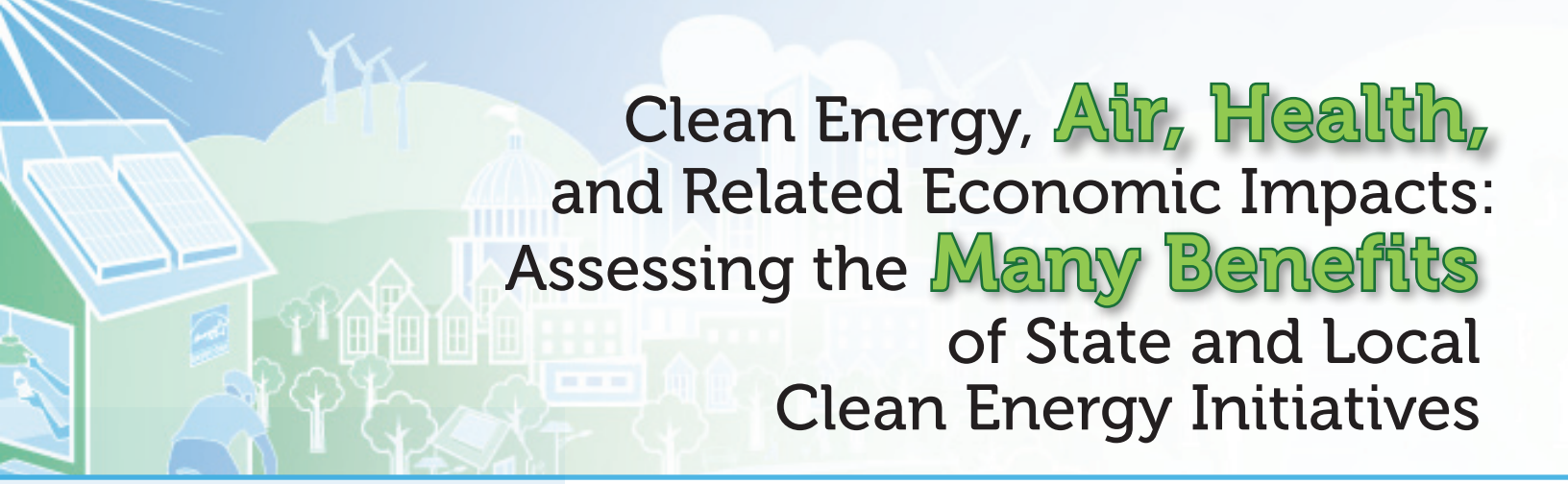


Clean Energy, Air, Health, and Related Economic Impacts: Assessing the Many Benefits of State and Local Clean Energy Initiatives

Multiple Benefits of Clean Energy Initiatives

Reducing energy demand and/or increasing renewable energy generation from state and local clean energy initiatives—such as goals, standards, codes, funds, and programs—can generate many benefits, including:

- Security, diversity, and overall reliability improvements for the electric system.
- **Improved environmental quality, human health, and quality of life.**
- Positive economic gains through energy costs saved, avoided medical costs, higher disposable incomes, increased labor productivity, and more jobs.

This brief is part of a series and focuses on **environmental and human health benefits.**

State and local governments can analyze their clean energy initiatives using methods and tools described in EPA's *Assessing the Multiple Benefits of Clean Energy: A Resource for States.*

What's Inside:

What are air quality, health, and economic benefits of clean energy initiatives?

Besides their direct energy, economic, and overall energy system benefits, clean energy initiatives also:

- Reduce air pollution.
- Improve public health.
- Lower health costs.
- Enhance worker productivity.
- Decrease costs for industry.
- Lower emissions that cause climate change.

How do clean energy initiatives benefit air quality, health, and the economy?

Electricity generation from fossil fuels is a major source of air pollution, including criteria air pollutants and greenhouse gases (GHGs). Air pollution contributes to many short- and long-term environmental problems—including health issues and climate change—that impose costs to society.

Clean energy initiatives reduce air pollution because they:

Reduce total electricity demand through increased energy efficiency, ***OR***

Displace (or replace) conventional electricity supplies with clean distributed generation (DG) or renewable energy sources.

By avoiding emissions of harmful pollutants, clean energy initiatives improve air quality and human health, and reduce contributions to climate change. These benefits extend further in a number of ways:

- Better air quality enhances local quality of life, helps communities meet federal air quality standards, and decreases costs to industry for complying with environmental regulations.
- Healthier people increase economic prosperity by reducing strain on the health system, using fewer sick days, improving productivity and spending more money on goods and less on medical costs.
- Lower carbon dioxide emissions in the near term may have a large impact on our ability to meet long-term climate goals since GHGs accumulate and can remain in the atmosphere for decades, affecting our global climate system and human health for the long term.

Why assess the air quality, health, and economic benefits of clean energy initiatives?

Understanding these benefits can help planners:

- Comprehensively assess the full value of clean energy investments.
- **Better understand** the potential for clean energy to enhance air quality, health, and economic welfare and meet long-term climate change goals.

EPA United States Environmental Protection Agency

State and Local Climate and Energy Program

Benefits Flash

A **New England** study analyzed benefits of energy efficiency (EE) and renewable energy (RE) efforts from Public Benefits Funds and Renewables Portfolio Standard programs. Between 2000 and 2010, these EE and RE efforts reduced:

- **31,700,000 tons, a 6 percent reduction in CO_2**
- **34,200 tons of SO_2**
- **22,039 tons of NO_x**

and increased:

- **Net economic output by $6.1B**
- **Net wage income by $1.04M**
- **Job years by 28,190**

Source: RAP, 2005.

The **Texas** Emissions Reduction Plan (TERP) requires use of energy efficiency and renewable energy to meet air quality standards and has reduced:

- **346 tons of NO_x per year in 2004**
- **824 tons of NO_x per year in 2007**

Projected reductions include:

- **1,416 tons of NO_x in 2012**
- **2,121 tons of NO_x in 2013**

Source: Haberl et al., 2004.

A **Massachusetts** study that analyzed the **benefits of energy efficiency actions** (such as weatherization, and refrigerator replacement) from 1977–1997 and projected benefits through 2015.

Between 1977 and 1997, the state achieved reductions of:

- **2,000,000 tons of CO_2**
- **11,000 tons of SO_2**
- **4,000 tons of NO_x**

From 1977–1997, energy efficiency produced:

- **$1,644–$2,562 in per capita Gross State Product (GSP)**

Projected per capita gains by 2015 are expected to be:

- **$323–$2,322**

Source: Bernstein et al., 2002.

- Design or select program options that maximize benefits.
- Reduce the compliance costs of meeting air quality standards.
- Build support for clean energy initiatives among state and local decision makers.

How can state and local governments estimate the air, health, and economic benefits of clean energy initiatives?

Step 1: Develop a baseline emissions profile/GHG inventory.

State and local governments can compile air pollutant data and/or GHG emissions from available sources into an aggregate top-down emissions inventory or a source-specific bottom-up one and develop a forecast of future emissions. This establishes a baseline against which any reductions from clean energy can be measured.

Sources of data include: National Emissions Inventory (NEI); eGRID; Emissions Collection and Monitoring Plan System (ECMPS); World Resources Institute Climate Analysis Indicators Tool; state and local GHG inventories.

Step 2: Quantify air and GHG emissions reductions from clean energy initiatives.

State and local governments can use a range of tools and approaches—from basic to sophisticated—to quantify the emissions changes from clean energy policies; these changes can then be compared to the baseline emissions inventory to determine emission benefits:

- **Basic approaches** require planners to:
  - establish the operating characteristics, or load profile, of the clean energy resource.

Health Impacts of Fossil Fuel-Based Electricity Generation

Electricity generation from fossil fuels is a major source of criteria air pollutants that affect air quality and human health directly and in the short term, such as:

- Particulate matter (soot).
- Ground level ozone (smog).
- Carbon monoxide.
- Sulfur oxides (SO_2)
- Nitrogen oxides (NO_x)

Near term health effects from burning fossil fuels include: premature mortality in adults and infants, chronic bronchitis, non-fatal heart attacks, hospital admissions for respiratory and cardiovascular diseases, emergency room treatment for asthma, asthma attacks, and various symptom days, including work loss days. Electricity generation from fossil fuels is the single largest U.S. source of human-made carbon dioxide (CO2) which accumulates and contributes to climate change over the long term.

Climate change is projected to affect human health in a number of ways:

- **Direct temperature effects:** Severe heat waves are projected to intensify over portions of the U.S. where these events already occur, with potential increases in mortality and morbidity.
- **Extreme weather:** Intensity of rain, flooding and droughts is projected to increase and it is likely that hurricanes will become more intense.
- **Climate-sensitive diseases:** Climate change may increase the prevalence of some infectious diseases, particularly diseases that appear in warm areas and are spread by mosquitoes and ticks, such as malaria and Lyme disease.
- **Air quality:** Respiratory disorders, such as asthma and chronic bronchitis may be worsened by warming-induced increases in the frequency of smog (ground-level ozone).

Marginal Units

In each hour, electric generating resources are dispatched from least to most expensive, on a variable cost basis, until demand is satisfied. There are a host of complexities involved in dispatching the generating system, however, in concept, the unit that is displaced is the last unit to be dispatched. Estimating the air benefits of clean energy resources requires identifying this "marginal" unit and its avoided emissions.

For more information about the electricity system and how it relates to emissions, see Assessing the Multiple Benefits of Clean Energy, Section 4.1 How Clean Energy Initiatives Result in Air and Health Benefits and Section 3.1 How Clean Energy Can Achieve Electric System Benefits.

  - identify what generation resources—or marginal generating units—are expected to be displaced by clean energy and the units' emissions characteristics.
  - calculate the emission reductions using available emissions factors.

- **Sophisticated approache**s involve dynamic electricity or energy system representations using models that predict energy generation responses to policies considering the constantly changing set of available generating units and transmission constraints in the system and then calculating the effects on emissions based on their emissions characteristics. These approaches are more complex and often more expensive than basic approaches.

Resources and Tools available: There are many basic and more sophisticated tools and approaches available to help states and local governments quantify emissions reductions. For information on these approaches, along with their advantages, disadvantages, and uses, please see A Comparison of Approaches (at www.epa.gov/statelocalclimate/documents/pdf/Table_Comparison_of_Approaches.pdf).

Step 3: Estimate improvements in air quality resulting from emissions reductions.

When air pollution is released through the burning of fossil fuels, it mixes with other pollutants, transforms through chemical reactions and negatively affects air quality. It is also transported through the air from the individual sources to other locations. Since clean energy initiatives avoid emissions of harmful air pollutants, they can also prevent the negative effects on air quality that are avoided.

Tools are available that help state and local governments to estimate any changes in air quality that result when air pollution is reduced. While it can be a complex task requiring sophisticated air quality models and extensive data inputs (e.g., meteorology), estimating air quality improvements is an important step in a thorough analysis of the benefits of clean energy.

Tools available: Three types of models are available to conduct this type of analysis: dispersion models, photochemical models, and receptor models. Information about these models can be found through EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) (available at www.epa.gov/ttn/scram).

Step 4: Estimate health and related economic effects of air quality improvements.

By avoiding adverse changes in air quality, clean energy initiatives can avoid the adverse health effects that would have otherwise occurred, including approximating reductions of respiratory disorders, like asthma and bronchitis. State and local governments can estimate the health effects avoided and take their analysis a step further and to estimate the monetary value of avoided health effects—a key component of a comprehensive economic benefit-cost analysis.

This information can help planners and policy makers understand and communicate the magnitude of the opportunity to improve human health through clean energy.

Tools include:

- The **Co-Benefits Risk Assessment (COBRA) Screening Model** converts air pollution changes into changes in air quality and human health and estimates the economic value of those effects. See: http://epa.gov/statelocalclimate/resources/cobra.html
- EPA's **Benefits Mapping and Analysis Program (BenMAP)**, a more sophisticated tool, takes air quality changes and converts them into health effects and quantifies their economic value. See: http://www.epa.gov/air/benmap/

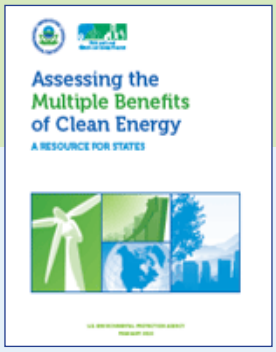
Tools and other resources are available to help state and local governments accomplish these four steps to estimate the impact of clean energy policies on air pollution, air quality, and related environmental and health impacts. These tools are highlighted in *Assessing the Multiple Benefits of Clean Energy: A Resource for States*

References:

- Bernstein, M., R. Lempert, D. Loughram, and D. Ortiz. 2002a. The Public Benefit of Energy Efficiency to the State of Massachusetts. Prepared by RAND Science and Technology.
- Haberl, J., C. Culp, B. Yazdani, D. Gilman, T. Fitzpatrick, S. Muns, M. Verdict, M. Ahmed, Z. Liu, J. Baltazer-Cervantes, J. Bryant, L. Degelman, and D. Turner. 2004. Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP). ESL-TR-04/12-01. December.
- Regulatory Assistance Project (RAP). 2005. Electric Energy Efficiency and Renewable Energy in New England: An Assessment of Existing Policies and Prospects for the Future. Prepared by The Regulatory Assistance Project and Synapse Energy Economics, Inc. May.

Where can state and local governments and policy makers go for more information about tools, methods, and resources available to estimate the benefits of clean energy initiatives?

Assessing the Multiple Benefits of Clean Energy: A Resource for States is an essential manual that can help you estimate and communicate the benefits of clean energy. Although developed primarily for states, many of the tools and approaches discussed in the Guide are applicable for local governments as well.



Assessing the Multiple Benefits of Clean Energy: A Resource for States

What the Guide includes:

- A **framework** for determining which benefits to estimate and how to do it.
- **Tools** and methods for estimating energy systems and environmental economic benefits across varying levels of rigor.
- **Easy-to-read tables** that present the range of tools and approaches, their strengths and limitations, and suggestions on when to use them.
- **Benefits estimates** that states have derived using various methods.
- **Analyses** that illustrate the use of multiple benefits to promote clean energy.
- **Case studies** in each chapter that profile how states are using the available tools to develop and implement clean energy policies and programs.

How the Guide is organized:

- ***Chapter 1*** is an introduction to assessing the multiple benefits of clean energy; it highlights the relationships between energy savings and other benefits of clean energy initiatives. Included in the chapter are discussions of what the multiple benefits of clean energy are and how and why states should assess these benefits.
- ***Chapter 2*** provides policy makers with methods they can use to estimate the potential direct energy impacts of electricity-related clean energy initiatives and policies for program planning, and includes:
  - Steps to estimate energy impacts of clean energy.
  - A sample framework for developing energy forecasts.
  - Energy data sources.
  - Comparisons of basic and sophisticated forecasting methods and tools.
  - Resources for retrospective data and potential studies.
  - Available tools for estimating impacts.
- ***Chapter 3*** presents detailed information about the energy system to help policy makers understand how to identify and assess the benefits of clean energy initiatives on electricity systems based on their state's needs and resources. It includes:
  - An overview of how the electricity system operates.
  - Information on how to select which benefits to evaluate.
  - Steps for estimating electricity system benefits.
  - Descriptions and comparisons of basic and sophisticated forecasting methods and tools.
  - Considerations for determining whether to analyze the various benefits, who typically estimates the specific benefits, and the most effective time for undertaking the analyses.
- ***Chapter 4*** provides help for agencies in assessing the greenhouse gas, air pollution, air quality, and human health benefits of clean energy options:
  - Various methods to estimate air and health benefits.
  - Comparisons of different models and tools, including advantages and disadvantages, and when to use them.
  - Data needs and data sources.
- ***Chapter 5*** presents simple to sophisticated methods and tools for assessing the economic benefits of clean energy options so that state and local governments may:
  - Conduct and manage analyses.
  - Review cost and benefit estimates.
  - Understand the potential job effects of clean energy initiatives.
  - Make recommendations about clean energy options and appropriate evaluation approaches and tools.

How to access the Guide and get more information:

- Assessing the Multiple Benefits of Clean Energy: A Resource for States Web site: www.epa.gov/statelocalclimate/resources/benefits.html
- State and Local Climate and Energy Program Web site: www.epa.gov/statelocalclimate
- State and Local Climate and Energy Listserv: www.epa.gov/statelocalclimate/listservs/index.html
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