Emission Factors from AVERT

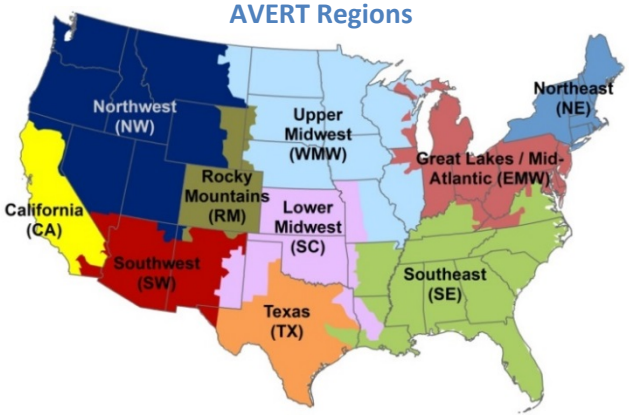
Estimating the emission benefits of energy efficiency (EE) and renewable energy (RE) policies and programs

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 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 that begin on the next page provide marginal emission factors for specific EE/RE resources, which EPA pre-generated by running AVERT with data for each year from 2007 to 2016.



When to Use AVERT Emission Factors

The emission factors presented here are intended for quick estimates of avoided emissions. For more detailed planning efforts, 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 5% displacement of the existing regional demand. They are divided into four categories: wind, utility photovoltaic (PV), portfolio EE, and baseload EE. Use the portfolio EE emission factors if you are assessing a wide range of EE programs. Use the baseload EE emission 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.

For More Information

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

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

Data Year: 2016

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,557	1,559	1,641	1,640
Avoided NO_x Rate	1.06	1.09	1.14	1.12
Avoided SO_2 Rate	1.50	1.45	1.53	1.55
Avoided $PM_{2.5}$ Rate	0.11	0.11	0.12	0.12

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2016 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,070	1,114	1,181	1,143
Great Lakes / Mid-Atlantic	1,711	1,706	1,798	1,795
Southeast	1,456	1,499	1,578	1,557
Lower Midwest	1,677	1,662	1,751	1,760
Upper Midwest	1,922	1,872	1,971	2,004
Rocky Mountains	1,851	1,810	1,898	1,921
Texas	1,483	1,444	1,531	1,552
Southwest	1,445	1,411	1,443	1,478
Northwest	1,655	1,634	1,704	1,722
California	1,004	1,016	1,065	1,055

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.41	0.53	0.59	0.49
Great Lakes / Mid-Atlantic	1.33	1.30	1.38	1.36
Southeast	0.92	1.02	1.06	1.01
Lower Midwest	1.16	1.26	1.32	1.26
Upper Midwest	1.51	1.47	1.54	1.57
Rocky Mountains	1.31	1.25	1.32	1.34
Texas	0.66	0.74	0.77	0.73
Southwest	1.38	1.29	1.26	1.35
Northwest	1.32	1.30	1.36	1.37
California	0.34	0.36	0.40	0.37

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.30	0.35	0.40	0.33
Great Lakes / Mid-Atlantic	2.06	2.02	2.15	2.15
Southeast	1.34	1.35	1.41	1.40
Lower Midwest	1.84	1.73	1.82	1.90
Upper Midwest	2.35	2.14	2.26	2.40
Rocky Mountains	0.74	0.76	0.79	0.79
Texas	1.67	1.51	1.63	1.71
Southwest	0.47	0.44	0.37	0.43
Northwest	0.93	0.89	0.96	0.96
California	0.07	0.06	0.07	0.07

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.04	0.05	0.05	0.04
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	0.10	0.10
Upper Midwest	0.10	0.09	0.10	0.10
Rocky Mountains	0.03	0.03	0.03	0.03
Texas	0.08	0.08	0.08	0.09
Southwest	0.08	0.08	0.07	0.08
Northwest	0.09	0.09	0.09	0.09
California	0.04	0.04	0.04	0.04

Data Year: 2015

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,568	1,561	1,648	1,646
Avoided NO_x Rate	1.13	1.13	1.19	1.18
Avoided SO_2 Rate	2.09	1.97	2.08	2.11
Avoided $PM_{2.5}$ Rate	0.12	0.11	0.12	0.12

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2015 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,139	1,145	1,214	1,194
Great Lakes / Mid-Atlantic	1,773	1,758	1,852	1,854
Southeast	1,501	1,495	1,589	1,584
Lower Midwest	1,774	1,747	1,838	1,856
Upper Midwest	1,890	1,852	1,958	1,976
Rocky Mountains	1,876	1,843	1,922	1,952
Texas	1,399	1,430	1,502	1,486
Southwest	1,268	1,267	1,296	1,305
Northwest	1,520	1,547	1,640	1,617
California	1,044	1,054	1,107	1,099

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.60	0.66	0.70	0.65
Great Lakes / Mid-Atlantic	1.53	1.48	1.57	1.56
Southeast	0.99	1.00	1.06	1.05
Lower Midwest	1.26	1.33	1.40	1.35
Upper Midwest	1.49	1.42	1.50	1.54
Rocky Mountains	1.83	1.77	1.87	1.89
Texas	0.63	0.76	0.78	0.71
Southwest	0.98	1.00	0.95	0.97
Northwest	1.11	1.20	1.27	1.22
California	0.52	0.49	0.48	0.52

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.66	0.65	0.71	0.65
Great Lakes / Mid-Atlantic	3.83	3.72	3.87	3.88
Southeast	1.90	1.72	1.85	1.89
Lower Midwest	2.17	2.02	2.13	2.22
Upper Midwest	2.62	2.47	2.63	2.70
Rocky Mountains	0.90	0.85	0.89	0.92
Texas	1.41	1.36	1.45	1.47
Southwest	0.74	0.66	0.65	0.71
Northwest	0.60	0.67	0.74	0.68
California	0.07	0.07	0.07	0.07

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.23	0.22	0.23	0.23
Southeast	0.10	0.10	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	0.03
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	0.04	0.04

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Data Year: 2014

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,563	1,527	1,610	1,628
Avoided NO_x Rate	1.23	1.22	1.28	1.28
Avoided SO_2 Rate	2.35	2.28	2.39	2.43
Avoided $PM_{2.5}$ Rate	0.12	0.11	0.12	0.12

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2014 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,176	1,141	1,228	1,213
Great Lakes / Mid-Atlantic	1,755	1,723	1,816	1,833
Southeast	1,496	1,455	1,545	1,556
Lower Midwest	1,750	1,688	1,786	1,822
Upper Midwest	1,922	1,884	1,980	2,011
Rocky Mountains	1,829	1,799	1,884	1,904
Texas	1,331	1,295	1,364	1,390
Southwest	1,222	1,187	1,211	1,238
Northwest	1,596	1,583	1,621	1,666
California	1,021	1,025	1,076	1,072

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.77	0.78	0.85	0.80
Great Lakes / Mid-Atlantic	1.62	1.61	1.69	1.68
Southeast	1.08	1.09	1.15	1.13
Lower Midwest	1.50	1.49	1.58	1.58
Upper Midwest	1.66	1.63	1.72	1.73
Rocky Mountains	1.64	1.57	1.65	1.68
Texas	0.68	0.70	0.72	0.73
Southwest	0.87	0.79	0.75	0.81
Northwest	1.40	1.41	1.40	1.46
California	0.64	0.62	0.61	0.65

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1.01	0.90	1.02	0.94
Great Lakes / Mid-Atlantic	4.11	4.11	4.26	4.29
Southeast	2.22	2.16	2.27	2.30
Lower Midwest	2.20	2.04	2.18	2.26
Upper Midwest	3.02	2.91	3.06	3.14
Rocky Mountains	1.13	1.08	1.12	1.16
Texas	1.57	1.38	1.47	1.58
Southwest	0.39	0.32	0.28	0.33
Northwest	1.00	0.98	0.98	1.04
California	0.06	0.05	0.05	0.06

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.22	0.21	0.22	0.23
Southeast	0.11	0.11	0.11	0.11
Lower Midwest	0.10	0.10	0.10	0.11
Upper Midwest	0.10	0.10	0.10	0.10
Rocky Mountains	0.03	0.03	0.04	0.04
Texas	0.07	0.07	0.07	0.07
Southwest	0.06	0.06	0.06	0.06
Northwest	0.08	0.08	0.08	0.09
California	0.04	0.04	0.04	0.04

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Data Year: 2013

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,524	1,505	1,587	1,595
Avoided NO_x Rate	1.23	1.23	1.30	1.29
Avoided SO_2 Rate	2.29	2.21	2.35	2.38
Avoided $PM_{2.5}$ Rate	0.12	0.12	0.13	0.13

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
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Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,172	1,167	1,252	1,228
Great Lakes / Mid-Atlantic	1,686	1,672	1,765	1,770
Southeast	1,425	1,437	1,517	1,510
Lower Midwest	1,731	1,660	1,751	1,788
Upper Midwest	1,918	1,867	1,970	1,995
Rocky Mountains	1,841	1,784	1,861	1,894
Texas	1,382	1,331	1,409	1,436
Southwest	1,202	1,172	1,218	1,228
Northwest	1,473	1,446	1,504	1,531
California	1,012	1,026	1,077	1,066

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.72	0.76	0.86	0.77
Great Lakes / Mid-Atlantic	1.46	1.46	1.54	1.53
Southeast	0.97	1.02	1.09	1.06
Lower Midwest	1.66	1.68	1.76	1.75
Upper Midwest	1.87	1.80	1.91	1.94
Rocky Mountains	1.85	1.76	1.85	1.89
Texas	0.71	0.75	0.77	0.75
Southwest	0.95	0.85	0.83	0.88
Northwest	1.71	1.65	1.83	1.79
California	0.72	0.70	0.71	0.73

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1.02	0.94	1.07	1.01
Great Lakes / Mid-Atlantic	3.97	3.85	4.10	4.14
Southeast	2.05	2.15	2.28	2.23
Lower Midwest	2.31	2.06	2.19	2.32
Upper Midwest	3.11	2.91	3.09	3.19
Rocky Mountains	1.38	1.29	1.33	1.38
Texas	1.68	1.36	1.48	1.64
Southwest	0.26	0.24	0.25	0.26
Northwest	0.91	0.87	0.87	0.93
California	0.08	0.07	0.07	0.08

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.05	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.20	0.19	0.20	0.20
Southeast	0.12	0.12	0.13	0.13
Lower Midwest	0.10	0.10	0.10	0.10
Upper Midwest	0.13	0.13	0.14	0.14
Rocky Mountains	0.06	0.06	0.07	0.07
Texas	0.07	0.07	0.08	0.08
Southwest	0.08	0.07	0.07	0.08
Northwest	0.08	0.08	0.08	0.09
California	0.06	0.06	0.06	0.06

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Data Year: 2012

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,576	1,564	1,648	1,654
Avoided NO_x Rate	1.30	1.33	1.39	1.37
Avoided SO_2 Rate	2.46	2.45	2.58	2.60
Avoided $PM_{2.5}$ Rate	0.13	0.13	0.14	0.14

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,099	1,154	1,222	1,183
Great Lakes / Mid-Atlantic	1,757	1,744	1,841	1,846
Southeast	1,513	1,526	1,609	1,602
Lower Midwest	1,689	1,622	1,717	1,754
Upper Midwest	1,932	1,867	1,974	2,007
Rocky Mountains	1,930	1,855	1,949	1,985
Texas	1,381	1,389	1,458	1,454
Southwest	1,340	1,246	1,297	1,339
Northwest	1,685	1,672	1,736	1,761
California	1,020	1,057	1,112	1,087

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.49	0.66	0.72	0.60
Great Lakes / Mid-Atlantic	1.69	1.68	1.77	1.77
Southeast	1.08	1.16	1.21	1.18
Lower Midwest	1.88	1.94	2.01	1.99
Upper Midwest	1.71	1.68	1.76	1.78
Rocky Mountains	2.14	2.02	2.14	2.18
Texas	0.59	0.70	0.71	0.66
Southwest	1.47	1.14	1.18	1.32
Northwest	1.62	1.60	1.67	1.69
California	0.52	0.54	0.57	0.56

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.64	0.82	0.89	0.77
Great Lakes / Mid-Atlantic	4.34	4.31	4.58	4.60
Southeast	2.25	2.44	2.53	2.46
Lower Midwest	2.02	1.75	1.87	2.02
Upper Midwest	3.66	3.39	3.62	3.76
Rocky Mountains	1.60	1.44	1.50	1.58
Texas	1.34	1.22	1.28	1.35
Southwest	0.61	0.51	0.53	0.58
Northwest	1.48	1.33	1.48	1.48
California	0.10	0.09	0.10	0.10

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.04	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.21	0.21	0.22	0.22
Southeast	0.13	0.13	0.14	0.14
Lower Midwest	0.10	0.10	0.10	0.10
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	0.10	0.08	0.08	0.09
Northwest	0.11	0.11	0.11	0.12
California	0.06	0.06	0.07	0.06

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Data Year: 2011

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,628	1,592	1,680	1,697
Avoided NO_x Rate	1.46	1.44	1.51	1.52
Avoided SO_2 Rate	3.38	3.15	3.38	3.49
Avoided $PM_{2.5}$ Rate	0.15	0.14	0.15	0.15

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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 (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,215	1,245	1,318	1,290
Great Lakes / Mid-Atlantic	1,815	1,775	1,881	1,894
Southeast	1,584	1,566	1,660	1,662
Lower Midwest	1,681	1,593	1,687	1,737
Upper Midwest	2,015	1,936	2,053	2,088
Rocky Mountains	1,924	1,872	1,948	1,985
Texas	1,333	1,305	1,375	1,392
Southwest	1,347	1,268	1,309	1,348
Northwest	1,688	1,672	1,681	1,758
California	994	979	1,016	1,029

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.61	0.73	0.78	0.70
Great Lakes / Mid-Atlantic	1.76	1.69	1.81	1.83
Southeast	1.40	1.39	1.45	1.45
Lower Midwest	1.95	1.98	2.07	2.06
Upper Midwest	1.90	1.80	1.92	1.96
Rocky Mountains	2.18	2.10	2.18	2.23
Texas	0.69	0.82	0.84	0.78
Southwest	1.33	1.11	1.11	1.22
Northwest	1.63	1.60	1.55	1.68
California	0.53	0.42	0.40	0.50

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1.77	1.84	1.96	1.89
Great Lakes / Mid-Atlantic	5.66	5.35	5.79	5.88
Southeast	3.41	3.25	3.51	3.56
Lower Midwest	2.35	1.93	2.08	2.32
Upper Midwest	4.75	4.42	4.69	4.85
Rocky Mountains	1.84	1.74	1.81	1.86
Texas	1.54	1.16	1.24	1.47
Southwest	0.58	0.47	0.45	0.51
Northwest	1.40	1.37	1.27	1.43
California	0.09	0.07	0.06	0.08

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.05	0.05	0.05	0.05
Great Lakes / Mid-Atlantic	0.24	0.22	0.24	0.24
Southeast	0.16	0.16	0.17	0.17
Lower Midwest	0.10	0.09	0.10	0.10
Upper Midwest	0.14	0.14	0.15	0.15
Rocky Mountains	0.07	0.07	0.07	0.07
Texas	0.06	0.06	0.07	0.07
Southwest	0.10	0.08	0.08	0.09
Northwest	0.11	0.11	0.10	0.12
California	0.05	0.05	0.05	0.05

Data Year: 2010

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,618	1,569	1,652	1,677
Avoided NO_x Rate	1.46	1.42	1.50	1.51
Avoided SO_2 Rate	3.50	3.18	3.39	3.53
Avoided $PM_{2.5}$ Rate	0.20	0.19	0.20	0.20

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2010 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,259	1,266	1,343	1,329
Great Lakes / Mid-Atlantic	1,814	1,766	1,864	1,887
Southeast	1,574	1,525	1,609	1,629
Lower Midwest	1,686	1,603	1,679	1,734
Upper Midwest	1,998	1,929	2,032	2,069
Rocky Mountains	1,765	1,727	1,807	1,830
Texas	1,388	1,337	1,412	1,444
Southwest	1,385	1,281	1,343	1,384
Northwest	1,496	1,494	1,528	1,565
California	940	949	999	986

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.59	0.73	0.79	0.69
Great Lakes / Mid-Atlantic	1.84	1.77	1.87	1.89
Southeast	1.32	1.32	1.40	1.39
Lower Midwest	2.17	2.09	2.17	2.24
Upper Midwest	1.94	1.84	1.94	1.99
Rocky Mountains	2.02	1.88	2.01	2.03
Texas	0.68	0.72	0.74	0.73
Southwest	1.43	1.11	1.17	1.30
Northwest	1.52	1.53	1.56	1.60
California	0.22	0.20	0.20	0.20

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1.33	1.37	1.47	1.42
Great Lakes / Mid-Atlantic	5.80	5.32	5.67	5.85
Southeast	3.62	3.37	3.60	3.68
Lower Midwest	2.82	2.30	2.47	2.77
Upper Midwest	4.92	4.54	4.81	5.01
Rocky Mountains	1.40	1.35	1.42	1.42
Texas	1.86	1.33	1.46	1.77
Southwest	0.67	0.55	0.58	0.62
Northwest	0.99	0.99	0.94	1.03
California	0.03	0.02	0.01	0.02

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.06	0.08	0.08	0.07
Great Lakes / Mid-Atlantic	0.42	0.39	0.41	0.43
Southeast	0.18	0.18	0.19	0.19
Lower Midwest	0.10	0.10	0.10	0.11
Upper Midwest	0.14	0.13	0.14	0.14
Rocky Mountains	0.09	0.09	0.10	0.10
Texas	0.07	0.07	0.08	0.08
Southwest	0.11	0.09	0.09	0.10
Northwest	0.09	0.08	0.09	0.09
California	0.03	0.03	0.03	0.03

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Data Year: 2009

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,618	1,569	1,655	1,680
Avoided NO_x Rate	1.44	1.42	1.49	1.50
Avoided SO_2 Rate	4.15	4.00	4.19	4.29
Avoided $PM_{2.5}$ Rate	0.20	0.20	0.21	0.21

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2009 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,262	1,225	1,315	1,307
Great Lakes / Mid-Atlantic	1,832	1,798	1,904	1,923
Southeast	1,571	1,508	1,595	1,621
Lower Midwest	1,711	1,612	1,713	1,763
Upper Midwest	2,024	1,993	2,091	2,113
Rocky Mountains	1,807	1,766	1,840	1,871
Texas	1,347	1,293	1,364	1,398
Southwest	1,350	1,260	1,326	1,358
Northwest	1,440	1,411	1,430	1,490
California	1,015	1,038	1,088	1,072

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.66	0.68	0.76	0.69
Great Lakes / Mid-Atlantic	1.65	1.67	1.77	1.75
Southeast	1.32	1.32	1.38	1.38
Lower Midwest	2.09	2.05	2.15	2.18
Upper Midwest	1.95	1.93	2.00	2.03
Rocky Mountains	2.19	2.10	2.17	2.23
Texas	0.81	0.90	0.93	0.89
Southwest	1.46	1.10	1.17	1.30
Northwest	1.50	1.45	1.43	1.53
California	0.49	0.49	0.51	0.50

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1.73	1.58	1.76	1.71
Great Lakes / Mid-Atlantic	7.81	7.79	8.19	8.24
Southeast	4.11	3.96	4.14	4.22
Lower Midwest	2.56	2.11	2.29	2.52
Upper Midwest	5.40	5.35	5.55	5.63
Rocky Mountains	2.50	2.34	2.45	2.48
Texas	1.79	1.32	1.39	1.69
Southwest	0.64	0.51	0.51	0.57
Northwest	1.07	1.08	0.95	1.12
California	0.07	0.06	0.06	0.07

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.07	0.07	0.07	0.07
Great Lakes / Mid-Atlantic	0.45	0.44	0.47	0.47
Southeast	0.18	0.17	0.19	0.19
Lower Midwest	0.10	0.10	0.11	0.11
Upper Midwest	0.14	0.14	0.14	0.15
Rocky Mountains	0.08	0.09	0.10	0.09
Texas	0.06	0.06	0.06	0.06
Southwest	0.10	0.08	0.08	0.09
Northwest	0.08	0.08	0.08	0.09
California	0.03	0.03	0.03	0.03

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Data Year: 2008

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,616	1,563	1,655	1,679
Avoided NO_x Rate	2.05	1.81	1.94	2.00
Avoided SO_2 Rate	4.97	4.38	4.72	4.97
Avoided $PM_{2.5}$ Rate	0.20	0.19	0.20	0.21

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2008 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,228	1,225	1,298	1,288
Great Lakes / Mid-Atlantic	1,837	1,779	1,885	1,911
Southeast	1,585	1,497	1,602	1,636
Lower Midwest	1,663	1,577	1,674	1,716
Upper Midwest	1,954	1,915	2,013	2,035
Rocky Mountains	1,844	1,800	1,878	1,908
Texas	1,403	1,368	1,454	1,470
Southwest	1,223	1,200	1,253	1,259
Northwest	1,520	1,515	1,560	1,591
California	995	1,039	1,082	1,059

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.65	0.72	0.78	0.71
Great Lakes / Mid-Atlantic	3.16	2.60	2.84	2.93
Southeast	1.99	1.68	1.81	1.91
Lower Midwest	2.30	2.21	2.34	2.38
Upper Midwest	2.46	2.31	2.48	2.51
Rocky Mountains	2.49	2.36	2.47	2.53
Texas	0.77	0.88	0.91	0.86
Southwest	1.18	1.05	1.10	1.13
Northwest	1.63	1.64	1.63	1.70
California	0.33	0.35	0.37	0.36

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1.40	1.13	1.35	1.38
Great Lakes / Mid-Atlantic	9.19	8.41	9.02	9.28
Southeast	5.70	4.67	5.14	5.56
Lower Midwest	2.89	2.43	2.63	2.86
Upper Midwest	4.96	4.78	4.99	5.12
Rocky Mountains	1.84	1.77	1.88	1.89
Texas	1.72	1.20	1.40	1.68
Southwest	0.45	0.30	0.33	0.37
Northwest	2.22	2.70	2.39	2.53
California	0.03	0.02	0.02	0.03

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.06	0.07	0.07	0.07
Great Lakes / Mid-Atlantic	0.44	0.41	0.43	0.45
Southeast	0.19	0.18	0.19	0.20
Lower Midwest	0.10	0.10	0.10	0.10
Upper Midwest	0.13	0.12	0.13	0.13
Rocky Mountains	0.08	0.08	0.09	0.08
Texas	0.06	0.06	0.06	0.06
Southwest	0.07	0.06	0.06	0.07
Northwest	0.09	0.09	0.10	0.10
California	0.03	0.03	0.03	0.03

Data Year: 2007

National Emission Factors

National Weighted Averages (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Avoided CO_2 Rate	1,602	1,545	1,632	1,656
Avoided NO_x Rate	2.15	1.90	2.01	2.08
Avoided SO_2 Rate	5.23	4.47	4.80	5.10
Avoided $PM_{2.5}$ Rate	0.20	0.18	0.19	0.20

- **Wind** = Wind power generation
- **Utility PV** = Utility-scale photovoltaic power generation
- **Portfolio EE** = Represents a wide range of EE program types
- **Baseload 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 2007 fossil generation in each region.

Regional Emission Factors

Avoided CO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	1,289	1,284	1,362	1,348
Great Lakes / Mid-Atlantic	1,799	1,742	1,839	1,863
Southeast	1,604	1,516	1,615	1,646
Lower Midwest	1,654	1,558	1,654	1,702
Upper Midwest	1,943	1,883	1,994	2,021
Rocky Mountains	1,721	1,689	1,763	1,785
Texas	1,288	1,255	1,324	1,340
Southwest	1,169	1,137	1,180	1,190
Northwest	1,543	1,552	1,562	1,607
California	1,066	1,072	1,131	1,120

Avoided NO_x Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.93	1.01	1.07	1.00
Great Lakes / Mid-Atlantic	3.25	2.65	2.85	2.96
Southeast	2.13	1.85	1.97	2.06
Lower Midwest	2.55	2.42	2.54	2.62
Upper Midwest	2.60	2.42	2.61	2.66
Rocky Mountains	2.00	1.93	1.97	2.03
Texas	0.70	0.77	0.80	0.77
Southwest	1.11	1.03	1.04	1.06
Northwest	1.67	1.75	1.59	1.74
California	0.45	0.39	0.42	0.44

Avoided SO_2 Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	2.02	1.86	2.02	2.01
Great Lakes / Mid-Atlantic	9.68	8.57	9.13	9.52
Southeast	6.05	4.84	5.29	5.76
Lower Midwest	3.11	2.53	2.72	3.02
Upper Midwest	5.39	5.02	5.33	5.51
Rocky Mountains	1.69	1.62	1.64	1.70
Texas	1.34	0.99	1.07	1.24
Southwest	0.31	0.25	0.25	0.27
Northwest	1.39	1.04	1.00	1.26
California	0.04	0.03	0.03	0.04

Avoided $PM_{2.5}$ Rate (lbs/MWh)				
	Wind	*Utility PV*	*Portfolio EE*	*Baseload EE*
Northeast	0.07	0.08	0.08	0.08
Great Lakes / Mid-Atlantic	0.40	0.37	0.39	0.40
Southeast	0.20	0.18	0.19	0.20
Lower Midwest	0.10	0.10	0.10	0.10
Upper Midwest	0.14	0.14	0.14	0.14
Rocky Mountains	0.10	0.11	0.12	0.11
Texas	0.06	0.06	0.06	0.06
Southwest	0.07	0.06	0.06	0.06
Northwest	0.09	0.09	0.09	0.09
California	0.03	0.04	0.04	0.03