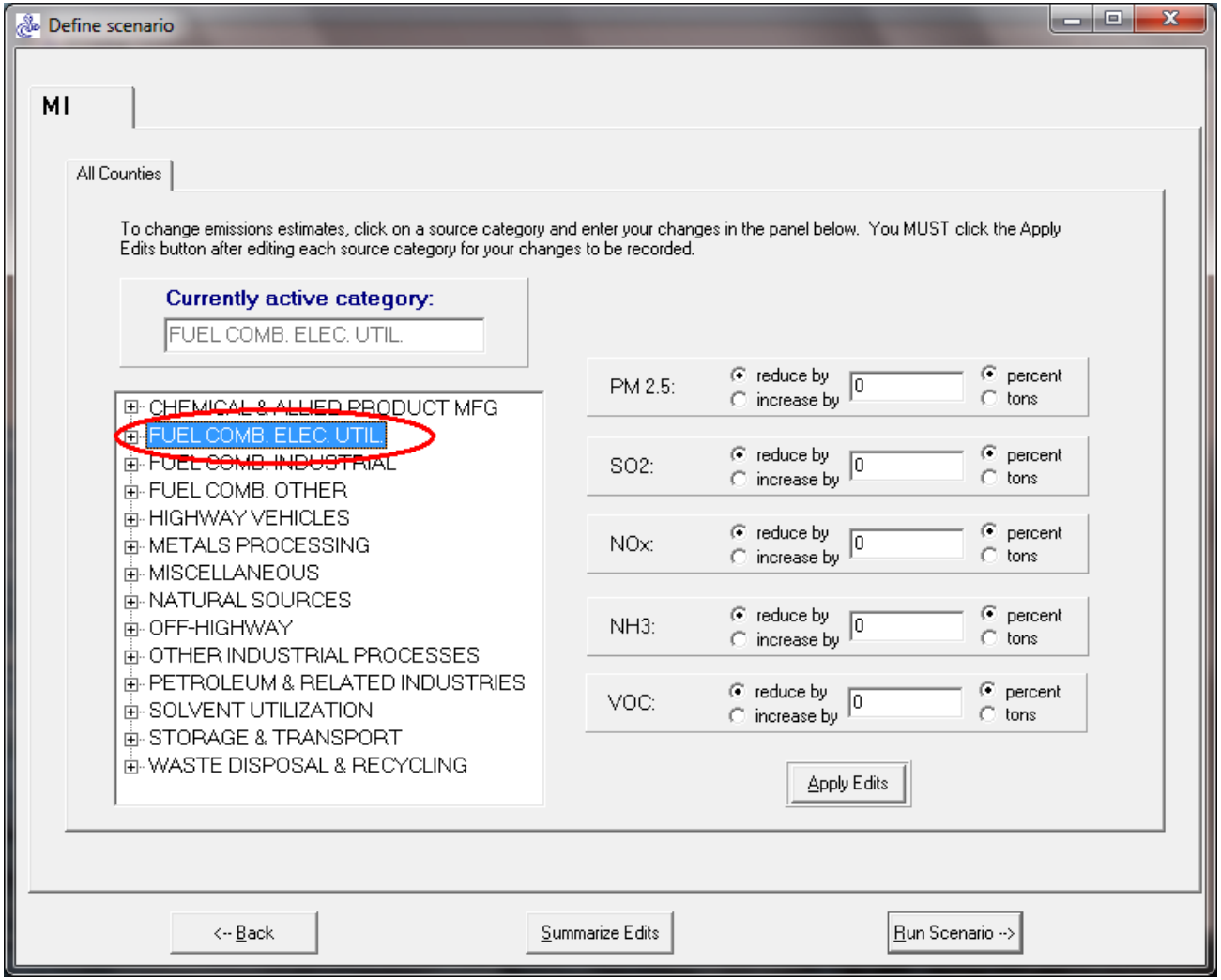
  = **6,000 tons**

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

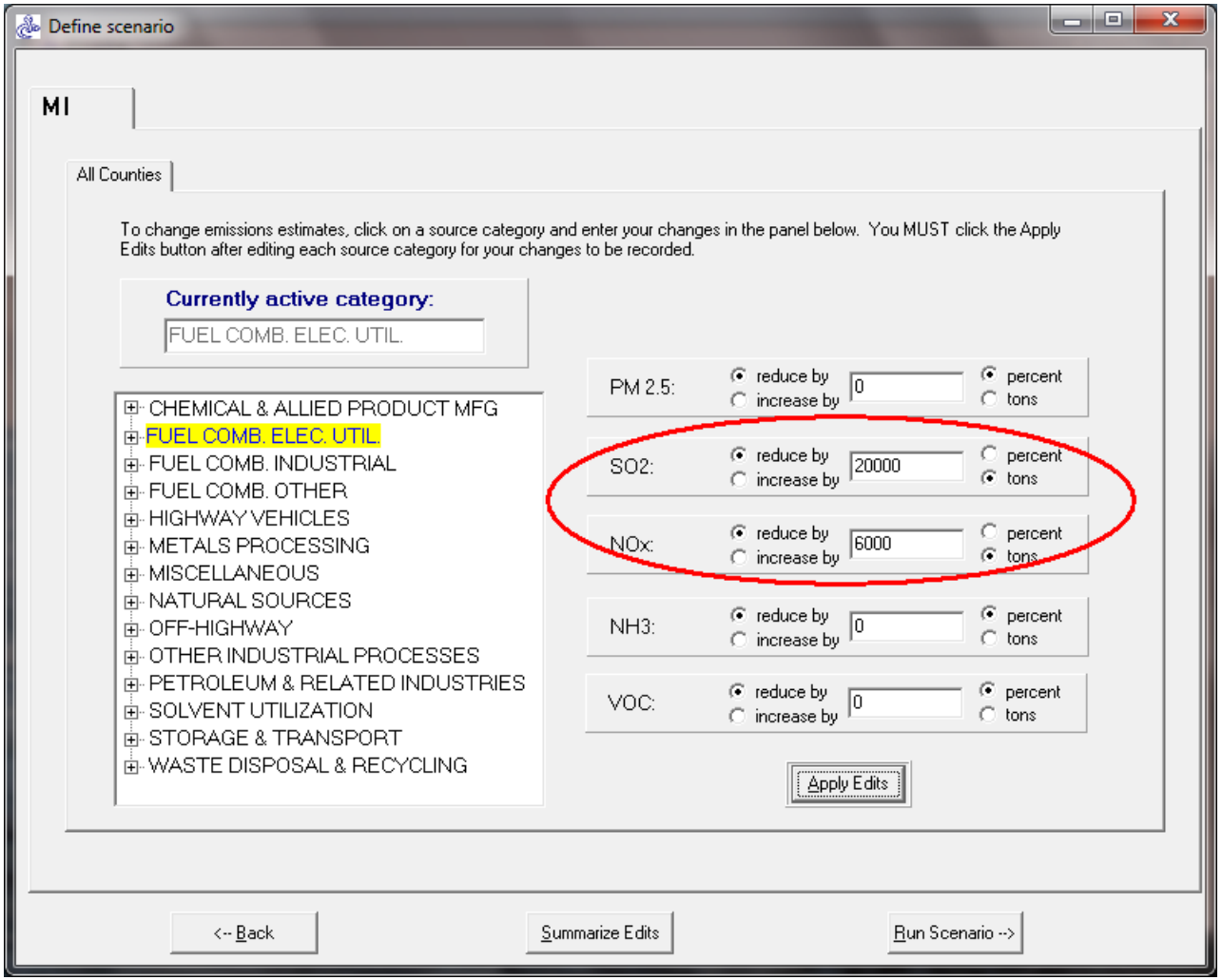
Step 2: Set up Scenario in COBRA
(a) Location of Emission Reductions Expected



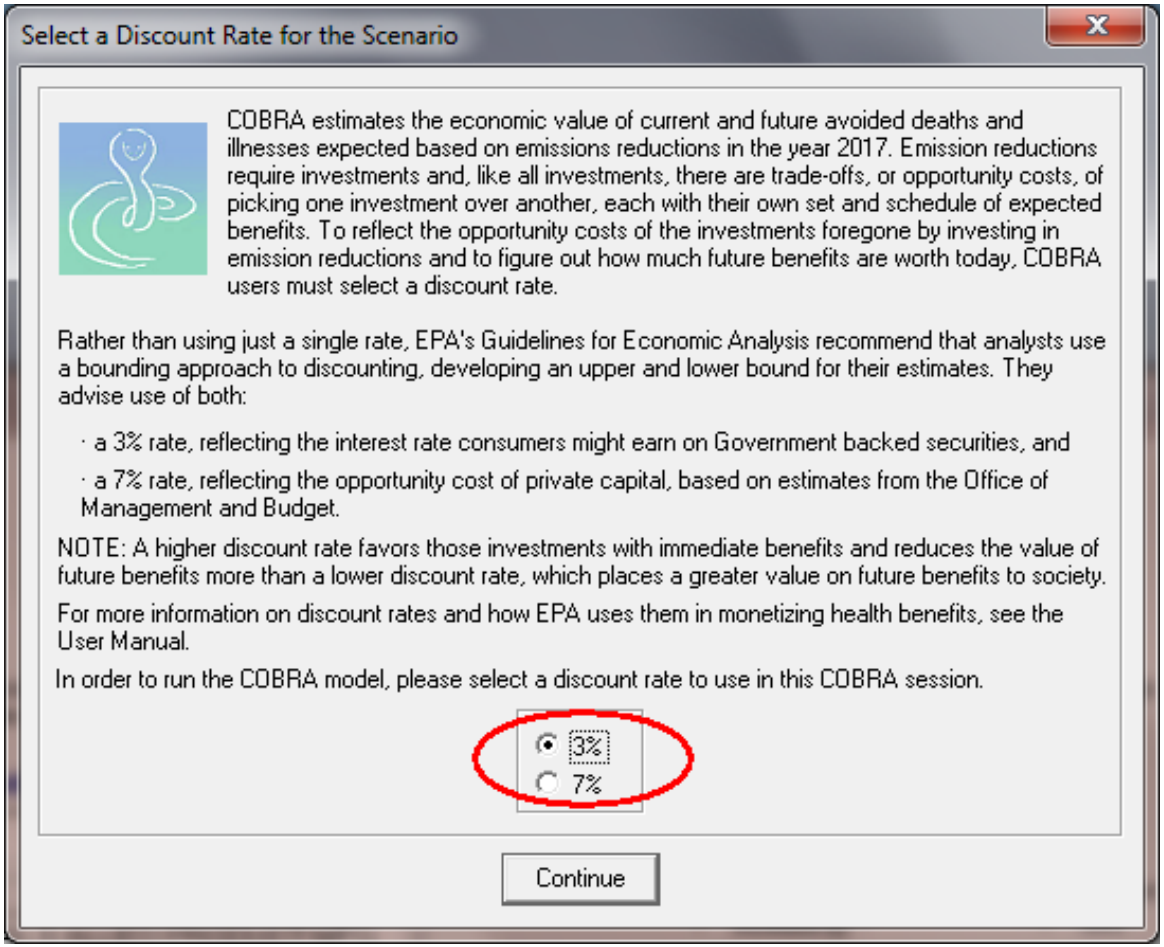
Step 2: Set up Scenario in COBRA
(b) Types of Emission Reductions Expected



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



Step 3: Select a discount rate



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	119 - 304
Asthma Exacerbations	3,236
Heart Attacks	16 - 146
Hospital Admissions	93
Acute Bronchitis	169
Respiratory Symptoms	5,233
Asthma ER Visits	68
Minor Restricted Activity Days	88,325
Work Days Lost	14,784

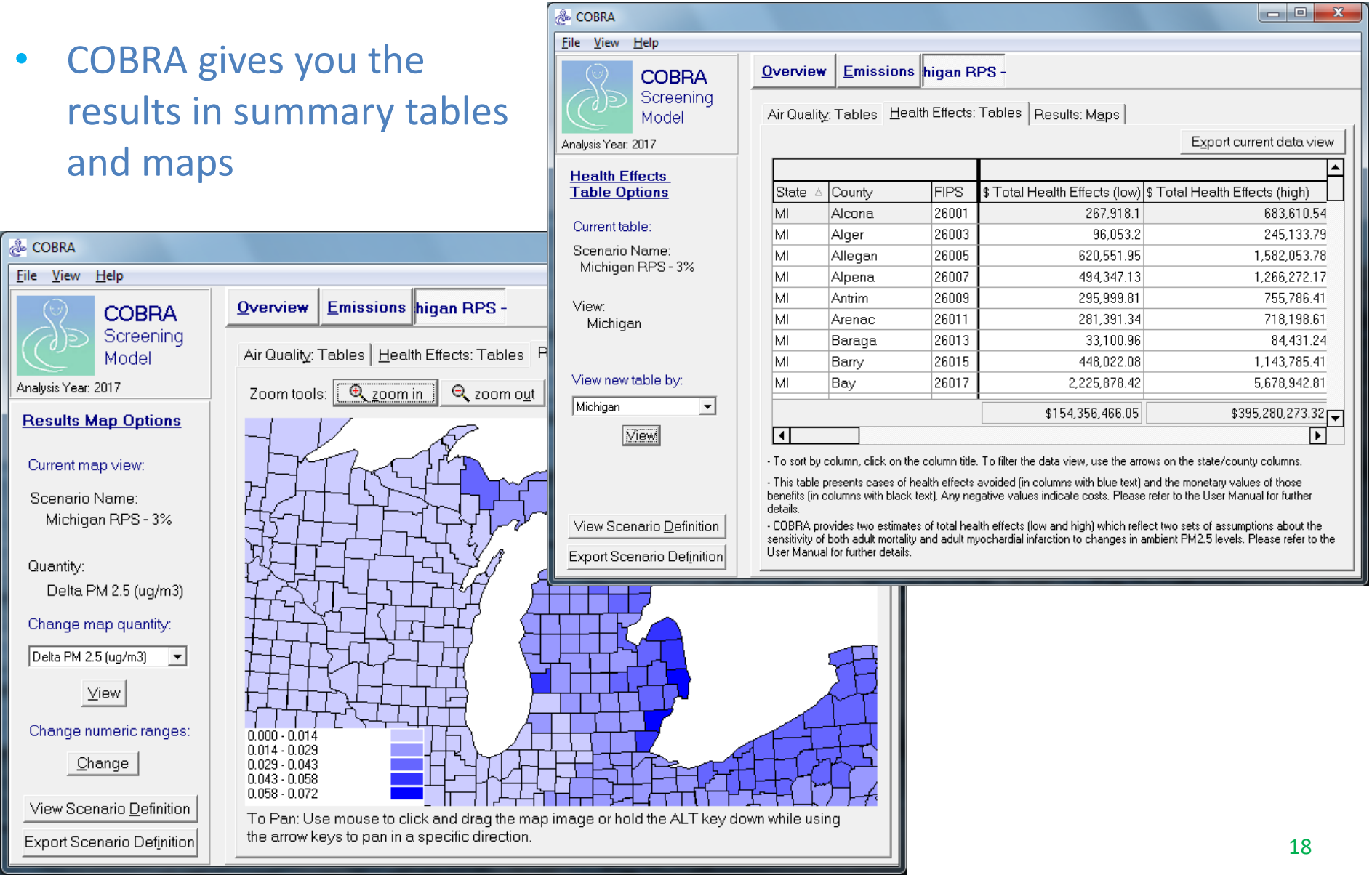
COBRA monetized the value or benefits of the avoided adverse health effects.

Annual Benefits (2010, $1,000s)

Dollar Value
$1,000,174 - $2,563,875
$372
$1,923 - $17,864
$3,107
$81
$294
$29
$6,006
$2,232
total $1,014,218 - $2,593,859

Step 4: Review & Promote Results

- COBRA gives you the results in summary tables and maps



How can I get more information?

Visit Our Website

http://www.epa.gov/statelocalclimate/resources/cobra.html where you can:

- Learn more through online presentations, including:
  - Why Use COBRA?
  - How Does COBRA Work?
  - Quick start Tutorial: How To Use COBRA
- Find all of the documentation for COBRA
- Download the model

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