

Public Health Benefits of Energy Efficiency Programs

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on Energy Efficiency as a Resource

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**State and Local
Energy and Environment Program**



Air Quality and Health Benefits Quantification

- We are increasingly hearing from state and local governments that there is growing demand for credible tools to quantify and document the health benefits of energy efficiency (EE)
- Key questions about estimating public health effects and energy efficiency:
 - ▶ What are the public health effects of poor ambient air quality?
 - ▶ How can energy efficiency improve air quality and people's health?
 - ▶ Is there already research readily available that consistently quantifies the health benefits of energy efficiency?
 - ▶ How can EPA provide credible and useful resources to quantify health benefits of energy efficiency?

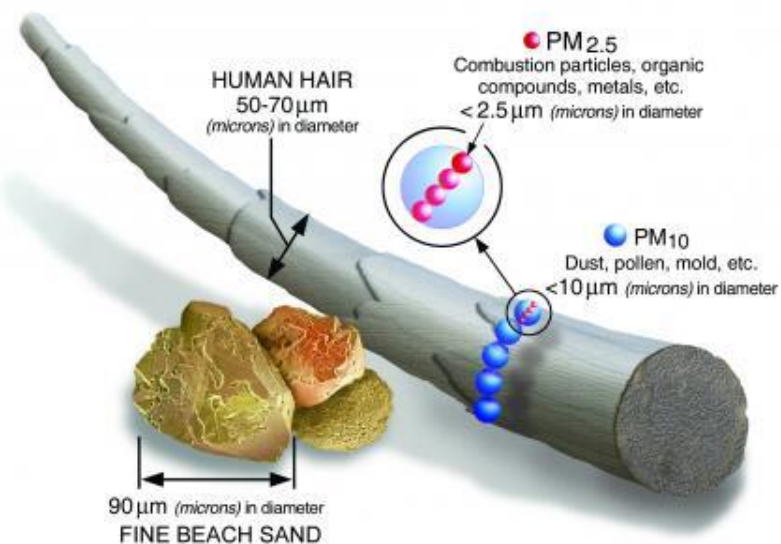


Public Health Effects of Fine Particulate Matter PM 2.5

Numerous scientific studies have linked PM 2.5 exposure to a variety of problems, including:

- premature death in people with heart or lung disease
- nonfatal heart attacks
- irregular heartbeat
- aggravated asthma
- decreased lung function
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

PM 2.5 inhalable fine particulates



Source: <https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm>



Improving Public Health

Energy Efficiency



- Energy efficiency is a resource
- Energy efficiency reduces total electricity demand on the grid
- There are incremental and long term cumulative impacts of EE

Energy Efficiency

Reduces Emissions

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

- There is related economic value for health benefits (\$)
- People avoid costly illnesses.
- Businesses benefit from greater worker productivity.
- Children miss fewer school days.

Monetized Societal Benefits



Exploring Existing Research: Linking EE and Public Health

- To understand the current state of existing research linking EE with public health benefits we conducted a literature review:
 - Searched studies and reports that estimated the monetized health benefits (e.g., \$/kWh) of an EE and/or RE resource type
 - Surveyed studies for both outdoor and indoor air quality impacts
 - Found 12 studies that met our criteria of having sufficient quantitative data (only outdoor AQ studies met criteria)
 - Compared methodologies and assumptions for quantifying and monetizing health effects of EE/RE



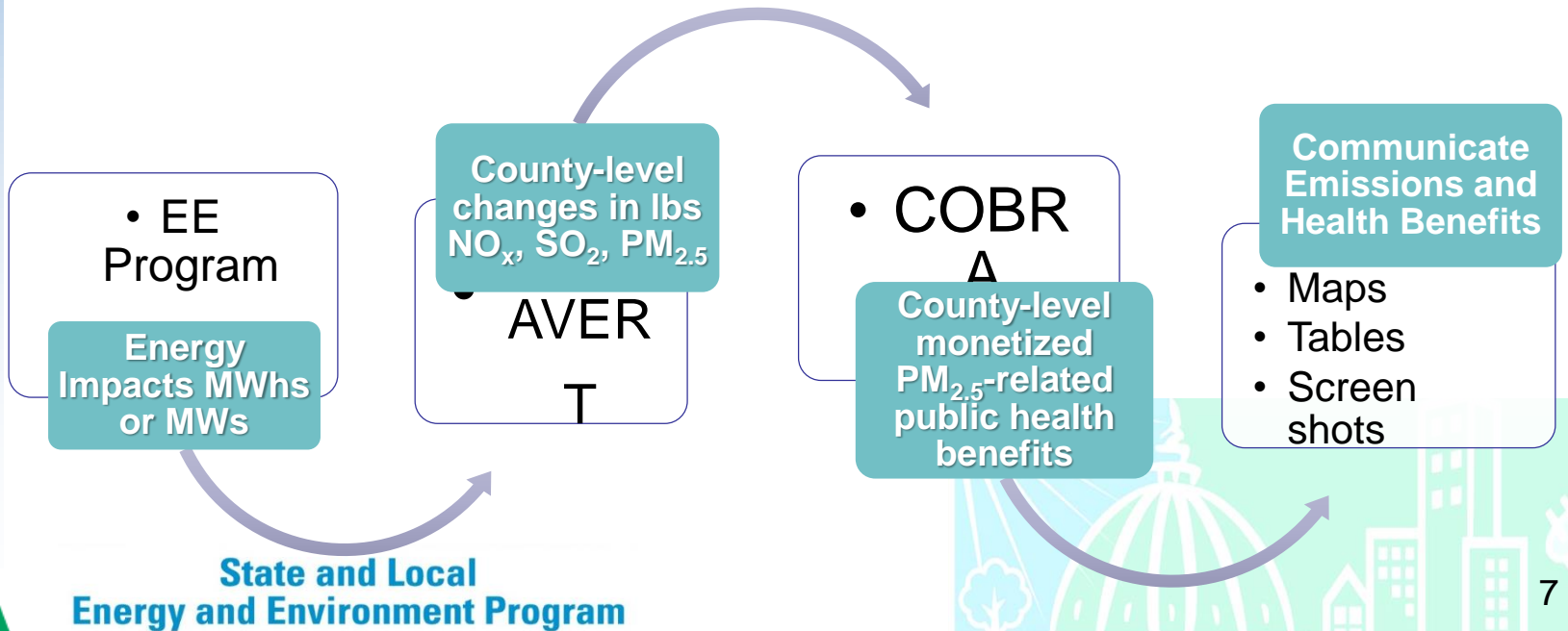
Exploring Existing Research: Linking EE and Public Health

- To evaluate emerging best practices we ranked the complexity and rigor of each qualifying study based on four methodological characteristics:
 - ▶ Electricity and Emissions Modeling
 - ▶ AQ Modeling
 - ▶ Health Impacts and Valuation Modeling
 - ▶ Internal Consistency
- Findings:
 - ▶ \$/kWh estimates range widely (i.e. 0.1 ¢/kWh to 17.1 ¢/kWh) and cannot be easily compared
 - ▶ Methodologies are applied inconsistently across EE/RE technology types and geographic regions.
 - ▶ EPA could provide value-added in this area with readily available tools



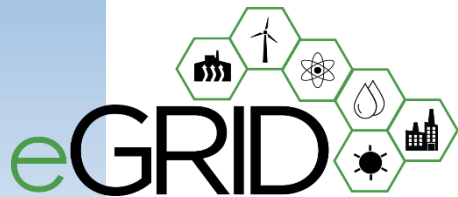
Air Quality and Health Benefits Quantification

EPA is uniquely positioned to provide public health related tools and resources:

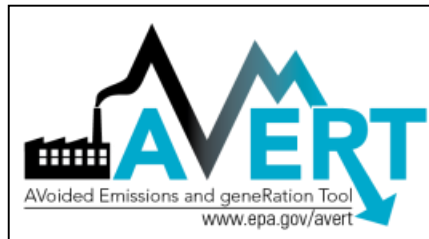


Emission Quantification Methods Basic to Sophisticated

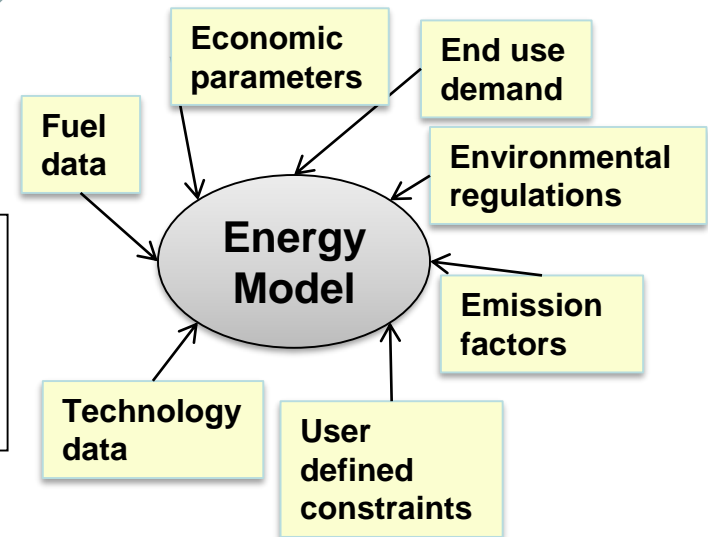
Basic Method
eGRID region non-
baseload emission rates



Intermediate Method
Historical hourly
emission rates



Sophisticated Method
Capacity Expansion
Energy Modeling



Using the AVERT model



AVERT was built to be:

- user friendly, transparent, credible

To use:

- Obtain energy saved (MWhs) for EE programs, or the capacity of wind and solar installation (MW)
 - Multiple options are built into the tool
- Locate your AVERT region
- Run the model

AVERT Regions



- **Model and training available at:**
<https://www.epa.gov/statelocalenergy/avoided-emissions-and-generation-tool-avert>



Estimate the Health and Related Economic Co-Benefits: COBRA



EPA offers the **Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool** to help policymakers fully assess the value of clean energy investments – including health and societal benefits – and compare benefits to costs.



State and local policymakers can use COBRA to estimate the economic value of human health improvements from clean and renewable energy projects or transportation projects and to select options that maximize benefits.



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.

What is COBRA & How Does It Work?

COBRA¹ 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 or 2025 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 illness cases and deaths avoided as well as the related economic value.

¹COBRA is a peer-reviewed screening model that based on rigorous methods used by EPA health benefits assessments as described in [the User Manual](#).

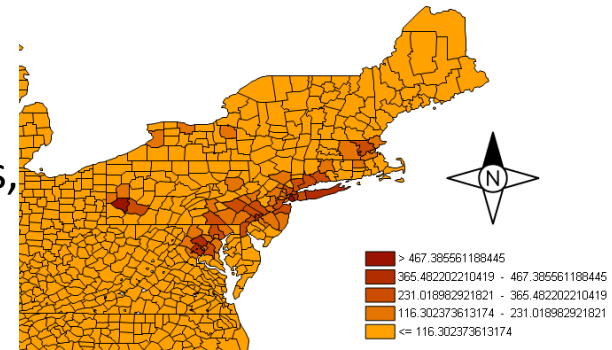
²COBRA estimates only particulate matter-related benefits and may be conservative in that respect.



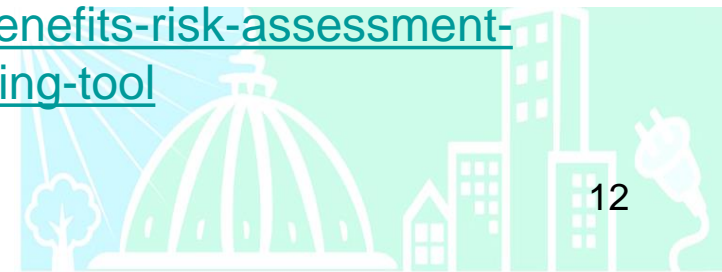
Human Health Effects in COBRA

- 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

0 100 200 300 400
km
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<https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool>



Estimating Benefits of Energy Efficiency

Accounting for relevant costs *and* benefits ensures symmetry in policy decisions and EE cost tests

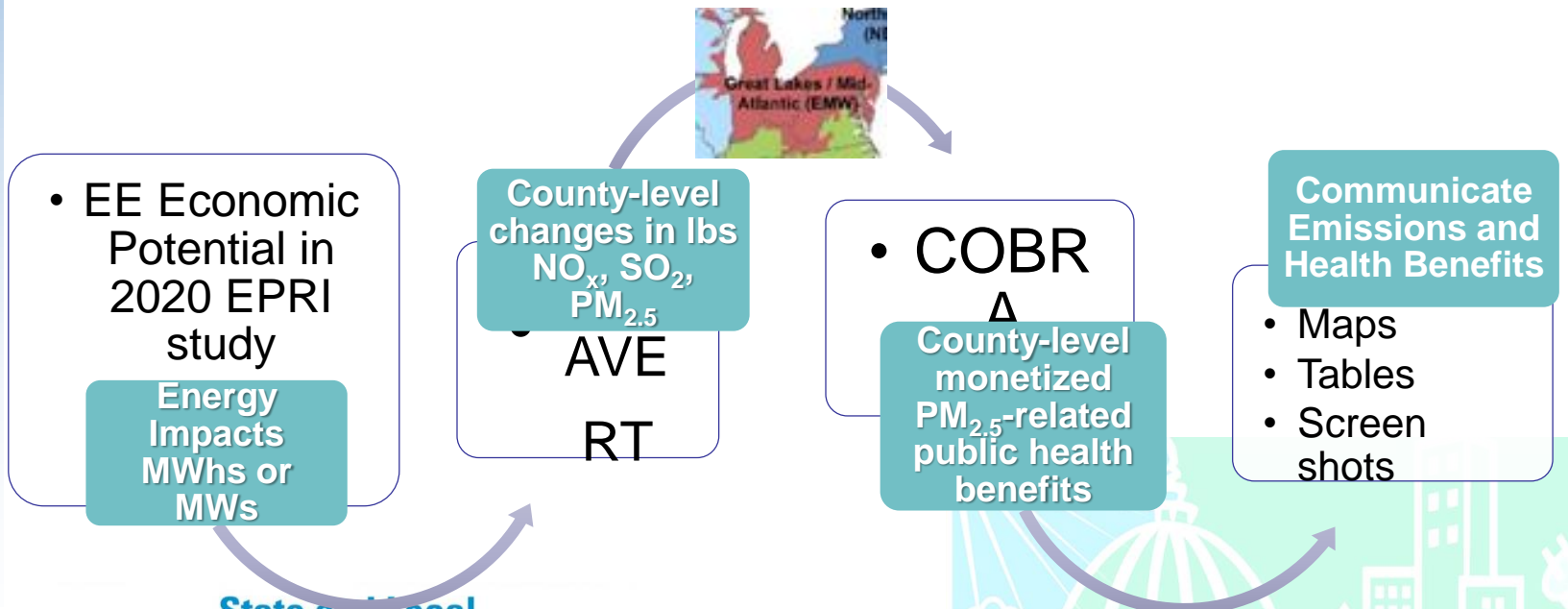
We've heard from stakeholders who want to use health benefits information:

- State and local governments seek to understand the public health impacts of proposed EE/RE and electricity-system decisions
- PUCs and EE implementers want to make investment decisions based on a comprehensive accounting of costs & benefits
- Financial sector/green banks want to demonstrate environmental value of their EE/RE investments
- A variety of public health, energy and environmental stakeholders are looking for fairness/equivalency in cost tests (i.e., robust estimates on benefits side)



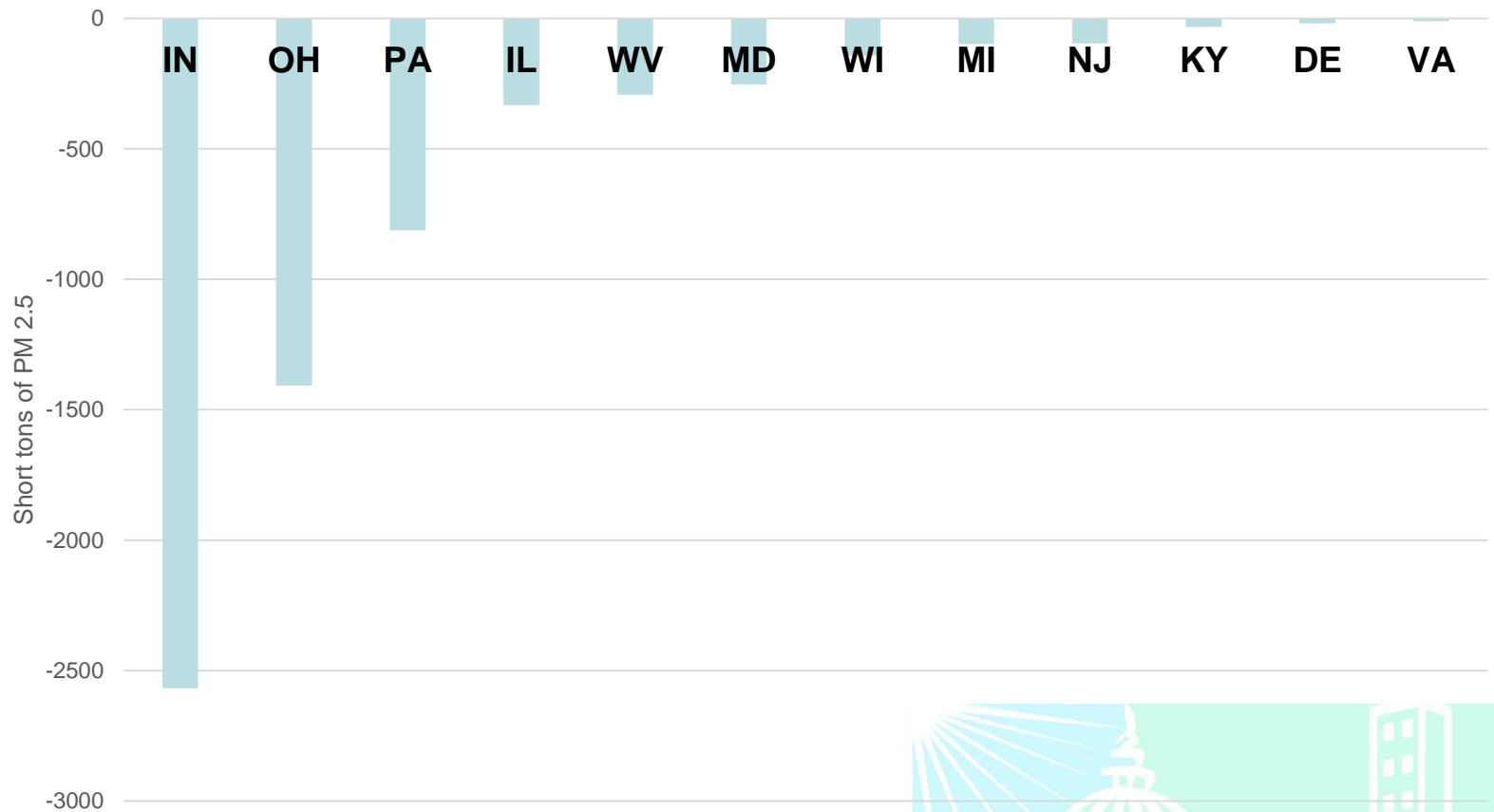
Air Quality and Health Benefits Illustrative Example – EPRI’s EE Economic Potential

EPRI assessed state-level energy efficiency potentials achievable in 2020, 2025, 2030 & 2035.



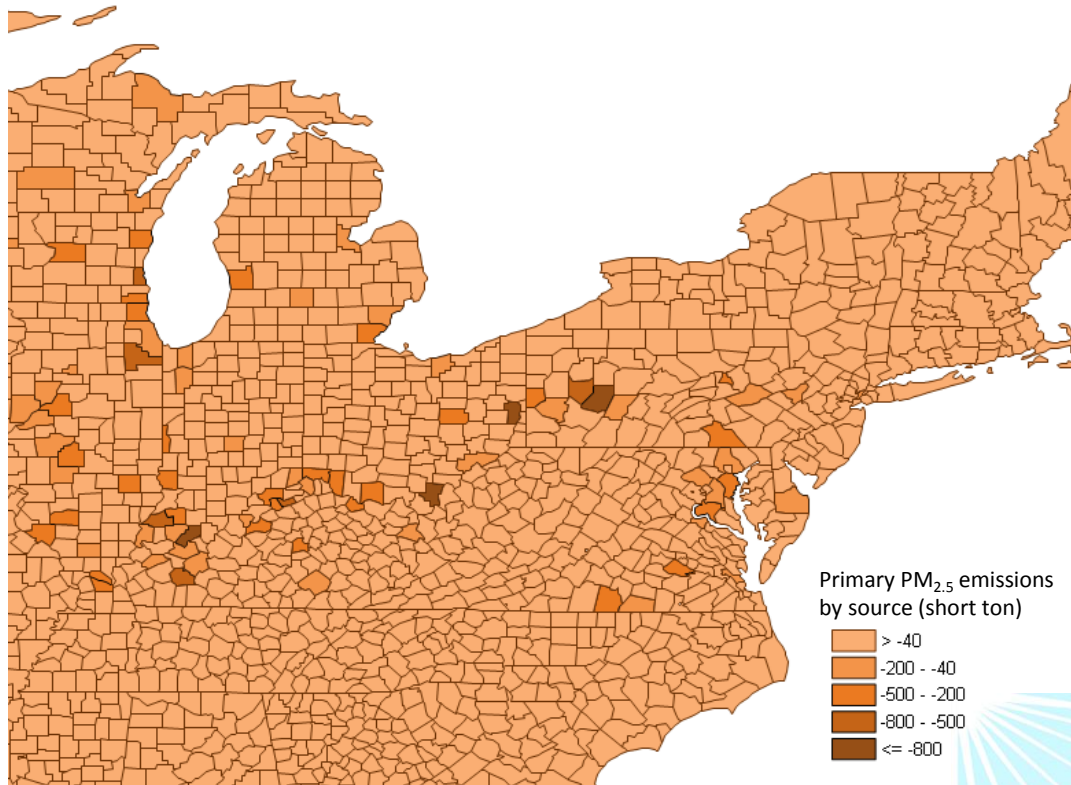
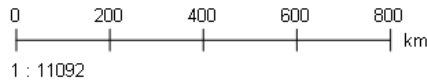
EPRI Illustrative application in AVERT

PM 2.5 Emission Reduction Potential in 2020
AVERT's Great Lake/Mid-Atlantic States



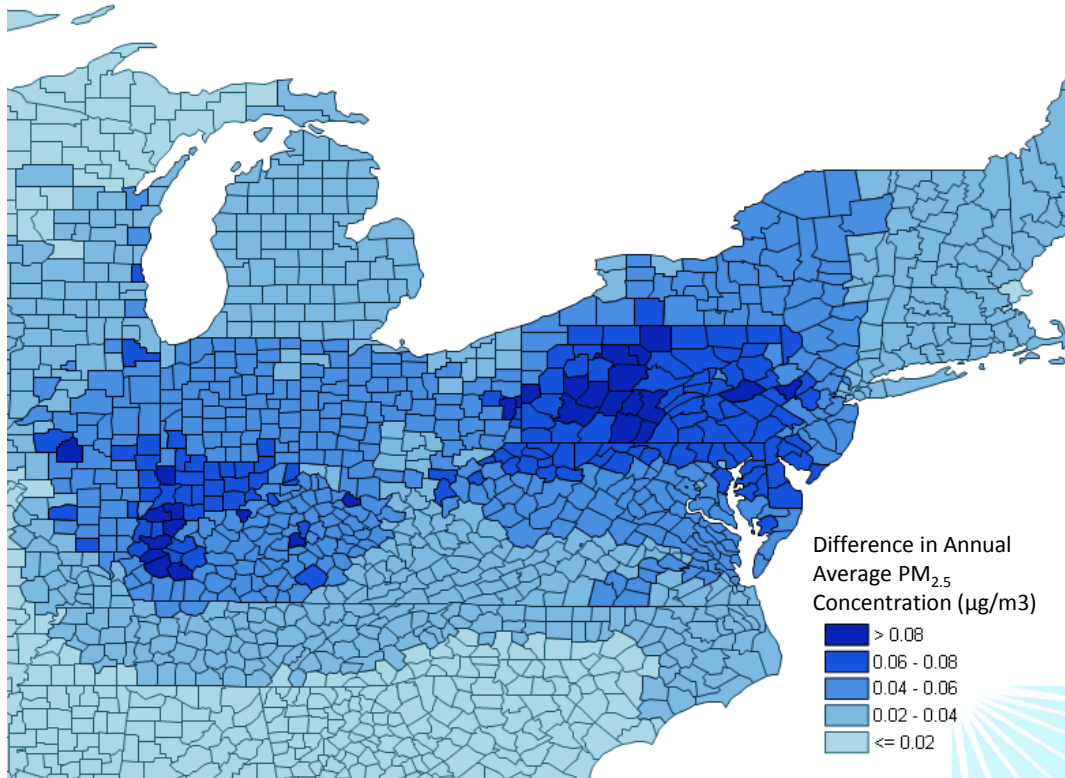
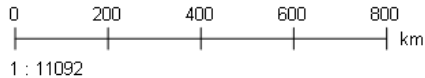
Illustrative EE Scenario: Great Lakes PM 2.5 Reduction Inputs from AVERT

- PM_{2.5} source-level emission reductions are concentrated in western Pennsylvania, Ohio, and Indiana, and are substantial across the entire Great Lakes region.



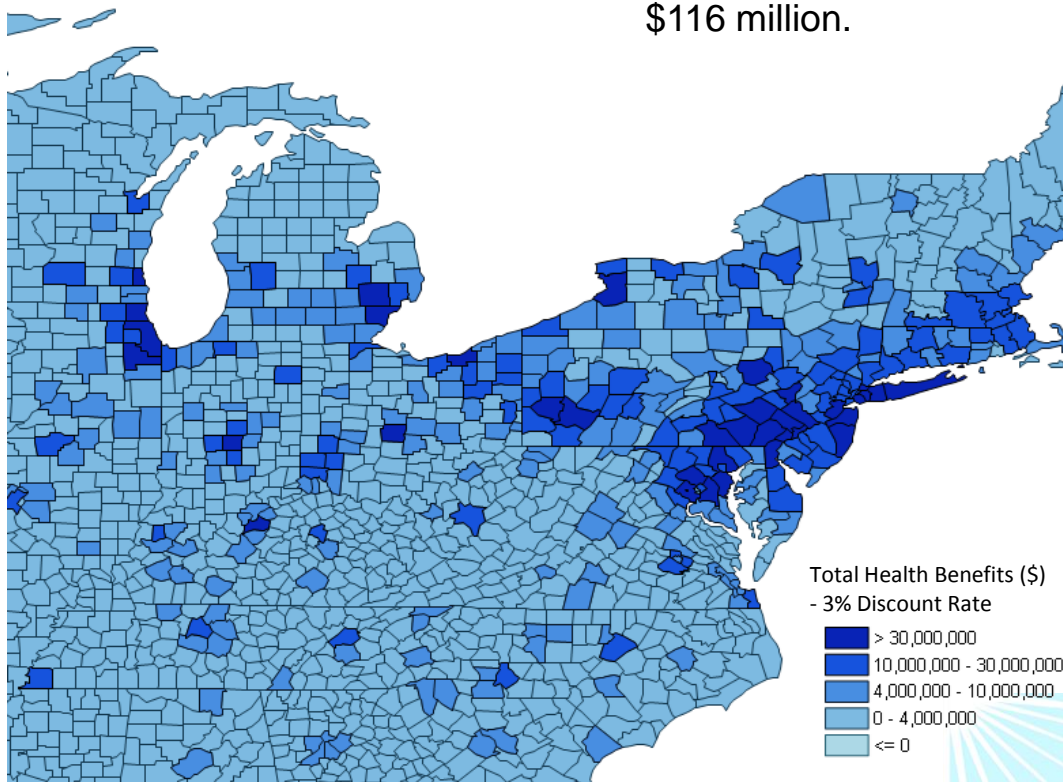
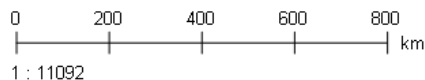
Illustrative EE Scenario: PM 2.5 Concentration Outputs in COBRA

- Five of the Great Lakes states (IN, KY, OH, PA, VA) see over a 2 $\mu\text{g}/\text{m}^3$ shift in annual $\text{PM}_{2.5}$ concentrations.
- Annual $\text{PM}_{2.5}$ concentrations in Great Lakes states change by 21.4 $\mu\text{g}/\text{m}^3$.



Illustrative EE Scenario: \$ Health Benefits (high) in COBRA

- Total health benefits from emissions reductions in the Great Lakes states range from \$2.0 – \$4.5 billion.
- Benefits are concentrated in densely populated urban areas. By itself, Illinois' Cook County could save up to \$116 million.



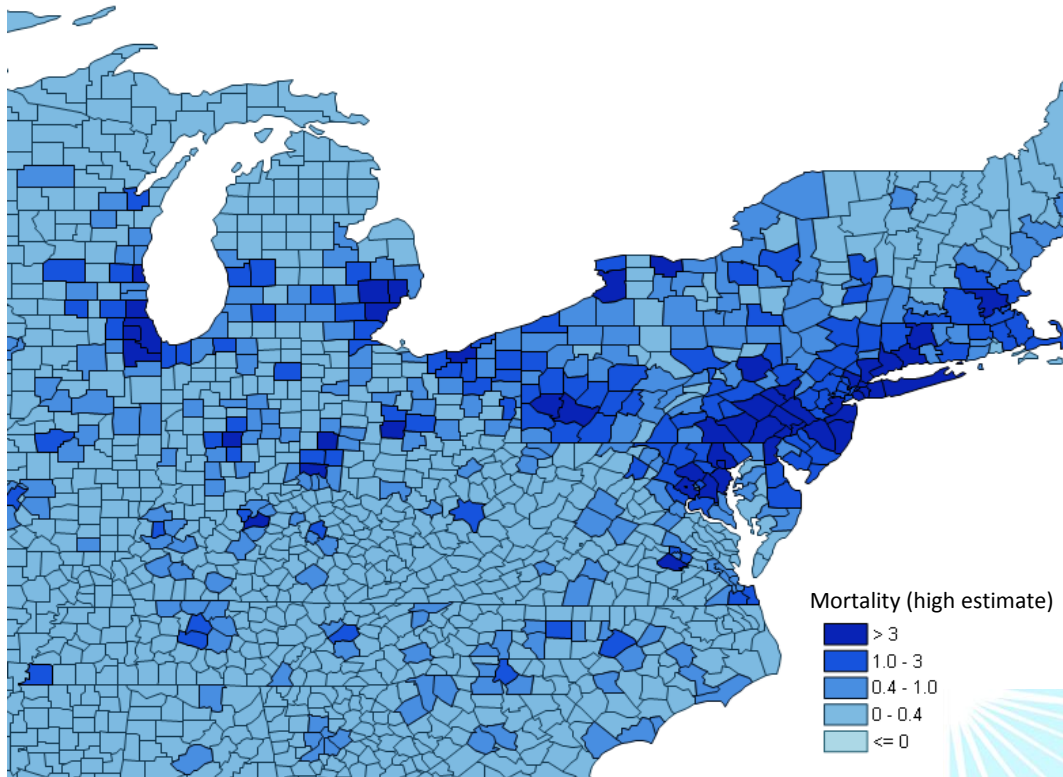
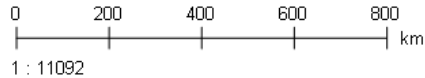
Illustrative EE Scenario: Changes in Health Incidences from COBRA

Region/State	Total Health Benefits (million\$)	Changes in Mortality	Avoided Hospital Visits	Avoided Heart Attacks
Great Lakes Region	1,986 - 4,485	221 - 500	154	29 - 267
Delaware	33 - 75	4 - 8	3	0 - 4
Illinois	195 - 442	22 - 49	18	3 - 31
Indiana	159 - 359	18 - 40	14	3 - 24
Kentucky	114 - 259	13 - 29	11	2 - 19
Maryland	160 - 361	18 - 40	11	2 - 18
Michigan	141 - 318	16 - 35	10	2 - 20
New Jersey	187 - 422	21 - 47	15	3 - 25
Ohio	234 - 528	26 - 59	17	3 - 30
Pennsylvania	465 - 1050	52 - 117	30	6 - 57
Virginia	165 - 373	18 - 42	15	2 - 23
West Virginia	54 - 123	6 - 14	5	1 - 8
Wisconsin	78 - 175	9 - 20	5	1 - 9



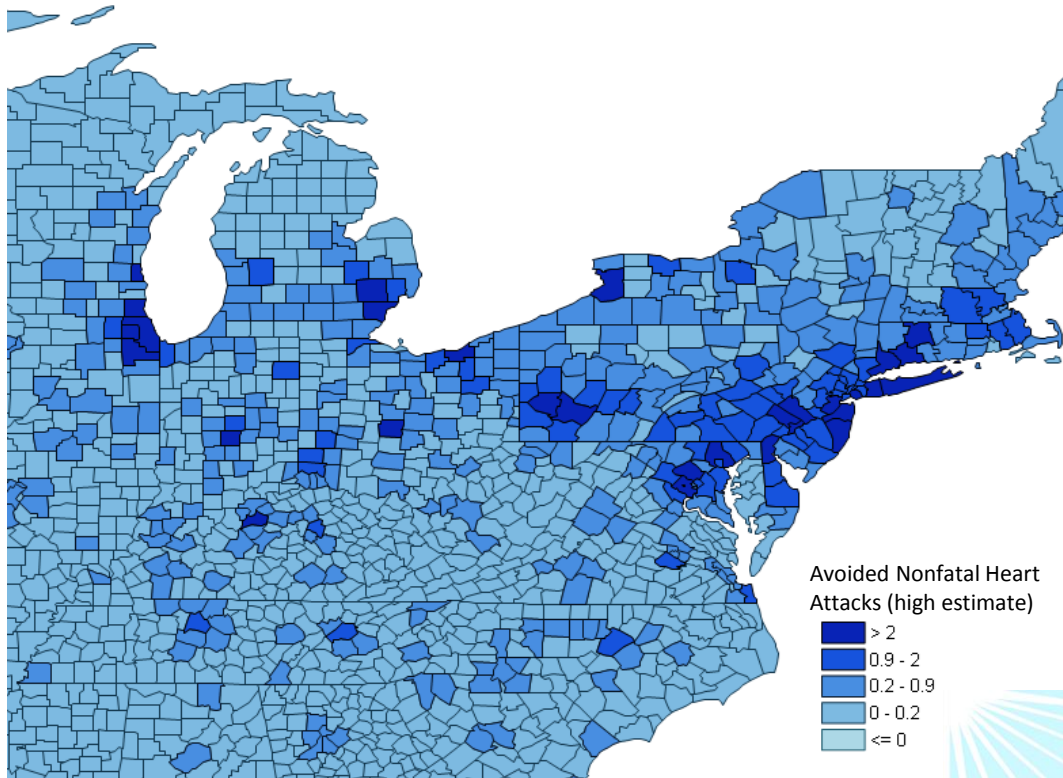
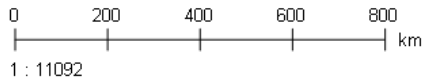
Illustrative EE Scenario: Changes in Mortality from COBRA

- Emissions reductions lead to from 221 to 500 fewer deaths across the entire Great Lakes region.
- Pennsylvania could see over 100 fewer deaths from these reductions.

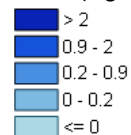


Illustrative EE Scenario: Avoided Heart Attacks (high) in COBRA

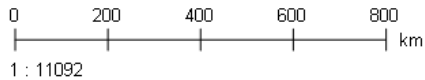
- Nonfatal hearts attacks decrease by 157 across the Great Lakes region.
- Pennsylvania could see hearts attacks decrease anywhere from 6 to 57.



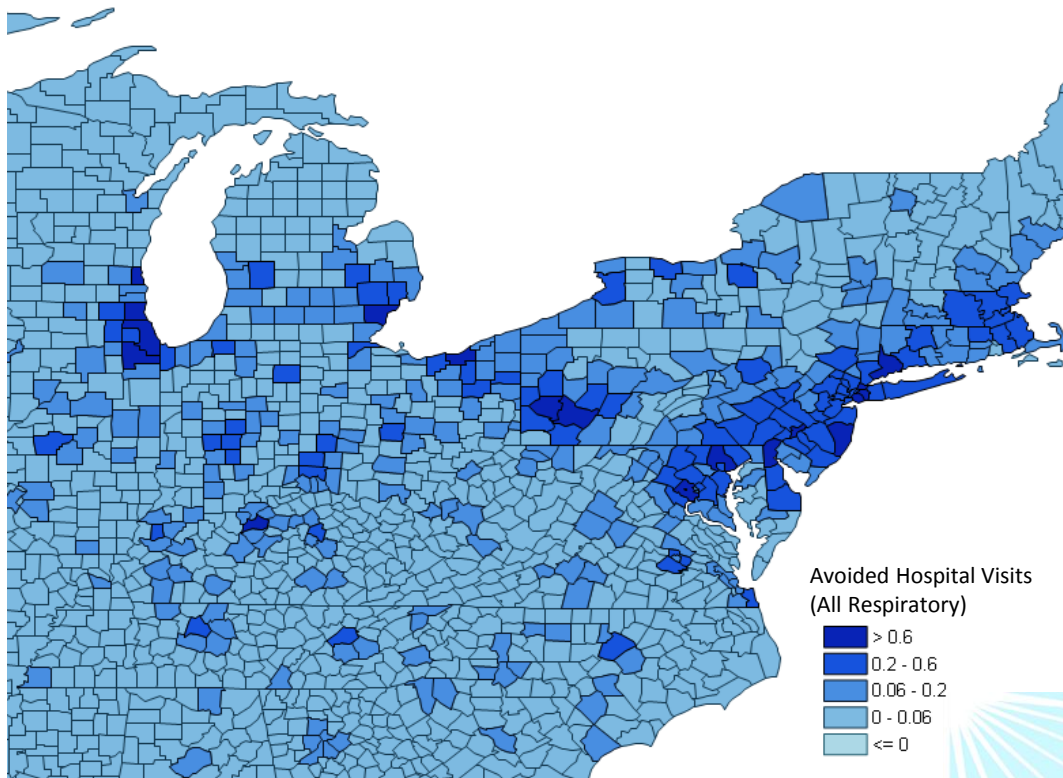
Avoided Nonfatal Heart Attacks (high estimate)



Illustrative EE Scenario: Avoided Hospital Visits in COBRA



- Hospital visits decrease by up to 267 across the region.



Pacific Northwest Example with Quantifying Public Health Benefits of EE

- NWPCC explored monetizing health benefits of reduced wood smoke emissions attributed to energy efficiency
 - Major contributor to PM_{2.5} emissions
- Installed ductless heat pumps and improved home weatherization to reduce wood stove usage
- Northwest's Regional Technical Forum (RTF) used:
 - combined survey data on wood heating use,
 - impact evaluations, and
 - EPA's COBRA
- Health benefits of reduced PM_{2.5} emissions ranged from \$0.02/kWh to \$0.24/kWh
- Results used to inform policy makers and for consideration in cost-effectiveness evaluations



Information needs for EE programs

Discussion questions:

- How would you use public health benefits information in your work?
- Do you have recent applications to share with group?
- What information do you already have?
- What type of information would make it easier to use the economic health benefits of EE?



Where can I get more information?

Visit Our Website:

EPA State and Local Energy and Environment Program

<https://www.epa.gov/statelocalenergy>

Register for our Newsletters:

<https://www.epa.gov/statelocalenergy/state-and-local-energy-newsletters>

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