AVERT
AVoided Emissions and geneRation Tool
www.epa.gov/avert

May 2019

Emission Factors from AVERT

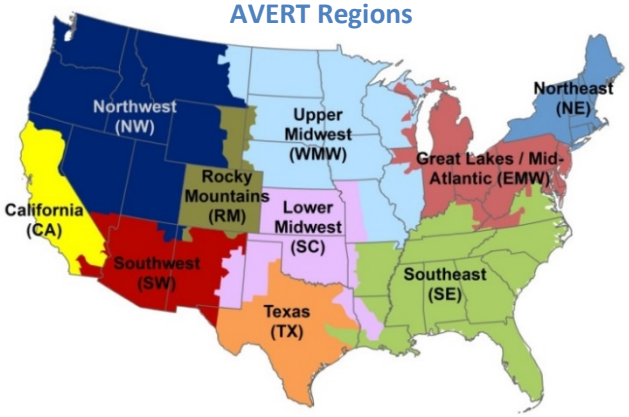
Estimating the emission benefits of energy efficiency (EE) and renewable energy (RE) policies and programs

What is AVERT?

The AVoided Emissions and geneRation Tool (AVERT) is a free EPA tool with a simple user interface. Environmental agency staff, air quality planners, energy officials, public utility commission staff, and others can use AVERT to evaluate the fine particulate matter ($PM_{2.5}$), carbon dioxide (CO_2), nitrogen oxides (NO_X), and sulfur dioxide (SO_2) emissions avoided at electric power plants by EE/RE policies and programs. AVERT calculates displaced emissions based on actual historical hourly patterns in generation by electric power plants within the contiguous 48 states and DC.

Emission Factors

AVERT uses a peer-reviewed methodology to analyze electric power sector impacts on an hour-by-hour basis, but it can also produce average emission factors for each AVERT region and for the nation. The tables in this file provide marginal emission factors for specific EE/RE resources, which EPA pre-generated by running AVERT with data for each year from 2007 to 2018.



When to Use AVERT Emission Factors

The emission factors presented here are intended for quick estimates of avoided emissions from EE/RE programs, policies, or projects. For more detailed planning, download and use AVERT to generate a custom analysis that accounts for seasonal and time-of-day variations or to analyze different EE/RE combinations.

The emission factors in this compendium were calculated by assuming a 0.5% displacement of the existing demand in each AVERT region. They are divided into four categories: wind, utility photovoltaic (PV), portfolio EE, and uniform EE. Use the portfolio EE factors if you are assessing a wide range of EE programs. Use the uniform EE factors if energy savings are consistent throughout the year. If you have a RE project, use the appropriate renewable energy technology type: utility PV or wind. Emission factors should not be used to examine the emission impacts of changes that extend more than 5 years into the future. All avoided emission rates in this document were produced on a net generation basis, incorporating the latest historical estimates of transmission and distribution line losses where appropriate.

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Using Capacity Factors for Wind and PV Power Generation

Estimating avoided emissions of wind and solar projects involves multiplying the appropriate emission factor from this document (in pounds per megawatt-hour [MWh]) by the size of the RE resource and the RE technology's capacity factor. It is not appropriate to simply multiply the emission factor by the size of the RE installation because a wind turbine or PV panel rarely (if ever) achieves its maximum possible output under actual operating conditions. This is a consequence of natural hourly, daily, and seasonal fluctuations in wind speed, cloud cover, the sun's angle of incidence, and hours of sunlight per day. These factors all vary regionally; for example, the Southwest has more sunny days per year than the Northeast.

To estimate avoided emissions from wind or PV, multiply the RE capacity by an additional *capacity factor* that reflects actual operating conditions. If actual capacity factors are unavailable, the table at right provides an average capacity factor for wind and PV resources for each AVERT region as well as the contiguous 48 states, for national-scale analysis. These factors reflect annual averages based on the hourly RE profiles embedded in AVERT. Appendix C of the AVERT User Manual describes how these hourly profiles were developed.

Annual Average Capacity Factors		
	Wind	*Utility PV*
Northeast	19.93%	17.93%
Great Lakes / Mid-Atlantic	26.00%	17.69%
Southeast	13.75%	19.35%
Lower Midwest	40.14%	21.51%
Upper Midwest	41.22%	19.26%
Rocky Mountains	35.04%	22.48%
Texas	33.86%	20.85%
Southwest	24.45%	25.80%
Northwest	25.24%	19.90%
California	17.32%	22.18%
Contiguous 48 states	27.70%	20.70%

Example

For illustration, consider the avoided $PM_{2.5}$ emissions from a project to add 100 MW of wind capacity in the Texas region:

Annual generation = capacity factor for RE technology (0.3386) × installed capacity (100 MW) x hours in a year (8,760 h, except leap years) = ***296,614 MWh***

Avoided $PM_{2.5}$ emissions = avoided electricity generation (296,614 MWh) × emission factor (0.06 lb/MWh) = ***17,797 lb***

Unit Conversions

1 MW = 1,000 kW = 0.001 GW.

To convert units from power (**kW, MW, GW**) to energy (**kWh, MWh, GWh**), multiply by the total number of hours in the year.

To convert in the other direction, divide by the total number of hours in the year. There are 8,760 hours in a non-leap year and 8,784 hours in a leap year.

For More Information

- Visit the AVERT website at www.epa.gov/avert.
- Contact EPA's AVERT manager at avert@epa.gov.

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Emissions Accounting and Claims

Although the avoided emission estimates provided by AVERT are intended to support RE initiatives, AVERT is a marginal emissions assessment tool and not a tool for emissions accounting. EPA cautions RE users and retailers from using AVERT's avoided emissions estimates to take or give credit for emission reductions, particularly in corporate greenhouse gas (GHG) accounting and reporting. While RE users that own renewable energy certificates (RECs) or similar market-based energy attribute certificates have unique ownership and claim to the emissions attributes of the associated electricity generation, they generally do not have a unique claim to the impacts on regional grid operations and emissions.

Corporate GHG accounting typically includes an inventory of emissions associated with purchased electricity, but not an assessment of the impact of an organization's purchased electricity on regional grid emissions. Organizations interested in quantifying RE's impact on regional grid emissions should consider project accounting. This type of emissions accounting is designed to quantify the benefits of emission mitigation projects.

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Data Year: 2018

National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,460	1,450	1,559	1,562
Avoided NO_x Rate	0.88	0.91	0.97	0.95
Avoided SO_2 Rate	0.99	0.92	1.02	1.04
Avoided $PM_{2.5}$ Rate	0.10	0.10	0.11	0.11

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Uniform EE** = Represents consistent energy savings throughout the year

National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2018 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,077	1,105	1,199	1,163
Great Lakes / Mid-Atlantic	1,558	1,560	1,671	1,668
Southeast	1,412	1,399	1,505	1,507
Lower Midwest	1,604	1,605	1,717	1,721
Upper Midwest	1,822	1,759	1,914	1,942
Rocky Mountains	1,622	1,576	1,723	1,758
Texas	1,275	1,264	1,326	1,336
Southwest	1,248	1,250	1,377	1,375
Northwest	1,531	1,534	1,634	1,665
California	999	1,008	1,107	1,097

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.42	0.54	0.61	0.50
Great Lakes / Mid-Atlantic	0.96	0.94	1.02	1.00
Southeast	0.85	0.90	0.94	0.92
Lower Midwest	1.15	1.24	1.31	1.26
Upper Midwest	1.26	1.21	1.32	1.34
Rocky Mountains	1.08	0.99	1.08	1.14
Texas	0.55	0.70	0.70	0.62
Southwest	0.72	0.76	0.84	0.82
Northwest	1.16	1.17	1.24	1.26
California	0.33	0.32	0.40	0.37

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.40	0.46	0.53	0.44
Great Lakes / Mid-Atlantic	1.21	1.19	1.28	1.29
Southeast	0.81	0.76	0.83	0.84
Lower Midwest	1.38	1.36	1.47	1.47
Upper Midwest	1.89	1.64	1.88	1.98
Rocky Mountains	0.50	0.47	0.51	0.53
Texas	0.96	0.78	0.87	0.96
Southwest	0.11	0.13	0.15	0.14
Northwest	0.95	0.87	0.98	0.99
California	0.07	0.06	0.08	0.08

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.18	0.17	0.19	0.19
Southeast	0.09	0.10	0.10	0.10
Lower Midwest	0.09	0.09	0.10	0.10
Upper Midwest	0.09	0.09	0.09	0.09
Rocky Mountains	0.03	0.04	0.04	0.04
Texas	0.06	0.06	0.07	0.07
Southwest	0.05	0.05	0.06	0.06
Northwest	0.07	0.07	0.08	0.08
California	0.04	0.04	0.05	0.05

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,485	1,486	1,592	1,598
Avoided NO_x Rate	0.88	0.94	0.99	0.96
Avoided SO_2 Rate	1.00	0.96	1.05	1.07
Avoided $PM_{2.5}$ Rate	0.11	0.11	0.12	0.12

- **Wind** = Wind power generation
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Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,057	1,075	1,163	1,140
Great Lakes / Mid-Atlantic	1,596	1,595	1,712	1,709
Southeast	1,406	1,452	1,548	1,534
Lower Midwest	1,747	1,667	1,809	1,855
Upper Midwest	1,884	1,794	1,966	2,009
Rocky Mountains	1,612	1,562	1,702	1,738
Texas	1,329	1,266	1,361	1,395
Southwest	1,264	1,268	1,359	1,365
Northwest	1,558	1,591	1,653	1,697
California	1,034	1,051	1,136	1,127

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.37	0.46	0.51	0.43
Great Lakes / Mid-Atlantic	0.93	0.94	1.01	0.99
Southeast	0.83	0.96	0.97	0.93
Lower Midwest	1.10	1.17	1.24	1.20
Upper Midwest	1.31	1.23	1.35	1.38
Rocky Mountains	1.33	1.27	1.38	1.42
Texas	0.60	0.66	0.69	0.65
Southwest	0.90	0.94	1.00	0.99
Northwest	1.18	1.22	1.24	1.29
California	0.32	0.32	0.33	0.34

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.27	0.30	0.33	0.28
Great Lakes / Mid-Atlantic	1.08	1.20	1.28	1.25
Southeast	0.73	0.75	0.79	0.79
Lower Midwest	1.80	1.61	1.77	1.88
Upper Midwest	1.94	1.67	1.91	2.03
Rocky Mountains	0.58	0.52	0.57	0.60
Texas	1.31	1.05	1.18	1.32
Southwest	0.27	0.22	0.20	0.24
Northwest	0.83	0.86	0.93	0.92
California	0.07	0.07	0.07	0.08

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.20	0.20	0.21	0.21
Southeast	0.09	0.10	0.11	0.10
Lower Midwest	0.09	0.09	0.10	0.10
Upper Midwest	0.09	0.09	0.10	0.10
Rocky Mountains	0.03	0.04	0.04	0.04
Texas	0.07	0.07	0.07	0.08
Southwest	0.07	0.07	0.07	0.08
Northwest	0.08	0.08	0.09	0.09
California	0.04	0.05	0.05	0.05

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,562	1,561	1,680	1,681
Avoided NO_x Rate	1.07	1.12	1.18	1.16
Avoided SO_2 Rate	1.52	1.44	1.56	1.60
Avoided $PM_{2.5}$ Rate	0.11	0.11	0.12	0.12

- **Wind** = Wind power generation
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Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,078	1,136	1,215	1,175
Great Lakes / Mid-Atlantic	1,718	1,707	1,836	1,838
Southeast	1,472	1,509	1,616	1,602
Lower Midwest	1,677	1,665	1,788	1,798
Upper Midwest	1,913	1,845	1,999	2,038
Rocky Mountains	1,840	1,779	1,974	2,001
Texas	1,478	1,436	1,547	1,571
Southwest	1,442	1,411	1,505	1,543
Northwest	1,644	1,619	1,774	1,797
California	1,000	1,012	1,119	1,106

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.43	0.59	0.63	0.52
Great Lakes / Mid-Atlantic	1.35	1.33	1.42	1.41
Southeast	0.93	1.06	1.10	1.05
Lower Midwest	1.18	1.32	1.38	1.31
Upper Midwest	1.50	1.46	1.56	1.60
Rocky Mountains	1.30	1.23	1.36	1.39
Texas	0.67	0.78	0.80	0.75
Southwest	1.36	1.28	1.29	1.38
Northwest	1.31	1.29	1.42	1.43
California	0.34	0.36	0.43	0.39

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.33	0.41	0.44	0.37
Great Lakes / Mid-Atlantic	2.11	2.03	2.20	2.23
Southeast	1.38	1.39	1.46	1.46
Lower Midwest	1.83	1.73	1.86	1.93
Upper Midwest	2.31	2.02	2.25	2.41
Rocky Mountains	0.74	0.74	0.82	0.83
Texas	1.66	1.48	1.63	1.73
Southwest	0.44	0.38	0.37	0.42
Northwest	0.92	0.88	0.99	1.00
California	0.07	0.06	0.07	0.07

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.20	0.20	0.21	0.21
Southeast	0.10	0.11	0.11	0.11
Lower Midwest	0.10	0.10	0.11	0.11
Upper Midwest	0.10	0.09	0.10	0.10
Rocky Mountains	0.03	0.03	0.04	0.04
Texas	0.08	0.08	0.08	0.09
Southwest	0.08	0.08	0.08	0.08
Northwest	0.09	0.08	0.09	0.09
California	0.04	0.04	0.04	0.04

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,570	1,561	1,688	1,689
Avoided NO_x Rate	1.13	1.15	1.23	1.21
Avoided SO_2 Rate	2.10	1.96	2.12	2.17
Avoided $PM_{2.5}$ Rate	0.12	0.11	0.12	0.12

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Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,145	1,156	1,250	1,231
Great Lakes / Mid-Atlantic	1,778	1,755	1,894	1,903
Southeast	1,510	1,509	1,629	1,630
Lower Midwest	1,770	1,731	1,874	1,897
Upper Midwest	1,879	1,827	1,990	2,013
Rocky Mountains	1,837	1,782	1,966	1,998
Texas	1,403	1,426	1,509	1,498
Southwest	1,243	1,234	1,348	1,354
Northwest	1,527	1,552	1,706	1,691
California	1,043	1,054	1,158	1,148

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.62	0.68	0.74	0.69
Great Lakes / Mid-Atlantic	1.54	1.48	1.60	1.60
Southeast	1.00	1.03	1.10	1.08
Lower Midwest	1.27	1.37	1.44	1.40
Upper Midwest	1.49	1.39	1.53	1.57
Rocky Mountains	1.82	1.73	1.92	1.97
Texas	0.65	0.82	0.82	0.74
Southwest	0.93	0.95	0.99	1.01
Northwest	1.12	1.20	1.34	1.29
California	0.51	0.47	0.50	0.54

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.71	0.69	0.75	0.71
Great Lakes / Mid-Atlantic	3.84	3.63	3.92	3.99
Southeast	1.92	1.79	1.91	1.95
Lower Midwest	2.16	1.98	2.14	2.26
Upper Midwest	2.60	2.37	2.65	2.74
Rocky Mountains	0.87	0.80	0.91	0.93
Texas	1.42	1.35	1.45	1.48
Southwest	0.71	0.62	0.65	0.72
Northwest	0.62	0.71	0.79	0.73
California	0.07	0.06	0.07	0.07

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.23	0.21	0.23	0.24
Southeast	0.11	0.11	0.11	0.11
Lower Midwest	0.10	0.10	0.10	0.10
Upper Midwest	0.09	0.09	0.10	0.10
Rocky Mountains	0.03	0.03	0.04	0.04
Texas	0.08	0.08	0.08	0.08
Southwest	0.05	0.06	0.06	0.06
Northwest	0.08	0.08	0.09	0.09
California	0.04	0.04	0.05	0.05

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,548	1,502	1,640	1,660
Avoided NO_x Rate	1.23	1.21	1.31	1.31
Avoided SO_2 Rate	2.33	2.19	2.41	2.47
Avoided $PM_{2.5}$ Rate	0.12	0.11	0.12	0.12

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Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,177	1,156	1,264	1,247
Great Lakes / Mid-Atlantic	1,745	1,705	1,853	1,874
Southeast	1,487	1,424	1,566	1,584
Lower Midwest	1,732	1,661	1,818	1,854
Upper Midwest	1,895	1,820	1,996	2,034
Rocky Mountains	1,813	1,769	1,964	1,986
Texas	1,307	1,268	1,358	1,378
Southwest	1,169	1,136	1,261	1,273
Northwest	1,586	1,593	1,703	1,753
California	1,019	1,028	1,134	1,129

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.79	0.82	0.89	0.84
Great Lakes / Mid-Atlantic	1.62	1.59	1.72	1.73
Southeast	1.10	1.11	1.19	1.17
Lower Midwest	1.51	1.52	1.63	1.63
Upper Midwest	1.63	1.56	1.72	1.75
Rocky Mountains	1.61	1.51	1.70	1.73
Texas	0.67	0.70	0.73	0.72
Southwest	0.75	0.68	0.78	0.79
Northwest	1.38	1.40	1.47	1.53
California	0.64	0.59	0.62	0.67

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1.05	0.99	1.08	1.00
Great Lakes / Mid-Atlantic	4.06	3.90	4.27	4.36
Southeast	2.23	2.15	2.35	2.38
Lower Midwest	2.19	2.01	2.21	2.31
Upper Midwest	2.95	2.71	3.03	3.14
Rocky Mountains	1.10	1.00	1.13	1.18
Texas	1.50	1.28	1.44	1.54
Southwest	0.32	0.24	0.28	0.31
Northwest	0.98	0.99	1.03	1.09
California	0.06	0.05	0.05	0.06

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.22	0.20	0.22	0.23
Southeast	0.11	0.11	0.12	0.12
Lower Midwest	0.10	0.10	0.11	0.11
Upper Midwest	0.10	0.09	0.10	0.10
Rocky Mountains	0.03	0.04	0.04	0.04
Texas	0.07	0.07	0.07	0.07
Southwest	0.06	0.05	0.06	0.06
Northwest	0.08	0.08	0.09	0.09
California	0.04	0.04	0.04	0.04

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,510	1,495	1,626	1,633
Avoided NO_x Rate	1.23	1.24	1.34	1.33
Avoided SO_2 Rate	2.28	2.19	2.41	2.44
Avoided $PM_{2.5}$ Rate	0.12	0.12	0.13	0.13

- **Wind** = Wind power generation
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- **Portfolio EE** = Represents a wide range of EE program types
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National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2013 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,171	1,203	1,294	1,270
Great Lakes / Mid-Atlantic	1,680	1,668	1,811	1,820
Southeast	1,427	1,446	1,562	1,555
Lower Midwest	1,700	1,613	1,780	1,817
Upper Midwest	1,893	1,819	2,000	2,029
Rocky Mountains	1,807	1,717	1,923	1,959
Texas	1,360	1,313	1,404	1,427
Southwest	1,166	1,151	1,267	1,272
Northwest	1,450	1,443	1,569	1,592
California	1,012	1,026	1,131	1,118

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.74	0.86	0.91	0.81
Great Lakes / Mid-Atlantic	1.48	1.49	1.60	1.59
Southeast	1.00	1.08	1.14	1.10
Lower Midwest	1.64	1.69	1.81	1.80
Upper Midwest	1.85	1.74	1.93	1.96
Rocky Mountains	1.83	1.70	1.92	1.96
Texas	0.71	0.75	0.78	0.77
Southwest	0.84	0.75	0.85	0.87
Northwest	1.67	1.62	1.85	1.83
California	0.70	0.65	0.71	0.74

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1.01	1.07	1.13	1.08
Great Lakes / Mid-Atlantic	3.96	3.84	4.23	4.28
Southeast	2.09	2.24	2.37	2.31
Lower Midwest	2.23	1.92	2.17	2.32
Upper Midwest	3.02	2.72	3.08	3.20
Rocky Mountains	1.33	1.17	1.36	1.42
Texas	1.60	1.27	1.44	1.60
Southwest	0.26	0.26	0.27	0.28
Northwest	0.86	0.86	0.90	0.95
California	0.08	0.07	0.07	0.08

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.05	0.05	0.06	0.05
Great Lakes / Mid-Atlantic	0.19	0.18	0.21	0.21
Southeast	0.12	0.12	0.13	0.13
Lower Midwest	0.10	0.09	0.10	0.10
Upper Midwest	0.13	0.13	0.14	0.14
Rocky Mountains	0.06	0.07	0.07	0.07
Texas	0.07	0.07	0.08	0.08
Southwest	0.07	0.07	0.08	0.08
Northwest	0.08	0.08	0.09	0.09
California	0.06	0.06	0.07	0.06

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Data Year: 2012

National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,566	1,558	1,691	1,696
Avoided NO_x Rate	1.30	1.33	1.43	1.42
Avoided SO_2 Rate	2.44	2.43	2.65	2.66
Avoided $PM_{2.5}$ Rate	0.13	0.13	0.14	0.14

- **Wind** = Wind power generation
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- **Portfolio EE** = Represents a wide range of EE program types
- **Uniform EE** = Represents consistent energy savings throughout the year

National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2012 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,102	1,176	1,269	1,224
Great Lakes / Mid-Atlantic	1,751	1,742	1,889	1,895
Southeast	1,513	1,534	1,656	1,650
Lower Midwest	1,670	1,593	1,761	1,794
Upper Midwest	1,913	1,834	2,009	2,046
Rocky Mountains	1,880	1,784	2,001	2,042
Texas	1,379	1,383	1,444	1,444
Southwest	1,300	1,201	1,349	1,385
Northwest	1,663	1,645	1,802	1,831
California	1,029	1,073	1,179	1,152

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.51	0.73	0.77	0.64
Great Lakes / Mid-Atlantic	1.68	1.69	1.82	1.82
Southeast	1.09	1.18	1.26	1.23
Lower Midwest	1.88	1.93	2.08	2.05
Upper Midwest	1.69	1.66	1.80	1.82
Rocky Mountains	2.09	1.93	2.19	2.25
Texas	0.60	0.74	0.73	0.67
Southwest	1.37	1.01	1.20	1.32
Northwest	1.58	1.55	1.72	1.74
California	0.55	0.55	0.61	0.60

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.65	0.91	0.94	0.79
Great Lakes / Mid-Atlantic	4.34	4.33	4.72	4.74
Southeast	2.25	2.46	2.63	2.55
Lower Midwest	1.96	1.62	1.91	2.05
Upper Midwest	3.60	3.23	3.64	3.80
Rocky Mountains	1.49	1.28	1.49	1.57
Texas	1.32	1.19	1.26	1.33
Southwest	0.60	0.49	0.54	0.60
Northwest	1.41	1.26	1.47	1.50
California	0.10	0.09	0.10	0.11

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.21	0.21	0.23	0.23
Southeast	0.13	0.14	0.15	0.15
Lower Midwest	0.10	0.10	0.11	0.11
Upper Midwest	0.14	0.14	0.15	0.15
Rocky Mountains	0.07	0.07	0.07	0.07
Texas	0.06	0.07	0.07	0.07
Southwest	0.09	0.07	0.08	0.09
Northwest	0.11	0.11	0.11	0.12
California	0.06	0.07	0.07	0.07

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,618	1,583	1,723	1,742
Avoided NO_x Rate	1.46	1.44	1.55	1.57
Avoided SO_2 Rate	3.39	3.14	3.46	3.57
Avoided $PM_{2.5}$ Rate	0.15	0.14	0.15	0.16

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National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2011 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,223	1,275	1,355	1,329
Great Lakes / Mid-Atlantic	1,815	1,775	1,929	1,945
Southeast	1,598	1,580	1,706	1,718
Lower Midwest	1,649	1,544	1,714	1,759
Upper Midwest	1,989	1,874	2,074	2,116
Rocky Mountains	1,878	1,792	2,041	2,083
Texas	1,310	1,285	1,358	1,372
Southwest	1,302	1,217	1,383	1,417
Northwest	1,676	1,644	1,778	1,864
California	981	976	1,091	1,096

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.63	0.80	0.83	0.74
Great Lakes / Mid-Atlantic	1.77	1.71	1.86	1.88
Southeast	1.43	1.41	1.51	1.53
Lower Midwest	1.94	1.95	2.13	2.11
Upper Midwest	1.89	1.75	1.94	1.99
Rocky Mountains	2.10	1.96	2.25	2.31
Texas	0.70	0.83	0.85	0.78
Southwest	1.22	0.99	1.15	1.25
Northwest	1.61	1.55	1.64	1.78
California	0.51	0.39	0.42	0.51

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1.85	1.96	2.03	1.97
Great Lakes / Mid-Atlantic	5.72	5.45	5.95	6.06
Southeast	3.51	3.28	3.62	3.73
Lower Midwest	2.23	1.71	2.07	2.29
Upper Midwest	4.66	4.12	4.67	4.87
Rocky Mountains	1.80	1.64	1.89	1.96
Texas	1.43	1.01	1.18	1.38
Southwest	0.53	0.38	0.46	0.52
Northwest	1.40	1.34	1.36	1.52
California	0.09	0.06	0.06	0.08

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.05	0.05	0.06	0.05
Great Lakes / Mid-Atlantic	0.24	0.22	0.24	0.25
Southeast	0.16	0.16	0.18	0.18
Lower Midwest	0.10	0.09	0.10	0.10
Upper Midwest	0.14	0.14	0.15	0.15
Rocky Mountains	0.06	0.06	0.07	0.07
Texas	0.06	0.06	0.07	0.07
Southwest	0.09	0.07	0.08	0.09
Northwest	0.11	0.11	0.11	0.12
California	0.05	0.05	0.06	0.06

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,595	1,539	1,669	1,694
Avoided NO_x Rate	1.44	1.40	1.51	1.52
Avoided SO_2 Rate	3.43	2.99	3.37	3.54
Avoided $PM_{2.5}$ Rate	0.19	0.18	0.20	0.21

- **Wind** = Wind power generation
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- **Portfolio EE** = Represents a wide range of EE program types
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National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2010 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,255	1,278	1,371	1,357
Great Lakes / Mid-Atlantic	1,804	1,744	1,888	1,917
Southeast	1,558	1,510	1,634	1,654
Lower Midwest	1,636	1,527	1,679	1,729
Upper Midwest	1,959	1,847	2,026	2,072
Rocky Mountains	1,715	1,646	1,804	1,831
Texas	1,363	1,310	1,421	1,448
Southwest	1,322	1,225	1,339	1,368
Northwest	1,464	1,472	1,554	1,588
California	942	968	1,033	1,012

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.60	0.78	0.83	0.71
Great Lakes / Mid-Atlantic	1.84	1.76	1.90	1.93
Southeast	1.33	1.34	1.44	1.43
Lower Midwest	2.10	1.99	2.17	2.23
Upper Midwest	1.88	1.72	1.90	1.96
Rocky Mountains	1.96	1.79	1.98	2.03
Texas	0.67	0.74	0.77	0.74
Southwest	1.27	0.97	1.12	1.20
Northwest	1.48	1.54	1.58	1.63
California	0.23	0.24	0.24	0.22

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1.35	1.39	1.49	1.47
Great Lakes / Mid-Atlantic	5.81	5.19	5.74	5.98
Southeast	3.60	3.28	3.62	3.73
Lower Midwest	2.60	1.93	2.34	2.62
Upper Midwest	4.74	4.10	4.67	4.93
Rocky Mountains	1.37	1.28	1.40	1.44
Texas	1.70	1.11	1.40	1.68
Southwest	0.58	0.43	0.51	0.56
Northwest	0.91	0.92	0.93	1.01
California	0.02	0.02	0.01	0.02

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.06	0.08	0.08	0.07
Great Lakes / Mid-Atlantic	0.42	0.37	0.41	0.43
Southeast	0.18	0.18	0.19	0.19
Lower Midwest	0.10	0.09	0.10	0.11
Upper Midwest	0.13	0.13	0.14	0.14
Rocky Mountains	0.09	0.10	0.11	0.10
Texas	0.07	0.08	0.08	0.08
Southwest	0.10	0.07	0.08	0.09
Northwest	0.09	0.08	0.09	0.09
California	0.03	0.03	0.03	0.03

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,597	1,541	1,687	1,711
Avoided NO_x Rate	1.42	1.42	1.53	1.53
Avoided SO_2 Rate	4.10	3.86	4.24	4.35
Avoided $PM_{2.5}$ Rate	0.20	0.19	0.21	0.21

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National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2009 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,271	1,237	1,357	1,348
Great Lakes / Mid-Atlantic	1,825	1,782	1,947	1,966
Southeast	1,552	1,487	1,636	1,658
Lower Midwest	1,683	1,565	1,744	1,791
Upper Midwest	1,997	1,919	2,109	2,141
Rocky Mountains	1,750	1,672	1,864	1,904
Texas	1,322	1,264	1,348	1,378
Southwest	1,312	1,221	1,369	1,394
Northwest	1,378	1,383	1,463	1,525
California	1,015	1,046	1,139	1,119

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.69	0.75	0.81	0.73
Great Lakes / Mid-Atlantic	1.69	1.69	1.82	1.81
Southeast	1.32	1.33	1.44	1.43
Lower Midwest	2.07	2.02	2.21	2.23
Upper Midwest	1.94	1.85	2.03	2.07
Rocky Mountains	2.06	1.90	2.13	2.22
Texas	0.80	0.93	0.95	0.89
Southwest	1.29	0.95	1.16	1.26
Northwest	1.34	1.34	1.41	1.51
California	0.48	0.48	0.52	0.52

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1.83	1.67	1.85	1.80
Great Lakes / Mid-Atlantic	7.82	7.67	8.33	8.42
Southeast	4.06	3.89	4.26	4.34
Lower Midwest	2.45	1.91	2.28	2.50
Upper Midwest	5.35	5.02	5.54	5.68
Rocky Mountains	2.37	2.08	2.40	2.48
Texas	1.65	1.08	1.29	1.57
Southwest	0.57	0.40	0.48	0.54
Northwest	0.94	0.96	0.87	1.06
California	0.07	0.05	0.06	0.07

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.07	0.07	0.08	0.07
Great Lakes / Mid-Atlantic	0.45	0.44	0.48	0.48
Southeast	0.18	0.17	0.19	0.19
Lower Midwest	0.10	0.10	0.11	0.11
Upper Midwest	0.14	0.13	0.15	0.15
Rocky Mountains	0.09	0.10	0.10	0.10
Texas	0.06	0.06	0.06	0.06
Southwest	0.09	0.07	0.08	0.09
Northwest	0.08	0.08	0.09	0.09
California	0.03	0.03	0.04	0.03

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,592	1,530	1,685	1,708
Avoided NO_x Rate	1.98	1.73	1.96	2.02
Avoided SO_2 Rate	4.75	4.03	4.67	4.93
Avoided $PM_{2.5}$ Rate	0.20	0.18	0.20	0.21

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Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,219	1,241	1,341	1,326
Great Lakes / Mid-Atlantic	1,817	1,743	1,923	1,951
Southeast	1,558	1,469	1,634	1,665
Lower Midwest	1,622	1,529	1,694	1,732
Upper Midwest	1,921	1,840	2,034	2,062
Rocky Mountains	1,788	1,707	1,912	1,943
Texas	1,388	1,351	1,440	1,457
Southwest	1,199	1,190	1,302	1,305
Northwest	1,488	1,462	1,592	1,625
California	999	1,058	1,137	1,109

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.68	0.80	0.85	0.76
Great Lakes / Mid-Atlantic	3.05	2.44	2.85	2.95
Southeast	1.92	1.62	1.84	1.93
Lower Midwest	2.23	2.15	2.37	2.40
Upper Midwest	2.40	2.17	2.49	2.53
Rocky Mountains	2.38	2.15	2.47	2.54
Texas	0.77	0.94	0.94	0.86
Southwest	1.09	1.08	1.17	1.17
Northwest	1.54	1.49	1.62	1.69
California	0.34	0.36	0.39	0.37

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1.38	1.32	1.46	1.45
Great Lakes / Mid-Atlantic	9.00	7.93	9.07	9.41
Southeast	5.36	4.19	5.02	5.44
Lower Midwest	2.67	2.14	2.55	2.75
Upper Midwest	4.75	4.29	4.91	5.06
Rocky Mountains	1.83	1.73	1.93	1.96
Texas	1.55	1.01	1.30	1.54
Southwest	0.35	0.30	0.32	0.34
Northwest	1.97	2.26	2.13	2.34
California	0.02	0.02	0.02	0.02

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.06	0.07	0.08	0.07
Great Lakes / Mid-Atlantic	0.43	0.39	0.44	0.45
Southeast	0.19	0.17	0.19	0.20
Lower Midwest	0.10	0.10	0.10	0.11
Upper Midwest	0.12	0.12	0.13	0.13
Rocky Mountains	0.08	0.10	0.10	0.09
Texas	0.06	0.06	0.06	0.06
Southwest	0.06	0.06	0.07	0.07
Northwest	0.09	0.09	0.10	0.10
California	0.03	0.03	0.03	0.03

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National Emission Factors

National Weighted Averages (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Avoided CO_2 Rate	1,574	1,513	1,661	1,682
Avoided NO_x Rate	2.08	1.83	2.04	2.10
Avoided SO_2 Rate	4.99	4.07	4.73	5.04
Avoided $PM_{2.5}$ Rate	0.19	0.18	0.20	0.20

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National factors presented here reflect a weighted average of the avoided emission rates of AVERT's 10 regions. Averages are weighted by the fraction of 2007 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	1,295	1,311	1,409	1,391
Great Lakes / Mid-Atlantic	1,777	1,702	1,867	1,893
Southeast	1,571	1,486	1,641	1,669
Lower Midwest	1,613	1,500	1,667	1,714
Upper Midwest	1,909	1,818	2,011	2,040
Rocky Mountains	1,675	1,598	1,788	1,808
Texas	1,263	1,227	1,343	1,354
Southwest	1,118	1,111	1,217	1,215
Northwest	1,529	1,561	1,627	1,667
California	1,064	1,092	1,175	1,160

Avoided NO_x Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.96	1.10	1.13	1.05
Great Lakes / Mid-Atlantic	3.14	2.49	2.85	2.97
Southeast	2.05	1.78	1.99	2.07
Lower Midwest	2.48	2.33	2.57	2.64
Upper Midwest	2.55	2.33	2.62	2.67
Rocky Mountains	1.83	1.65	1.90	1.96
Texas	0.71	0.83	0.85	0.80
Southwest	0.95	0.99	1.07	1.05
Northwest	1.65	1.81	1.71	1.85
California	0.42	0.40	0.43	0.44

Avoided SO_2 Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	2.04	1.96	2.08	2.08
Great Lakes / Mid-Atlantic	9.42	7.87	9.01	9.49
Southeast	5.64	4.33	5.19	5.63
Lower Midwest	2.86	2.09	2.60	2.88
Upper Midwest	5.20	4.61	5.28	5.46
Rocky Mountains	1.50	1.24	1.52	1.60
Texas	1.14	0.72	1.00	1.13
Southwest	0.20	0.24	0.24	0.24
Northwest	1.41	1.31	1.17	1.38
California	0.04	0.03	0.03	0.03

Avoided $PM_{2.5}$ Rate (lb/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Uniform EE*
Northeast	0.07	0.08	0.09	0.08
Great Lakes / Mid-Atlantic	0.39	0.34	0.39	0.40
Southeast	0.19	0.17	0.19	0.20
Lower Midwest	0.10	0.09	0.10	0.11
Upper Midwest	0.14	0.13	0.14	0.15
Rocky Mountains	0.11	0.14	0.14	0.13
Texas	0.06	0.06	0.06	0.06
Southwest	0.06	0.05	0.06	0.06
Northwest	0.09	0.09	0.10	0.10
California	0.03	0.04	0.04	0.04