Estimating the Co-Benefits of Clean Energy Policies

State and Local Climate and Energy Program

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

Air Quality | Human Health | Societal Benefits

EPA United States Environmental Protection Agency

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Co-Benefits Risk Assessment (COBRA) Screening Model At-A-Glance

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.

Energy Choices Matter

Electricity from Fossil Fuels

- 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.

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.

Societal Costs

- 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.

Energy Choices Matter

Clean Energy

Energy Efficiency and Renewable Energy

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

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.

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?

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.

Inputs = Change in 2017 Emissions

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

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

Outputs = Tables and maps of illnesses and deaths avoided and 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.

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.

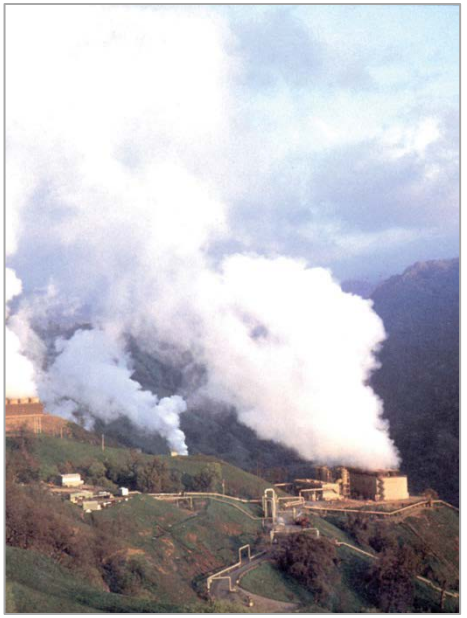

Image courtesy of USGS

[1] US DOE (2011) "Retrospective Benefit–Cost Evaluation of U.S. DOE Geothermal Technologies R&D Program Investments: Impacts of a Cluster of Energy Technologies." December 2011. Prepared by RTI.

Case Study: How DOE Used COBRA

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

Annual Emission Reductions (short tons)

Pollutant	BINARY	TOUGH
Particulate Matter (PM)	1,530	3,307
Sulfur Dioxide (SO2)	637	1,447
Nitrogen Oxides (NOx)	334	758

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

Annual Adverse Health Impacts Avoided

Outcome	BINARY	TOUGH
Mortality	5	12
Chronic Bronchitis	4	8
Heart Attacks	8	17
Hospital Admissions	3	7
Acute bronchitis	9	20
Respiratory Symptoms	188	415
Asthma ER Visits	3	7
Minor Restricted Activity Days	4,500	9,939
Work Days Lost	763	1,680

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

Annual Benefits, 2008 $

BINARY	TOUGH
$34,217,000	$75,230,000
$1,620,000	$3,564,000
$860,000	$1,890,000
$73,000	$164,000
$3,000	$8,000
$4,000	$9,000
$1,000	$2,000
$280,000	$605,000
$61,000	$134,000
total $37,119,000	$81,606,000

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).

Please contact DOE or RTI For more information on this study

Metric (2008 $)	BINARY technology	TOUGH technology
Present Value (PV) of Market Benefits	$19,878,000	$115,771,000
PV of Non-Market (Health) Benefits*	**$22,970,000**	**$103,674,000**
PV of Total Benefits	$42,848,000	$219,445,000
PV of Program Cost	$26,819,000	$8,619,000
PV of Net Benefits	$16,029,000	$210,826,000
Benefit-Cost Ratio (excluding health benefits)	0.7	13.5
Benefit-Cost Ratio (with health benefits)	**1.6**	**25.5**

Costs and benefits assume 7% discount rate with PV base year 1976;
*Benefits accrued for binary plants between 1984-2008 and TOUGH models between 1980-2008.

How can I learn more?

Visit Our Website:

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

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