

# AVERT Overview and Step-by-Step Instructions

U.S. Environmental Protection Agency  
State Energy and Environment Program  
Updated May 2019





# Overview of AVERT Development for Energy Efficiency and Renewable Energy (EE/RE) Programs

- AVERT (AVoided Emissions and geneRation Tool) translates the energy impacts of EE/RE policies and programs into emission reductions (PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and CO<sub>2</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 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 at U.S. EPA's International Emissions Inventory Conference 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 factors to support quick analyses and program calculations

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

## Ongoing activities

- Annual data updates
- Enhancements
- Compatibility updates

# Emission Quantification Methods

## Basic to Sophisticated

### Basic Method

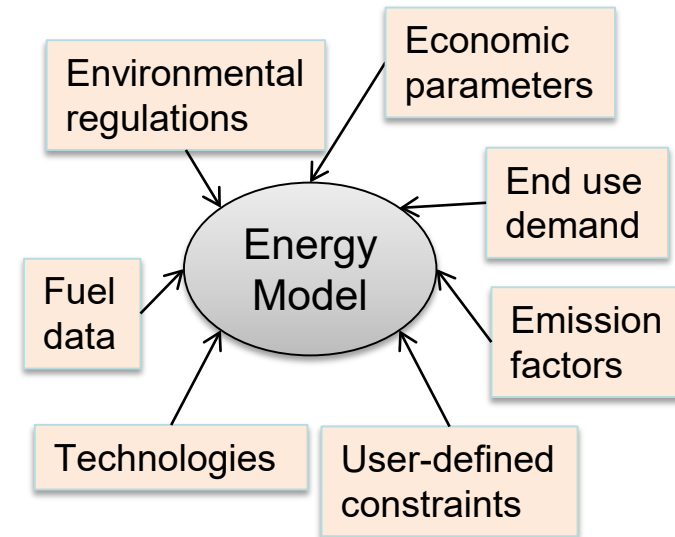
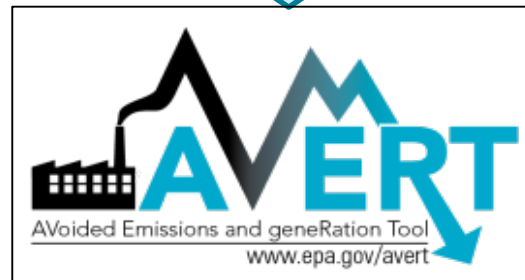
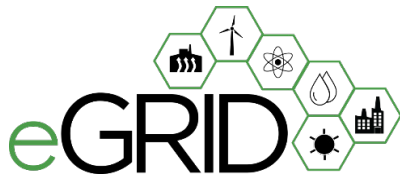
eGRID region non-baseload emission rates

### 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
- Compare emission impacts of varying levels of EE/RE programs, projects, and policies
- Calculate emission reductions in your state or county using AVERT's web-based edition
- Use AVERT-generated emission factors to estimate magnitude of emission reductions without running the tool
  - Four categories include wind, 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

## 90+ citations as of spring 2019

The Clean Air Benefits of Wind Energy

The 2012 American Wind Energy Association



Reports and analyses



Peer-reviewed papers

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

Resource pages and factsheets





# Examples Using AVERT

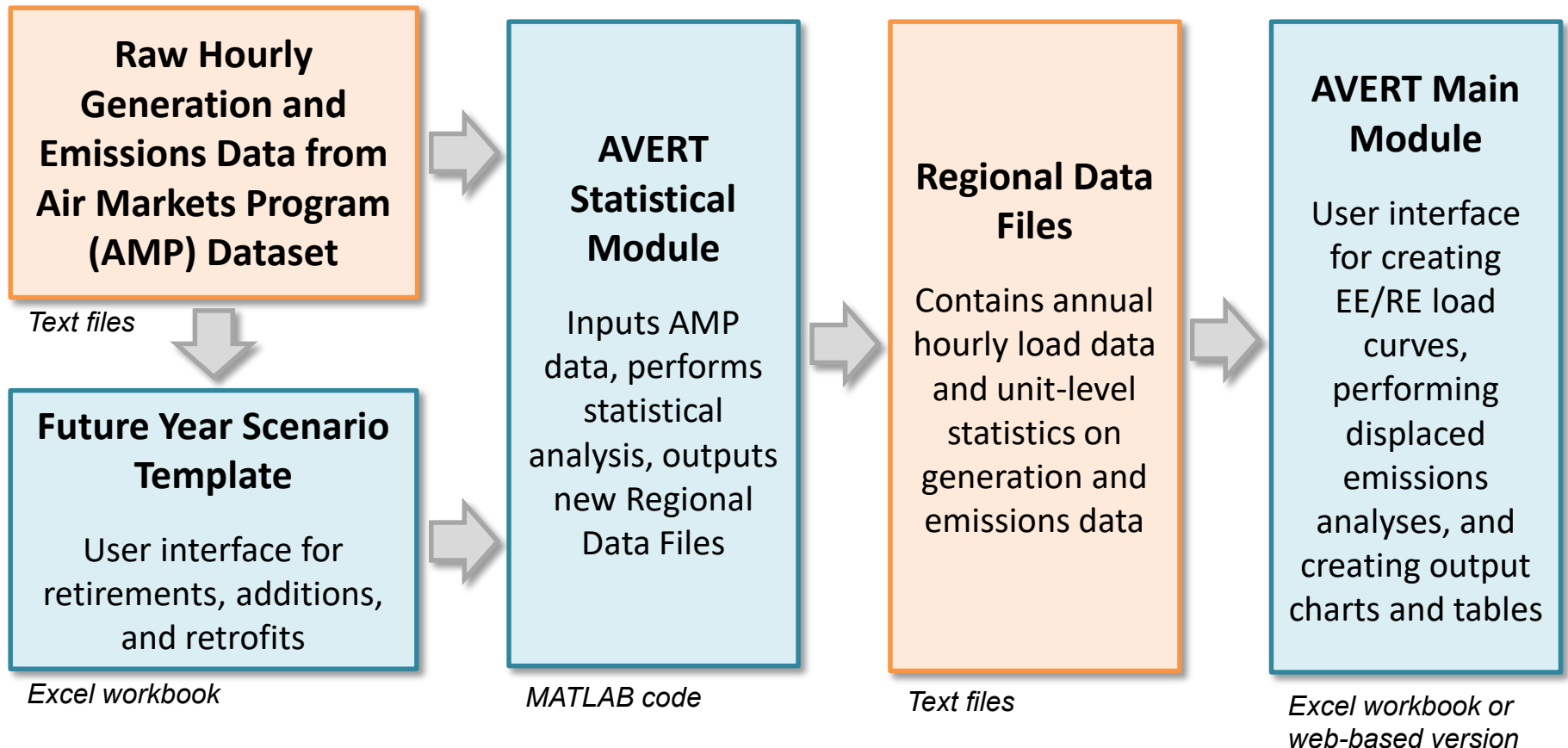
- Maine Distributed Solar Valuation Study ([Maine PUC, March 2015](#))
- CarbonCount™ Green Bonds Scores ([Alliance to Save Energy, March 2015](#))
- Assessing Emission Benefits of Renewable Energy and Energy Efficiency Programs ([U.S. EPA, April 2015](#))
- U.S. EPA's Ozone Advance Program - [Clark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

# How AVERT Works

- AVERT's Main Module simulates the hourly changes in generation and air emissions ( $\text{PM}_{2.5}$ ,  $\text{NO}_x$ ,  $\text{SO}_2$ , and  $\text{CO}_2$ ) at EGU resulting from EE/RE policies and programs.
- User input: MWhs saved from EE programs, or wind and solar generation (MW)
  - Multiple options are built into the tool
  - Users can manually enter hourly data of any EE/RE resource type
- 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 EGU respond to marginal changes in load reduction.
  - AVERT analyzes EGU datasets from EPA's Air Markets and Program Data (hourly, unit-by-unit generation & emissions).
    - Dataset includes EGUs with capacity of 25 MWs or greater.
    - Supplemented with PM<sub>2.5</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.

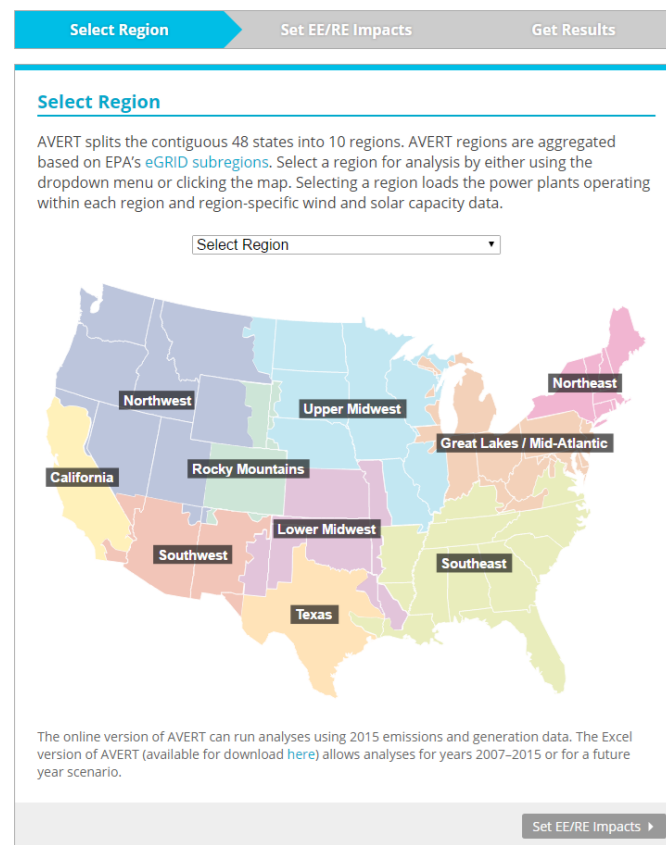
# Part I

## 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 EE/RE program impacts using current year dataset
  - Users can enter standard EE/RE settings
  - Results are shown in graphical form and savable formats

## AVERT Web Edition



The screenshot shows the AVERT Web Edition interface. At the top, there are three tabs: 'Select Region' (highlighted in blue), 'Set EE/RE Impacts', and 'Get Results'. Below the tabs, the 'Select Region' section is active. It contains a heading 'Select Region', a paragraph explaining that AVERT splits the contiguous 48 states into 10 regions based on EPA's eGRID subregions, and a dropdown menu labeled 'Select Region'. Below the dropdown is a map of the United States divided into 10 color-coded regions: California (yellow), Northwest (blue), Southwest (orange), Texas (light orange), Rocky Mountains (green), Lower Midwest (purple), Upper Midwest (light blue), Great Lakes / Mid-Atlantic (brown), Southeast (light green), and Northeast (pink). At the bottom of the interface, there is a 'Set EE/RE Impacts' button.



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

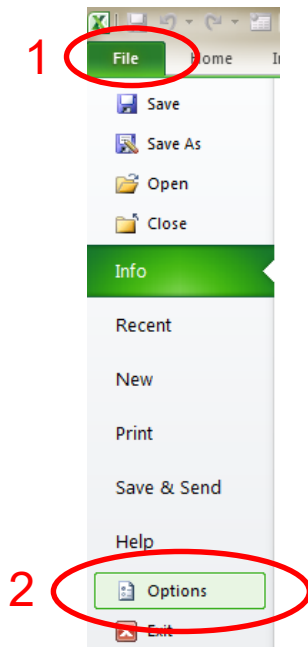
- Enabling Macros
- Using AVERT
- Step 1. Load Regional Data File
- Step 2. Set Energy Efficiency and Renewable Energy Data
- Step 3. Run Displacement
- Step 4. Display Outputs

# AVERT's Excel-Based Main Module Enabling Macros

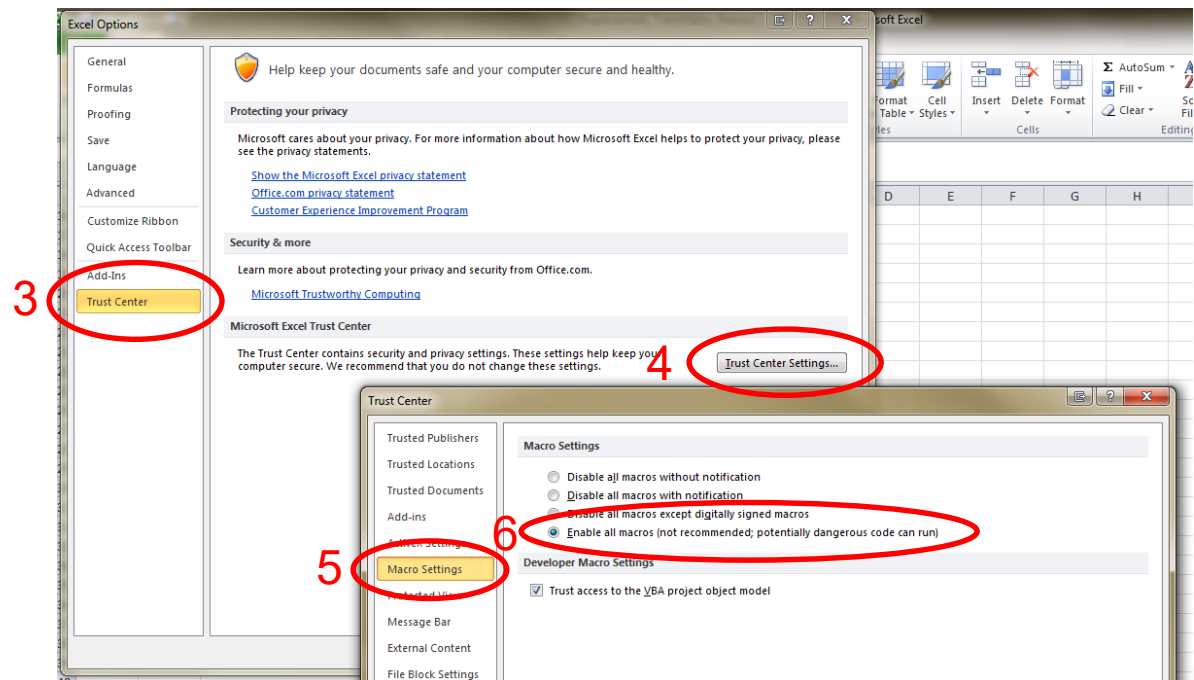
- In Windows, AVERT is compatible with Excel 2007 or newer versions.
- On a Mac, AVERT is compatible with Excel 2011 or newer versions.
  - Only the Main Module has been optimized for Mac. Other components (e.g., the Statistical Module) require Windows.
- You may want to revert to the default macro settings 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**

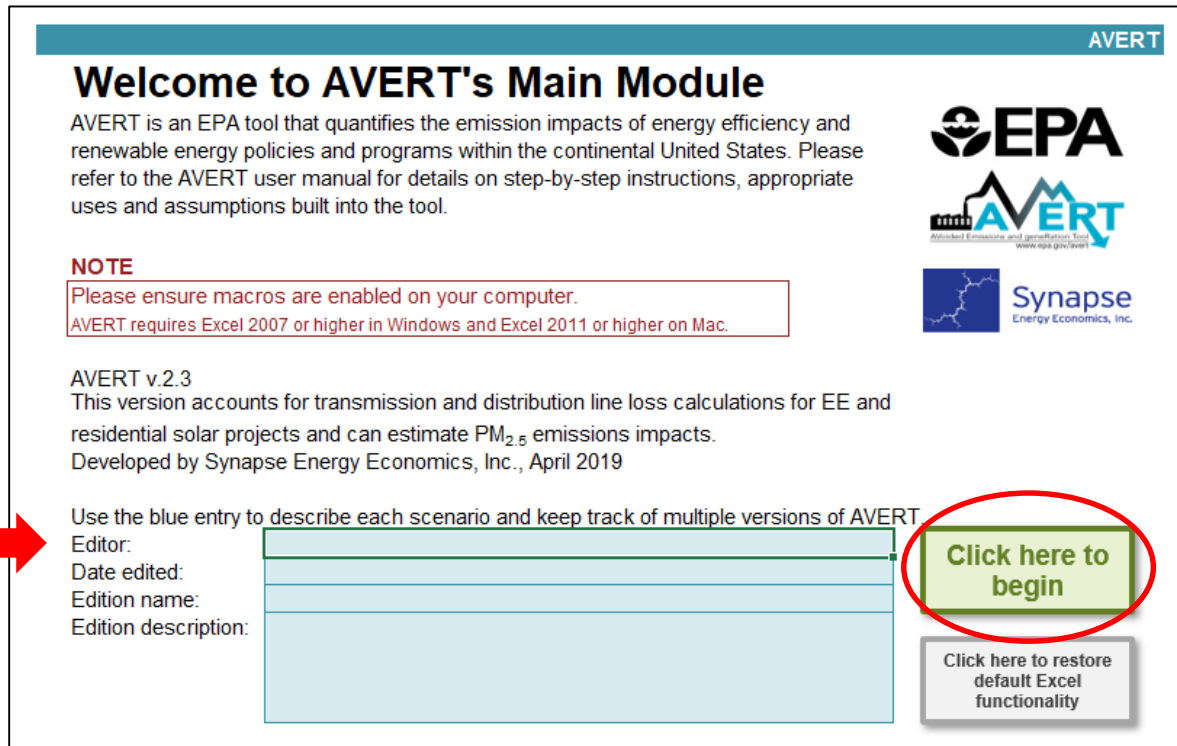


\*If using Excel 2007, click the Microsoft Office Button:

\*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 EE/RE program for which displacements are to be estimated.
- Click on the button labeled “Click here to begin”.



The screenshot shows the AVERT Main Module interface. At the top right, the word "AVERT" is displayed in a teal box. Below this is the heading "Welcome to AVERT's Main Module". The main text describes AVERT as an EPA tool for quantifying emission impacts. To the right of the text are logos for EPA, AVERT, and Synapse Energy Economics, Inc. A red-bordered box contains a "NOTE" about enabling macros. Below the note, the version "AVERT v.2.3" is listed, along with details about its capabilities and development date. A red arrow points to a form with four input fields: "Editor:", "Date edited:", "Edition name:", and "Edition description:". To the right of the form is a green button labeled "Click here to begin" which is circled in red. Below it is a grey button labeled "Click here to restore default Excel functionality".

AVERT

## Welcome to AVERT's Main Module

AVERT is an EPA tool that quantifies the emission impacts of energy efficiency and renewable energy policies and programs within 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 v.2.3  
This version accounts for transmission and distribution line loss calculations for EE and residential solar projects and can estimate PM<sub>2.5</sub> emissions impacts.  
Developed by Synapse Energy Economics, Inc., April 2019

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

Editor:

Date edited:

Edition name:

Edition description:

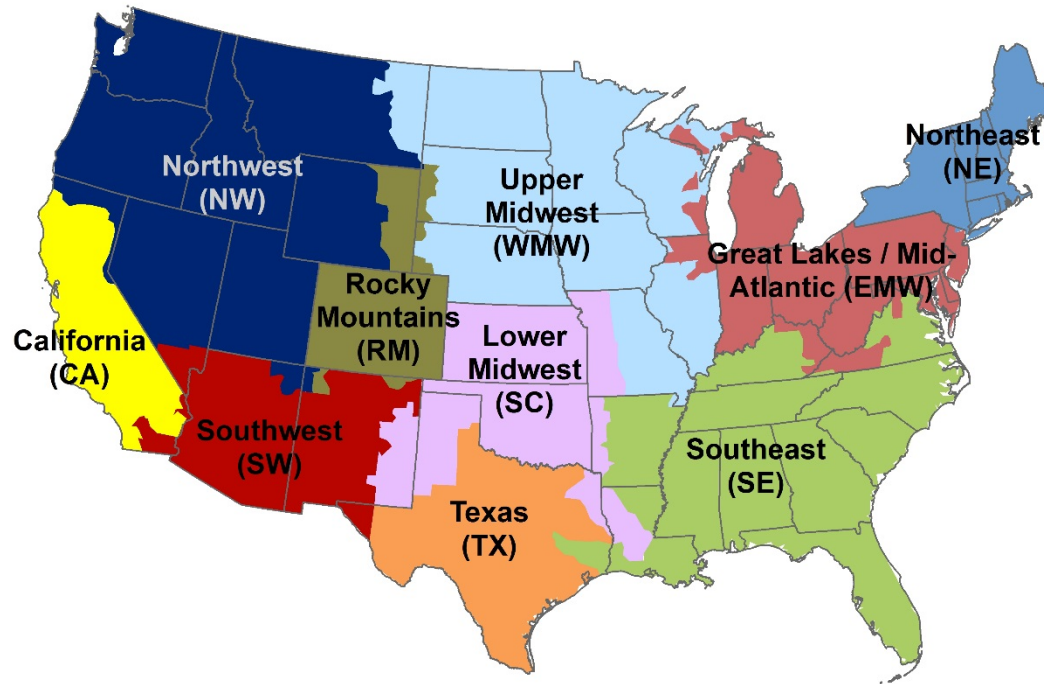
**Click here to begin**

Click here to restore default Excel functionality



# AVERT's Excel-Based Main Module

## Step 1. Load Regional Data File



Regions represent relatively autonomous electricity production zones, and are based on electricity market module regions.

Regions include

- California
- Great Lakes/Mid-Atlantic
- Lower Midwest
- Northeast
- Northwest
- Rocky Mountains
- Southeast
- Southwest
- Texas
- Upper Midwest

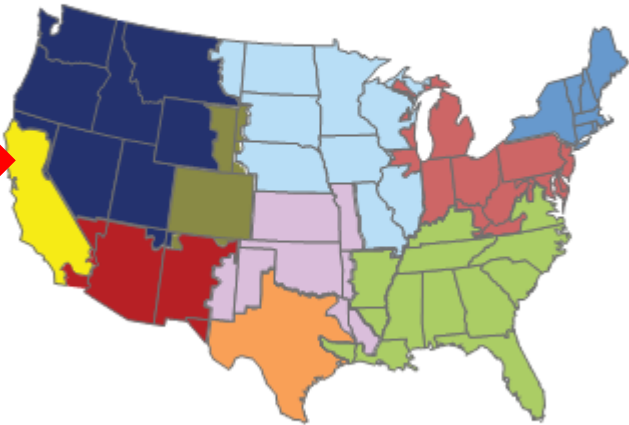
# AVERT's Excel-Based Main Module

## 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.](#)

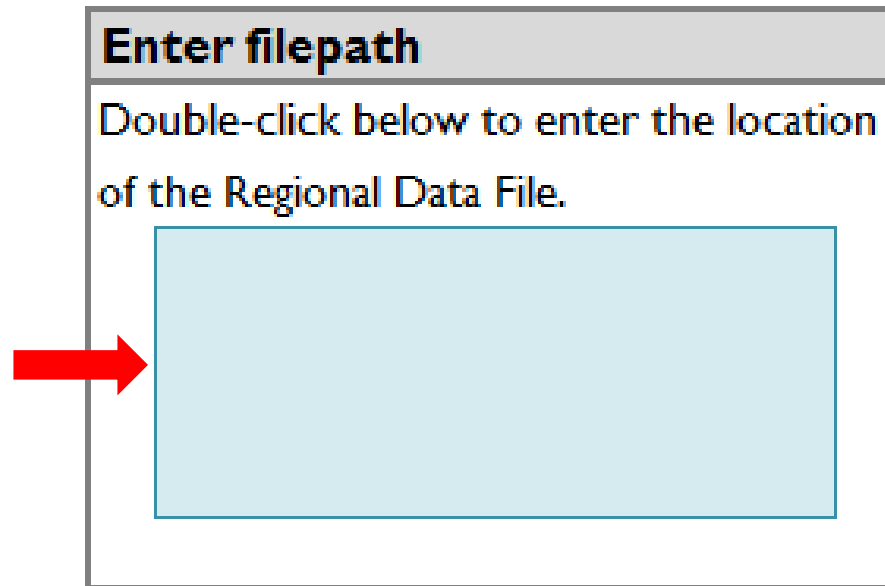
- Selecting a region loads region-specific data for wind and solar capacity factors, and dynamically creates a hyperlink to that region's data on EPA's website.

- 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

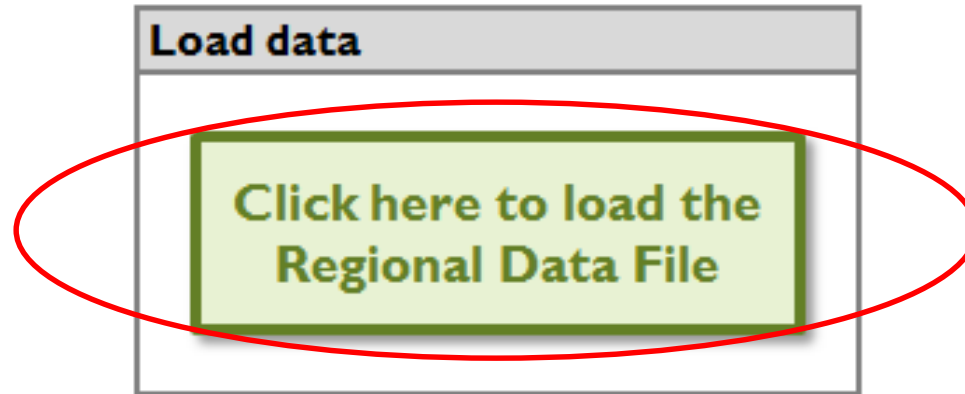
- In the box labeled “Enter filepath,” double-click the blue area to navigate to the location of the downloaded regional data file.



# 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.

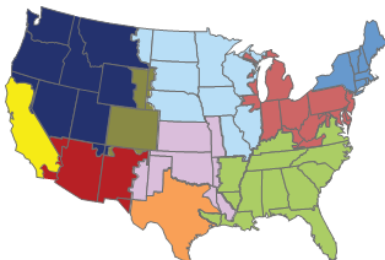
AVERT

### Step 1: Import Regional Data File

**Select region**

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

Southeast



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

**Enter filepath**

Double-click below to enter the filepath of the Regional Data File.

K:\AVERT\_CLELEX\AVERT and data files\regional files\AVERT RDF 2015 (Southeast).xlsx

**Load data**

Click here to download Regional Data File

AVERT

Import complete.

You have loaded the 2015 Southeast (SE) Regional Data File. This region contains 1003 fossil units.

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

- Alabama
- Florida
- Georgia
- North Carolina
- South Carolina
- Tennessee

Generation from the following states is only partially represented in this AVERT region:

- Arkansas (89%)
- Kentucky (91%)
- Louisiana (76%)
- Missouri (21%)
- Mississippi (99%)
- Oklahoma (4%)
- Texas (6%)
- Virginia (95%)
- West Virginia (12%)

Appendix G of the User Manual describes a rule of thumb that users analyzing partially represented states should consider for assessing the impact of EE/RE over multiple AVERT regions. The Southeast (SE) region may include generation from units in states with a representation too small to be considered significant for this analysis.

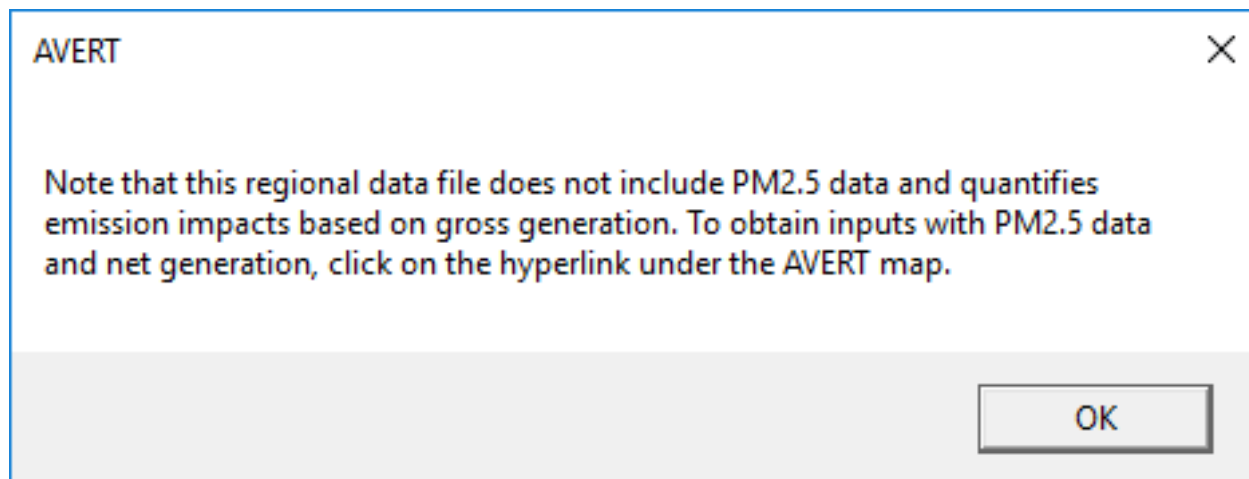
Click the red "Next" button to continue.

OK

# 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 EE and RE Data

- This page leads you through the process of creating a load impact profile depicting the load reductions expected from an EE/RE program.

Upper Midwest, 2012

AVERT

### Step 2: Set Energy Efficiency and Renewable Energy Impacts

**DIRECTIONS:** Enter the EERE load for one or a group of EERE policies and programs. To include the impacts of hourly data manually, click the green button on the right. Each entry is additive and will create a portfolio of EE/RE impacts. For further instructions consult Section 4 of the AVERT user manual.

Enter hourly data manually

#### Enter EE impacts based on the % reduction of regional fossil load

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

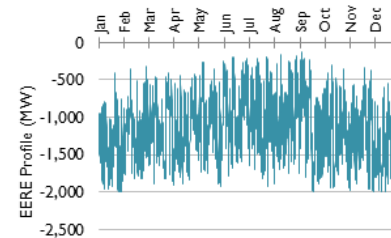
#### And/or enter EE impacts distributed evenly throughout the year

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

Wind Capacity:	2000	MW
Utility Solar PV Capacity:	0	MW
Rooftop Solar PV Capacity:	0	MW

Selected EERE Profile Portfolio:



The currently entered reduction profile equals 10,159 GWh, or 4.1% of regional fossil load.

Welcome

1. Regional Data File

2. Set EERE Profile

3. Run Displacement

4. Display Outputs

Next →

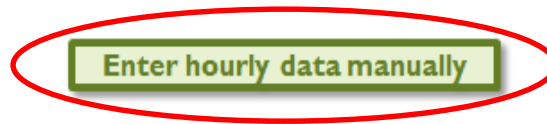
← Back

BaseEPA

# AVERT's Excel-Based Main Module

## Step 2. Set EE and RE Data

- If the hourly load reductions expected from a particular EE/RE policy, program, or measure are known, a manual stream of load reduction values can be entered for every hour of the year by clicking the “Enter hourly data manually” button. Displacements (load reductions) should be entered as positive values.



Northwest, 2017 AVERT

### Manual EERE Data Entry

When complete, click here to return to Step 2: Enter Energy Efficiency and Renewable Energy Data Delete all manual data

Date	Hour	Day of Week	Regional Fossil Load (MW)	Manual EE RE Profile (MW)	Total Change (MW)	Larger than 15%?	Outside of Range?
1/1/2017	1	Sunday	11,878		0		
1/1/2017	2	Sunday	11,839		0		
1/1/2017	3	Sunday	11,777		0		
1/1/2017	4	Sunday	11,466		0		
1/1/2017	5	Sunday	11,421		0		
1/1/2017	6	Sunday	11,742		0		
1/1/2017	7	Sunday	12,469		0		
1/1/2017	8	Sunday	12,662		0		
1/1/2017	9	Sunday	13,375		0		
1/1/2017	10	Sunday	13,297		0		
1/1/2017	11	Sunday	12,881		0		
1/1/2017	12	Sunday	12,796		0		
1/1/2017	13	Sunday	12,647		0		
1/1/2017	14	Sunday	12,576		0		
1/1/2017	15	Sunday	12,340		0		
1/1/2017	16	Sunday	12,493		0		
1/1/2017	17	Sunday	13,518		0		
1/1/2017	18	Sunday	14,657		0		





# AVERT's Excel-Based Main Module

## Step 2. Set EE and RE Data

This page also allows you to estimate a load reduction 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
- Combination of EE/RE programs including combining pre-set options with manual entry

### Enter EE impacts based on the % reduction of regional fossil load

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 impacts 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

Wind Capacity:	2000	MW
Utility Solar PV Capacity:	0	MW
Rooftop Solar PV Capacity:	0	MW

# AVERT's Excel-Based Main Module

## Step 2. Set EE and RE Data

- If you enter an EE/RE program 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.

Upper Midwest, 2011

AVERT

### Step 2: Set Energy Efficiency and Renewable Energy Impacts

**DIRECTIONS:** Enter the EERE load for one or a group of EERE policies and programs.

To include the impacts of hourly data manually, click the green button on the right.

Each entry is additive and will create a portfolio of EE/RE impacts.

For further instructions consult Section 4 of the AVERT user manual.

Enter hourly data manually

#### Enter EE impacts based on the % reduction of regional fossil load

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 impacts 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

Wind Capacity:

6000	MW
------	----

Utility Solar PV Capacity:

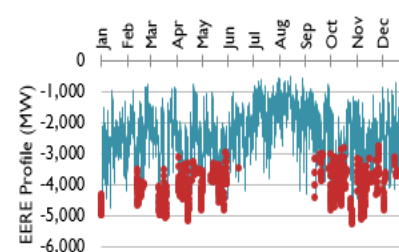
0	MW
---	----

Rooftop Solar PV Capacity:

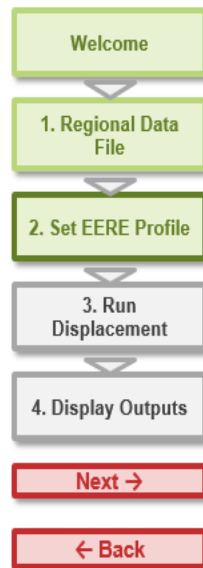
0	MW
---	----

Caution! EERE profile exceeds 15% of fossil load in one or more hours (see below).

Selected EERE Profile Portfolio:



The currently entered reduction profile equals 21,667 GWh, or 8.1% of regional fossil load.



# AVERT's Excel-Based Main Module

## Step 2. Set EE and RE Data

- If you enter an EE/RE program or hourly profile that exceeds the calculable displacement 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 EERE Data Entry page. These cells must be corrected before you may proceed.

Northwest, 2017 AVERT

### Manual EERE Data Entry

When complete, click here to return to Step 2: Enter Energy Efficiency and Renewable Energy Data Delete all manual data

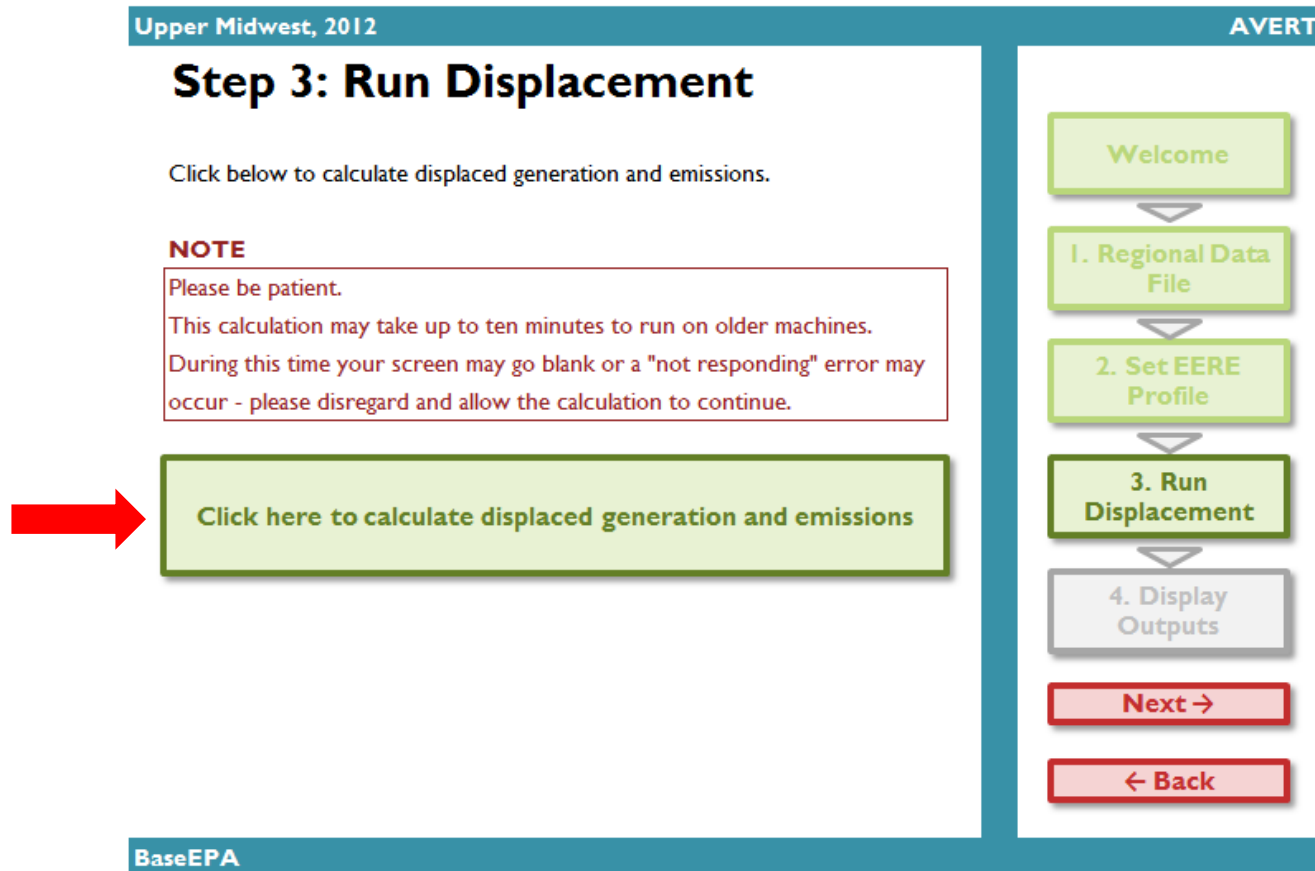
Date	Hour	Day of Week	Regional Fossil Load (MW)	Manual EE RE Profile (MW)	Total Change (MW)	Larger than 15%?	Outside of Range?
8/1/2017	16	Tuesday	19,400		1,044		
8/1/2017	17	Tuesday	19,483		1,044		
8/1/2017	18	Tuesday	19,431		1,044		
8/1/2017	19	Tuesday	19,730		1,044		
8/1/2017	20	Tuesday	19,742		1,044		
8/1/2017	21	Tuesday	19,513		1,044		
8/1/2017	22	Tuesday	18,945		1,044		
8/1/2017	23	Tuesday	18,205		1,044		
8/1/2017	24	Tuesday	17,242		1,044		
8/2/2017	1	Wednesday	16,375		1,044		
8/2/2017	2	Wednesday	15,754		1,044		
8/2/2017	3	Wednesday	15,343		1,044		
8/2/2017	4	Wednesday	15,225		1,044		
8/2/2017	5	Wednesday	15,542		1,044		

*Note: A red box highlights the row for 8/1/2017 at hour 20, where the 'Outside of Range?' column contains the error message: "ERROR: New load is too high, please reduce".*

# AVERT's Excel-Based Main Module

## Step 3. Run Displacement

- Run displacement by selecting the button entitled “Click here to calculate displaced generation and emissions.”



The screenshot shows the AVERT software interface for the "Upper Midwest, 2012" region. The main heading is "Step 3: Run Displacement". Below the heading, there is a instruction: "Click below to calculate displaced generation and emissions." A red arrow points to a large green button with the text "Click here to calculate displaced generation and emissions". To the right of the main content is a vertical navigation menu with buttons for "Welcome", "1. Regional Data File", "2. Set EERE Profile", "3. Run Displacement", "4. Display Outputs", "Next →", and "← Back". The "3. Run Displacement" button is highlighted in green, indicating it is the current step. The "4. Display Outputs" button is greyed out. The "Next" and "Back" buttons are red.

Upper Midwest, 2012

AVERT

### Step 3: Run Displacement

Click below to calculate displaced 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 continue.

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

Welcome

1. Regional Data File

2. Set EERE Profile

3. Run Displacement

4. Display Outputs

Next →

← Back

BaseEPA

# AVERT's Excel-Based Main Module

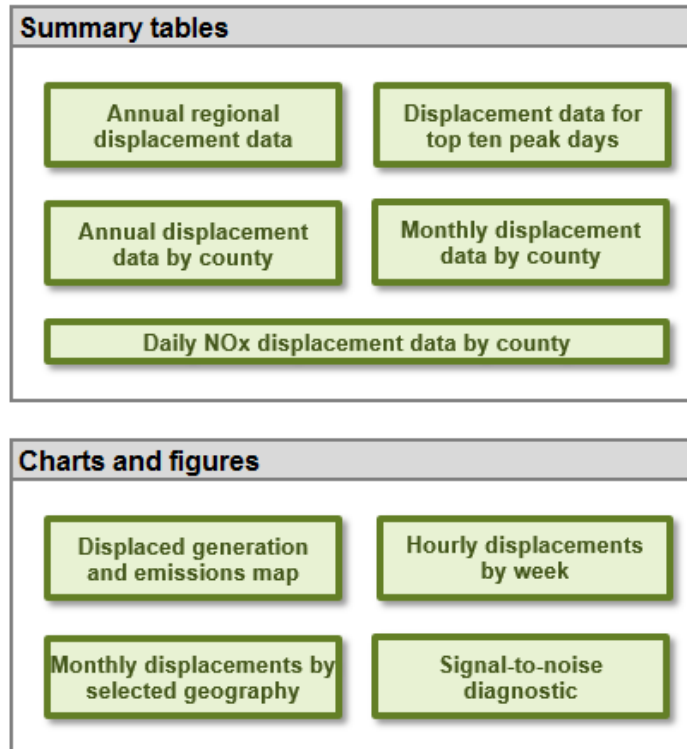
## Step 3. Run Displacement

- This step calculates hourly displaced generation and emissions ( $PM_{2.5}$ ,  $SO_2$ ,  $NO_x$ ,  $CO_2$ ) 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 ten minutes.

# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

- The data generated in Step 3 are aggregated in two groups of charts and tables in Step 4.



# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### *Annual regional displacements*

- 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 EE/RE reduction ("Post-EERE").

Upper Midwest, 2011

AVERT

### Output: Annual Regional Displacements

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

	Original	Post-EERE	Impacts
Generation (MWh)	267,436,050	260,240,200	-7,195,850
<b>Total Emissions from Fossil Generation Fleet</b>			
SO <sub>2</sub> (lbs)	1,301,793,140	1,268,694,580	-33,098,570
NO <sub>x</sub> (lbs)	540,761,980	527,072,950	-13,689,030
CO <sub>2</sub> (tons)	300,935,610	293,707,130	-7,228,480
PM <sub>2.5</sub> (lbs)	43,319,100	42,280,340	-1,038,760
<b>Fossil Generation Fleet Emission Rates</b>			
SO <sub>2</sub> (lbs/MWh)	4.868	4.875	
NO <sub>x</sub> (lbs/MWh)	2.022	2.025	
CO <sub>2</sub> (tons/MWh)	1.125	1.129	
PM <sub>2.5</sub> (lbs/MWh)	0.162	0.162	

*Negative numbers indicate displaced generation and emissions.*

*All results are rounded to the nearest ten. A dash ("—") indicates a result greater than zero, but lower than the level of reportable significance.*

# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### Annual displacement data by county

- This table presents a summary of the displaced generation and 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.

Upper Midwest, 2012

### Output: Annual Displacement Data by County

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

State	County	Peak Gross	Annual Gross	Annual Displaced	Annual Displacement
		Generation, Post-EERE (MW)	Generation, Post-EERE (MWh)		
IA	Allamakee	250	1,152,800	-91,800	-639,700
IA	Appanoose	17	2,700	-600	-5,300
IA	Audubon	125	39,100	-8,800	-
IA	Black Hawk	109	42,300	-8,900	-30,700
IA	Cerro Gordo	522	772,800	-154,400	-600
IA	Clay	30	11,000	-2,300	-21,000
IA	Clinton	143	583,900	-30,500	-195,700
IA	Des Moines	210	1,195,400	-58,200	-438,500
IA	Dubuque	42	91,300	-1,600	-500
IA	Louisa	770	5,304,300	-197,800	-642,500
IA	Marshall	57	32,500	-1,700	-200
IA	Muscatine	262	960,200	-79,200	-353,300
IA	Polk	481	343,100	-59,900	-2,100

For each county, annual output statistics are given for:

- Peak Gross Generation Post-EE/RE
- Annual Gross Generation Post-EE/RE
- Capacity Factor
- Annual Change in Generation
- Annual Change in Heat Input/ $PM_{2.5}/SO_2/NO_x/CO_2$
- Ozone Season Change in  $SO_2/NO_x$
- Ozone Season, 10 Peak Days Change in  $SO_2/NO_x$



# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### *Displacement data 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.

Upper Midwest, 2011

AVERT

### Output: Displacement Data for Top Ten Peak Days

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

Day Rank	Date	Total Fossil Generation (MWh)	Expected Displaced Generation (MWh)	Displaced Generation (MWh)	Displaced NO <sub>x</sub> (lbs)	Displaced SO <sub>2</sub> (lbs)	Displaced CO <sub>2</sub> (Tons)	Displaced PM <sub>2.5</sub> (lbs)
1	Jul 18	1,048,930	-13,490	-13,860	-39,530	-17,890	-8,730	-1,770
2	Jul 19	1,039,940	-17,190	-17,270	-61,370	-25,000	-13,150	-2,440
3	Jul 21	1,024,750	-15,770	-15,820	-58,630	-23,210	-13,000	-2,350
4	Jul 20	1,018,680	-16,810	-16,810	-57,920	-22,360	-13,410	-2,590
5	Jul 22	1,003,160	-12,930	-13,030	-44,900	-17,970	-10,620	-1,960
6	Aug 02	993,440	-12,690	-12,700	-46,380	-18,640	-10,370	-1,860
7	Aug 01	988,190	-12,610	-12,650	-46,790	-19,670	-10,530	-1,880
8	Aug 03	983,760	-12,070	-12,110	-34,960	-14,660	-9,550	-1,830
9	Jul 28	979,210	-10,310	-10,290	-36,970	-15,170	-8,330	-1,440
10	Jul 29	975,520	-8,010	-8,130	-25,300	-10,340	-6,580	-1,210

*Negative numbers indicate displaced generation and emissions.*

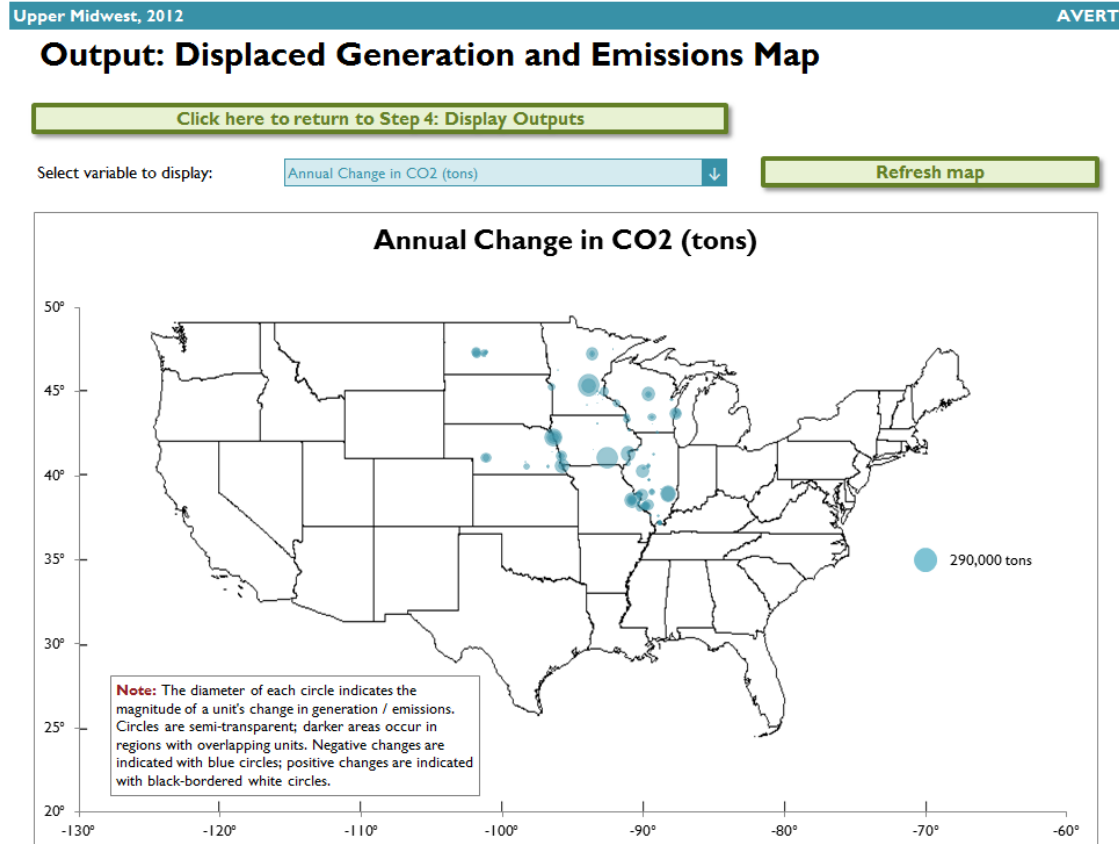
*All results are rounded to the nearest ten. A dash ("—") indicates a result greater than zero, but lower than the level of reportable significance.*

# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### *Displaced generation and emissions map*

- This dynamic map allows the user to view where emissions have been displaced within the selected region. 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>.



# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### Displacement data 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.

Upper Midwest, 2011

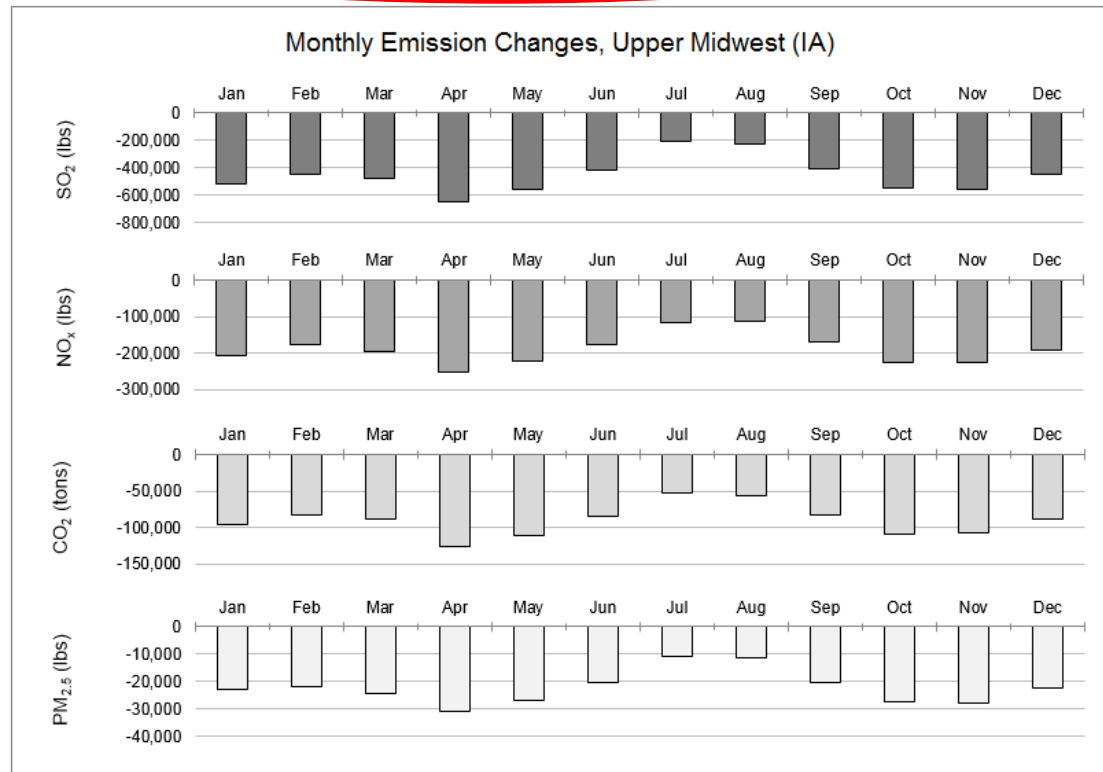
AVERT

### Output: Monthly Displacements by Selected Geography

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

Select level of aggregation:  
Select state:

State  
IA

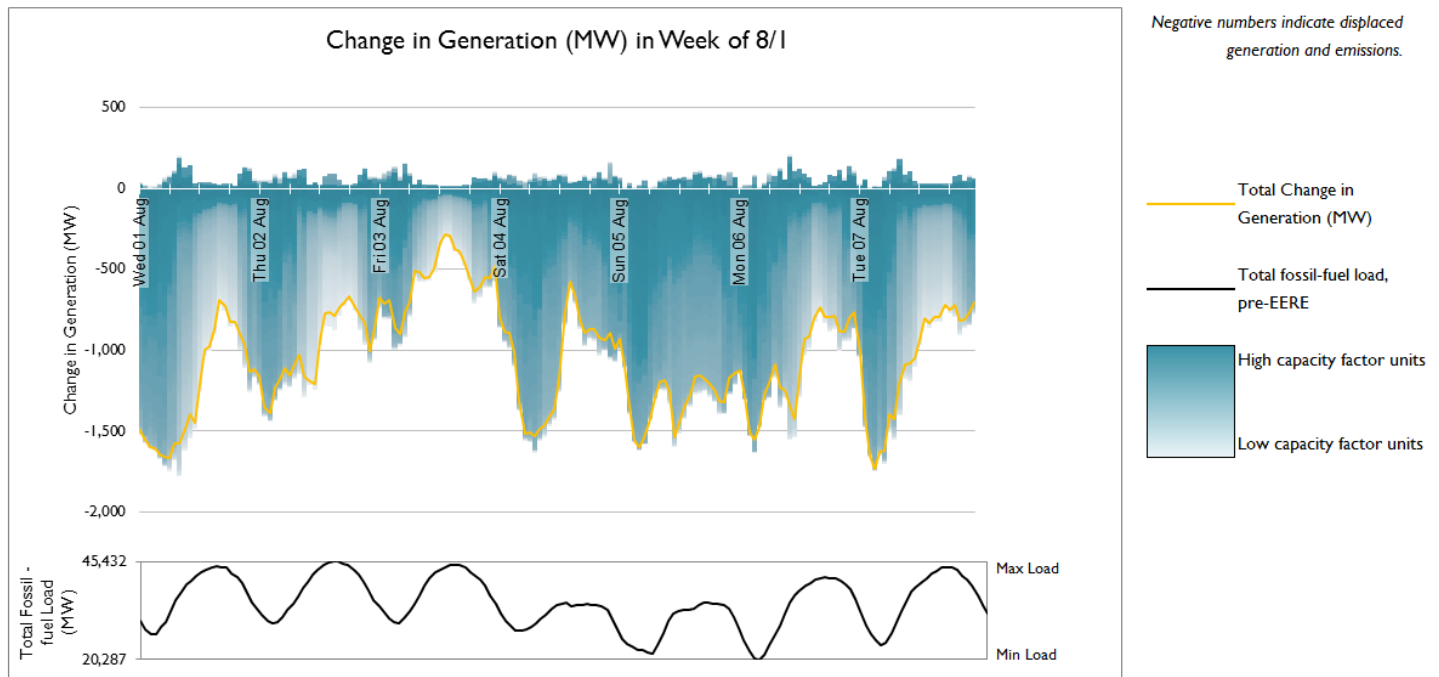


# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### Hourly displacements by week

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

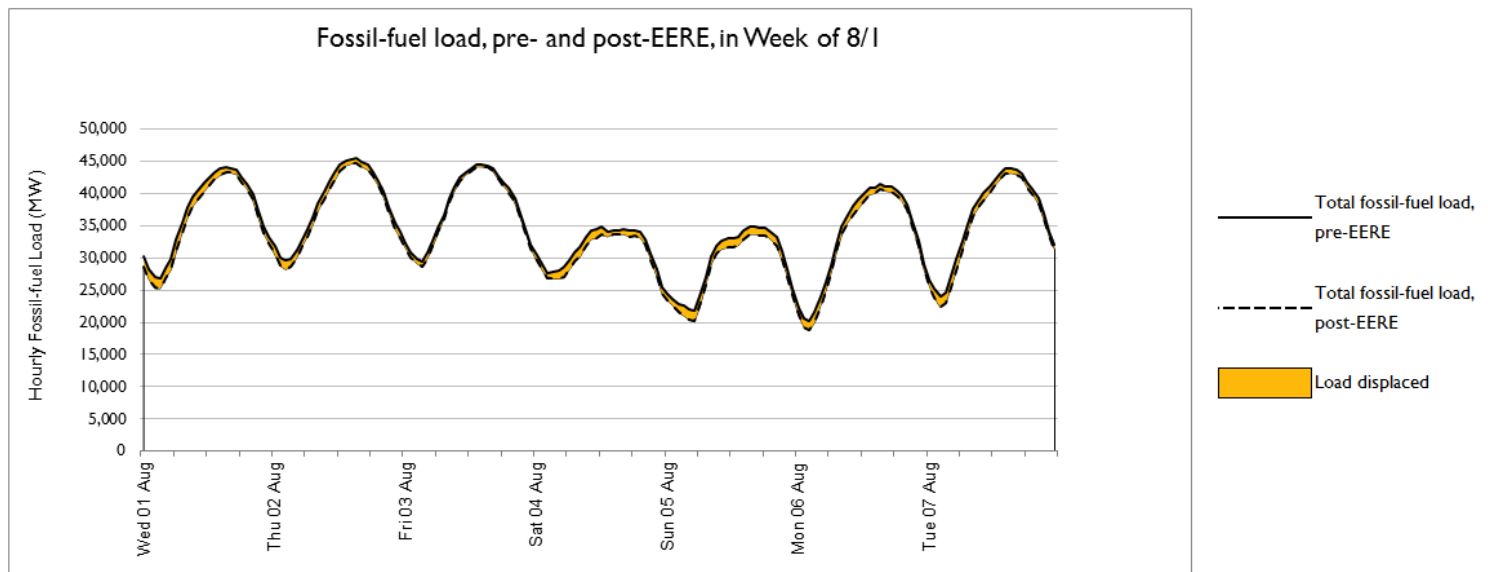


# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### *Hourly displacements by week*

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



# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### Signal-to-noise diagnostic

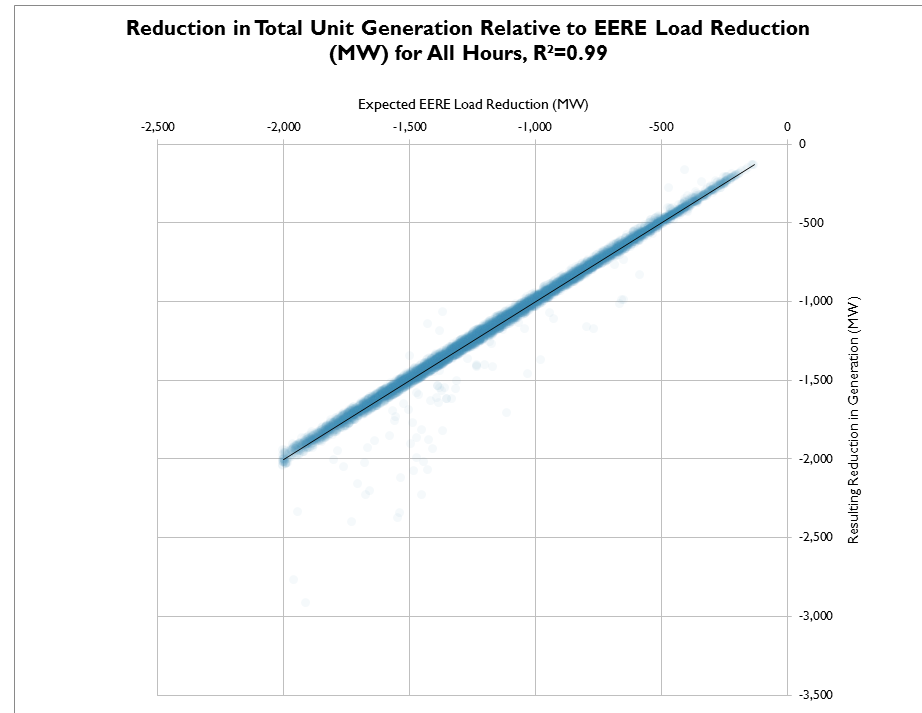
- This chart is a scatterplot of every hour of the year, showing calculated total generation reduction in each hour (y-axis) against the user-input EE/RE load reduction in each hour (x-axis).
- Ideally, AVERT perfectly matches unit generation reductions to the amount of EE/RE load reduction requested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

Upper Midwest, 2012

AVERT

### Output: Signal-to-noise diagnostic

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



# AVERT's Excel-Based Main Module

## Step 4. Display Outputs

### 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 EE/RE public health implications
- 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>, and NO<sub>x</sub>, and will be ready for upload into COBRA

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
23	05093,Arkansas,Mississippi County,FUEL COMB. ELEC. UTIL.,-0.755,-1.515,-0.035

**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**

# Part II

## AVERT Statistical Module Operation





# AVERT Statistical Module Overview

- Purpose
  - Basis of AVERT analysis
  - Processes raw CAMD data to determine behavioral characteristics of fossil-fired EGU
  - Returns expected generation and emissions behavior to AVERT Main Module
  - Allows users to alter EGU characteristics, retire and add EGU with Future Year Template
- Advanced use of AVERT
  - Most users will not require the Statistical Module
  - Based in MATLAB
  - Executable version available for public use
  - Requires MATLAB Compiler Runtime (MCR) to be installed (free from Mathworks) **R2012b (8.0)**.
  - Requires Windows
- Output file can be used directly in Main Module

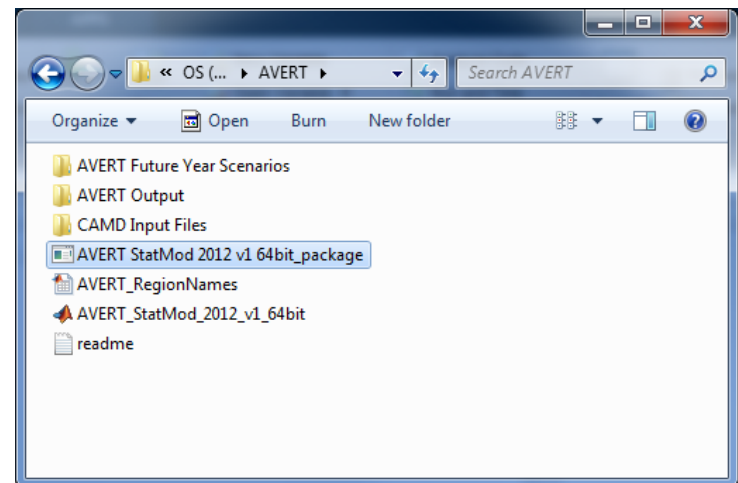
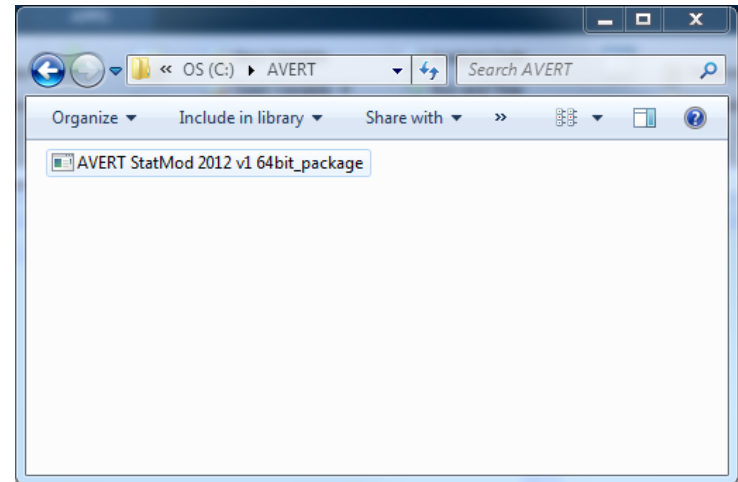
# AVERT Statistical Module

## Obtain Correct Version

- AVERT Statistical Module requires is sensitive to PC specifications.
- Requires 64-bit operating system.
- Obtain correct version of MCR from Mathworks:  
**R2012b (8.0).**
  - **Use the exact version noted on the AVERT website and in the user guide. An older or newer version will give you an error when you try to run the analysis.**
- Determine if your Windows system operates in a 32-bit or 64-bit environment.
  - Find this information in “properties” of “My Computer” in Windows XP, or “Computer” in Windows Vista, Windows 7, or Windows 8.
  - Follow these instructions:  
<https://support.microsoft.com/en-us/help/15056/windows-7-32-64-bit-faq>.

# AVERT Statistical Module Unpacking and Startup

- Download the AVERT Statistical Module package.
- Run the executable to decompress the package to three files and three subfolders.



To obtain historical base years, visit <https://www.epa.gov/statelocalenergy/download-avert> and obtain both the CAMD input file and the Future Year Scenario Template for that same year.

# AVERT Statistical Module File Structure

- **AVERT Future Year Scenarios**

- Excel-based input files for altering EGU

- **AVERT Output**

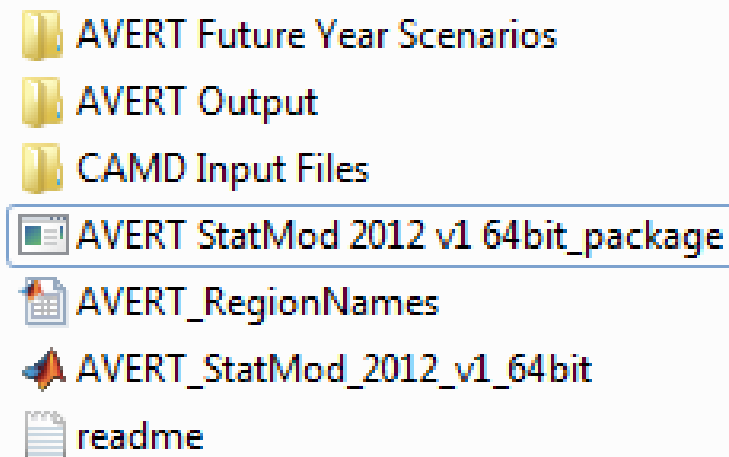
- Statistical Module output files
- These become Main Module input files

- **CAMD Input Files**

- Processed CAMD data files
- New versions expected 2<sup>nd</sup> quarter annually

- **AVERT\_StatMod\_2012\_v1\_64bit**

- Executable

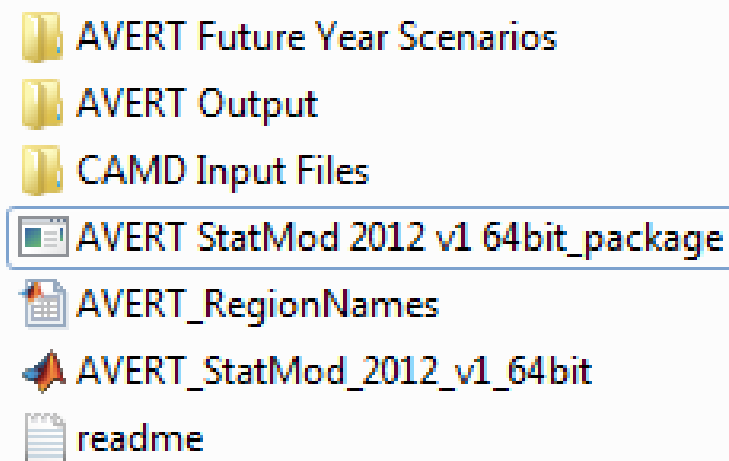


# Obtaining Other Base Years

To obtain additional historical base year data, visit:

<https://www.epa.gov/statelocalenergy/download-avert>.

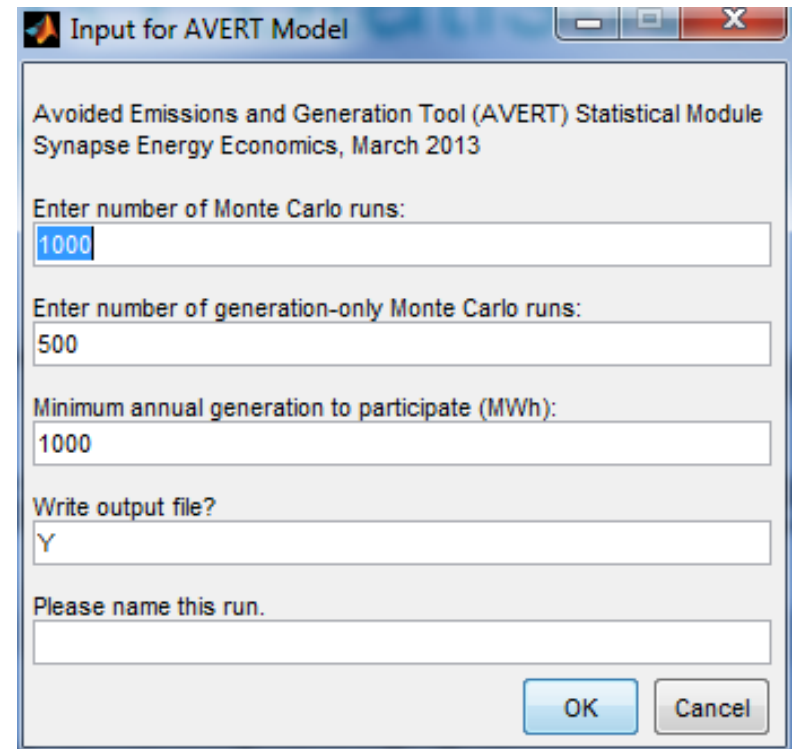
- Download AVERT Future Year Scenario for the same historical base year.
  - Place the file in “AVERT Future Year Scenarios”
- Download the CAMD input file for the historical base year.
  - Place the file in “CAMD Input Files”



# AVERT Statistical Module

## Input Parameters

- Higher number of Monte Carlo (MC) runs reduces noise.
  - For test runs, use a low number of MC runs (10) and generation-only MC runs (5).
  - For final runs, use a high number of MC runs (1,000) and generation-only MC runs (500).
- Select “Y” to write output and save runs.



Input for AVERT Model

Avoided Emissions and Generation Tool (AVERT) Statistical Module  
Synapse Energy Economics, March 2013

Enter number of Monte Carlo runs:  
1000

Enter number of generation-only Monte Carlo runs:  
500

Minimum annual generation to participate (MWh):  
1000

Write output file?  
Y

Please name this run.  
[Empty text box]

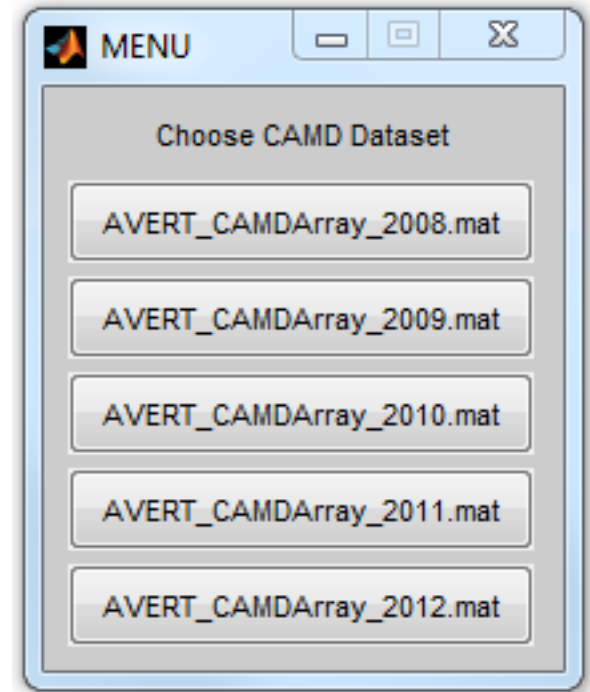
OK Cancel

*Use letters and numbers only.  
No special characters and no spaces.*

# AVERT Statistical Module

## Choose Data File

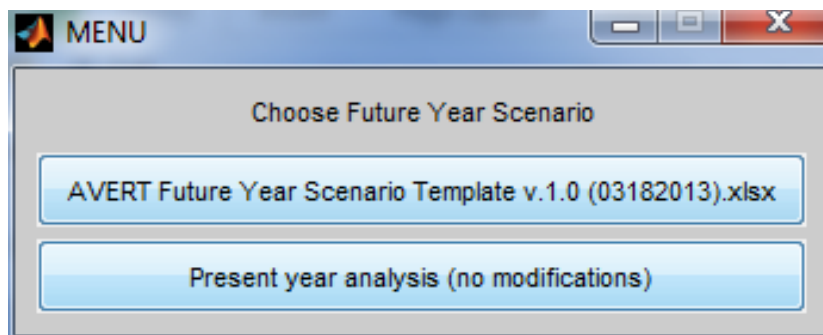
- Choose base year for analysis.
  - Data from 2007 through 2018 are available.
  - New data will be ready by the second quarter of the next year.
    - Requires data to be vetted by EPA and post-processed.



# AVERT Statistical Module

## Choose Future Year Scenario

- Select either
  - Saved future year scenario
  - Present year analysis



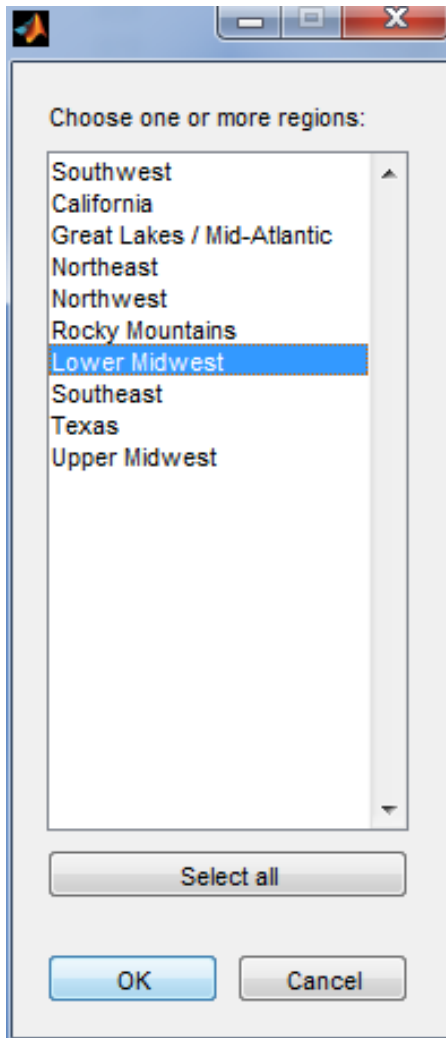
Present year analysis makes no modifications to the AVERT dataset.

- Uses EGU that exist in data year
- No changes in emissions rates

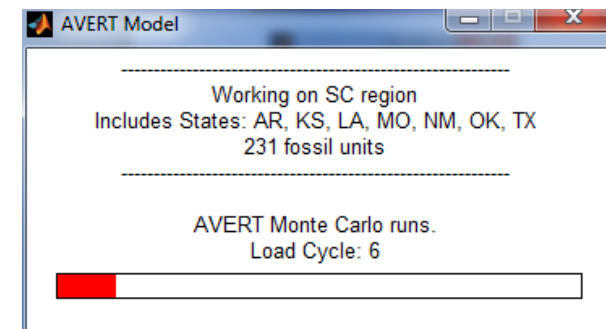


# AVERT Statistical Module

## Choose Region(s) of Interest



- Choose region (or multiple regions) of interest.
- Same regions as in AVERT Main Module
- Once you hit “OK”, the program will run uninterrupted until completion.
  - Program returns updated run status on a regular basis.
  - Output graphic and file indicate successful completion.



# Part III

## AVERT Future Year Scenario Template



# AVERT Future Year Scenario Overview

- Purpose
  - AVERT is not forward-looking: cannot predict EGU retirements, new additions, or emissions modifications.
  - Future Year Scenarios allow users to
    - Remove EGU from analysis.
    - Include additional proxy EGU.
    - Modify emissions characteristics.
- Advanced use of AVERT
  - Excel spreadsheet
  - Read into AVERT Statistical Module
- Each spreadsheet becomes a scenario.
  - Spreadsheet becomes input file for AVERT Statistical Module.
  - Each future year scenario template is specifically designed to match the same historical base year.

# Use AVERT Future Year Scenario in Statistical Module

- Obtain Future Year Scenario Template (slides 42-45).
- Modify Future Year Scenario Template (slides 53-55).
- Save Future Year Scenario Template with a meaningful name.
- Run Statistical Module (slides 46-49).
  - Provide a unique name for the statistical module run (slide 46).
  - Choose saved future year scenario (slide 48).

# AVERT Future Year Scenario Retires and Modifications



Retiring Units / Emission Modifications													
Enter an option manually in blue cells													
Facility Name	ORSPL UnitID	Retire?	Retire (binary)	Revise Emissions Rates?	Revise (binary)	Revised SO2 Rate (lbs/MWh)	Revised NOx Rate (lbs/MWh)	Revised CO2 Rate (Tons/MWh)	Revised PM2.5 Rate (Tons/MMBTU)	AVERT Region	capacity	unit type	CF
Healy Power Plant	6288	1	No	0	No	0	0.000	0.000	0.000	0.000	0	0 Coal	0%
Healy Power Plant	6288	2	No	0	No	0	0.000	0.000	0.000	0.000	0	0 Other	0%
AMEA Sylacauga Plant	56018	1	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	49 Gas	6%
AMEA Sylacauga Plant	56018	2	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	49 Gas	5%
Ascend (Decatur Plant)	880041	X015	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	0 Coal	0%
Ascend (Decatur Plant)	880041	Z005	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	0 Coal	0%
Ascend (Decatur Plant)	880041	Z006	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	0 Coal	0%
Barry	3	1	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	58 Gas	2%
Barry	3	2	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	56 Gas	2%
Barry	3	4	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	354 Coal	36%
Barry	3	5	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	791 Coal	46%
Barry	3	6A	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	291 Gas	83%
Barry	3	6B	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	288 Gas	78%
Barry	3	7A	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	288 Gas	82%
Barry	3	7B	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	288 Gas	83%
Calhoun Energy Center	55409	CT1	Yes	1	No	0	0.000	0.000	0.000	0.000	Southeast	163 Gas	4%
Calhoun Energy Center	55409	CT2	Yes	1	No	0	0.000	0.000	0.000	0.000	Southeast	164 Gas	2%
Calhoun Energy Center	55409	CT3	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	165 Gas	3%
Calhoun Energy Center	55409	CT4	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	161 Gas	5%
Charles R Lowman	56	1	No	0	Yes	1	1.000	1.000	1.000	1.000	Southeast	80 Coal	3%
Charles R Lowman	56	2	No	0	Yes	1	1.000	1.000	1.000	1.000	Southeast	239 Coal	30%
Charles R Lowman	56	3	No	0	Yes	1	1.000	1.000	1.000	1.000	Southeast	241 Coal	43%
Colbert	47	1	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	170 Coal	16%
Colbert	47	2	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	156 Coal	17%
Colbert	47	3	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	164 Coal	11%
Colbert	47	4	No	0	No	0	0.000	0.000	0.000	0.000	Southeast	163 Coal	9%

- Find EGU of interest, or filter by state or region.
- To retire, select “Yes” in the “Retire?” column.
- To change emissions rate, select “Yes” in the “Revise Emissions Rates?” column and enter new rate(s) in columns I, J, K, or L.



# AVERT Future Year Scenario Additions

AVERT Future Year Scenario Template v.1.0 (03182013) - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View PDF Acrobat

J7 250

Additions													Dropdown builder (fill down this section with e				
#	Region	Fuel Type	Unit Type	Unit	ORSPL	UNIT ID	Description <small>(Note that "0 MW" units did not run in 2011.)</small>	Capacity (MW)	State	County	Lat - County	Lon - County	Region Ref 1	Region Ref 2	Fuel Select Range	Fuel Ref 1	Fuel Ref 2
1	SC	Gas	CC	Redbud Power Plant CT-01	55463	CT-01	This is a 332 MW unit. It is located in Oklahoma County, OK. In 2011, it ran for 1155 GWh at a capacity factor of 40%.	250	OK	Oklahoma	35.510	-97.497	2599	282	Dropdowns\G2 599-G2880	2665	2878
2	SC	Gas	CC	Redbud Power Plant CT-02	55463	CT-02	This is a 328 MW unit. It is located in Oklahoma County, OK. In 2011, it ran for 1267 GWh at a capacity factor of 44%.	250	OK	Oklahoma	35.510	-97.497	2599	282	Dropdowns\G2 599-G2880	2665	2878
3	SC	Gas	CC	Mustang Station 1	55065	1	This is a 243 MW unit. It is located in Yoakum County, TX. In 2011, it ran for 1297 GWh at a capacity factor of 61%.	250	TX	Potter	35.257	-101.842	2599	282	Dropdowns\G2 599-G2880	2665	2878
4	SC	Gas	CT	John Twitty Energy Center CT2A	6195	CT2A	This is a 28 MW unit. It is located in Greene County, MO. In 2011, it ran for 1 GWh at a capacity factor of 0%.	35	OK	Tulsa	36.125	-95.939	2599	282	Dropdowns\G2 599-G2880	2665	2878
5	SC	Gas	CT	John Twitty Energy Center CT1B	6195	CT1B	This is a 24 MW unit. It is located in Greene County, MO. In 2011, it ran for 1 GWh at a capacity factor of 0%.	35	OK	Tulsa	36.125	-95.939	2599	282	Dropdowns\G2 599-G2880	2665	2878
6	SC	Gas	CT	West Gardner Generating Station 1	7929	1	This is a 81 MW unit. It is located in Johnson County, KS. In 2011, it ran for 15 GWh at a capacity factor of 2%.	75	KS	Labette	37.216	-95.259	2599	282	Dropdowns\G2 599-G2880	2665	2878
7	SC	Gas	CT	West Gardner Generating Station 2	7929	2	This is a 71 MW unit. It is located in Johnson County, KS. In 2011, it ran for 14 GWh at a capacity factor of 2%.	75	KS	Labette	37.216	-95.259	2599	282	Dropdowns\G2 599-G2880	2665	2878
8					0	#N/A	#N/A				#N/A	#N/A	#N/A	0	#N/A	#N/A	#N/A

Retires\_Modifications Additions EPA\_Facilities EPA\_AMP eGRID PLNT09 CapacityGen

Ready 85%

## In order

1. Select region
2. Select fuel type
3. Select generator type

4. Select specific EGU (unit)

Description will appear about EGU type automatically.

# AVERT Future Year Scenario Additions

AVERT Future Year Scenario Template v.1.0 (03182013) - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View PDF Acrobat

J7 250

Additions													Dropdown builder (fill down this section with e				
#	Region	Fuel Type	Unit Type	Unit	ORSPL	UNIT ID	Description <small>(Note that "0 MW" units did not run in 2011.)</small>	Capacity (MW)	State	County	Lat - County	Lon - County	Region Ref 1	Region Ref 2	Fuel Select Range	Fuel Ref 1	Fuel Ref 2
1	SC	Gas	CC	Redbud Power Plant CT-01	55463	CT-01	This is a 332 MW unit. It is located in Oklahoma County, OK. In 2011, it ran for 1155 GWh at a capacity factor of 40%.	250	OK	Oklahoma	35.510	-97.497	2599	282	Dropdowns\G2 599-G2880	2665	2878
2	SC	Gas	CC	Redbud Power Plant CT-02	55463	CT-02	This is a 328 MW unit. It is located in Oklahoma County, OK. In 2011, it ran for 1267 GWh at a capacity factor of 44%.	250	OK	Oklahoma	35.510	-97.497	2599	282	Dropdowns\G2 599-G2880	2665	2878
3	SC	Gas	CC	Mustang Station 1	55065	1	This is a 243 MW unit. It is located in Yoakum County, TX. In 2011, it ran for 1297 GWh at a capacity factor of 61%.	250	TX	Potter	35.257	-101.842	2599	282	Dropdowns\G2 599-G2880	2665	2878
4	SC	Gas	CT	John Twitty Energy Center CT2A	6195	CT2A	This is a 28 MW unit. It is located in Greene County, MO. In 2011, it ran for 1 GWh at a capacity factor of 0%.	35	OK	Tulsa	36.125	-95.939	2599	282	Dropdowns\G2 599-G2880	2665	2878
5	SC	Gas	CT	John Twitty Energy Center CT1B	6195	CT1B	This is a 24 MW unit. It is located in Greene County, MO. In 2011, it ran for 1 GWh at a capacity factor of 0%.	35	OK	Tulsa	36.125	-95.939	2599	282	Dropdowns\G2 599-G2880	2665	2878
6	SC	Gas	CT	West Gardner Generating Station 1	7929	1	This is a 81 MW unit. It is located in Johnson County, KS. In 2011, it ran for 15 GWh at a capacity factor of 2%.	75	KS	Labette	37.216	-95.259	2599	282	Dropdowns\G2 599-G2880	2665	2878
7	SC	Gas	CT	West Gardner Generating Station 2	7929	2	This is a 71 MW unit. It is located in Johnson County, KS. In 2011, it ran for 14 GWh at a capacity factor of 2%.	75	KS	Labette	37.216	-95.259	2599	282	Dropdowns\G2 599-G2880	2665	2878
8					0	#N/A	#N/A				#N/A	#N/A	#N/A	0	#N/A	#N/A	#N/A

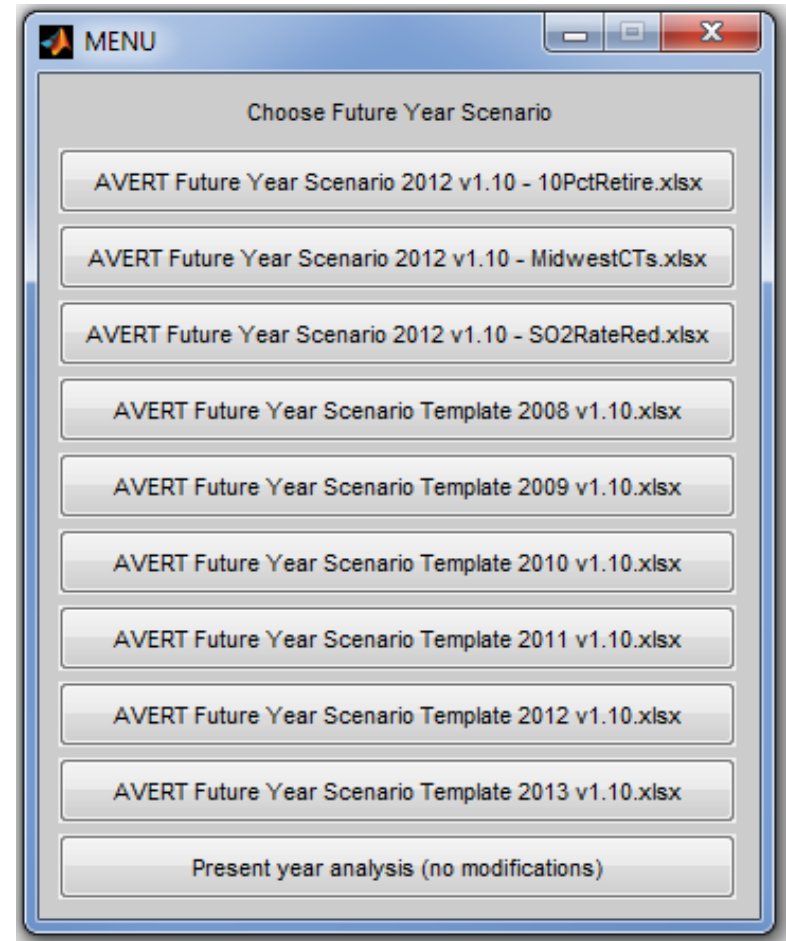
Retires\_Modifications Additions EPA\_Facilities EPA\_AMP eGRID PLNT09 CapacityGen

Ready 85%

- Choose proxy unit capacity (will scale all other factors)
- Choose state (within region)
- Choose county (within region)
- Save file

# Use AVERT Future Year Scenario in Statistical Module

- Run Statistical Module (slides 46-49).
- Provide a unique name for the statistical module run (slide 46).
- Choose saved future year scenario (slide 48).





# 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).

## AVoided Emissions and geneRation Tool (AVERT)

A tool that estimates the emissions benefits of energy efficiency and renewable energy policies and programs



- [Cost-effective ways to reduce air pollution and include emission benefits in Clean Air Act Plans](#)
- [What is AVERT?](#)
- [Why use AVERT?](#)
- [When should AVERT not be used?](#)
- [Who should use AVERT?](#)
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- [How to run scenarios in AVERT](#)
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Cost-effective ways to reduce air pollution and include emission benefits in Clean Air Act Plans

### Helpful Links

- [AVERT Training Module](#)
- [AVERT Main Module Quick Start Guide](#)
- [AVERT User Manual](#)
- [The AVERT Overview and Step-by-Step instructions](#)
- [Fact Sheet for Decision Makers](#)
- [Contact AVERT](#)