Tools To Measure The Non-Energy Benefits of Clean Energy

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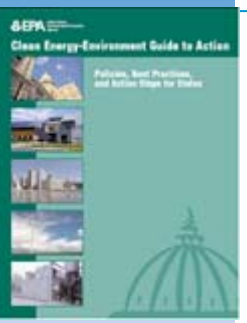
ACEEE Workshop on Valuation of Non-Energy Benefits
Washington, DC

July 19, 2007

The Clean Energy-Environment State Partnership



Guidance:

- Clean Energy-Environment Guide to Action: Policies, Best Practices and Action Steps for States

Quantifying State Emissions:

- **State GHG Inventory Tool**
- **NACAA Clean Air and Climate Protection Software**
- **E-Grid**
- E-Calc

Coordination with Other Voluntary Programs:

- Green Power Partnership
- CHP Partnership
- National Action Plan for Energy Efficiency

Evaluating Clean Energy Policy Options:

- **CACPS Policy Assessment Module**
- Clean Energy potential assessments
- SEP Toolkit
- SIP Guidance for EE/RE Actions
- Access to Economic Models
- Co-Benefits Risk Assessment (COBRA)
- Mitigation Impact Screening Tool (MIST)

State-to-State Peer Exchange

- EE/RE State Technical Forums
- Conferences and training sessions
- Reports and white-papers

Blue = GHG focus

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Selecting the Right Tool for the Job – Key Questions for Getting Started with Measurement

- Why is measurement being undertaken?
- Is it in a voluntary or regulatory context?
- Who is the audience and what kinds of information do they need?
- Is the analysis retrospective or prospective?
- What financial and staff resources are available?
- Is a new analysis required or do data exist from another analysis, state, or region?
- What kinds of data and expertise are available?

Answering these questions helps determine what tools & models are appropriate to the policy or program context.

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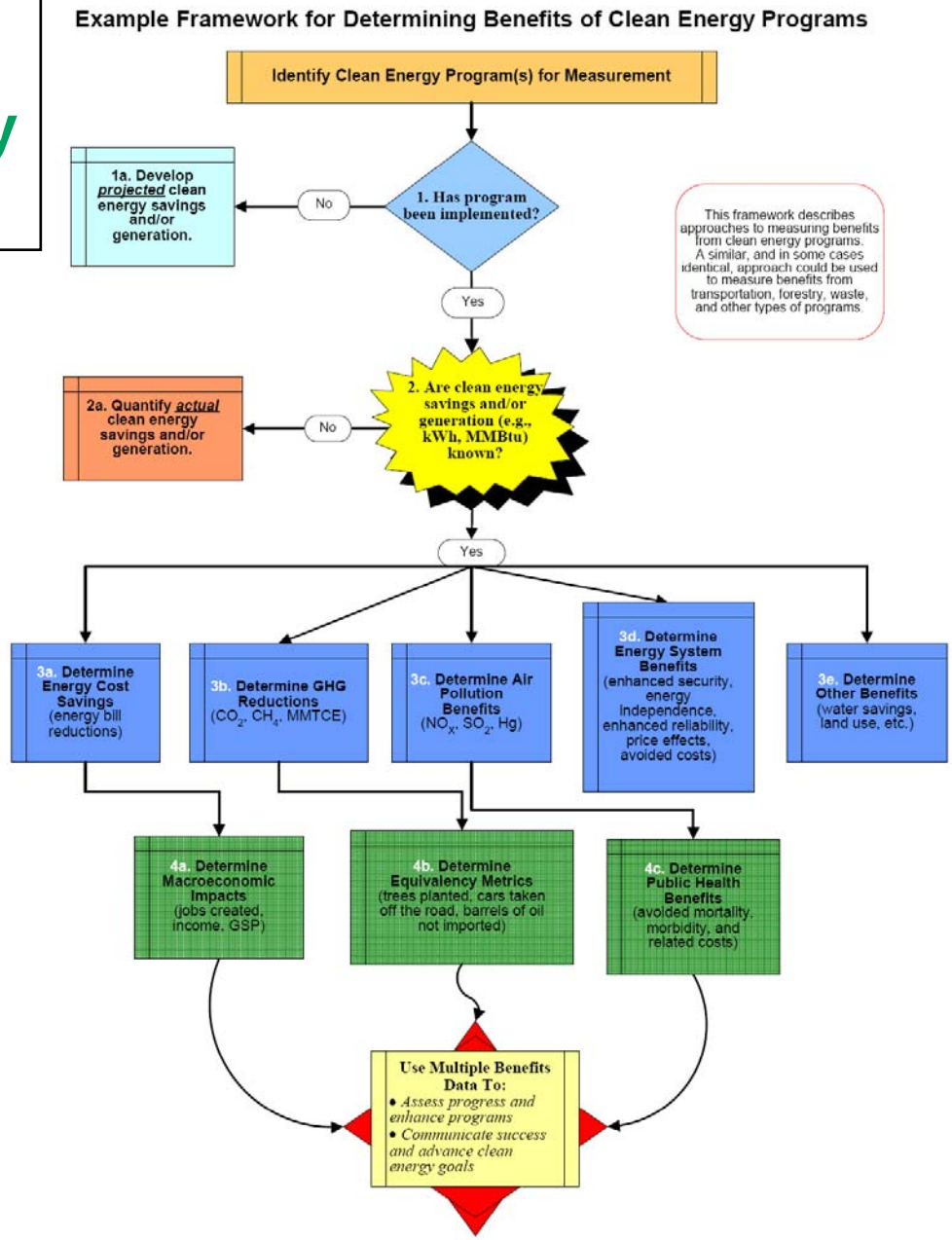
Applying the Framework to Measure Clean Energy Benefits

The rest of this presentation gives examples of tools and resources that can be used to 'operationalize' the framework shown here.

Representative analyses with "low" and "high" levels of rigor and complexity are presented.



Measuring Benefits Using Low & Medium-Effort Tools

This section shows how these tools can be applied to measure the benefits of clean energy programs:

- Clean Air Climate Protection Software
- Co-Benefits Risk Assessment Model
- Equivalency Metrics
- Community Energy Opportunity Finder

These tools typically:

- **Are simplified representations of more detailed research and analysis**
- **Require minimal data gathering**
- **Are easy to use (don't require technical/expert assistance)**
- **Present results in easy-to-understand terms**
- **Are used to 'make the case' or share results with stakeholders**
- **Are used in both voluntary and regulatory contexts**

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Example of Medium-Effort Measurement: Air Emissions & Cost-Savings

3a. Determine Energy Cost Savings (energy bill reductions)

3b. Determine GHG Reductions (CO_2, CH_4, MMTCE)

3c. Determine Air Pollution Benefits (NO_X, SO_2, Hg)

- **Sample analysis:** Estimate the multiple benefits of generating 10% electricity from wind in New York using the Clean Air Climate Protection Software (CACPS)

- Running the model
  - Choose policy measure from list
  - Enter amount of electricity from wind (MWh associated with 10% by 2010 goal)
  - Select emissions factors (regional, state, marginal)

- CACPS calculates GHG, criteria pollutants savings
  - Uses region-specific emission factors
  - Electricity prices specified by user
  - Generate summary graphs, reports

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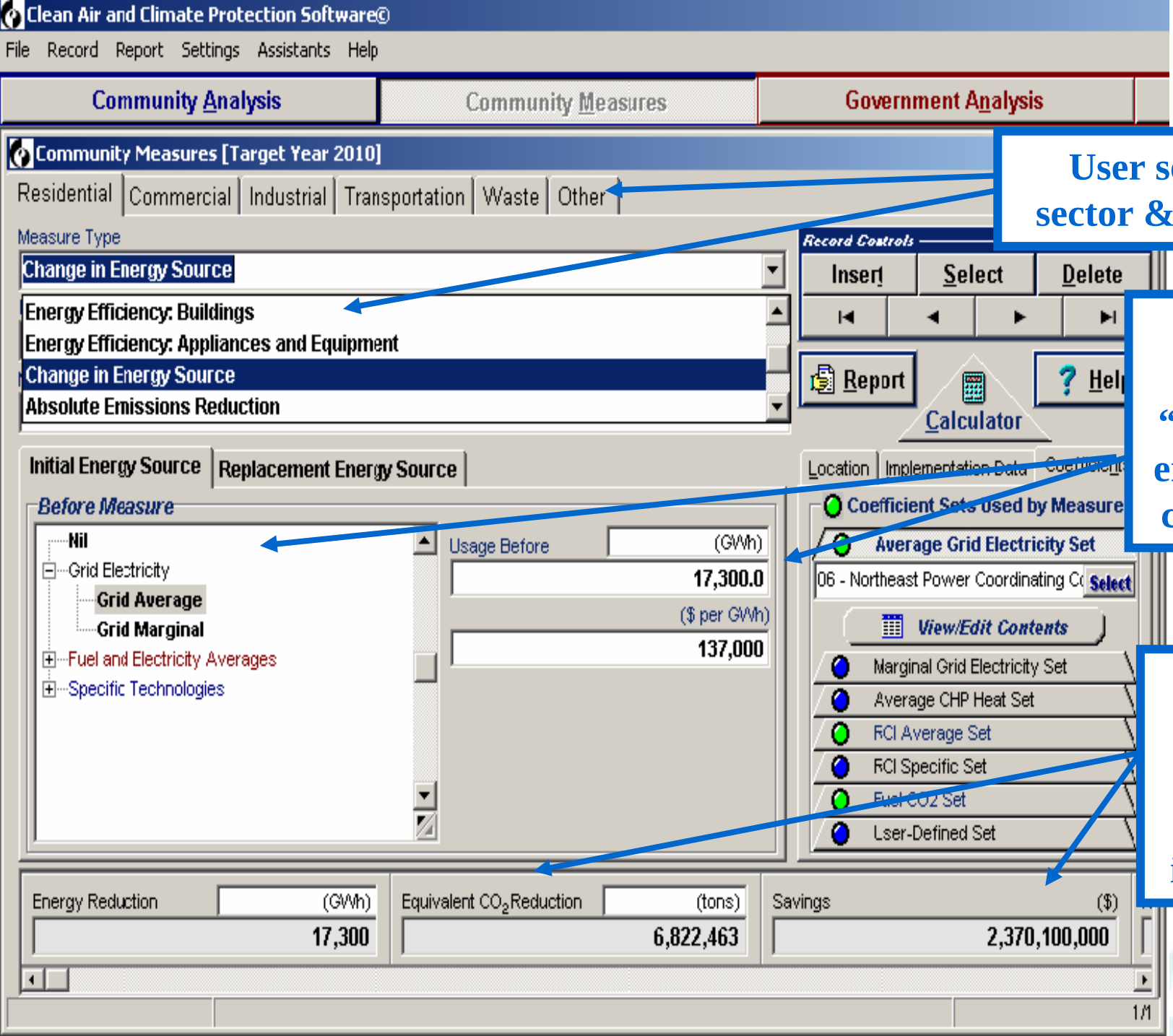
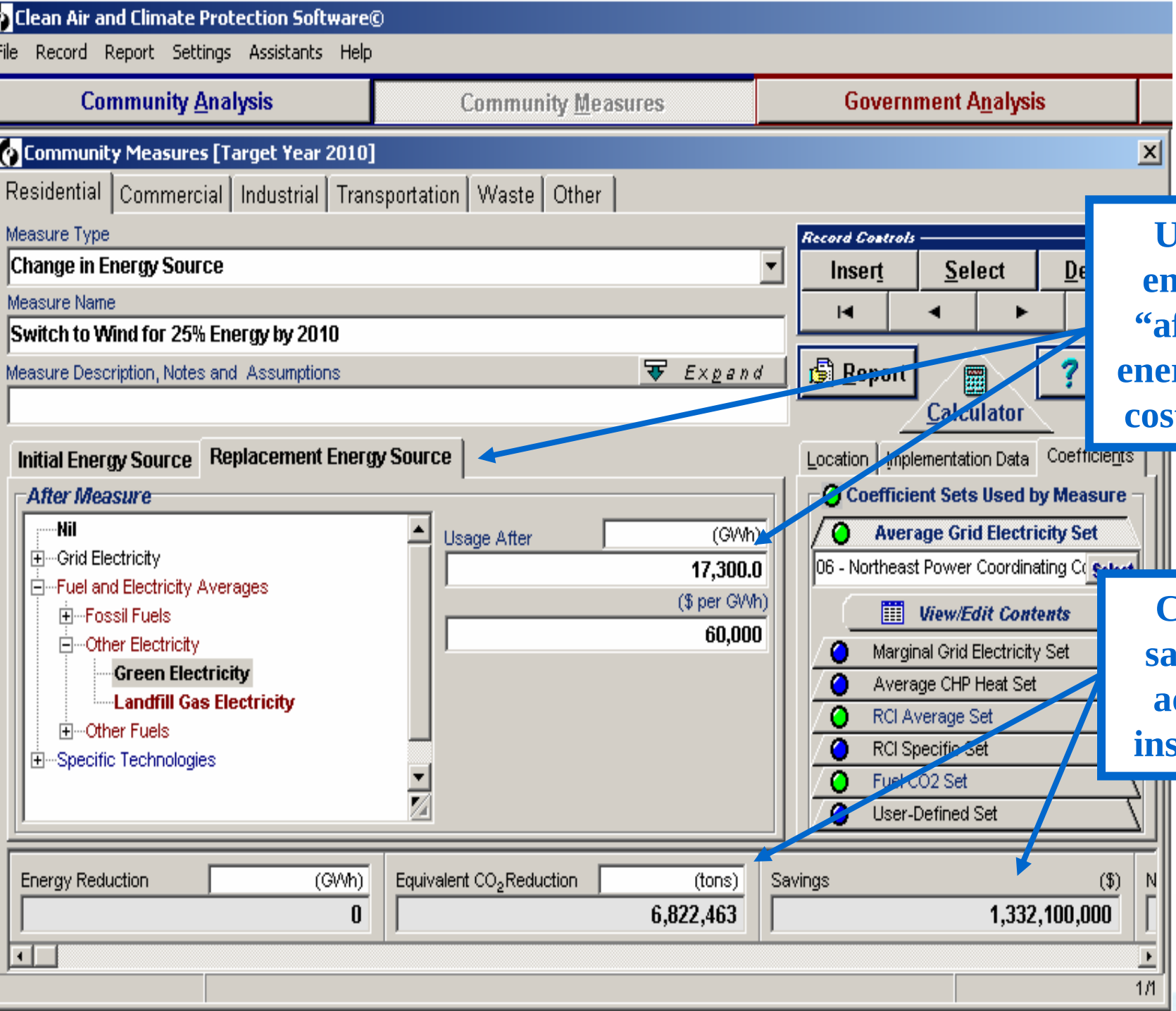


User selects sector & policy

User enters "before" energy & cost info

Energy, CO_2 & $ savings show up instantly



User enters "after" energy & cost info

CO_2 + savings adjust instantly

2/4/2003 Page 1

New York

Community Greenhouse Gas and Air Pollutant Reductions in 2007
Measures Listing

Residential Sector — Location of Measure: New York, New York

Type of Measure: Change in Energy Source

Measure Name

wind

Measure Details

Initial Energy Source		Replacement Energy Source	
Electricity		Green Electricity	
Usage Before	17,000	Usage After	17,000
Unit	(GWh)	Unit	(GWh)
Price per Unit	$.00	Price per Unit	$.00
Ramp-in Factor	100%	Energy Reduction (GWh)	0
Year Implemented		Emission Reduction (tons eCO2)	6,502,843
Implementation Cost	$0	Savings ($/year)	$0
		Payback Period (years)	0

The emission reduction from this measure as a percentage of total reductions: *2.2%*

NOx Reduction (tons)	SOx Reduction (tons)	CO Reduction (tons)	VOC Reduction (tons)	PM10 Reduction (tons)
8,443	26,987	9,251	1,032	7,475

Full Description of Measure

2/4/2003 Page 1

New York

Community Greenhouse Gas Emissions Reductions in 2007
Measures Detailed Report

	Equiv CO_2 (tons)	Equiv CO_2 (%)	Energy (GWh)	Energy Cost Savings ($)
Residential Sector				
New York, New York				
Change in Energy Source				
Koday Recycling Project	236,612	0.1	629	86,238,322
wind	6,502,843	2.2	0	0
Energy Efficiency: Appliances and Equipment				
Energy Star Lights and	1,541,724	0.5	4,102	561,914,063
New York Energy Smart	849,217	0.3	2,558	0
Energy Efficiency: Buildings				
New York State Energy	266,983,633	89.7	879,276	37,812,000
Statewide Cumulative	21,521,780	7.2	57,256	7,844,072,000
Subtotal Residential	297,635,808	100.0	943,821	8,530,036,385
Other Sector				
New York, New York				
Absolute Emissions Reduction				
	16,000	0.0		
Subtotal Other	16,000	0.0		
Total	297,651,808	100.0	943,821	8,530,036,385

2/4/2003 Page 1

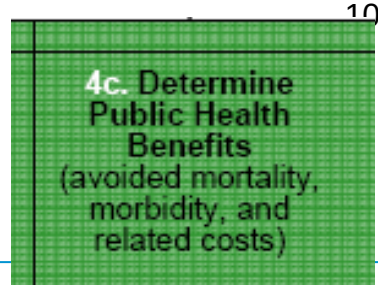
New York

Community Criteria Air Pollutants Reductions in 2007
Measures Detailed Report

	NOx (tons)	SOx (tons)	CO (tons)	VOC (tons)	PM10 (tons)
Residential Sector					
New York, New York					
Koday Recycling Project	307	982	337	38	272
wind	8,443	26,987	9,251	1,032	7,475
Energy Star Lights and	2,002	6,398	2,193	245	1,772
New York Energy Smart	956	1,585	652	84	448
New York State Energy	263,494	10,470	65,217	13,896	7,825
Statewide Cumulative	27,942	89,316	30,616	3,415	24,740
Subtotal Residential	303,144	135,738	108,267	18,709	42,532
All Measures	303,144	135,738	108,267	18,709	42,532

CACPS model provides results reports for individual & combos of measures

Example of Low-Effort Measurement: Health Impacts



- **Sample analysis:** Estimate the human health benefits of a 10% reduction in criteria air pollutants using the Co-Benefits Risk Assessment (COBRA) model
- COBRA…
  - Estimates PM changes from air pollution reductions
  - Translates PM into health impacts, economic values
  - Visually maps benefits by county for state, region, U.S.
- Developed for EPA under contract with Abt Associates
  - Other Key Players = OAQPS, state officials
  - Formal technical peer review (Fall 2004)
- Is COBRA the right tool to evaluate human health?
  - Rigor (BenMAP) vs. ease of use (COBRA)

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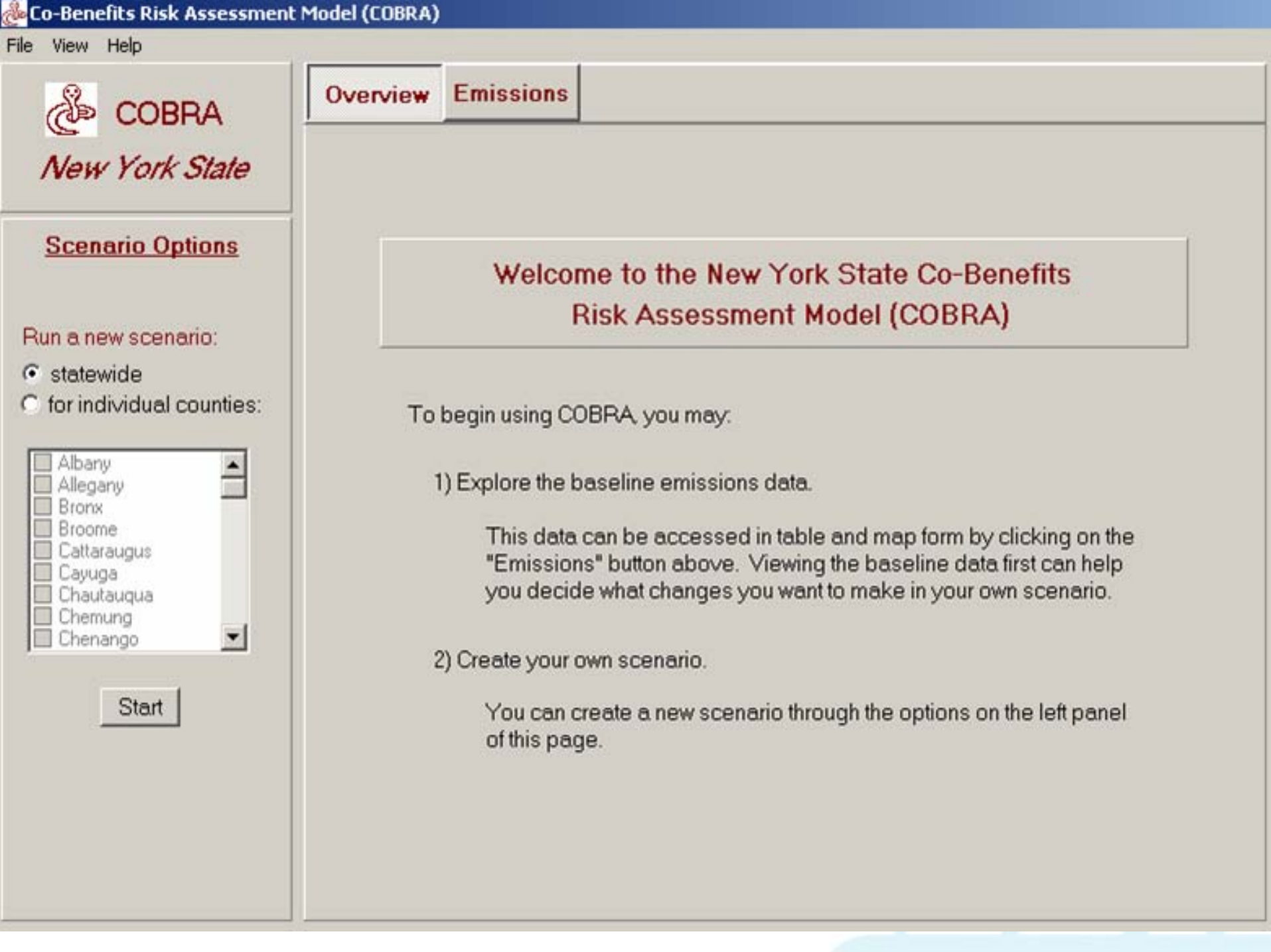

Co-Benefits Risk Assessment Model (COBRA)
File View Help
COBRA
New York State
Scenario Options
Run a new scenario:
statewide
for individual counties:
Albany
Allegany
Bronx
Broome
Cattaraugus
Cayuga
Chautauqua
Chemung
Chenango
Start
Overview
Emissions
Welcome to the New York State Co-Benefits Risk Assessment Model (COBRA)
To begin using COBRA, you may:
1) Explore the baseline emissions data.
This data can be accessed in table and map form by clicking on the "Emissions" button above. Viewing the baseline data first can help you decide what changes you want to make in your own scenario.
2) Create your own scenario.
You can create a new scenario through the options on the left panel of this page.

Co-Benefits Risk Assessment Model (COBRA)

File View Help

COBRA

New York State

Base Emissions Map Options

Current map view:

Pollutant:
SO2

Category:
All categories (total)

Change map quantity:

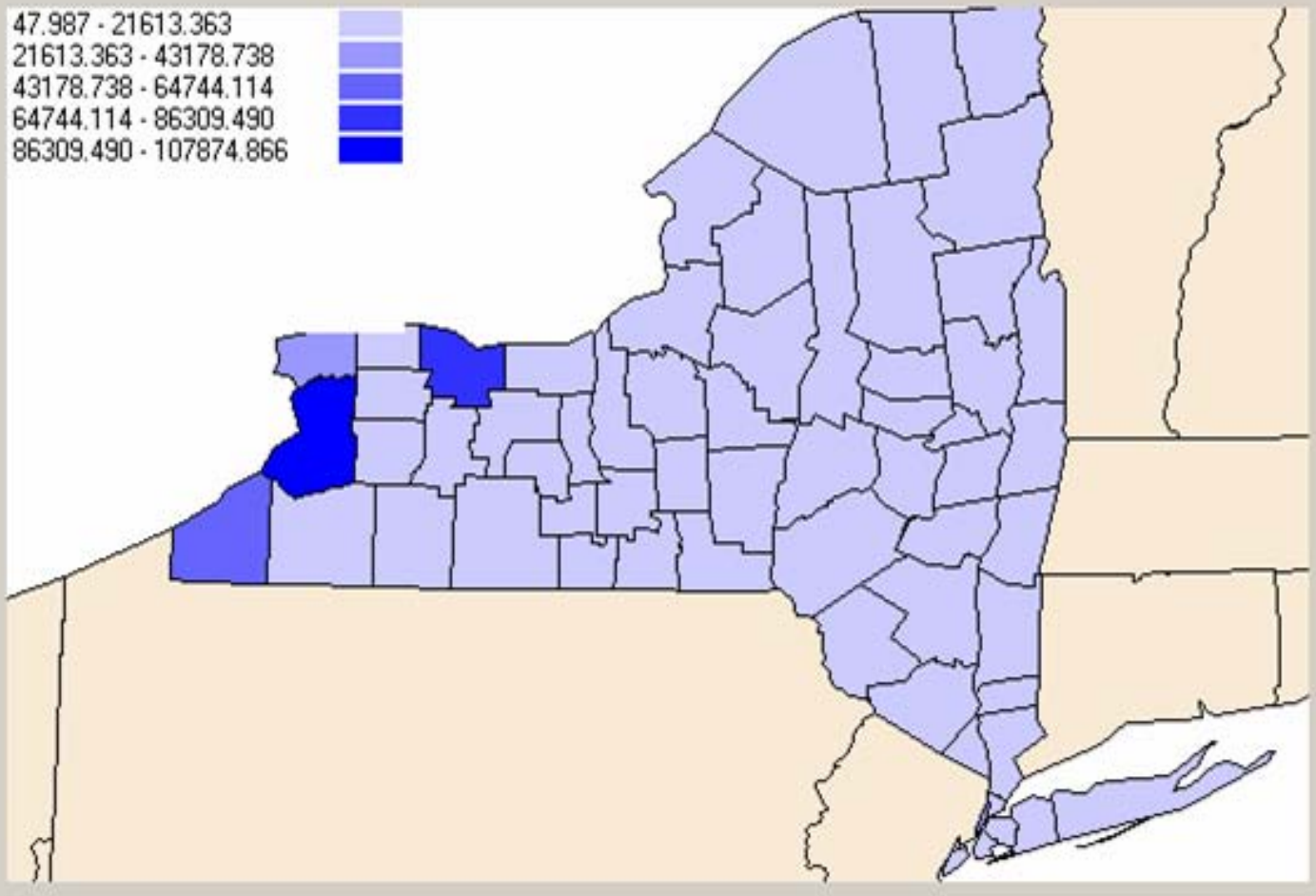
---pollutant---
---pollutant---
NH3
NOx
PM 2.5
PM Coarse
SO2
VOC

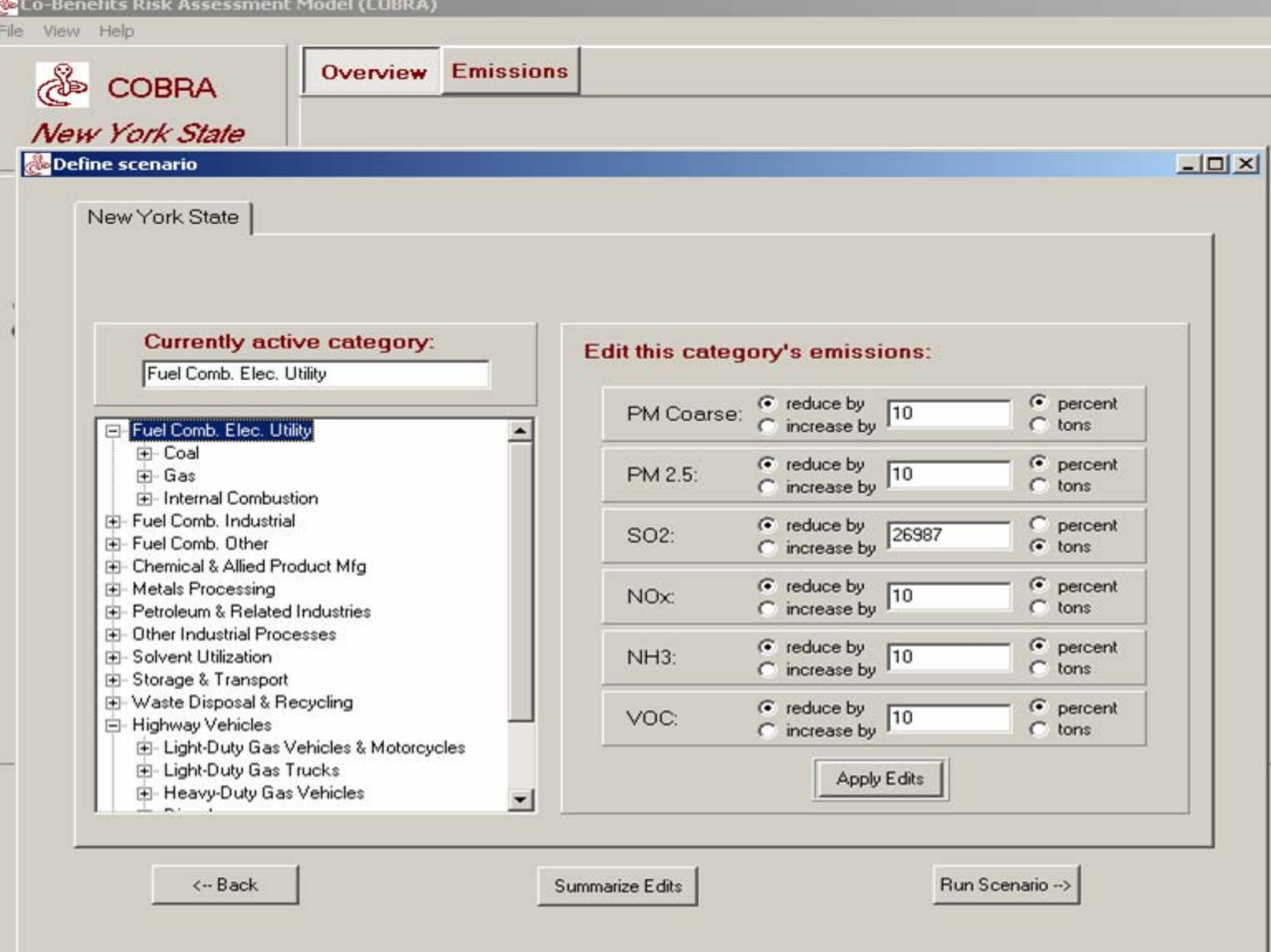
Change

Overview | Emissions

Base Emissions: Tables | Base Emissions: Maps

Export Map




Co-Benefits Risk Assessment Model (COBRA)
File View Help
COBRA
New York State
Overview
Emissions
Define scenario
New York State
Currently active category:
Fuel Comb. Elec. Utility
Fuel Comb. Elec. Utility
Coal
Gas
Internal Combustion
Fuel Comb. Industrial
Fuel Comb. Other
Chemical & Allied Product Mfg
Metals Processing
Petroleum & Related Industries
Other Industrial Processes
Solvent Utilization
Storage & Transport
Waste Disposal & Recycling
Highway Vehicles
Light-Duty Gas Vehicles & Motorcycles
Light-Duty Gas Trucks
Heavy-Duty Gas Vehicles
Edit this category's emissions:
PM Coarse: reduce by 10 percent
increase by tons
PM 2.5: reduce by 10 percent
increase by tons
SO2: reduce by 26987 percent
increase by tons
NOx: reduce by 10 percent
increase by tons
NH3: reduce by 10 percent
increase by tons
VOC: reduce by 10 percent
increase by tons
Apply Edits
<-- Back
Summarize Edits
Run Scenario -->

Co-Benefits Risk Assessment Model (COBRA)

File View Help

COBRA

New York State

Health Effects Table Options

Current table:

Scenario Name:
Switch to 10% Wind

View:
New York

View new table by:

---choose state---

---choose state---
All States
Alabama
Arizona
Arkansas
California
Colorado
Connecticut

Overview | **Emissions** | **Scenario 1** | **Scenario 2**

Scenario Emissions: Tables | Air Quality: Tables | Health Effects: Tables | Results: Maps

Export Table

County	Sta...	Mort...	Chron...	Resp_...	CV_hosp	UpperR...	Lower...	Asthma...
Albany	NY	.348	.3	.193	.208	8.934	6.943	9.29
Allegany	NY	.078	.047	.035	.034	1.653	1.702	1.5
Bronx	NY	.899	.566	.366	.322	26.86	27.912	20.2
Broome	NY	.348	.256	.182	.201	7.679	6.353	7.73
Cattaraugus	NY	.145	.085	.06	.06	2.894	2.984	2.63
Cayuga	NY	.101	.086	.053	.057	2.755	2.132	2.58
Chautauqua	NY	.362	.248	.176	.188	7.924	7.014	7.62
Chemung	NY	.077	.047	.033	.034	1.447	1.495	1.40
Chenango	NY	.067	.041	.028	.028	1.367	1.411	1.21
Clinton	NY	.056	.061	.035	.037	1.937	1.334	1.91
Columbia	NY	.09	.072	.047	.052	2.151	1.665	2.04
Cortland	NY	.055	.035	.023	.022	1.128	1.167	1.14
Delaware	NY	.073	.04	.031	.033	1.108	1.142	1.13
[illegible]	NY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		21.78	18.24	11.57	11.90	600.84	518.25	565.9

Note: All values represent the change in the number of annual cases of the health effect.
Data represent estimates for 2007.

Example of Medium-Effort Measurement: Equivalency Metrics

4b. Determine Equivalency Metrics (trees planted, cars taken off the road, barrels of oil not imported)

Greenhouse Gas Equivalencies Calculator

The Greenhouse Gas Equivalencies Calculator is designed to enable public and private sector organizations and individuals to quickly and easily translate greenhouse gas (GHG) reductions from units that are typically used to report reductions (e.g., metric tons of carbon dioxide equivalent) into terms that are easier to conceptualize (e.g., equivalent number of cars not driven for one year). Applications of this calculator might include developing a greenhouse gas reduction strategy, communicating reduction targets to the public or stakeholders, and supporting other initiatives aimed at reducing GHG emissions.

If you have already estimated the quantity of emission reductions (e.g., metric tons of carbon dioxide equivalent), please go directly to the table below. If the starting point for your conversion calculation is (a) gallons of gasoline, (b) kilowatt-hours of electricity, or (c) number of cars and light trucks (rather than quantity of greenhouse gas), please click here.

Enter the estimates of greenhouse gas emissions that you wish to convert, by individual gas or carbon equivalent.	Unit	Gas	
6,822,463	Tons	CO_2	
	Tons	CH_4	Calculate
	Tons	N_2O	
	Tons	HFC-23	

Your total greenhouse gas reduction is 6,822,463 Tons of Carbon Dioxide Equivalent.

This is equivalent to one of the following:

1,339,661	Passenger cars not driven for one year	Click Here for Calculations and References
1,107,198	Passenger cars and light trucks not driven for one year	Click Here for Calculations and References
704,924,151	Gallons of gasoline	Click Here for Calculations and References
14,393,568	Barrels of oil	Click Here for Calculations and References

Example of Medium-Effort Measurement: Economic Benefits

4a. Determine Macroeconomic Impacts (jobs created, income, GSP)

Sample analysis: Estimate the jobs benefits of a hypothetical energy efficiency scenario for Stamford, CT using RMI's Community Energy Opportunity Finder

- Helps communities estimate the benefits of investing in EE technologies
  - Free, web-based tool at: http://www.energyfinder.org
  - Benefits estimated: energy, cost, emissions, jobs impacts
  - Links directly to sources of information for the user

H. Jobs Creation

30. Residential

Annual Dollar Savings		
	100% Participation What's this?	User Defined Participation What's this?
Low	$4,364,657	$1,309,397
High	$7,542,552	$2,262,766

Sector payback = _____ years

Instructions / Explanation

Suggested Payback Entry:
LOW: <2 years
MEDIUM: 2-5 years
HIGH: >5 years

Total Jobs Created, Year 5		
	100% Participation	User Defined Participation
Low	58.1	17.4
High	100.5	30.1

Total Jobs Created, Year 1		
	100% Participation	User Defined Participation
Low	9.9	3.0
High	17.2	5.2

Benefits Measurement Using High-Effort Tools

This section shows how the following tools can be applied to measure the benefits of clean energy programs:

- eGRID
- Capacity Factor-Based Displaced Emissions Method Using eGRID
- Environmental Benefits Mapping and Analysis Program (BenMAP)
- Regional Economic Models, Inc. Policy Insight

These tools typically:

- **Are considered more "rigorous" and data-intensive**
- **Require data gathering**
- **Require at least some expert/con-tractor assistance**
- **Offer results that may need to be simplified (depending on the audience)**
- **Are used to evaluate large programs**
- **May be used to support regulatory decisions**

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What is eGRID?

- A comprehensive source of data on the environmental characteristics of U.S. power generation at various level of aggregation

  http://www.epa.gov/cleanenergy/egrid

  - Database of emissions (CO_2, NO_X, SO_2, Hg), fuel use, and generation from virtually all U.S. power plants
  - 1996-2000 & 2004 data (2005 data in progress)
  - Who uses it?
    - CPPD, SLB, Other Fed agencies, States, Companies,, Universities, NGOs, etc.
- Links electricity generation, air emissions and resource mix

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Levels of Data

- Basic Data
  - Boiler level
    - Unadjusted emissions and boiler characteristics
  - Generator level
    - Net generation and generator characteristics
  - Plant level
    - Emissions, generation, plant characteristics
    - Starting point for aggregated data

- Aggregation Levels
  - State
  - Electric Generating Company (EGC)
    - Location (operator)-based
    - Owner-based
  - Parent Company
    - Location (operator)-based
    - Owner-based
  - Power Control Area (PCA)
  - *eGRID Subregions*
  - NERC Regions
  - U.S.

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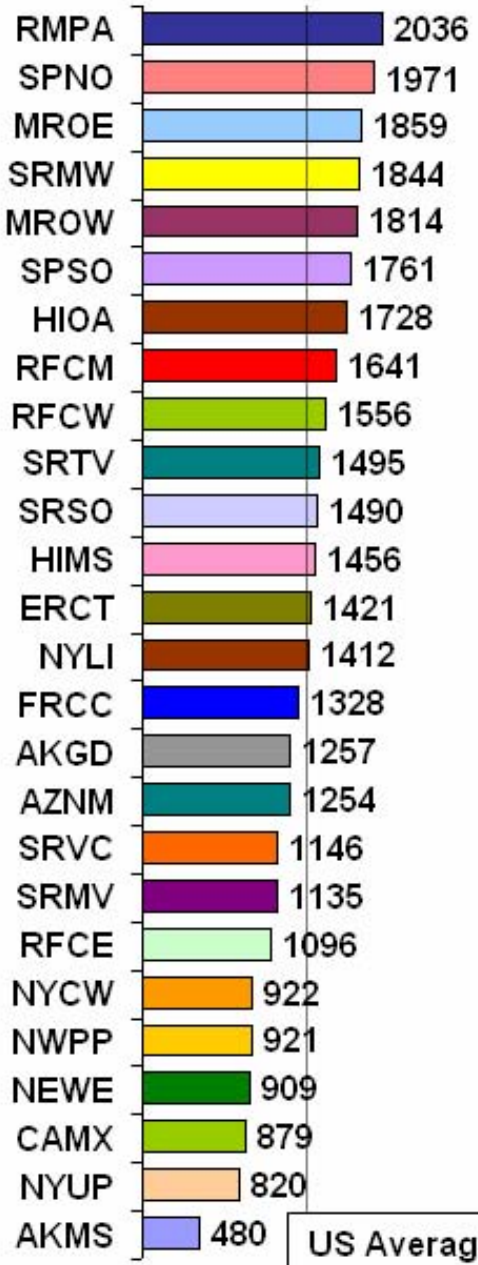
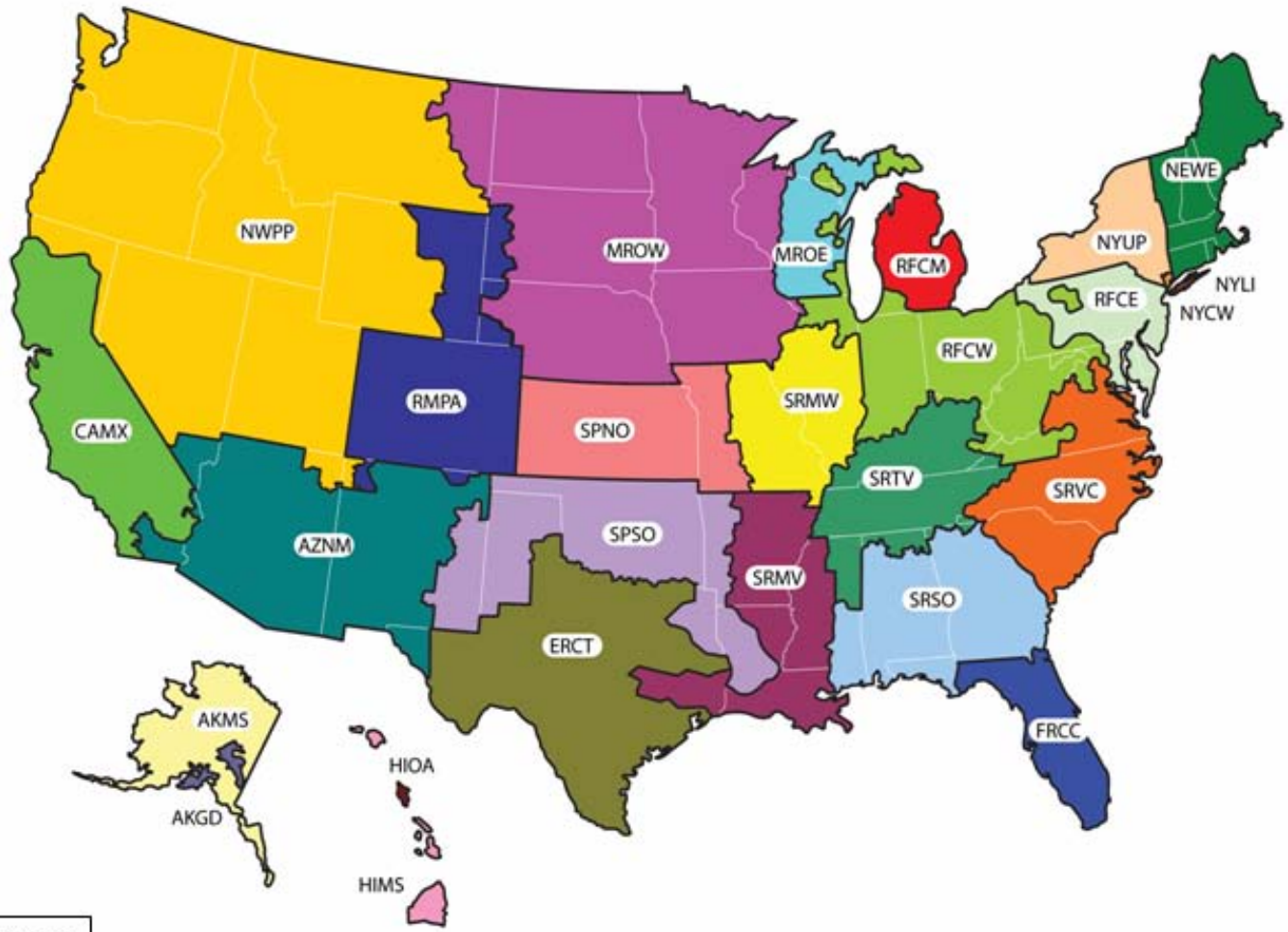
eGRID Subregion Annual CO2 Output Emission Rates (lb/MWh) (2004)





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Example of High-Effort Measurement: Air Emissions

3b. Determine GHG Reductions (CO_2, CH_4, MMTCE)

3c. Determine Air Pollution Benefits (NO_X, SO_2, Hg)

- **Sample analysis:** Estimating displaced emissions using eGRID data and a "capacity factor method" in Montgomery County, MD
  - Simplified approach that uses publicly available data to estimate the air emissions benefits of a new wind plant to meet power demand in PJM West (mostly coal-fired)
  - The capacity factor method takes the total energy generated or saved by the new resource and allocates it to the plants in the region based on each unit's capacity factor.

Figure 1. Unit Dispatch in a Simplified Power System

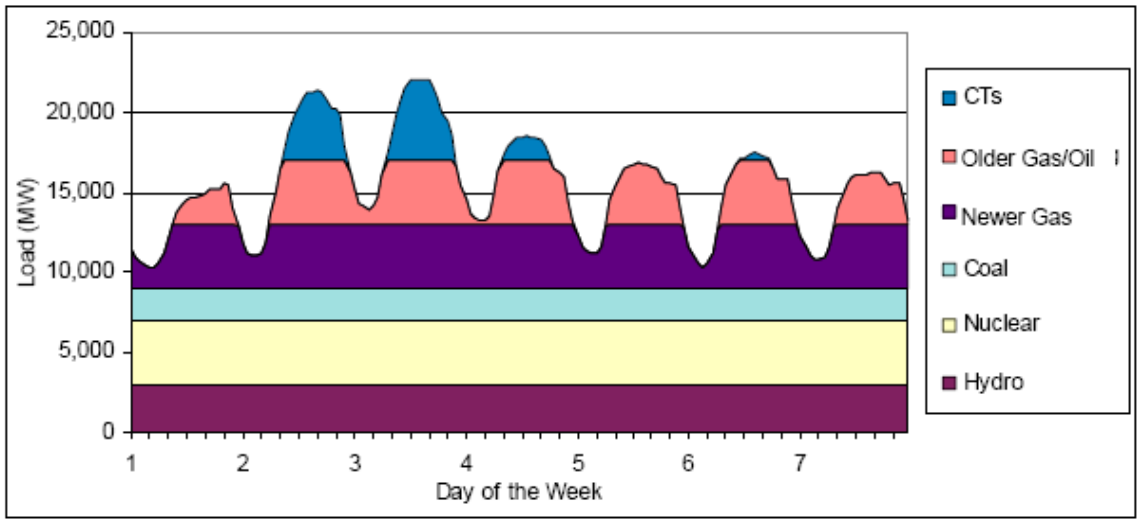
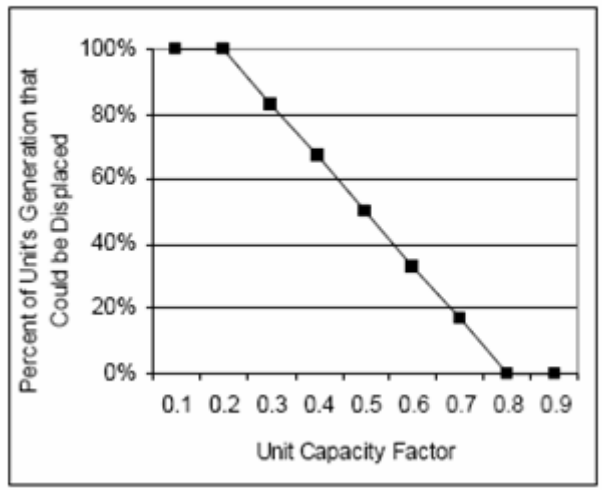
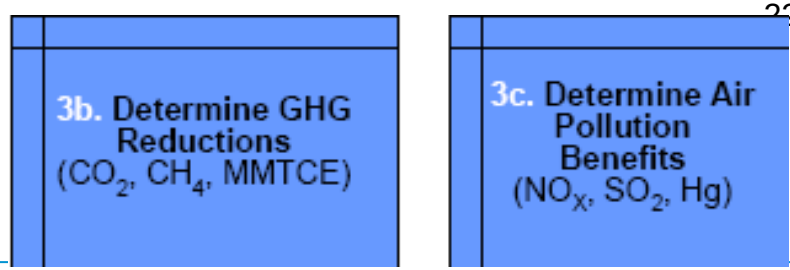


Figure 7. EPA/ERCOT Rule Applying Reduced Generation



Example of High-Effort Measurement: Air Emissions (con't)



- **Clean energy measure:** Montgomery County, MD agency wind power purchase
  - 5% of electricity use = 32.8 million kWh/year
  - Plus other jurisdictions = 38.4 million kWh/year
- **Analytic approach is consistent with EPA guidance document:**
  - "Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-sector EE and RE Measures" (August, 2004)
- **Results:** 0.05 tons NOx per day
  - 50% of estimated emission reductions (of 5.72 lb NOx per MWh) sought for SIP credit
  - Cap and trade area, commitment to retire allowances
  - EPA Region III issued final approval (See May 12, 2005, 70 FR 24987)

Control Measure	Cost (ton/year)
Wind Energy	$32,000
CNG Refueling Stations	$54,701
55 CNG Buses	$103,063
1967 Bike Lockers	$247,111

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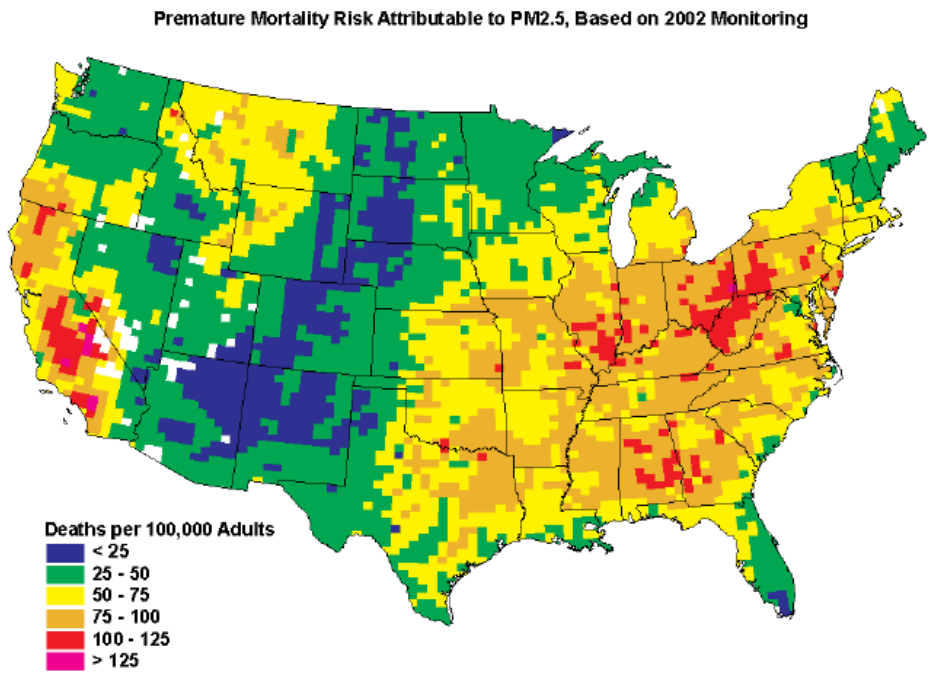
Example of High-Effort Measurement: Health Impacts

4c. Determine Public Health Benefits (avoided mortality, morbidity, and related costs)

- **Sample analysis:** Estimating health impacts using BenMAP
- BenMAP is the Environmental Benefits Mapping and Analysis Program
  - Developed by Abt Associates with funding from the EPA
  - Peer-reviewed software tool that estimates the health impacts and associated economic values connected with changes in ambient air pollution.
- BenMAP can be used to:
  - Compare benefits across regulatory options
  - Estimate health impacts and costs of existing air pollution levels
  - Estimate health benefits of alternative ambient air quality standards
  - Perform sensitivity analyses of health or valuation functions



BenMAP illustrates the risk to people in the United States of anthropogenic (man-made) particulate matter less than 2.5 microns in diameter.

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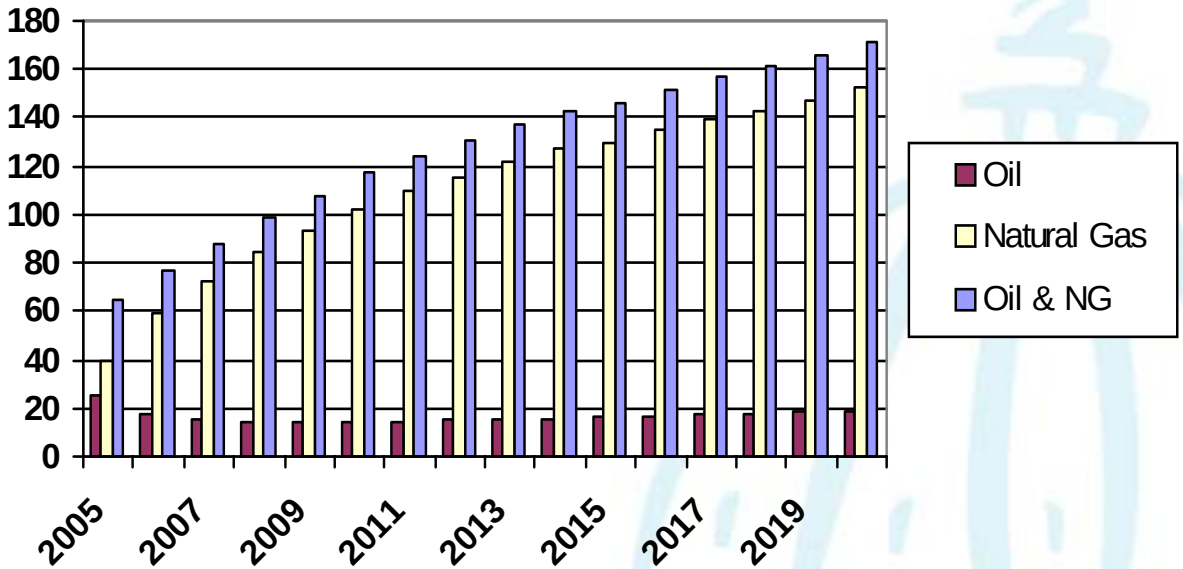
Example of High-Effort Measurement: Economic Impacts

4a. Determine Macroeconomic Impacts (jobs created, income, GSP)

- **Sample analysis:** Estimating the economic impact of oil and natural gas conservation policies using Regional Economic Models, Inc. (REMI) Policy Insight
- CT has used REMI to evaluate:
  - Oil and natural gas conservation policies
  - EE measures of the Connecticut Energy Conservation & Management Board (ECMB) Fund
  - Feebates program

Results from oil & natural gas conservation policy. Annual increase in Gross State Product (Mil 96 $)



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For More Information

- Tools and resources for state and local governments
  - See: www.epa.gov/cleanrgy/stateandlocal/resources.htm
- Select Links:
  - CACPS: http://www.cacpsoftware.org/
  - COBRA: contact Denise Mulholland (EPA), 202-343-9274
  - Community Energy Opportunity Finder: http://www.energyfinder.org/
  - REMI: www.remi.com
  - BenMAP: http://www.epa.gov/ttn/ecas/benmapdownload.html
- Contact:

Dietsch.nikolaas@epa.gov
202-343-9299

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