Estimating the Co-Benefits of Clean Energy Policies

Co-Benefits Risk Assessment (COBRA) Screening Model: Why Use COBRA?

Air Quality | Human Health | Societal Benefits
Energy choices affect peoples’ health and social wellbeing. Yet, often policymakers consider only the economic costs of the investment – just a part of the story – and not the benefits.

State and local policymakers can use COBRA to estimate the economic value of human health improvements associated with clean and renewable energy projects and tell the whole story.

State and local policymakers can also use COBRA to estimate and present via easy-to-read maps the local impacts of switching to clean energy.
In 2010, fossil fuels accounted for 70% of the almost 4 trillion kWh of electricity generated in the U.S.

Burning fossil fuels causes emission of air pollutants like particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides.

Electricity generation is the largest source of U.S. CO2 emissions, representing 38% of total emissions and contributing to climate change in the long term.

**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**

**Major Source of Air Pollution**
Energy Choices Matter

Clean Energy

- Reduces total electricity demand
- Displaces (or replaces) fossil fuel electricity sources with clean distributed generation or renewable energy sources

Energy Efficiency and Renewable Energy

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

Reduces Emissions

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

Societal Benefits
Why estimate benefits of clean energy?

Estimating the benefits of clean energy helps policymakers fully assess the value of clean energy investments – including health and societal benefits – and compare benefits to costs.

Policy makers can also use benefit estimates to:

- Better understand the potential for clean energy to enhance air quality, health, and social wellbeing;
- Design or select program options that maximize benefits; and
- Build support for clean energy.
What is COBRA and How Does It Work?

**Inputs** = Change in 2017 Emissions
- PM2.5, SO2, NOx, NH3, VOCs

COBRA\(^1\) is a screening model that converts emission reductions into changes in air quality and estimates the number of cases of illness and death avoided as well as the economic value of those benefits.

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

**COBRA:**
- **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**

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\(^1\)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.
Who can use COBRA and For What?

Analysts, planners and officials from environmental, health, energy, transportation and economic development agencies can use COBRA to understand and communicate the potential for health and related economic benefits of clean energy. COBRA can be used:

- 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

- To 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

- To 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
Case Study: U.S. Dept. of Energy Investment in Geothermal Technology

- DOE typically estimates the costs of investment programs and weighs them against the economic benefits, such as the market value of additional electricity produced by more energy efficient technologies.

- But there are non-market benefits as well.

- In a recent analysis,1 DOE estimated the costs and benefits of displacing coal, petroleum and natural gas-fired power plants with two geothermal technologies:
  - BINARY: Binary Cycle Power Plant Technology
  - TOUGH: Transport of Unsaturated Groundwater and Heat Models

- DOE estimated market benefits using their standard approach and then used COBRA to quantify and monetize the non-market benefits – i.e., the environmental health benefits – associated with their investments.

Case Study: How DOE Used COBRA

DOE estimated emission reductions from using BINARY and TOUGH technologies instead of fossil fuels.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>BINARY</th>
<th>TOUGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter (PM)</td>
<td>1,530</td>
<td>3,307</td>
</tr>
<tr>
<td>Sulfur Dioxide (SO2)</td>
<td>637</td>
<td>1,447</td>
</tr>
<tr>
<td>Nitrogen Oxides (NOx)</td>
<td>334</td>
<td>758</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Outcome</th>
<th>BINARY</th>
<th>TOUGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Chronic Bronchitis</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Heart Attacks</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Hospital Admissions</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Acute bronchitis</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Respiratory Symptoms</td>
<td>188</td>
<td>415</td>
</tr>
<tr>
<td>Asthma ER Visits</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Minor Restricted Activity Days</td>
<td>4,500</td>
<td>9,939</td>
</tr>
<tr>
<td>Work Days Lost</td>
<td>763</td>
<td>1,680</td>
</tr>
</tbody>
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COBRA monetized the value or benefits of the avoided adverse health effects.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>BINARY</th>
<th>TOUGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>$34,217,000</td>
<td>$75,230,000</td>
</tr>
<tr>
<td>Chronic Bronchitis</td>
<td>$1,620,000</td>
<td>$3,564,000</td>
</tr>
<tr>
<td>Hospital Admissions</td>
<td>$860,000</td>
<td>$1,890,000</td>
</tr>
<tr>
<td>Acute Bronchitis</td>
<td>$73,000</td>
<td>$164,000</td>
</tr>
<tr>
<td>Respiratory Symptoms</td>
<td>$3,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>Asthma ER Visits</td>
<td>$4,000</td>
<td>$9,000</td>
</tr>
<tr>
<td>Minor Restricted Activity Days</td>
<td>$1,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>Work Days Lost</td>
<td>$280,000</td>
<td>$605,000</td>
</tr>
<tr>
<td>Total</td>
<td>$37,119,000</td>
<td>$81,606,000</td>
</tr>
</tbody>
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Case Study: DOE Included Health Benefits as Part of a Comprehensive Analysis

Including the value of *non-market* (e.g., health) benefits with that of market benefits helped DOE assess and communicate to the public the full value of their clean energy investments.

COBRA estimated the value of health benefits to be > $125 million
- Adding this to the market benefits of using geothermal technology more than doubled the magnitude of the overall benefits.

Including health benefits substantially increased the benefit-cost ratio for both technologies.
- For BINARY Technology, the benefit-cost ratio increased from 0.7 (i.e., costs > benefits) to 1.6 (i.e., costs < benefits).

<table>
<thead>
<tr>
<th>Metric (2008 $)</th>
<th>BINARY technology</th>
<th>TOUGH technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Value (PV) of Market Benefits</td>
<td>$19,878,000</td>
<td>$115,771,000</td>
</tr>
<tr>
<td>PV of Non-Market (Health) Benefits*</td>
<td>$22,970,000</td>
<td>$103,674,000</td>
</tr>
<tr>
<td>PV of Total Benefits</td>
<td>$42,848,000</td>
<td>$219,445,000</td>
</tr>
<tr>
<td>PV of Program Cost</td>
<td>$26,819,000</td>
<td>$8,619,000</td>
</tr>
<tr>
<td>PV of Net Benefits</td>
<td>$16,029,000</td>
<td>$210,826,000</td>
</tr>
<tr>
<td>Benefit-Cost Ratio (excluding health benefits)</td>
<td>0.7</td>
<td>13.5</td>
</tr>
<tr>
<td>Benefit-Cost Ratio (with health benefits)</td>
<td>1.6</td>
<td>25.5</td>
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Please contact DOE or RTI for more information on this study.
How can I learn more?

Visit Our Website:

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

Contact EPA:

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