



**State and Local Climate
and Energy Program**

AVERT v4.2

Updates to vehicle emission rates

November 7, 2023



Our Tools and Resources Support State, Local and Tribal Stakeholders on Climate and Energy



Develop Inventories and Set Goals

GHG INVENTORY TOOLS

State Inventory and Projection Tool

Develop and update inventories for 11 sectors. Forecast emissions through 2050

Local Inventory Tool

Develop community-wide inventories or inventories of local government operations only

Tribal Inventory Tool

Develop community-wide inventories or inventories of tribal government operations only



Design, Compare, or Evaluate Policy



AVoided Emissions and geneRation Tool
Evaluate changes in power plant emissions from energy policy



Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool
Quantify and monetize health impacts of reducing emissions



Health Benefits per kWh
Estimate the health benefits per kWh of clean energy



Energy Savings and Impacts Scenario Tool
Analyze energy savings, costs, and multiple benefits from energy efficiency programs



Communicate and Support Policy Implementation



Greenhouse Gas Equivalencies Calculator
Convert a unit of energy to the equivalent amount of CO₂ emissions from using that amount



Heat Island Reduction Program
Resources to implement heat island mitigation policies and projects



Technical Support
Provide 1-1 technical support for state, local and tribal stakeholders



Convene Stakeholders
Engage state, local and tribal decision-makers



Local Action Framework:
A Guide to Help Communities Achieve Energy and Environmental Goals



Energy and Environment Guide to Action: State Policies and Best Practices for Advancing Energy Efficiency, Renewable Energy, and Combined Heat and Power



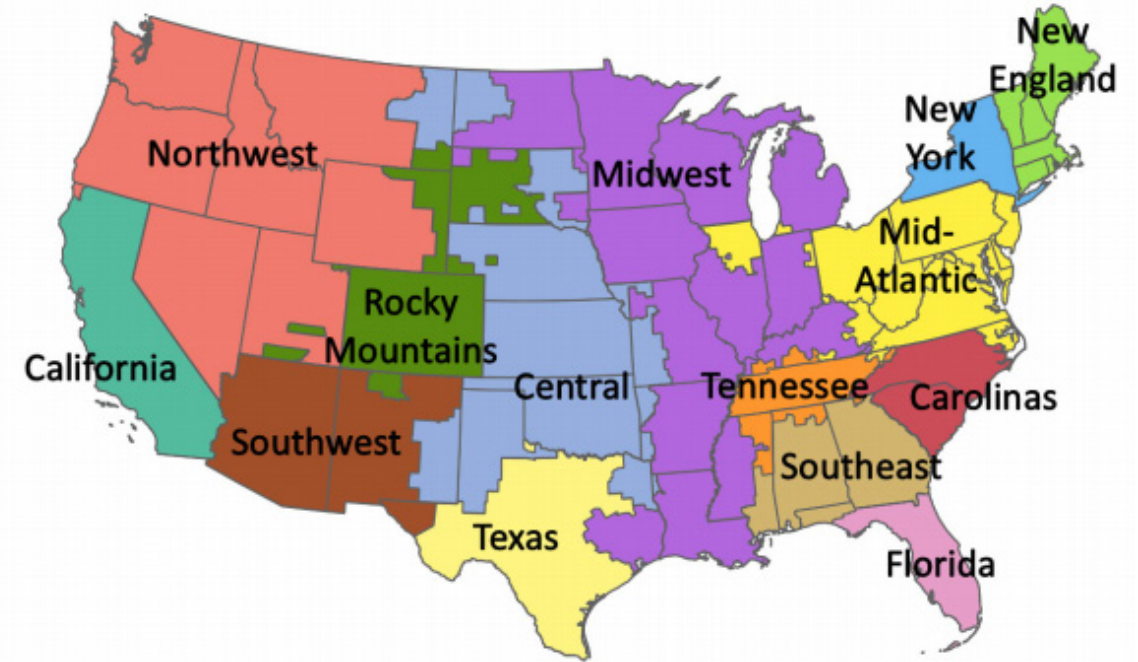
Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy:
A Guide for State and Local Governments



Local Government Climate and Energy Strategy Series:
A Guide to Developing and Implementing Greenhouse Gas Reduction Programs

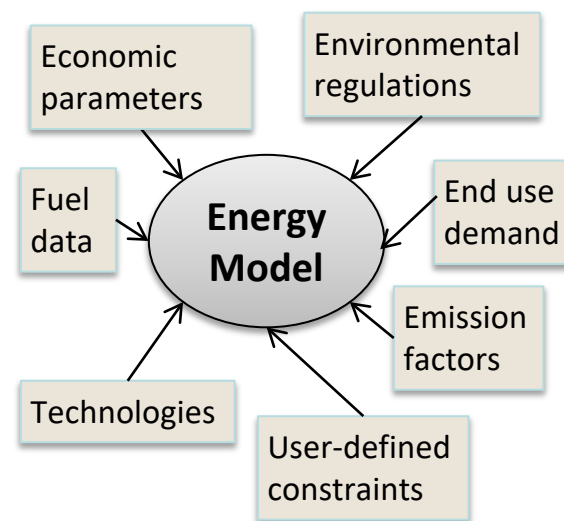
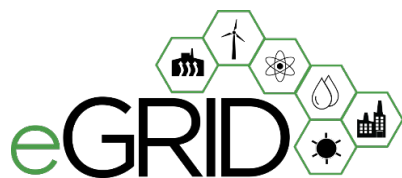
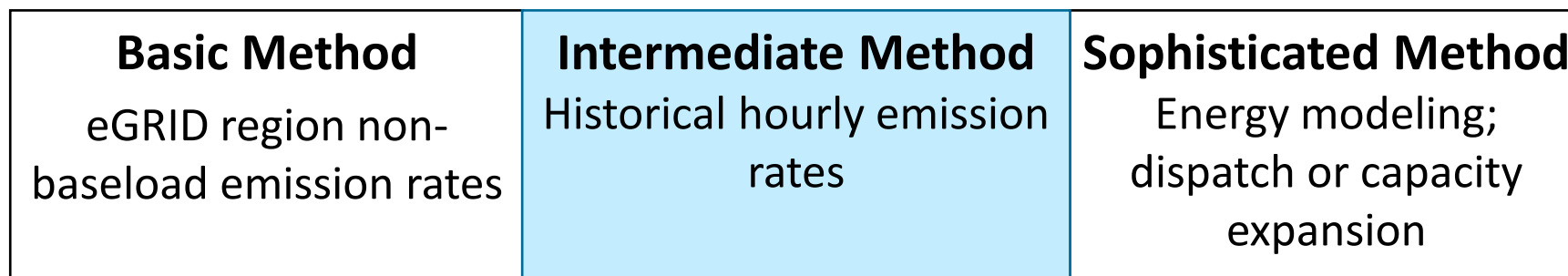
AVERT Review

- Free, easy to use:
 - Policy, program, and project analysis
- Excel & Web Editions
- Default load profiles for EE/RE
- Produces hourly marginal emissions (CO₂, NO_x, SO₂, PM_{2.5}, VOCs, NH₃)
- Data updated annually
- Target audience: State, local, tribal govt.

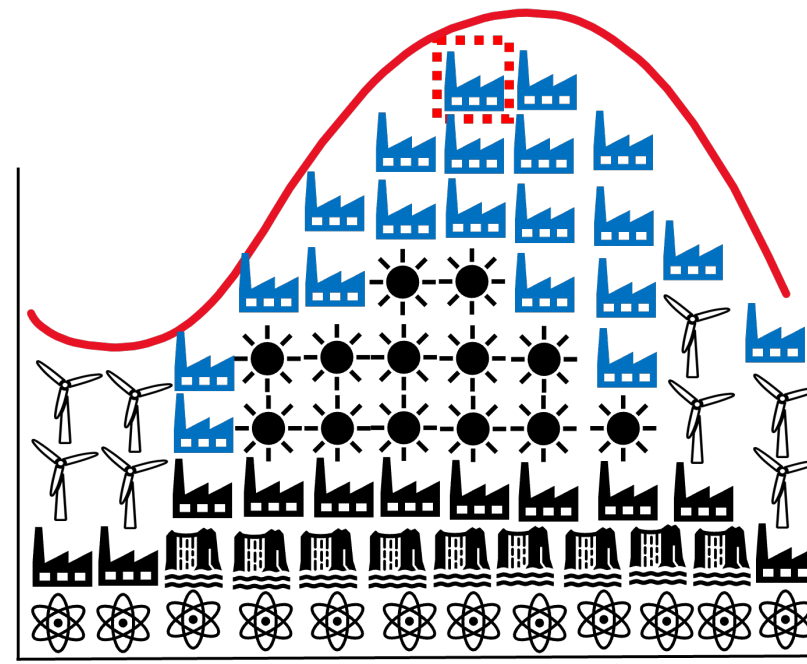
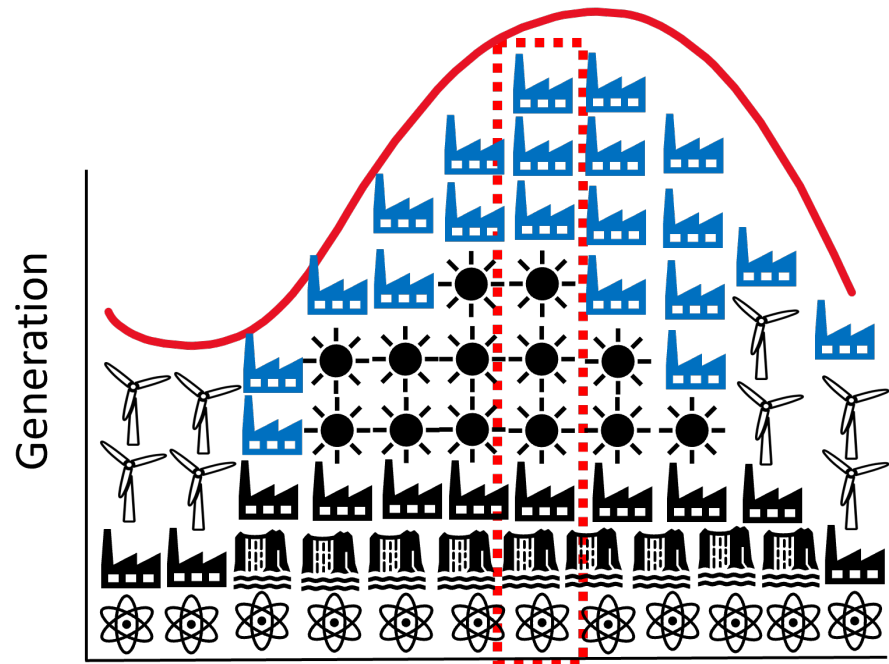


For more info: <https://www.epa.gov/avert>

Power Sector Emission Quantification Methods: Basic to Sophisticated

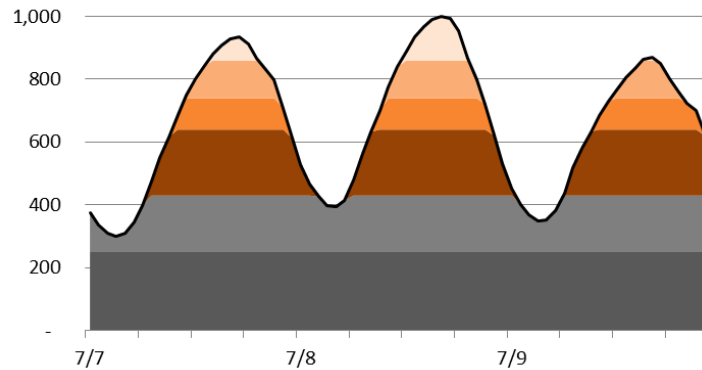


Average vs. Marginal Emissions

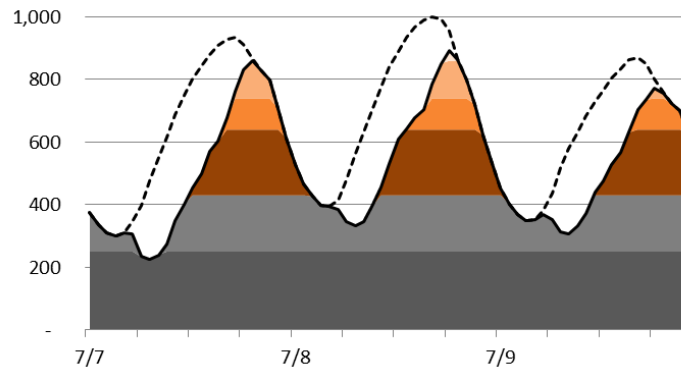


How AVERT Works: Loading Order and Displacement

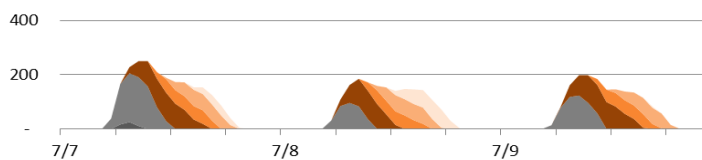
Generation Before RE



Generation After RE



Displaced Generation



- AVERT is an **operational** simulation model.
- Conceptually, generation is dispatched in a **loading order**, least expensive generators first
- EE/RE (generally) reduces requirement for fossil generation
- Reduced generation = reduced emissions

AVERT can be used for different types of analyses

- Model impacts of EVs deployed in a given, near-term year
 - GHG emissions analysis
 - Criteria pollutant emissions analysis
 - County-level geographic analysis (with lat/long EGU)
 - Temporal (hourly, seasonal) analysis
 - Health impacts and economic valuation with COBRA
 - Policy analysis
 - Supports the importance of EE/RE + EV
 - Charging profiles (time of use rates, related incentives)
- Easy, fast to use and modify

ICE Emissions in AVERT come from MOVES4

- MOVES4 is U.S. EPA's state-of-the-science emission modeling system that estimates emissions for mobile sources for criteria air pollutants, greenhouse gases, and air toxics.
<https://www.epa.gov/moves>
- AVERT based on many MOVES runs (51 states X 11 years = 561 runs)
 - 50 states, plus Washington D.C. = 51 entities
 - Calendar years 2023 through 2028 = 6 years
- MOVES Setup
 - Default Scale, Statewide Runs
 - Passenger Car, Passenger Truck, Transit Bus, School Bus and all available Fuel Types
 - All Emission Processes from Pollutants CO₂, NH₃, NO_x, PM_{2.5}, SO₂, and VOC
 - California standards overrode Federal standards, where applicable

ICE Emissions in AVERT come from MOVES4 (cont.)

- Post-processing generated emission factors in grams per mile, by state, vehicle type, fuel type, vehicle vintage, and month
- AVERT uses an aggregated version of these emission factors to estimate total ICE emissions
- AVERT allocates VMT to counties based on a separate analysis of the MOVES4 database that produced VMT by county for the U.S.

Year	Month	Model Year	State	Vehicle Type	Fuel Type	VMT (miles)	State Data					
							Atmospheric CO2 (lb/mile)	Oxides of Nitrogen (NOx) (lb/mile)	Sulfur Dioxide (SO2) (lb/mile)	Primary Exhaust PM2.5 - Total (lb/mile)	VOCs (Evaporative, Exhaust, Refueling) (lb/mile)	Ammonia (NH3) (lb/mile)
2023	I	2023	IL	Passenger Car	Gasoline	133,028,200	0.60	9.73E-05	3.33E-06	8.44E-06	2.63E-04	5.24E-05
2023	I	2023	IL	Passenger Truck	Gasoline	319,698,400	0.79	9.60E-05	4.40E-06	1.03E-05	2.61E-04	4.37E-05
2023	I	2023	IL	School Bus	Diesel Fuel	624,780	2.54	2.61E-03	8.48E-06	1.67E-05	2.74E-04	1.54E-04
2023	I	2023	IL	Transit Bus	Compressed Natural Gas (CNG)	43,753	3.14	1.97E-03	1.64E-05	1.13E-05	9.39E-04	2.46E-04
2023	I	2023	IL	Transit Bus	Diesel Fuel	293,837	3.33	4.94E-03	1.11E-05	6.90E-06	2.59E-04	2.01E-04
2023	I	2023	IL	Transit Bus	Gasoline	139,550	3.57	7.94E-04	1.99E-05	3.71E-05	2.78E-03	2.17E-04
2023	I	2023	IN	Passenger Car	Gasoline	106,249,760	0.60	1.01E-04	3.21E-06	8.29E-04	2.60E-04	5.35E-05
2023	I	2023	IN	Passenger Truck	Gasoline	265,865,600	0.79	9.65E-05	4.22E-06	9.80E-06	2.50E-04	4.56E-05
2023	I	2023	IN	School Bus	Diesel Fuel	530,032	2.53	2.59E-03	8.44E-04	1.67E-05	2.64E-04	1.54E-04
2023	I	2023	IN	Transit Bus	Compressed Natural Gas (CNG)	35,402	3.15	1.98E-03	1.67E-05	1.14E-05	9.46E-04	2.46E-04
2023	I	2023	IN	Transit Bus	Diesel Fuel	237,753	3.33	4.94E-03	1.11E-05	6.93E-06	2.58E-04	2.01E-04
2023	I	2023	IN	Transit Bus	Gasoline	112,914	3.56	7.89E-04	1.92E-05	3.69E-05	2.65E-03	2.17E-04
2023	I	2023	IA	Passenger Car	Gasoline	39,229,200	0.59	1.18E-04	3.13E-06	1.20E-05	3.69E-04	5.08E-05
2023	I	2023	IA	Passenger Truck	Gasoline	106,473,440	0.77	1.06E-04	4.10E-06	1.34E-05	3.29E-04	4.43E-05
2023	I	2023	IA	School Bus	Diesel Fuel	224,909	2.46	2.33E-03	8.22E-06	1.51E-05	2.61E-04	1.49E-04
2023	I	2023	IA	Transit Bus	Compressed Natural Gas (CNG)	14,079	3.05	1.82E-03	1.61E-05	1.04E-05	8.67E-04	2.40E-04
2023	I	2023	IA	Transit Bus	Diesel Fuel	94,553	3.25	4.51E-03	1.09E-05	6.55E-06	2.60E-04	1.96E-04
2023	I	2023	IA	Transit Bus	Gasoline	44,906	3.53	8.21E-04	1.89E-05	4.52E-05	2.37E-03	2.15E-04
2023	I	2023	KS	Passenger Car	Gasoline	37,564,192	0.57	1.02E-04	3.05E-06	8.50E-06	2.62E-04	5.01E-05
2023	I	2023	KS	Passenger Truck	Gasoline	97,357,800	0.76	9.48E-05	4.04E-06	9.79E-06	2.43E-04	4.39E-05
2023	I	2023	KS	School Bus	Diesel Fuel	202,719	2.46	2.32E-03	8.22E-06	1.51E-05	2.40E-04	1.49E-04
2023	I	2023	KS	Transit Bus	Compressed Natural Gas (CNG)	13,316	3.04	1.81E-03	1.61E-05	1.03E-05	8.60E-04	2.40E-04
2023	I	2023	KS	Transit Bus	Diesel Fuel	89,428	3.25	4.45E-03	1.09E-05	6.54E-06	2.42E-04	1.97E-04
2023	I	2023	KS	Transit Bus	Gasoline	42,471	3.54	8.26E-04	1.89E-05	3.70E-05	2.35E-03	2.16E-04
2023	I	2023	KY	Passenger Car	Gasoline	62,896,500	0.58	9.47E-05	3.12E-06	6.95E-06	2.17E-04	5.07E-05
2023	I	2023	KY	Passenger Truck	Gasoline	164,205,792	0.76	8.75E-05	4.13E-06	7.87E-06	2.01E-04	4.44E-05
2023	I	2023	KY	School Bus	Diesel Fuel	346,529	2.46	2.27E-03	8.20E-06	1.50E-05	2.29E-04	1.49E-04
2023	I	2023	KY	Transit Bus	Compressed Natural Gas (CNG)	22,619	3.03	1.78E-03	1.61E-05	1.02E-05	8.50E-04	2.40E-04
2023	I	2023	KY	Transit Bus	Diesel Fuel	151,908	3.25	4.37E-03	1.09E-05	6.51E-06	2.34E-04	1.94E-04
2023	I	2023	KY	Transit Bus	Gasoline	72,144	3.55	8.21E-04	1.92E-05	3.14E-05	2.64E-03	2.16E-04
2023	I	2023	LA	Passenger Car	Gasoline	66,642,752	0.57	6.87E-05	3.04E-06	4.17E-06	1.34E-04	5.10E-05
2023	I	2023	LA	Passenger Truck	Gasoline	167,182,000	0.75	6.53E-05	4.03E-06	4.67E-06	1.30E-04	4.45E-05
2023	I	2023	LA	School Bus	Diesel Fuel	338,910	2.49	2.34E-03	8.33E-06	1.58E-05	1.89E-04	1.51E-04
2023	I	2023	LA	Transit Bus	Compressed Natural Gas (CNG)	22,831	3.09	1.77E-03	1.63E-05	1.08E-05	8.96E-04	2.43E-04
2023	I	2023	LA	Transit Bus	Diesel Fuel	153,327	3.29	4.46E-03	1.10E-05	6.71E-06	2.10E-04	1.99E-04
2023	I	2023	LA	Transit Bus	Gasoline	72,818	3.55	7.50E-04	1.90E-05	2.54E-05	2.39E-03	2.17E-04
2023	I	2023	ME	Passenger Car	Gasoline	17,132,490	0.58	1.11E-04	3.22E-06	1.13E-05	3.51E-04	4.99E-05
2023	I	2023	ME	Passenger Truck	Gasoline	48,119,220	0.76	9.67E-05	4.24E-06	1.19E-05	3.04E-04	4.38E-05
2023	I	2023	ME	School Bus	Diesel Fuel	102,927	2.43	2.25E-03	8.12E-06	1.45E-05	2.58E-04	1.47E-04
2023	I	2023	ME	Transit Bus	Compressed Natural Gas (CNG)	6,286	3.00	1.76E-03	1.59E-05	1.00E-05	8.39E-04	2.37E-04
2023	I	2023	ME	Transit Bus	Diesel Fuel	42,219	3.22	4.34E-03	1.08E-05	6.39E-06	2.58E-04	1.94E-04
2023	I	2023	ME	Transit Bus	Gasoline	20,051	3.51	8.13E-04	1.96E-05	3.98E-05	2.68E-03	2.14E-04
2023	I	2023	MD	Passenger Car	Gasoline	72,994,992	0.59	8.45E-05	3.32E-06	6.19E-06	2.00E-04	5.19E-05
2023	I	2023	MD	Passenger Truck	Gasoline	170,327,408	0.78	8.51E-05	4.42E-06	7.44E-06	2.03E-04	4.54E-05
2023	I	2023	MD	School Bus	Diesel Fuel	322,972	2.52	2.59E-03	8.43E-06	1.64E-05	2.53E-04	1.53E-04
2023	I	2023	MD	Transit Bus	Compressed Natural Gas (CNG)	23,612	3.11	1.94E-03	1.65E-05	1.11E-05	9.23E-04	2.44E-04

How does AVERT assign ICE emissions to counties?

- AVERT calculates the total ICE emissions for the analyzed state or region using the vehicle type, emissions rate, and number of vehicles modeled in the scenario
- AVERT has data from MOVES on vehicle miles traveled (VMT) per county by vehicle type (i.e., passenger car, truck, transit bus, and school bus)
- AVERT calculates the portion of the total region or state's VMT in a county and multiplies that by the total calculated ICE emissions for the state or region analyzed

MOVES data

50 states

6 vehicle and fuel types

7 vehicle vintages

6 pollutants

X 12 months

154,224 data points

AVERT connects the power and transportation sector

- Power Sector

- Induced generation*

- Marginal power generation and emissions
 - 14 grid regions assigned at the county-level
 - County-level VMT is converted into electricity demand
 - EV charging profile (NREL's EVI-Pro Lite)
 - EE/RE Context

- Vehicles

- Emissions of avoided fossil-burning vehicles*

- **Emission factors:** State-specific
 - Exhaust, Evaporative, Refueling (MOVES4)
 - **Vehicle types:** Light-duty vehicles, transit bus, school bus
 - **Fuel types:** gasoline, diesel, CNG
 - **Vehicle vintage:** 2023-2028
 - **Vehicle age:** New or fleet average
 - **VMT** monthly, by county, by vehicle type

VMT: Vehicle miles traveled

Limitations of AVERT

- Same as previous versions of AVERT:
 - Near-term time horizon
 - Not for analyzing very large load changes
 - Others listed in user manual
- Not suitable for mobile source regulatory analyses, including state implementation plans (SIP) and transportation conformity analyses

Demonstration

In Review

- AVERT v4.2 can help you answer:
 - What is the emissions impact of adding a certain number of EVs in a given year?
 - How much EE/RE do we need to deploy to offset emissions of X number of EVs?
 - What are the ozone season NO_x implications of an energy scenario?
 - Where, in which counties and at which fossil fueled EGUs, are pollutants expected to change because of an energy scenario?
 - How do vehicle charging profiles impact emissions?
 - What are the health impacts of an energy scenario? (with COBRA)
 - and more...

Q&A

- Learn more about AVERT v4.2 at www.epa.gov/avert
- Email EPA: avert@epa.gov

