

# AVERT Overview and Step-by-Step Instructions

U.S. Environmental Protection Agency  
State Energy and Environment Program  
Updated April 2023





# Overview of AVERT Development for Energy Efficiency (EE), Renewable Energy (RE), and Electric Vehicle (EV) Programs

- AVERT (AVoided Emissions and geneRation Tool) translates the impacts of EE, RE, EVs, and other energy policies and programs into emission impacts (PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>2</sub>, CO<sub>2</sub>, VOCs, and NH<sub>3</sub>).
  - It aims to address a key reason states have not implemented previous [EE/RE State Implementation Plan \(SIP\) guidance](#).
- AVERT has been thoroughly reviewed, well documented, and tested. EPA has:
  - Conducted multiple external and internal peer reviews.
  - Benchmarked AVERT against industry standard electric power sector model – PROSYM.
  - Worked with states to beta-tested tool for functionality, appropriate uses, and clarity of user manual.
- AVERT was first released in 2014 and is built to be:
  - User friendly
  - Transparent
  - Credible



For more information on EPA's EE/RE SIP Roadmap visit: <https://www.epa.gov/energy-efficiency-and-renewable-energy-sips-and-tips/energy-efficiencyrenewable-energy-roadmap>.

# AVERT's Evolution

- 2014 ○ • Initial release of AVERT with data for CO<sub>2</sub>, NO<sub>x</sub>, and SO<sub>2</sub>.
- 2015 ○ • Published first paper comparing emissions from AVERT regions and EE/RE resources.
- 2016 ○ • Extensive training and outreach, including video tutorials.
- 2017 ○ • Addressed net vs. gross considerations by accounting for parasitic load and transmission and distribution line loss.  
• Added PM<sub>2.5</sub>.  
• Generated emission rates to support quick analyses.
- 2018 ○ • Added compatibility with EPA's COBRA tool.  
• Launch of web-based AVERT.
- 2019 ○ • Updated AVERT to provide year-specific transmission and distribution loss factors from EIA generation and sales data.
- 2020 ○ • Revised AVERT regions to reflect the modern electric grid.  
• Added offshore wind and scaleable RE capacity factors.  
• Added statewide analysis function (web AVERT only).
- 2021 ○ • Annual data updates, including newer source data and capacity factors.  
• Added VOCs and NH<sub>3</sub>.
- 2022 ○ • Annual data updates, including newer source data and capacity factors.
- 2023 ○ • Added capability to model the impact of electric vehicles.  
• Added new summary outputs, including vehicle emission changes and references to long-run marginal emission rates.

## Ongoing activities

- Annual data updates
- Enhancements
- Compatibility updates

# Emission Quantification Methods

## Basic to Sophisticated

### Basic Method

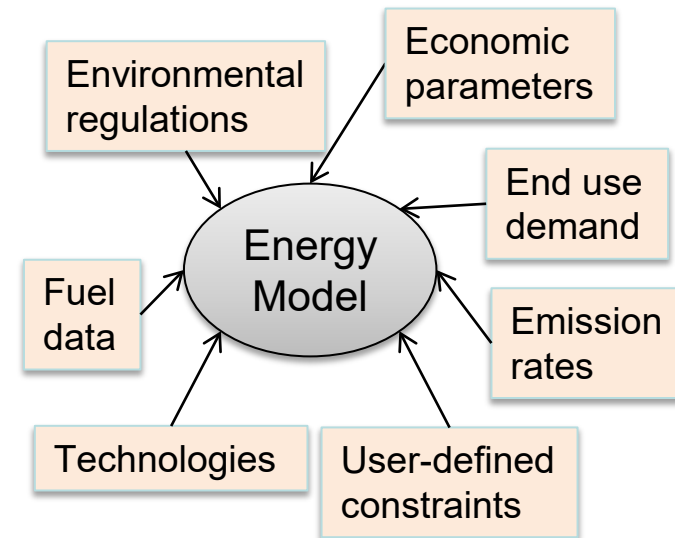
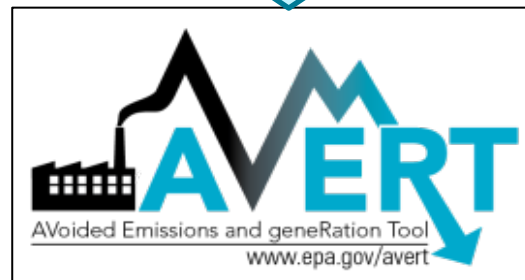
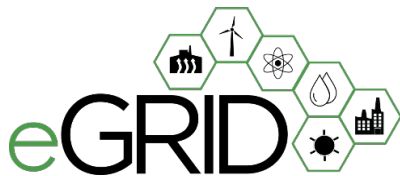
eGRID region non-baseload emission rates

### Intermediate Method

Historical hourly emission rates

### Sophisticated Method

Energy modeling  
Dispatch or capacity expansion





# Applications for AVERT-Calculated Emissions

- SIP credit in a state's National Ambient Air Quality Standard (NAAQS) Clean Air Act Plan
  - EE and RE only, not suitable for vehicles
- Compare emission impacts of varying levels of energy programs, projects, and policies
- Calculate emission reductions in your state or county using AVERT's web-based edition
- Use AVERT-generated emission rates to estimate magnitude of emission reductions without running the tool
  - Six categories include offshore and onshore wind, rooftop- and utility-scale solar, portfolio EE, and uniform EE programs
- This is not a long-term projection tool
  - To conduct analysis more than five years from the baseline, users must use AVERT's statistical module and future year scenario template

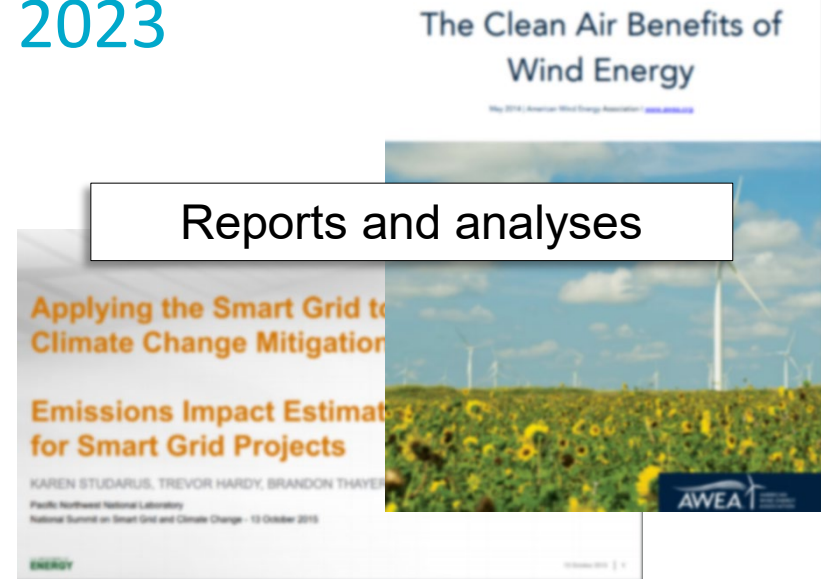
# How AVERT Has Been Used

## 100+ citations as of spring 2023

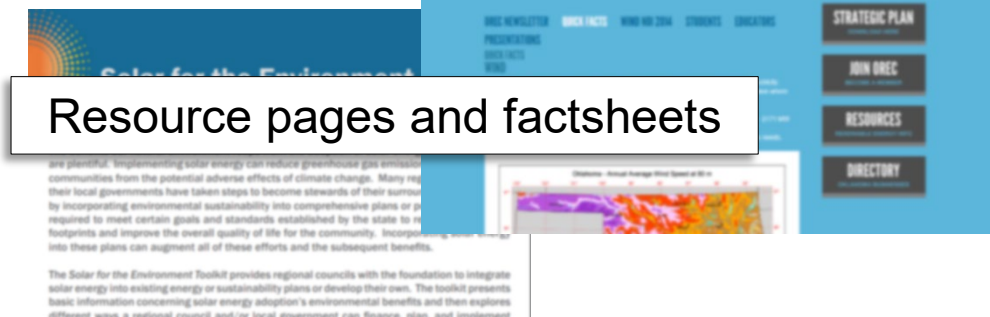


### Peer-reviewed papers

- Environmental Research Letters
- Environmental Science and Technology
- Nature Energy
- Journal of Industrial Ecology
- Energy Policy
- ...and more



### Reports and analyses



### Resource pages and factsheets



# Examples Using AVERT

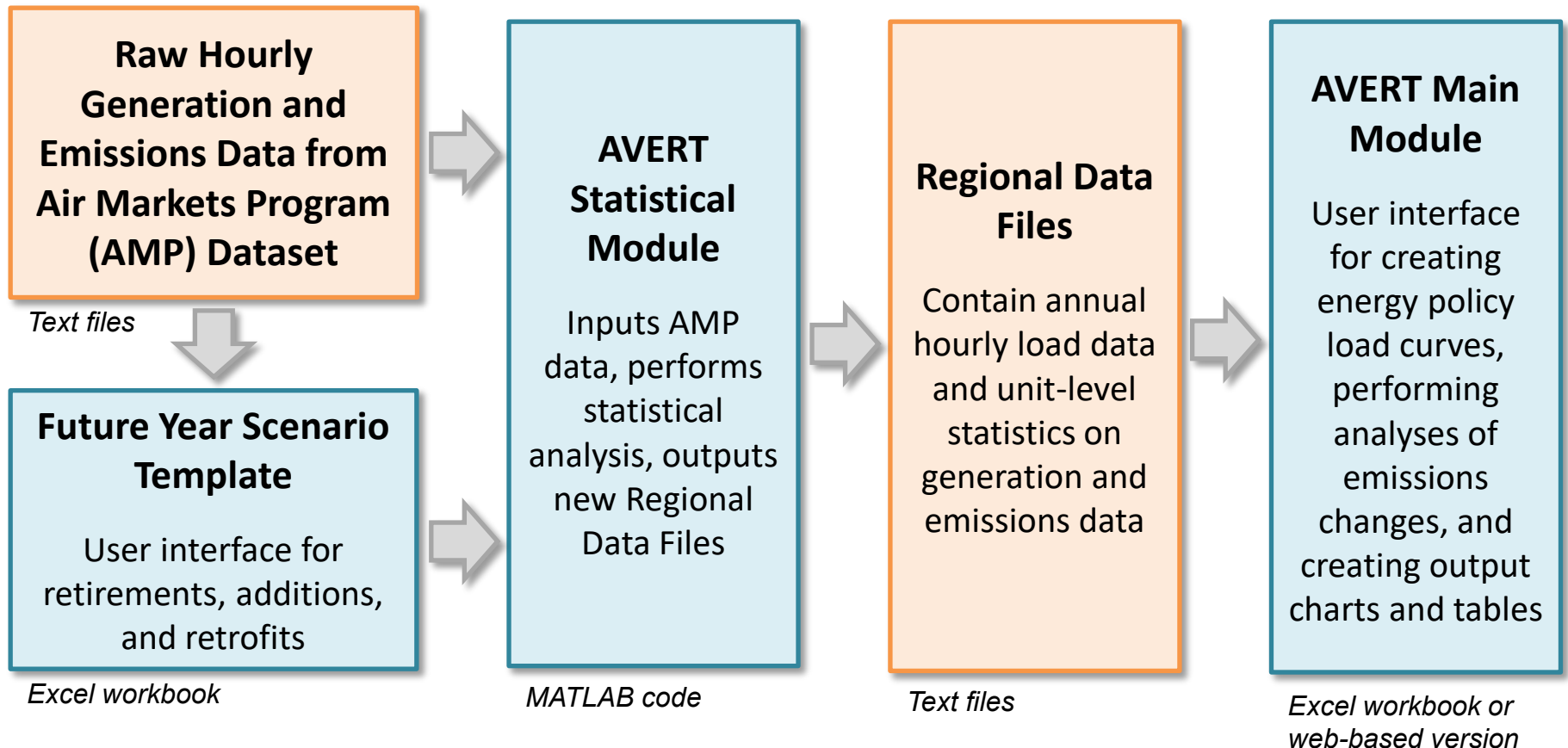
- Cost-Effectiveness Analysis for ASHRAE 90.1-2019 – Multiple States ([Pacific Northwest National Laboratory, 2021](#))
- Climate and Health Benefits of Increasing Renewable Energy Deployment in the United States ([Buonocore et al., 2019](#))
- Potential Air Quality Benefits from Increased Solar Photovoltaic Electricity Generation in the Eastern United States ([Abel et al., 2017](#))
- The Health and Environmental Benefits of Wind and Solar Energy in the United States, 2007-2015 ([LBNL, January 2017](#))
- Electric Vehicles and Air Quality ([North Carolina Department of Environmental Quality and the South Carolina Energy Office](#))
- Carbon Reductions and Health Co-benefits from U.S. Residential Energy Efficiency Measures ([Levy et al., 2016](#))
- Renewable Portfolio Standard (RPS) Benefits Report ([LBNL and NREL, January 2016](#))
- U.S. EPA's Ozone Advance Program - [Clark County, NV's](#) Paths Forward
- Assessing Emission Benefits of Renewable Energy and Energy Efficiency Programs ([U.S. EPA, April 2015](#))
- Maine Distributed Solar Valuation Study ([Maine PUC, March 2015](#))
- CarbonCount™ Green Bonds Scores ([Alliance to Save Energy, March 2015](#))

# How AVERT Works

- AVERT's Main Module simulates the hourly changes in generation and air emissions ( $PM_{2.5}$ ,  $NO_x$ ,  $SO_2$ ,  $CO_2$ , VOCs, and  $NH_3$ ) at EGUs resulting from EE, RE, EVs, and other energy policies and programs.
- User input: MWhs saved from energy programs, wind and solar generation (MW), or number of EVs and location of EV deployment
  - Multiple options are built into the tool
  - Users can manually enter hourly impact data
- User can retire, add and change emission rates of EGU and re-run simulation using AVERT's Future Year Scenario Template and Statistical Module.



# AVERT's Modules and Data Files



Most users will only need to use the Regional Data Files and AVERT Main Module to calculate emissions. The web version of the Main Module provides similar functionality without the need to download any files or software.

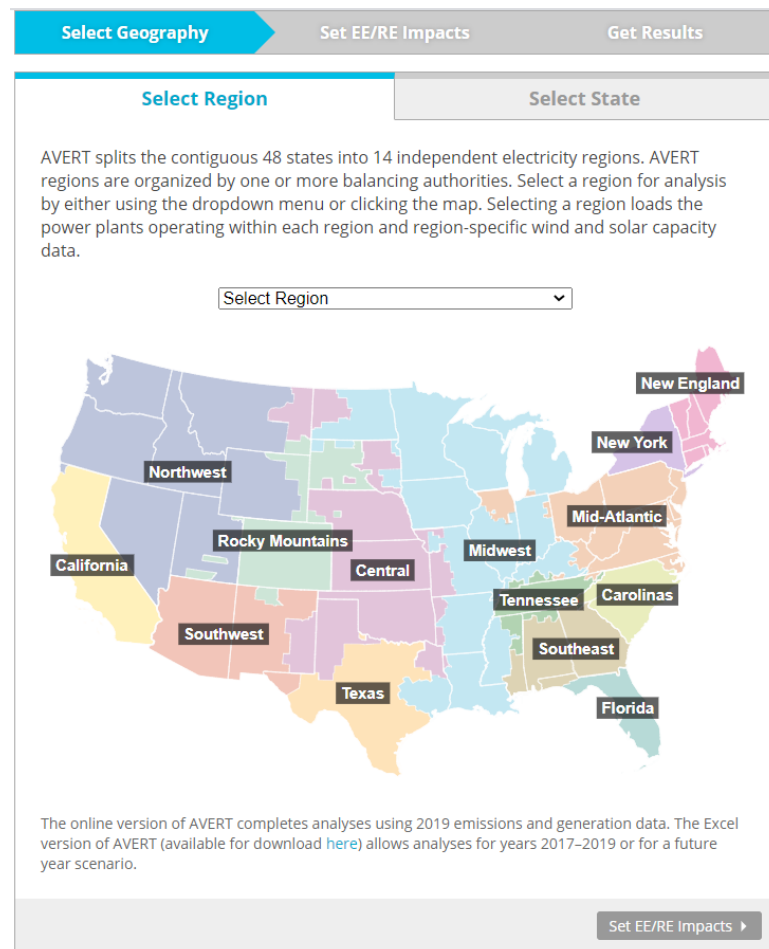
# AVERT's Data Driven Analysis

- AVERT uses a data-driven analysis to distinguish which EGUs respond to marginal changes in load.
  - AVERT analyzes EGU datasets from EPA's Air Markets and Program Data (hourly, unit-by-unit generation and emissions).
    - Dataset includes EGUs with capacity of 25 MW or greater.
    - Supplemented with PM<sub>2.5</sub>, VOCs, and NH<sub>3</sub> data from EPA's National Emissions Inventory.
  - AVERT's Statistical Module gathers statistics on EGU operations under specific load conditions, and then replicates changes through a Monte Carlo analysis.
  - AVERT's Regional Data Files contain hourly and unit-level emissions and generation data.

# AVERT Main Module

# AVERT's Web-Based Main Module

- Users can choose between AVERT's Excel-based version or the web edition
- In 2018, EPA released AVERT's web-based version
  - The online platform allows users to quickly estimate energy program impacts using current year dataset
  - Users can enter standard energy settings
  - Results are shown in graphical form and savable formats
- Allows statewide multi-region runs



Select Geography | Set EE/RE Impacts | Get Results

Select Region | Select State

AVERT splits the contiguous 48 states into 14 independent electricity regions. AVERT regions are organized by one or more balancing authorities. Select a region for analysis by either using the dropdown menu or clicking the map. Selecting a region loads the power plants operating within each region and region-specific wind and solar capacity data.

Select Region

California, Northwest, Southwest, Texas, Rocky Mountains, Central, Midwest, Tennessee, Southeast, Florida, Mid-Atlantic, New York, New England

The online version of AVERT completes analyses using 2019 emissions and generation data. The Excel version of AVERT (available for download [here](#)) allows analyses for years 2017–2019 or for a future year scenario.

Set EE/RE Impacts



# AVERT's Excel-Based Main Module Step-by-Step Overview

- Enabling Macros
- Using AVERT
- Step 1. Load Regional Data File
- Step 2. Set Energy Scenario
- Step 3. Run Scenario
- Step 4. Display Results

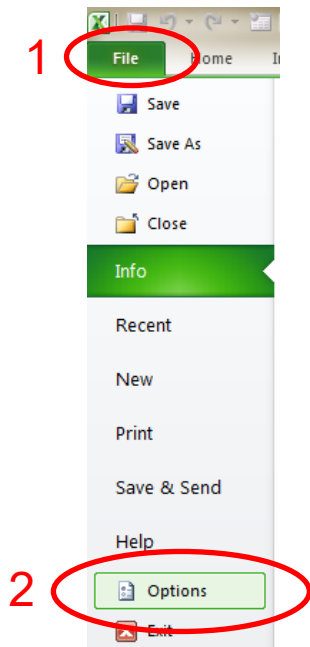
# AVERT's Excel-Based Main Module Enabling Macros

- In Windows, AVERT is compatible with Excel 2007 or newer versions.
- On a Mac, AVERT is compatible with Excel 2011 or newer versions.
  - Only the Main Module has been optimized for Mac. Other components (e.g., the Statistical Module) require Windows.
- You may want to revert to the default macro settings after using the model. Enabling macros in other Excel files may allow potentially dangerous code to run.

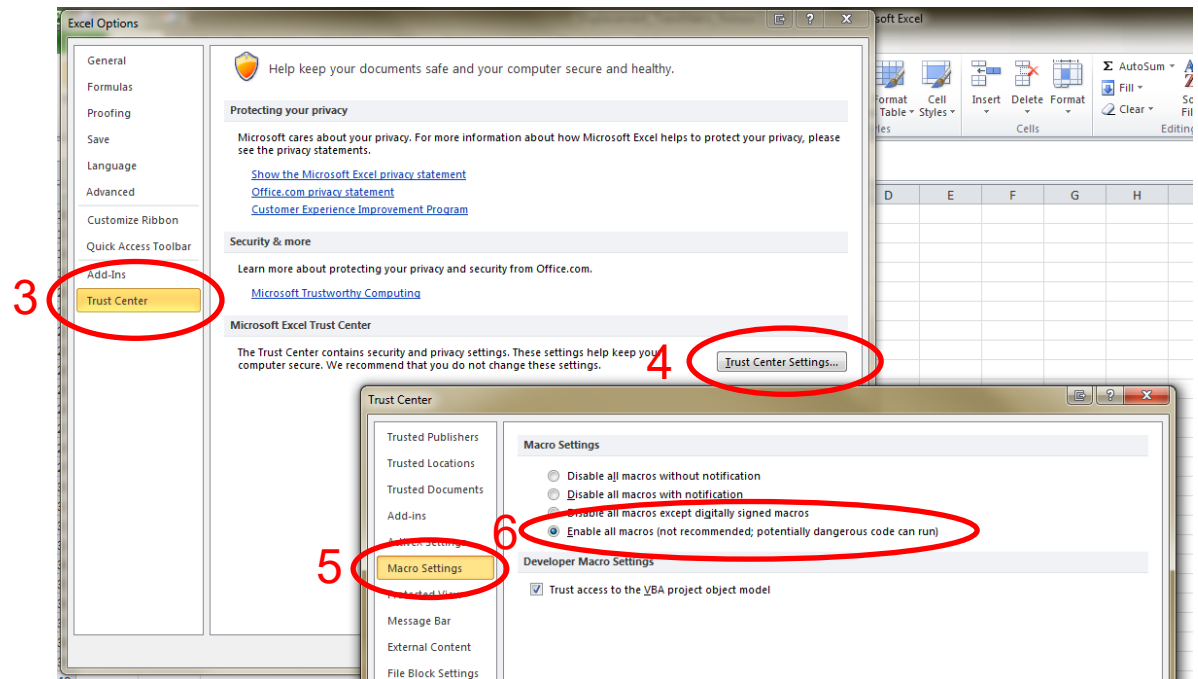
# AVERT's Excel-Based Main Module

## Enabling Macros in Windows\*

In Excel 2010 or newer, click **File** > **Options**



Next, click **Trust Center** > **Trust Center Settings** > **Macro Settings** > **Enable all macros**



\*If using Excel 2007, click the Microsoft Office Button: .

\*If using Excel on a Mac, select "Enable macros" in the dialog box that appears when opening the file.

# AVERT's Excel-Based Main Module Using AVERT

- Add details about the user, the date, and the energy program for which impacts are to be estimated.
- Click on the button labeled “Click here to begin.”

AVERT

## Welcome to AVERT's Main Module




AVERT is an EPA tool that quantifies the generation and emission changes of energy policies and programs in the continental United States. Please refer to the AVERT user manual for details on step-by-step instructions, appropriate uses and assumptions built into the tool.

**NOTE**  
Please ensure macros are enabled on your computer.  
AVERT requires Excel 2007 or higher in Windows and Excel 2011 or higher on Mac.

AVERT v4.0  
Developed by Synapse Energy Economics, Inc., January 2023

Use the blue entry to describe each scenario and keep track of multiple versions of AVERT.

Editor:	
Date edited:	
Edition name:	
Edition description	

Click here to begin

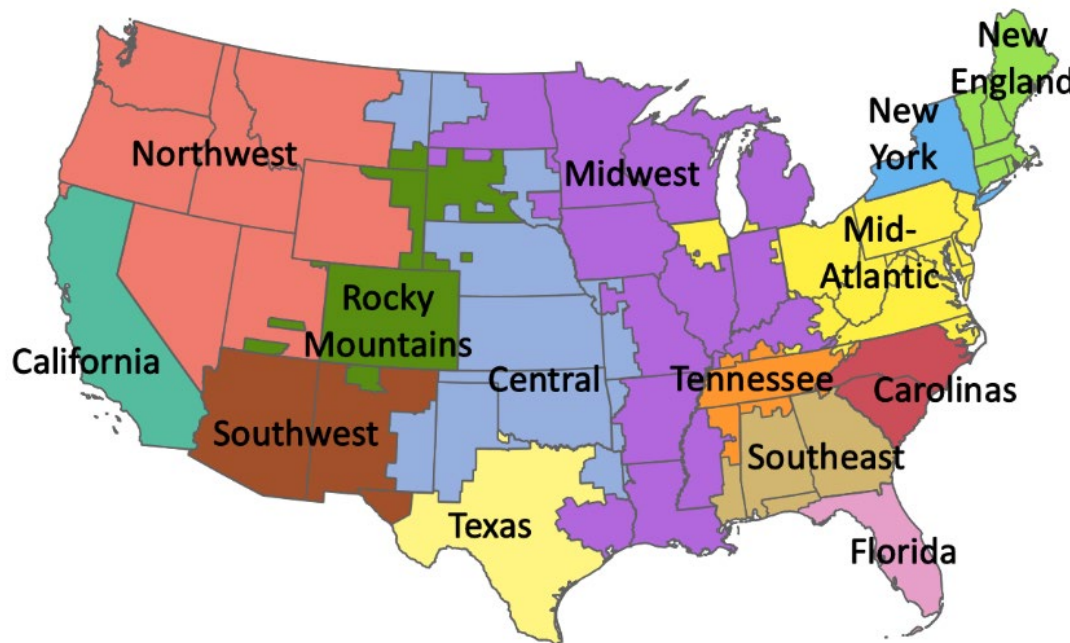
Click here to restore default Excel



# AVERT's Excel-Based Main Module

## Step 1. Load Regional Data File

Regions represent relatively autonomous electricity production zones and are aggregations of one or more balancing authority.



Regions include

- California
- Carolinas
- Central
- Florida
- Mid-Atlantic
- Midwest
- New England
- New York
- Northwest
- Rocky Mountains
- Southeast
- Southwest
- Tennessee
- Texas

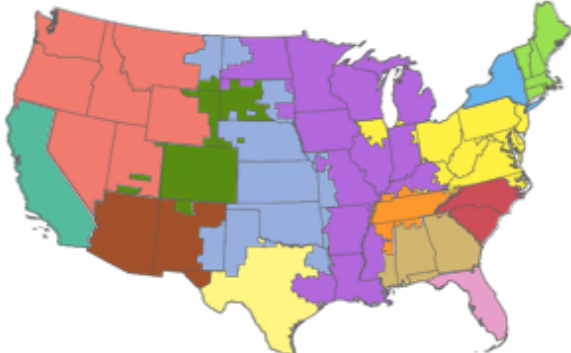
# AVERT's Excel-Based Main Module

## Step 1. Load Regional Data File

- Select a region for analysis by either using the dropdown or clicking the map.

**Select region**

Select a region for analysis by using the dropdown or by clicking the map.



[If you haven't yet downloaded a Regional Data File, click here.](#)

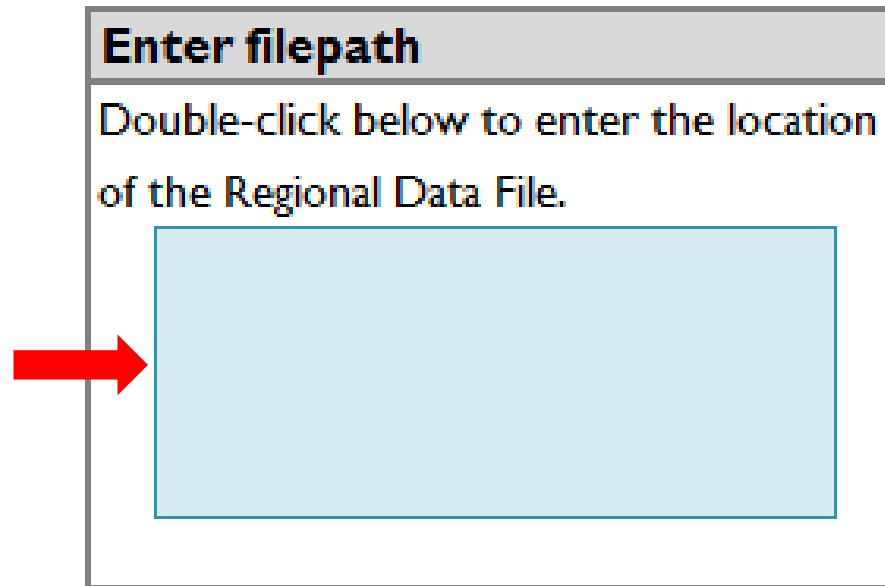
- Selecting a region loads region-specific data for wind and solar capacity factors and dynamically creates a hyperlink to that region's data on EPA's website.

- After selecting a region, click the link under the map to download it from EPA's website.

# AVERT's Excel-Based Main Module

## Step 1. Load Regional Data File

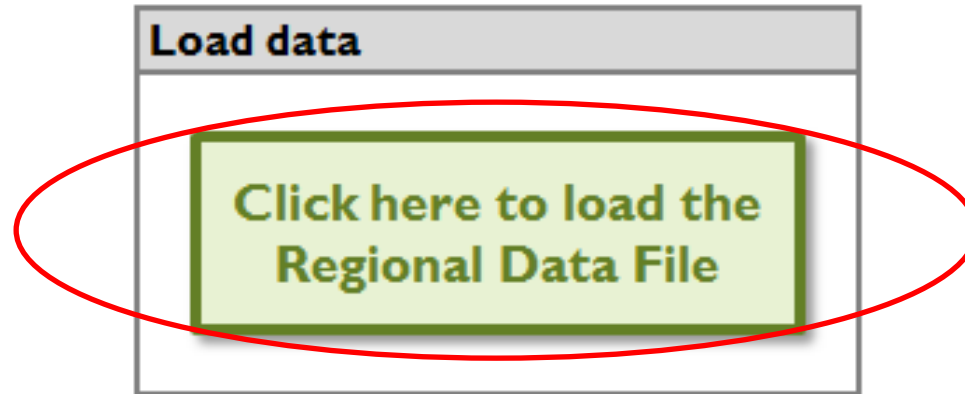
- In the box labeled “Enter filepath,” double-click the blue area to navigate to the location of the downloaded regional data file.



# AVERT's Excel-Based Main Module

## Step 1. Load Regional Data File

- Click the button under “Load data” entitled:



Clicking this button loads the following information from the regional data file:

- Hourly fossil load
- EGU information (e.g., location, fuel type)
- Typical EGU performance for generation and emissions at a given regional load

# AVERT's Excel-Based Main Module

## Step 1. Load Regional Data File

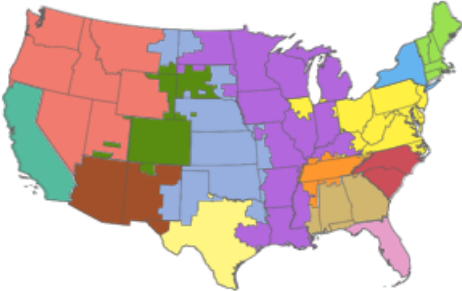
- A popup will indicate when the file has finished loading and remind you how to handle states that are split across multiple AVERT regions.

### Step 1: Import Regional Data File

**Select region**

Select a region for analysis by using the dropdown or by clicking the map.

Midwest



[If you haven't yet downloaded a Regional Data File, click here.](#)

**AVERT** [Close]

Import complete.

You have loaded the 2019 Midwest (MIDW) Regional Data File. This region contains 636 fossil units.

Load from the following states is fully represented in this AVERT region:  
WI

Load from the following states is only partially represented in this AVERT region: AR, IA, IL, IN, KY, LA, MI, MN, MO, MS, ND, OK, SD, TX

Appendix G of the User Manual describes the methodology for assessing the impact of energy policies and programs that are represented in multiple AVERT regions.

Click the red "Next" button to continue.

[OK]

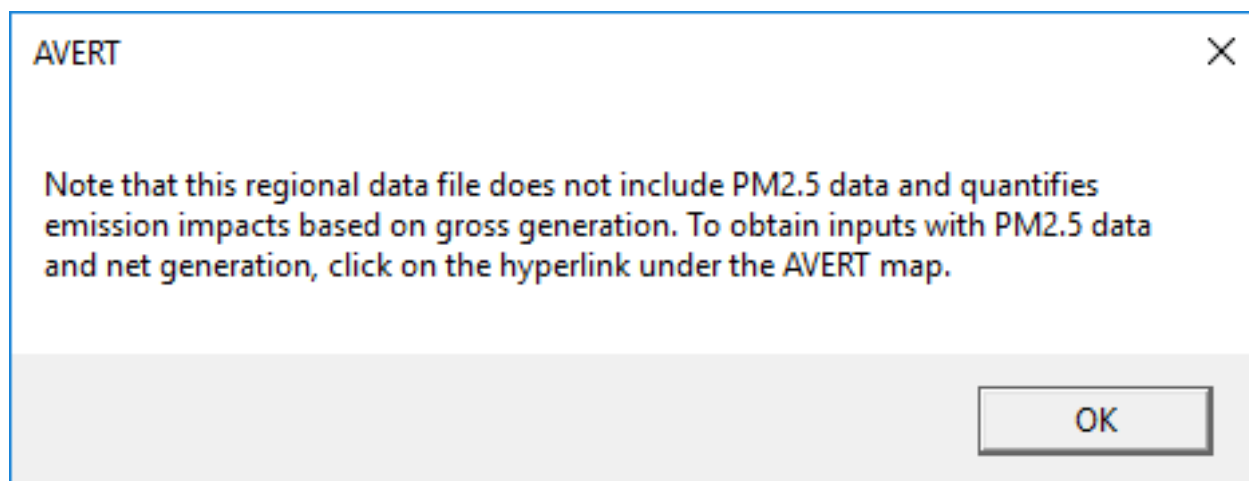
**Click here to load the Regional Data File**

Next →  
← Back

# Step 1. Load Regional Data File

## Regional Data File import pop-up

- Regional Data Files (RDFs) released before July 2017 do not have PM<sub>2.5</sub> emissions and they include net generation values to account for parasitic losses.
- If you are using an earlier RDF, another pop-up box will alert you and suggest that you download a newer RDF from EPA's website.



# AVERT's Excel-Based Main Module

## Step 2. Set Energy Scenario

- This page leads you through the process of creating an energy impact profile depicting the impacts expected from an energy program.

Midwest, 2019

AVERT

### Step 2: Set Energy Scenario

**DIRECTIONS:** Enter the energy efficiency and/or renewable energy and/or electric vehicle changes for one or more policies, programs, and/or projects. Each entry is additive, creating a single energy change profile. To modify each hour manually, click the button on the right. For further instructions consult Section 4 of the [AVERT User Manual](#)

#### Enter EE based on the % reduction of regional fossil generation

Reduce generation by a percent in some or all hours		
Apply reduction to top X% of hours:	0%	% of top hours
Reduction % in top X% of hours:	0.0%	% reduction

#### And/or enter EE distributed evenly throughout the year

Reduce generation by annual GWh	0	GWh
OR		
Reduce each hour by constant MW	0.0	MW

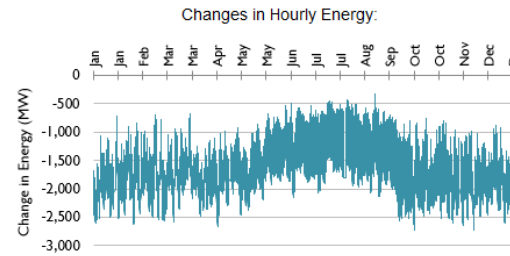
#### And/or enter annual capacity of RE resources

Onshore wind capacity:	5000	MW	<b>Edit capacity factors</b>
Offshore wind not available	0	MW	
Utility solar PV capacity:	0	MW	
Rooftop solar PV capacity:	0	MW	

#### And/or enter electric vehicle (EV) data

<b>Enter number of vehicles</b>	Battery EVs:	50,000	<b>View detailed EV data</b>
	Plug-in hybrid EVs:	0	
	Electric transit buses:	0	
	Electric school buses:	0	
Select location of EV deployment	Entire Region		

Enter detailed load change data by hour

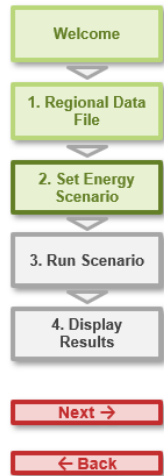


The currently entered reduction profile equals 13,796 GWh, or 2.7% of regional fossil generation.

Table 1. Sales and stock comparison	% of annual vehicle sales in entire region		% of registered vehicles in entire region	
Light-duty vehicles	2.0%		0.1%	
Transit buses	0.0%		0.0%	
School buses	0.0%		0.0%	

Table 2. EERE EV comparison for Entire Region	Historical additions (Annual Avg. 2018-2020)		EERE required to offset EV demand		EERE required divided by historical additions	
	MW	GWh	MW	GWh	MW	GWh
EE (retail)	626	5,481	10	83	2%	2%
Onshore Wind	3,074	8,615	43	121	1%	1%
Utility Solar	393	813	6	11	1%	1%
Total	4,142	15,334	58	216	-	-



# AVERT's Excel-Based Main Module

## Step 2. Set Energy Scenario

- If the hourly load impacts expected from an energy policy, program, or measure are known, a manual stream of load impact values can be entered for every hour of the year by clicking the “Enter detailed load change by hour” button. Displacements (load reductions) should be entered as positive values.



Midwest, 2019 AVERT

### Manual Energy Profile Entry

When complete, click here to return to Step 2: Set Energy Scenario

Positive numbers correspond to load reductions.

Delete all manual data

Date	Hour	Day of Week	Regional Fossil Load (M)	Manual Profile (MW)	Total Change (MW)	Larger than 15%?	Outside of Range?
1/1/2019	1	Tuesday	41,014		-2,118		
1/1/2019	2	Tuesday	39,656		-2,203		
1/1/2019	3	Tuesday	39,597		-2,306		
1/1/2019	4	Tuesday	39,994		-2,443		
1/1/2019	5	Tuesday	41,311		-2,436		
1/1/2019	6	Tuesday	43,352		-2,471		
1/1/2019	7	Tuesday	45,127		-2,430		
1/1/2019	8	Tuesday	47,024		-2,290		
1/1/2019	9	Tuesday	49,427		-2,183		
1/1/2019	10	Tuesday	52,645		-2,184		
1/1/2019	11	Tuesday	54,944		-2,137		
1/1/2019	12	Tuesday	56,125		-2,071		
1/1/2019	13	Tuesday	57,672		-1,898		
1/1/2019	14	Tuesday	58,192		-1,781		
1/1/2019	15	Tuesday	58,764		-1,678		
1/1/2019	16	Tuesday	59,484		-1,696		
1/1/2019	17	Tuesday	60,000		-1,714		



# AVERT's Excel-Based Main Module

## Step 2. Set Energy Scenario

This page also allows you to estimate an energy impact from basic characteristics:

- Reduce fossil-fuel generation by a percent in some or all hours
- Reduce fossil-fuel generation by total GWh
- Reduce each hour by a constant MW
- Renewable energy proxy, with the ability to scale hourly capacity factors
- Electric vehicle data by number of vehicles, with the ability to select a location of deployment and enter detailed data
- Combination of energy programs including combining pre-set options with manual hourly energy profile entry

**Enter EE based on the % reduction of regional fossil generation**

Reduce generation by a percent in some or all hours		
Apply reduction to top X% hours:	0%	% of top hours
Reduction % in top X% of hours:	0.0%	% reduction

**And/or enter EE distributed evenly throughout the year**

Reduce generation by annual GWh	0	GWh
<b>OR</b>		
Reduce each hour by constant MW	0.0	MW

**And/or enter annual capacity of RE resources**

Onshore wind capacity:	5000	MW	<b>Edit capacity factors</b>
Offshore wind not available	0	MW	
Utility solar PV capacity:	0	MW	
Rooftop solar PV capacity:	0	MW	

**And/or enter electric vehicle (EV) data**

<b>Enter number of vehicles</b>	Battery EVs:	50,000	<b>View detailed EV data</b>
	Plug-in hybrid EVs:	0	
	Electric transit buses:	0	
	Electric school buses:	0	
Select location of EV deployment	Entire Region		

# AVERT's Excel-Based Main Module

## Step 2. Set Energy Scenario

- If you enter a scenario that exceeds 15% of regional fossil load in any given hour, you will be shown an alert highlighting the hours of exceedance, but you can still proceed with the calculations.

Midwest, 2019
AVERT

### Step 2: Set Energy Scenario

**DIRECTIONS:** Enter the energy efficiency and/or renewable energy and/or electric vehicle changes for one or more policies, programs, and/or projects. Each entry is additive, creating a single energy change profile. To modify each hour manually, click the button on the right. For further instructions consult Section 4 of the [AVERT User Manual](#).

**Enter EE based on the % reduction of regional fossil generation**

Reduce generation by a percent in some or all hours

Apply reduction to top X% hours:  % of top hours

Reduction % in top X% of hours:  % reduction

**And/or enter EE distributed evenly throughout the year**

Reduce generation by annual GWh:  GWh

OR

Reduce each hour by constant MW:  MW

**And/or enter annual capacity of RE resources**

Onshore wind capacity:	<input type="text" value="12000"/>	MW
Offshore wind not available:	<input type="text" value="0"/>	MW
Utility solar PV capacity:	<input type="text" value="0"/>	MW
Rooftop solar PV capacity:	<input type="text" value="0"/>	MW

[Edit capacity factors](#)

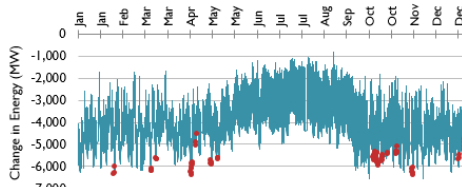
**And/or enter electric vehicle (EV) data**

Enter number of vehicles:	<input type="text" value="50,000"/>
Battery EVs:	<input type="text" value="0"/>
Plug-in hybrid EVs:	<input type="text" value="0"/>
Electric transit buses:	<input type="text" value="0"/>
Electric school buses:	<input type="text" value="0"/>
Select location of EV deployment:	<input type="text" value="Entire Region"/>

[View detailed EV data](#)

Enter detailed load change data by hour

Caution! Energy change profile exceeds 15% of fossil generation in one or more hours (see below).  
Changes in Hourly Energy:



The currently entered reduction profile equals 33,412 GWh, or 6.5% of regional fossil generation.

	% of annual vehicle sales in entire region	% of registered vehicles in entire region
Light-duty vehicles	2.0%	0.1%
Transit buses	0.0%	0.0%
School buses	0.0%	0.0%

	Historical additions (Annual Avg. 2018-2021)		EERE required to offset EV demand		EERE required divided by historical additions	
	MW	GWh	MW	GWh	MW	GWh
EE (retail)	626	5,481	10	83	2%	2%
Onshore Wind	3,074	8,615	43	121	1%	1%
Utility Solar	393	813	6	11	1%	1%
Total	4,142	15,334	58	216	-	-

Welcome

1. Regional Data File


2. Set Energy Scenario

3. Run Scenario

4. Display Results

Next →

← Back



EPA\_NetGen\_PMVOCNH3

# AVERT's Excel-Based Main Module

## Step 2. Set Energy Scenario

- If you enter a scenario that exceeds the calculable range in any given hour, you will be directed to change load impact in the hours identified in the "Outside of Range?" column of the Manual Energy Profile Entry page. These cells must be corrected before you may proceed.

Midwest, 2019 AVERT

### Manual Energy Profile Entry

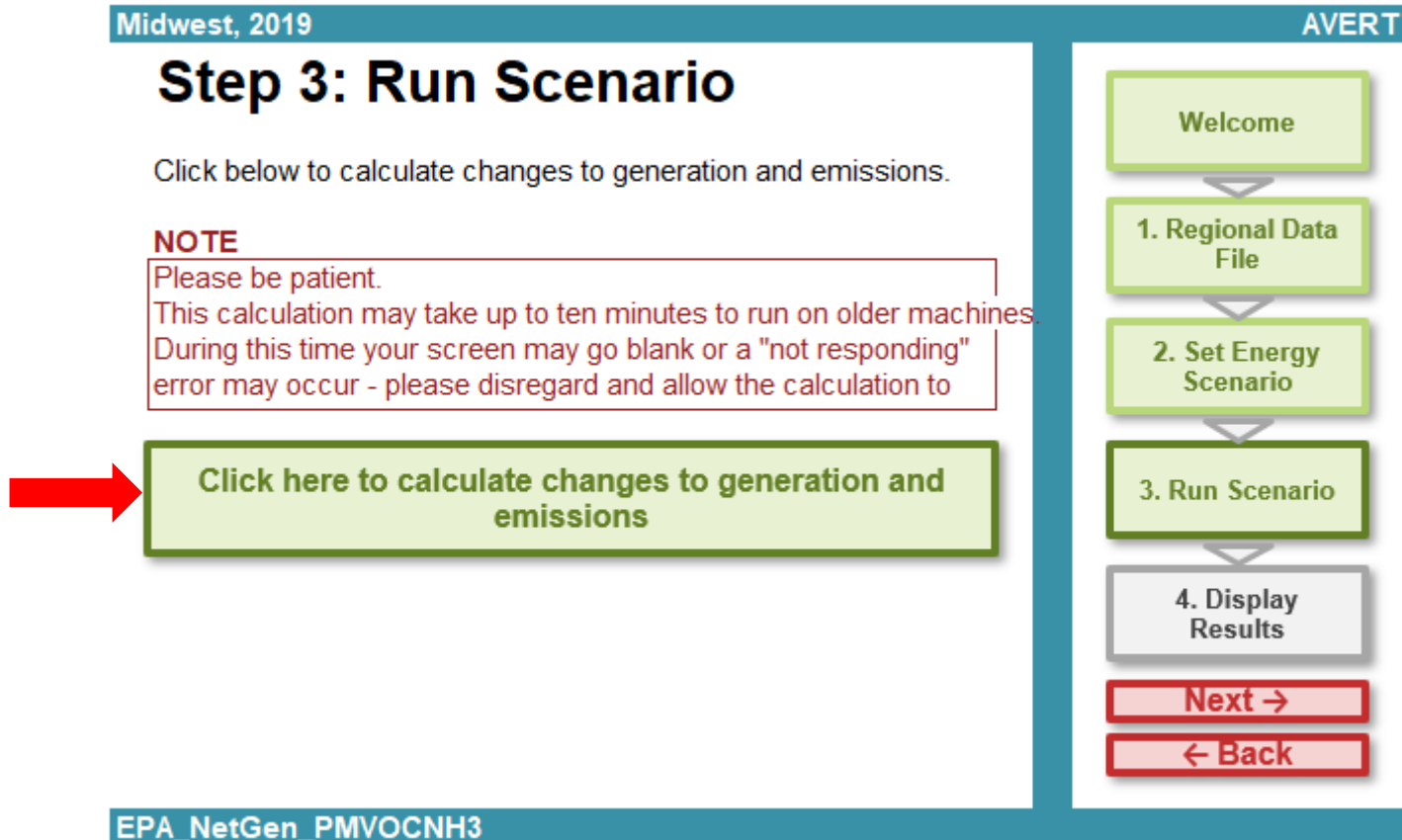
When complete, click here to return to Step 2: Set Energy Scenario *Positive numbers correspond to load reductions.* Delete all manual data

Date	Hour	Day of Week	Regional Fossil Load (M)	Manual Profile (MW)	Total Change (MW)	Larger than 15%?	Outside of Range?
9/3/2019	13	Tuesday	76,318		0		
9/3/2019	14	Tuesday	77,732		0		
9/3/2019	15	Tuesday	78,207		0		
9/3/2019	16	Tuesday	79,508		-81,391	ERROR: Yes	ERROR: New load is too low, please increase
9/3/2019	17	Tuesday	79,172		-81,047	ERROR: Yes	ERROR: New load is too low, please increase
9/3/2019	18	Tuesday	78,903		-80,772	ERROR: Yes	ERROR: New load is too low, please increase
9/3/2019	19	Tuesday	77,972		0		
9/3/2019	20	Tuesday	75,322		0		
9/3/2019	21	Tuesday	69,664		0		
9/3/2019	22	Tuesday	63,347		0		
9/3/2019	23	Tuesday	58,523		0		
9/3/2019	24	Tuesday	54,310		0		
9/4/2019	1	Wednesday	51,124		0		
9/4/2019	2	Wednesday	49,060		0		
9/4/2019	3	Wednesday	48,489		0		
9/4/2019	4	Wednesday	49,663		0		

# AVERT's Excel-Based Main Module

## Step 3. Run Scenario

- Run the scenario by selecting the button entitled "Click here to calculate changes to generation and emissions."



Midwest, 2019

AVERT

### Step 3: Run Scenario

Click below to calculate changes to generation and emissions.

**NOTE**  
Please be patient.  
This calculation may take up to ten minutes to run on older machines.  
During this time your screen may go blank or a "not responding" error may occur - please disregard and allow the calculation to

**Click here to calculate changes to generation and emissions**

Welcome

1. Regional Data File

2. Set Energy Scenario

3. Run Scenario

4. Display Results

Next →

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EPA\_NetGen\_PMVOCNH3

# AVERT's Excel-Based Main Module

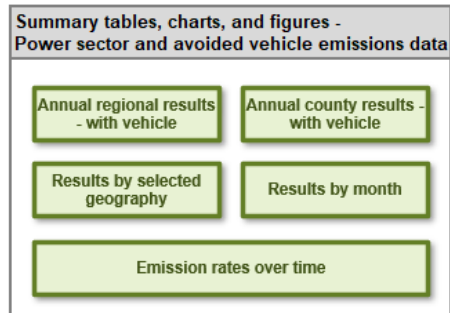
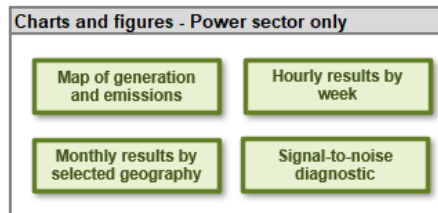
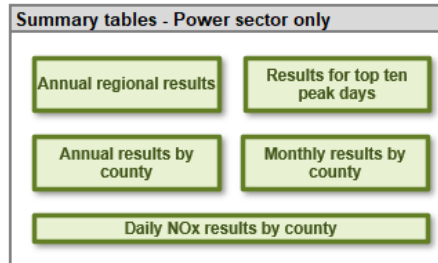
## Step 3. Run Scenario

- This step calculates hourly change in generation and emissions ( $PM_{2.5}$ ,  $SO_2$ ,  $NO_x$ ,  $CO_2$ , VOCs, and  $NH_3$ ) for each fossil EGU within the selected region.
- Note that this is a processor-intensive step. When using an older computer, or when analyzing regions with many fossil EGU, this step may take up to 10 minutes.

# AVERT's Excel-Based Main Module

## Step 4. Display Results

- The results generated in Step 3 are aggregated in three groups of charts and tables in Step 4.



# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Annual regional impacts

- This table displays the total annual generation and emissions as reported for the region in the base year ("Original") and as calculated by AVERT's Main Module after the modeled energy impact ("Post Impact").
- See the [user manual](#) for information on additional AVERT outputs that include vehicle emissions.

Midwest, 2019

AVERT

### Output: Annual Regional Results

[Click here to return to Step 4: Display Outputs](#)

	Original	Post Change	Change
Generation (MWh)	510,511,950	496,744,320	-13,767,630
Heat Input (MMBtu)	4,917,277,270	4,784,950,300	-132,326,970
<b>Total Emissions from Fossil Generation Fleet (lb)</b>			
SO <sub>2</sub>	710,791,670	689,174,570	-21,617,100
NO <sub>x</sub>	528,845,720	512,829,990	-16,015,740
Ozone season NO <sub>x</sub>	224,707,220	219,441,050	-5,266,180
CO <sub>2</sub>	881,078,630,540	857,291,333,570	-23,787,296,370
PM <sub>2.5</sub>	47,484,740	46,219,000	-1,265,740
VOCs	15,329,350	14,892,980	-436,370
NH <sub>3</sub>	10,163,730	9,902,340	-261,390
<b>AVERT-derived Emission Rates (lb/MWh)</b>			
	Average Fossil		Marginal Fossil
SO <sub>2</sub>	1.392		∅
NO <sub>x</sub>	1.036		∅
Ozone season NO <sub>x</sub>	0.976		∅
CO <sub>2</sub>	1,725.873		∅
PM <sub>2.5</sub>	0.093		∅
VOCs	0.030		∅
NH <sub>3</sub>	0.020		∅

Select unit for emissions

lb

Ozone season is defined as May 1 - September 30. Ozone season emissions are a subset of annual emissions.

Negative numbers indicate displaced generation and emissions.

All results are rounded to the nearest ten. A dash ("—") indicates non-zero results, but within +/- 10 units.

When users evaluate a portfolio scenario including EVs and EE or RE, marginal fossil values are not reported and a null sign ("∅") is shown.

Data on this page does not include changes to ICE vehicle emissions (e.g., emissions from tailpipes).



# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Annual Results by County

- This table presents a summary of the changes in generation and emissions, not including vehicle emissions, for each of the counties from each of the states contained within the region. A line for each county containing an EGU is displayed.

Midwest, 2019

### Output: Annual Results by County

[Click here to return to Step 4: Display Outputs](#)

State	County	Peak Generation, Post-Change (MW)	Annual Generation, Post-Change (MWh)	Annual Change in Generation (MWh)	Annual Change in SO <sub>2</sub> (lb)	Annual Change in NO <sub>x</sub> (lb)
AR	Craighead County	73	22,990	-3,120	-30	-4,68
AR	Hot Spring County	1,248	4,634,410	-173,350	-620	-51,8
AR	Independence County	1,400	5,323,000	-288,530	-1,567,510	-393,1
AR	Jefferson County	1,718	8,240,180	-356,340	-1,762,780	-474,8
AR	Mississippi County	1,142	7,025,260	-161,120	-169,110	-96,0
AR	Pulaski County	402	322,510	-36,800	-50	-48,1
AR	Union County	1,785	10,867,350	-256,220	-840	-16,4
IA	Allamakee County	213	422,630	-33,720	-17,910	-15,5
IA	Audubon County	84	102,130	-9,420	-800	-9,43
IA	Black Hawk County	8	3,900	-480	-	-2,34
IA	Cerro Gordo County	461	2,430,410	-116,600	-430	-4,95
IA	Des Moines County	193	1,124,230	-22,500	-131,590	-38,9
IA	Louisa County	678	3,087,630	-220,800	-704,830	-377,3
IA	Marshall County	709	3,627,530	-140,210	-460	-13,0
IA	Muscatine County	150	923,680	-24,090	-32,400	-68,0
IA	Polk County	312	269,920	-27,010	-180	-3,47
IA	Pottawattamie County	1,351	7,601,950	-315,500	-634,610	-490,5
IA	Scott County	38	5,140	-940	-	-1,69
IA	Story County	27	131,340	-4,820	-470	-6,83
IA	Union County	35	5,300	-1,010	-20	-11,1
IA	Wapello County	685	3,611,800	-149,470	-117,760	-159,5
IA	Woodbury County	1,087	2,942,210	-251,860	-885,140	-503,4

For each county, annual output statistics are given for:

- Peak Gross Generation Post-Impact
- Annual Gross Generation Post-Impact
- Annual Change in Generation
- Annual Change in Heat Input/PM<sub>2.5</sub>/SO<sub>2</sub>/NO<sub>x</sub>/CO<sub>2</sub>/VOCs/NH<sub>3</sub>
- Ozone Season Change in SO<sub>2</sub>/NO<sub>x</sub>/PM<sub>2.5</sub>
- Ozone Season, 10 Peak Days Change in SO<sub>2</sub>/NO<sub>x</sub>/PM<sub>2.5</sub>





# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Results for Top Ten Peak Days

- This table displays a summary of the ten days in the region featuring the highest level of fossil fuel load, not including changes to vehicle emissions.

Midwest, 2019

AVERT

### Output: Results for Top Ten Peak Days

[Click here to return to Step 4: Display](#)

Day Rank	Date	Total Fossil Generation (MWh)	Expected Change in Generation (MWh)	Change in Generation	Change in NO <sub>x</sub> (lb)	Change in SO <sub>2</sub> (lb)	Change in CO <sub>2</sub> (tons)	Change in PM <sub>2.5</sub> (lb)
1	Jul 19	1,966,680	-22,050	-22,230	-31,630	-25,220	-17,190	-2,080
2	Jan 30	1,930,570	-31,080	-31,280	-26,120	-35,090	-22,620	-2,930
3	Jul 17	1,900,580	-29,270	-29,140	-42,350	-34,120	-25,520	-2,880
4	Jan 31	1,897,480	-40,340	-40,930	-30,760	-48,590	-28,220	-3,820
5	Jul 02	1,895,160	-32,020	-32,120	-44,790	-39,600	-26,530	-2,980
6	Jul 18	1,887,940	-27,030	-27,140	-40,600	-32,440	-23,630	-2,700
7	Aug 06	1,879,770	-28,120	-28,230	-40,060	-34,570	-23,570	-2,700
8	Aug 12	1,863,210	-25,960	-25,420	-36,320	-28,570	-21,570	-2,570
9	Aug 19	1,842,710	-27,840	-27,400	-37,450	-31,340	-22,970	-2,730
10	Jul 16	1,841,700	-30,000	-29,910	-41,380	-35,660	-26,230	-3,050

Negative numbers indicate displaced generation and emissions.

All results are rounded to the nearest ten. A dash ("—") indicates non-zero results, but within +/- 10 units.

Data on this page does not include changes to ICE vehicle emissions (e.g., emissions from tailpipes).

# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Map of generation and emissions changes

- This dynamic map allows the user to view where emissions change within the selected region, not including changes from vehicle emissions. Users can view changes in generation, heat input, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub>.

Midwest, 2019

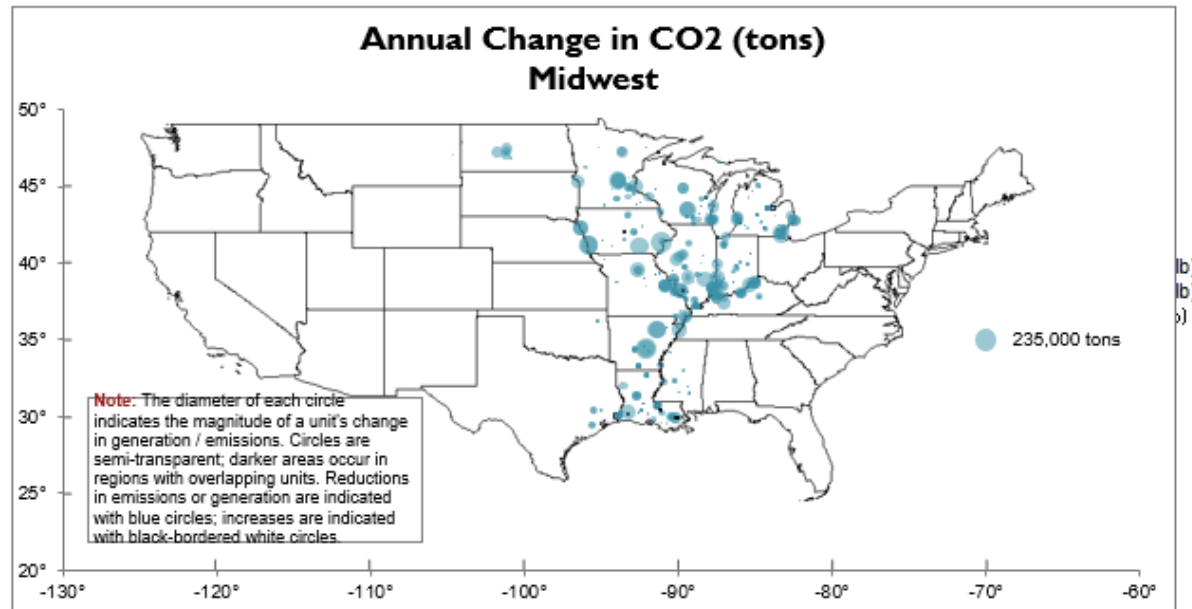
AVERT

### Output: Map of Generation and Emissions Changes

[Click here to return to Step 4: Display Outputs](#)

Select variable to display:

[Refresh map](#)



Data on this page does not include changes to ICE vehicle (tailpipe) emissions.

# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Results by month

Monthly output can be viewed over the entire region, or a specific state or county within the region.

- First select region, state, or county in the top dropdown menu.
- If selecting a state, choose the state in the next dropdown menu.
- If selecting a county, choose both the state and the county in the next two dropdown menus.
- See the [user manual](#) for information on additional AVERT outputs that include vehicle emissions.

Midwest, 2019

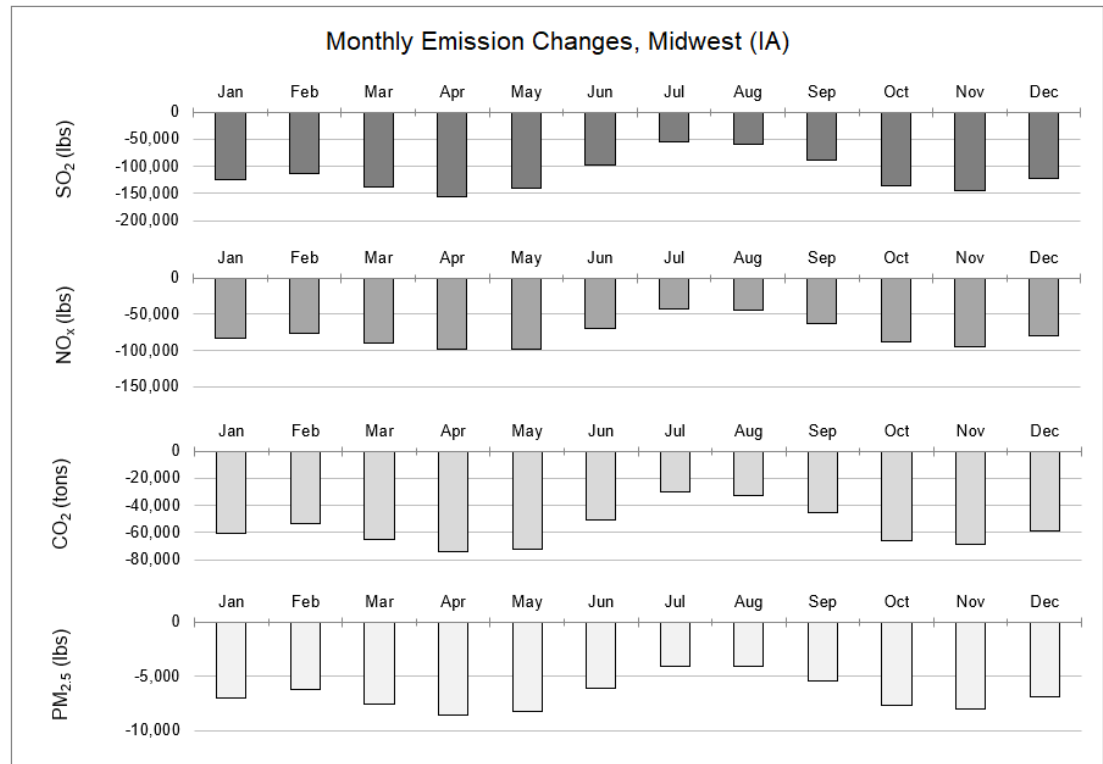
AVERT

### Output: Monthly Results by Selected Geography

[Click here to return to Step 4: Display Outputs](#)

Counties are displayed only if they contain power plants

Select level of aggregation: State  
Select state: IA

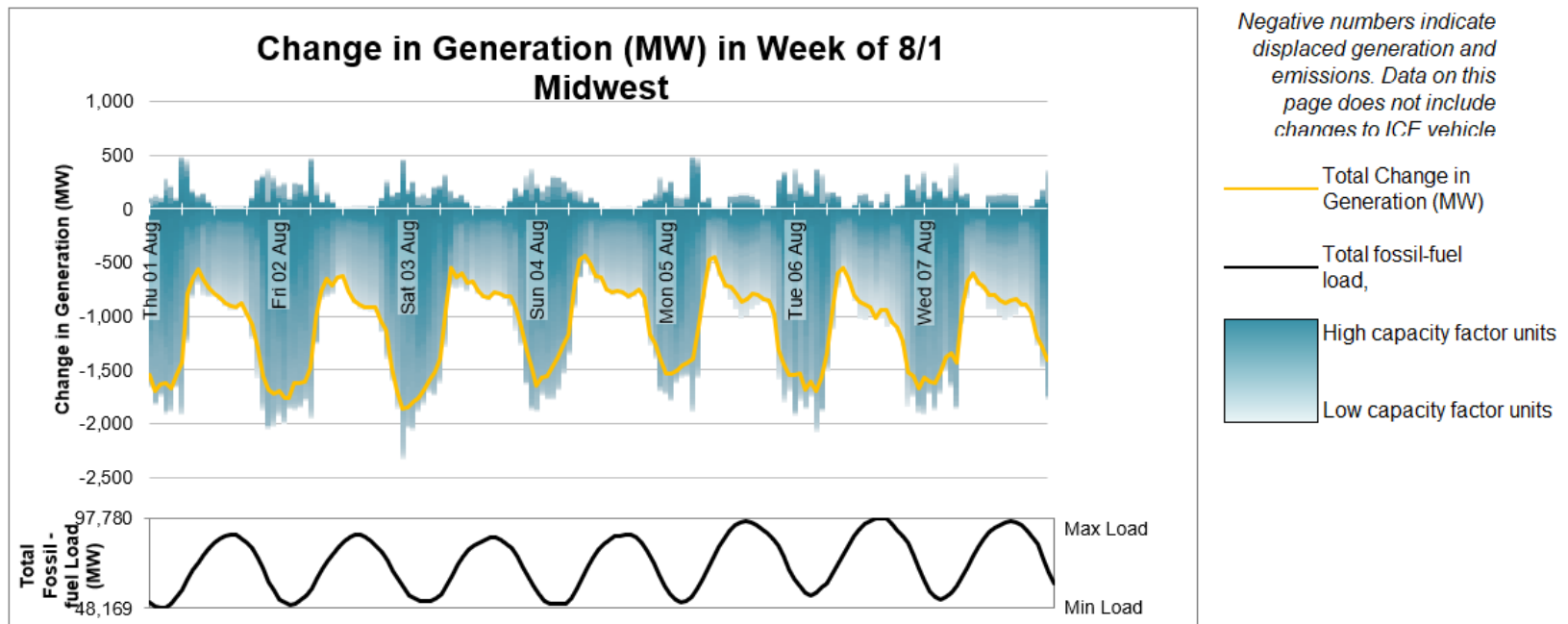


# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Hourly results by week

- This graph displays a dynamic representation of hourly impacts to each EGU in a region. Individual plants are stacked as gradated bar plots.

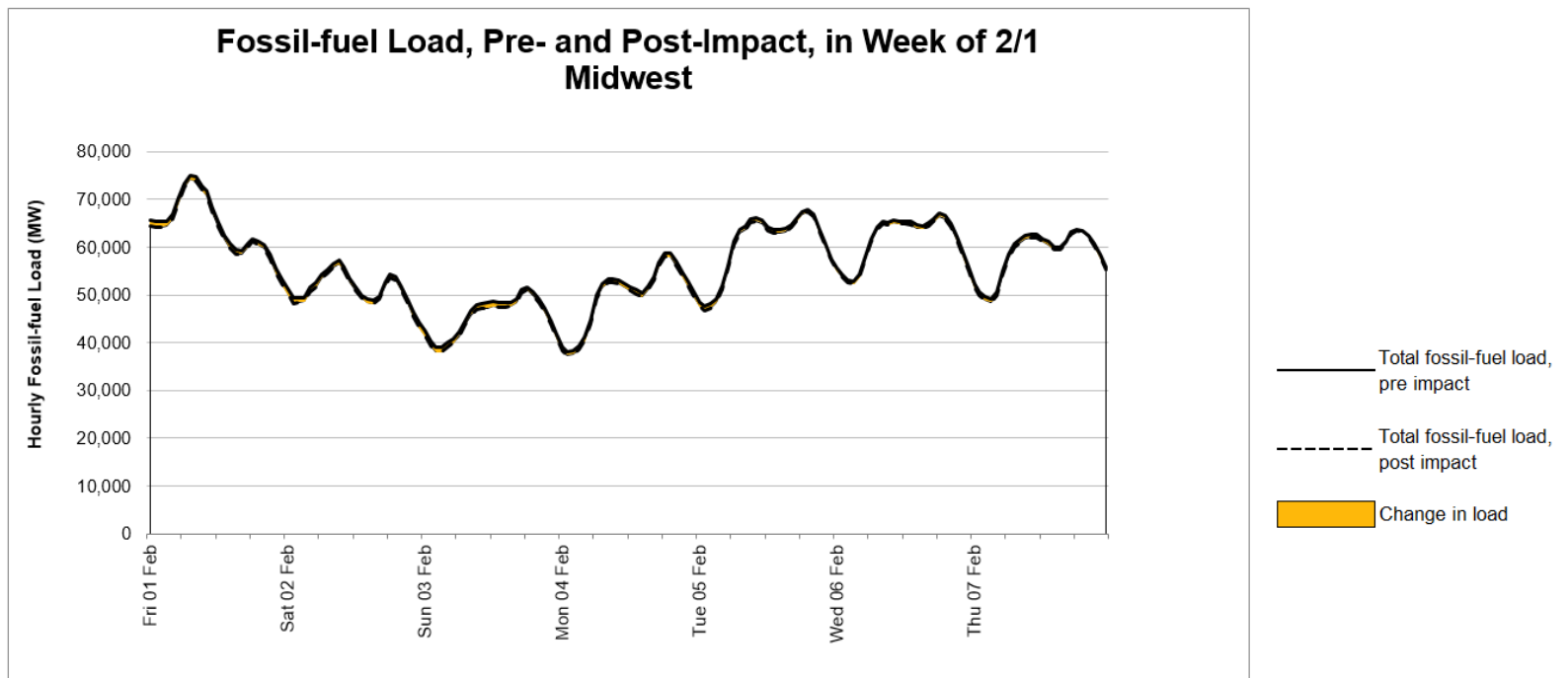


# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Hourly results by week

- The second figure shows the same week-long energy impact profile, but presents the change in generation in reference to the total fossil-fuel load to illustrate the degree of change represented by the energy program relative to the baseline.



# AVERT's Excel-Based Main Module

## Step 4. Display Results

### Signal-to-noise diagnostic

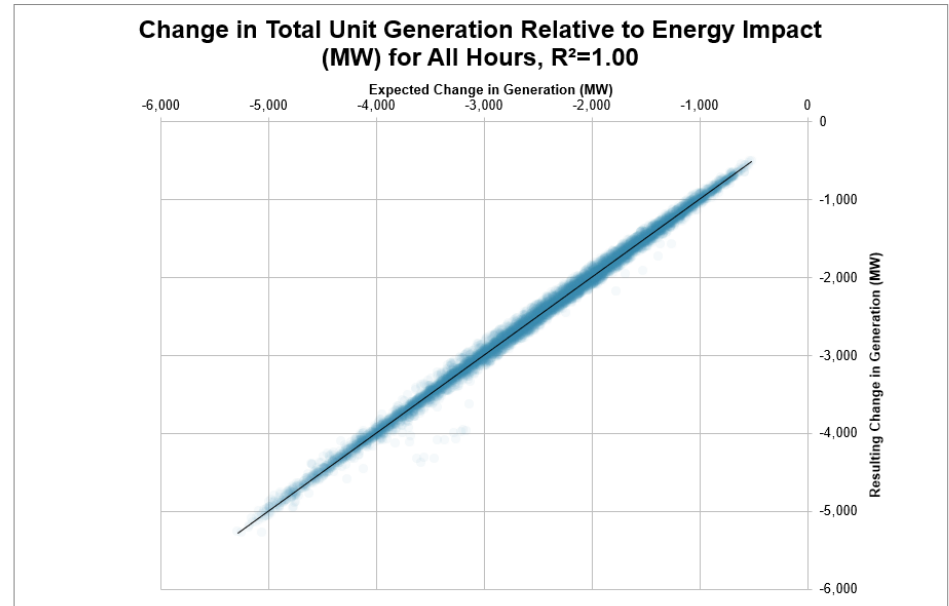
- This chart is a scatterplot of every hour of the year, showing calculated total change in generation in each hour (y-axis) against the user-input change in generation in each hour (x-axis).
- Ideally, AVERT perfectly matches change in unit generation to the amount of energy impacts requested by the user.
- This graphic shows where that assumption holds, where it does not hold, and to what extent.

Midwest, 2019

AVERT

### Output: Signal-to-noise diagnostic

[Click here to return to Step 4: Display Outputs](#)



# AVERT's Excel-Based Main Module

## Step 4. Display Results

### COBRA Output

- AVERT outputs may be used as inputs to EPA's CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool to assess public health implications of the modeled scenario.
- To download a COBRA-formatted file, double-click the blue box to enter a filepath and hit the green button to save a CSV file (example below).
- The file will contain county-level emission impacts for PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, VOCs, and NH<sub>3</sub> and will be ready for upload into COBRA.
- AVERT is only able to generate SMOKE emissions data for the power sector. Vehicle emissions will not be included.

```

1 FIPS, STATE, COUNTY, TIER1NAME, NOx_REDUCTIONS_TONS, SO2_REDUCTIONS_TONS, PM25_REDUCTIONS_TONS
2 01001, Alabama, Autauga County, FUEL COMB. ELEC. UTIL., -1.13, -0.05, -0.765
3 01015, Alabama, Calhoun County, FUEL COMB. ELEC. UTIL., -0.315, -0.005, -0.06
4 01033, Alabama, Colbert County, FUEL COMB. ELEC. UTIL., -3.23, -11.365, -0.13
5 01039, Alabama, Covington County, FUEL COMB. ELEC. UTIL., -0.5, -0.005, -0.09
6 01047, Alabama, Dallas County, FUEL COMB. ELEC. UTIL., -0.11, 0, -0.01
7 01063, Alabama, Greene County, FUEL COMB. ELEC. UTIL., -3.32, -12.685, -0.735
8 01073, Alabama, Jefferson County, FUEL COMB. ELEC. UTIL., -5.835, -8.575, -0.07
9 01081, Alabama, Lee County, FUEL COMB. ELEC. UTIL., -0.455, -0.01, -0.225
10 01085, Alabama, Lowndes County, FUEL COMB. ELEC. UTIL., -0.05, 0, -0.025
11 01097, Alabama, Mobile County, FUEL COMB. ELEC. UTIL., -5.89, -9.695, -0.265
12 01103, Alabama, Morgan County, FUEL COMB. ELEC. UTIL., -0.395, -0.025, -0.15
13 01113, Alabama, Russell County, FUEL COMB. ELEC. UTIL., -3.465, 0, -0.195
14 01117, Alabama, Shelby County, FUEL COMB. ELEC. UTIL., -3.57, -15.625, -0.22
15 01121, Alabama, Talladega County, FUEL COMB. ELEC. UTIL., -0.13, 0, -0.01
16 01123, Alabama, Tallapoosa County, FUEL COMB. ELEC. UTIL., -0.12, -0.01, -0.08
17 01127, Alabama, Walker County, FUEL COMB. ELEC. UTIL., -17.395, -15.505, -0.11
18 01129, Alabama, Washington County, FUEL COMB. ELEC. UTIL., -7.16, -1.605, -0.415
19 05031, Arkansas, Craighead County, FUEL COMB. ELEC. UTIL., -0.105, 0, -0.005
20 05059, Arkansas, Hot Spring County, FUEL COMB. ELEC. UTIL., -2.365, -0.015, -0.28
21 05063, Arkansas, Independence County, FUEL COMB. ELEC. UTIL., -15.845, -39.095, -0.46
22 05069, Arkansas, Jefferson County, FUEL COMB. ELEC. UTIL., -19.94, -42.335, -0.415

```

### COBRA text file generation

Enter a filepath, then click the button to save a COBRA text file.

#### NOTE

Please be patient.  
This calculation may take up to twenty minutes to run on older machines.

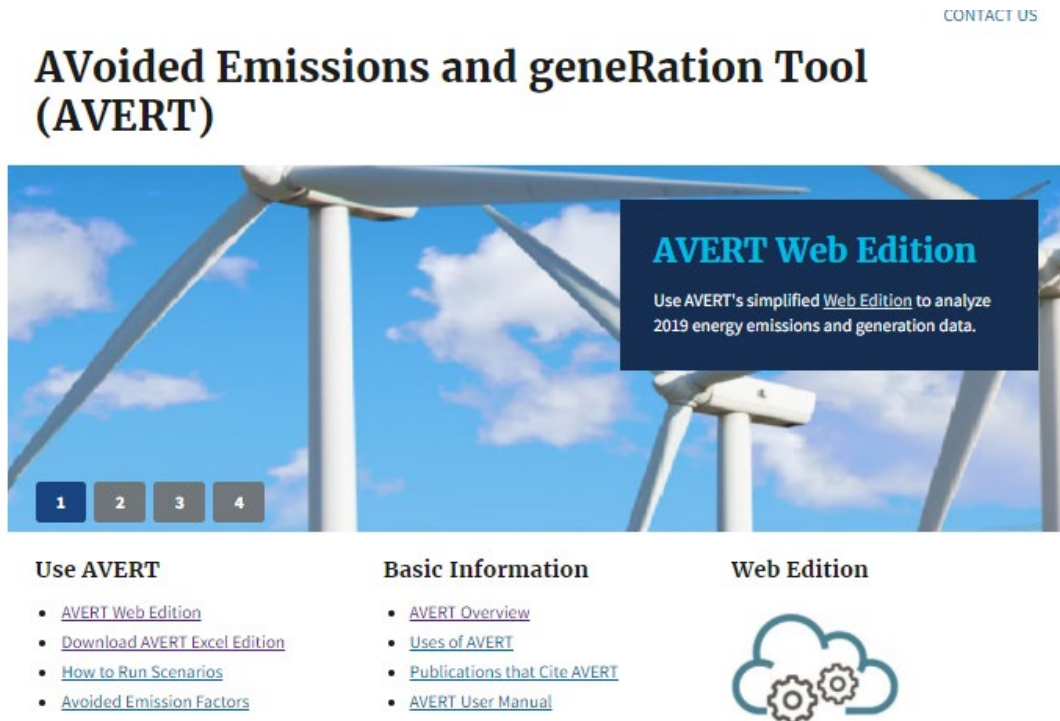
Generate COBRA text files

# For More Information

- Visit the AVERT website at [www.epa.gov/avert](http://www.epa.gov/avert).
- Contact EPA at [avert@epa.gov](mailto:avert@epa.gov).

CONTACT US

## AVoided Emissions and geneRation Tool (AVERT)



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Use AVERT's simplified [Web Edition](#) to analyze 2019 energy emissions and generation data.

1 2 3 4

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