Updating electric grid emissions factors

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NOMENCLATURE

ANL	Argonne National Laboratory
Coal IGCC	coal integrated gasification combined cycle
Coal ST	coal steam boiler
EIA	US Energy Information Administration
FCV	fuel cell vehicle
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Transportation
GHG	greenhouse gas
HHV	higher heating value
ICEV	internal combustion engine vehicle
LHV	lower heating value
NG CC	natural gas combined cycle
NG GT	natural gas turbine
NG ICE	natural gas internal combustion engine
NG ST	natural gas steam boiler
Oil GT	oil gas turbine
Oil ICE	oil internal combustion engine
Oil ST	oil steam boiler
PM	particulate matter
PU	physical unit

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1 INTRODUCTION

This document describes the data and processes utilized in updating the electric grid emissions factors within GREET.net. Since electricity markets are dynamic and data are generally reported on an annual basis, it was determined that, to the extent possible, the emissions profiles of the electrical grids within GREET should be updated annually. The data for this update are gathered from the US Energy Information Administration's (EIA) Form 923 (U.S. Energy Information Administration 2016b). Specifically, Argonne National Laboratory (ANL) used the 2014 EIA 923 data during this update since it was the most recently verified data set. It should be noted that, while EIA do release data on a monthly basis, the ANL team has opted to utilize only their verified data, which is done at some duration following final annual reporting. Updated data for subsequent years can be added by utilizing the procedures described herein.

The dynamic nature of the electrical grid (both temporal and geospatial) also means that some broad aggregation must be made in order to present meaningful estimations. An annual average approach is employed, while acknowledging that time-of-use considerations are important to identifying exactly which electrical generating units are being utilized at any specific moment in time. Such an account requires dispatch modeling with detailed facility, transmission and utility constraints along with knowledge of market economics and bidding. This effort does not attempt to capture such nuance. The grid average does provide important insights into the characteristic facilities and emissions within a specific grid boundary, but it may not accurately represent certain features. Importantly, the bulk average may not fully capture some time-of-use features for plug-in electric vehicles, or time-shifted appliances (e.g. laundry facilities and dishwashers). Those specific examples would need a time-of-use average for a more detailed characterization. Additionally, the bulk average cannot be used within a marginal analysis, which seeks to identify the electrical facility on the margin that would be used if a new electrical load were added to the grid.

2 METHODOLOGY

2.1 General Data Refinement

Within this analysis ANL uses these EIA 923's database pages: "Page 1 Generation and Fuel Data", "Page 3 Boiler Fuel Data" and "8C Emissions Control Info" (U.S. Energy

Information Administration 2016b). Within those data sets, any combined heat and power plants are removed, as are any plants that do not have a NAICS Code of 22. Additionally, we removed generators and boilers that have a reported heat input of 0 MMBtu (note that while nuclear, wind, water, and solar facilities do not burn fuel, the EIA data set does determine an energy input for those facilities based on assumed generating efficiencies, so this filtration does not remove them from needed calculations).

2.2 Geographic Aggregation

For this study, ANL used four different geographic aggregation boundaries: state, national, NERC, and eGrid. The state and national boundaries are self-explanatory, and can be identified using embedded data within the EIA 923 database for each plant. NERC (North American Electrical Reliability Corporation) regions are used to group electrical plants within the US and information for each plant's NERC affiliation is contained with EIA 923, see Figure 1 for region locations. eGrid (Emissions and Generation Integrated Database) is a US EPA developed database for the environmental characteristics of electricity generation; it has defined several regions (eGrid subregions), which have geographic boundaries, see Figure 2. ANL uses EIA's 860 database, which contains plant location information, along with eGrid shape files, to determine which plants are within a specific eGrid primary subregion (U.S. Energy Information Administration 2016a). That association is then coupled with the EIA 923 database for proper grouping.

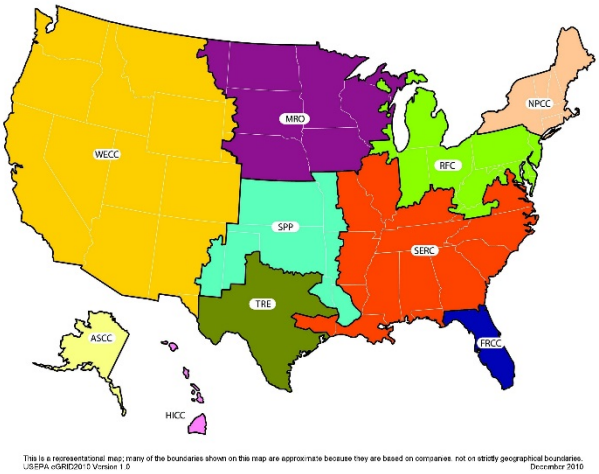

Figure 1 NERC region map. (U.S. Environmental Protection Agency 2016c)

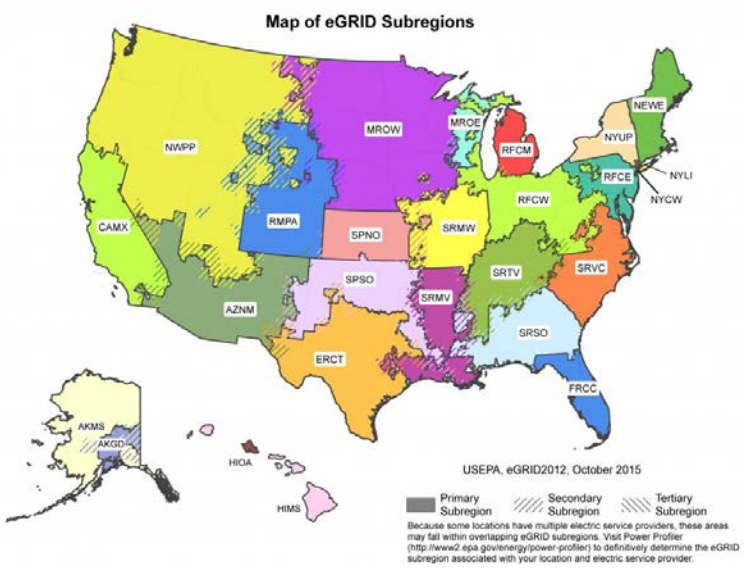

Figure 2 eGrid subregion map. (U.S. Environmental Protection Agency 2016b)

2.3 Electricity Generation Mixes

Page 1 of EIA 923's database ("Page 1 Generation and Fuel Data") contains electricity generation, *e*, and heat input, *h*, data. Those data are used to identify the efficiency of plants within each region (for simplicity, the term region will be used when discussing the various regional aggregations described previously). However, to determine that efficiency several calculations are required.

First, GREET uses the lower heating value (LHV) for fuels, while EIA uses higher heating values (HHV). Therefore, each plant's, *p*, fuel consumption, *f*, is converted from HHV_f to LHV_f using the LHV_f / HHV_f ratio available from GREET (presented in Table 1). Note that not all fuels listed in EIA have specific GREET counterparts, in those cases a comparable fuel was selected from GREET, as noted in Table 1. EIA includes fuel consumption for hydropower, wind, solar, and nuclear plants, however those values are not considered in this analysis. We chose not to take these input values into accounts because it seems that a generic "renewable efficiency" was used to calculate these inputs, and they do not represent an amount of fuel used, they do represent an amount of "renewable resource used" which is not of any interest in our model. But we are interested in their electricity generation. The reported heat input for each plant, fuel, prime mover combination from EIA (a unique identifier of the various generator types within each plant) in HHV is multiplied by the appropriate LHV_f / HHV_f ratio.

Table 1 Reported fuel codes from EIA 923 along with associated GREET parameters

Reported Fuel Type Code	GREET Fuel Code	Density (lbs/PU)	Physical Unit (PU)	LHV/HHV[a]	LHV Notes
ANT	Coal	2000	short tons	*0.958*	Use Bituminous Coal
BIT	Coal	2000	short tons	0.958	Use Bituminous Coal
LIG	Coal	2000	short tons	0.832	Use Lignite Coal
MSN	Coal	2000	short tons	*0.825*	Use MSW
PC	Coal	2000	short tons	0.942	Use Pet Coke
RC	Coal	2000	short tons	*0.958*	Use Synthetic Coal
SC	Coal	2000	short tons	0.958	Use Synthetic Coal
SGC	Coal	n/a	Mcf	*0.958*	Use Synthetic Coal
SUB	Coal	2000	short tons	0.922	Use Sub-bituminous Coal
TDF	Coal	2000	short tons	0.942	Use Tire Derived Fuel
WC	Coal	2000	short tons	0.832	Use Waste Coal
BFG	NG	78	Mcf	*0.903*	Use Natural Gas
LFG	NG	81.8	Mcf	*0.903*	Use Natural Gas
NG	NG	48.5	Mcf	0.903	Use Natural Gas
OBG	NG	48.5	Mcf	*0.903*	Use Natural Gas
OG	NG	48.5	Mcf	*0.903*	Use Natural Gas
OTH	NG	n/a	Mcf	*0.903*	Use Natural Gas
PG	NG	117.5	Mcf	0.922	Use Propane
PUR	NG	0	Mcf	*0.903*	Use Natural Gas
SGP	NG	n/a	Mcf	*0.942*	Use Pet Coke
AB	Biomass	2000	short tons	*0.825*	Use MSW
BLQ	Biomass	2000	short tons	*0.825*	Use MSW
MSB	Biomass	2000	short tons	*0.877*	Use Convertible MSW
MSW	Biomass	2000	short tons	*0.877*	Use Convertible MSW
OBL	Biomass	n/a	barrels	*0.825*	Use MSW
OBS	Biomass	2000	short tons	*0.877*	Use Convertible MSW
SLW	Biomass	2000	short tons	*0.825*	Use MSW
WDL	Biomass	n/a	barrels	*0.825*	Use MSW
WDS	Biomass	2000	short tons	*0.966*	Use Forest Residue
DFO	Oil	293.2	barrels	*0.935*	Use US Conventional Diesel
JF	Oil	281.1	barrels	0.935	Use Jet Fuel
KER	Oil	210.1	barrels	0.935	Use Bunker Fuel
RFO	Oil	347.4	barrels	*0.935*	Use Residual Oil
WO	Oil	347.4	barrels	*0.935*	Use Residual Oil
NUC	NUC			1	
SUN	Renewable			1	
WAT	Renewable			1	
WH	Renewable			1	
WND	Renewable			1	
GEO	Renewable			1	
MWH	Renewable			1	

a LHV/HHV ratios from GREET

Next, some plants are identified as combined cycle as indicated by their prime mover, *q*, with classifications of “CT”, “CS”, or “CA”. For purposes of plant and regional efficiency calculations, those combined cycle plants are all considered as one type, combined cycle. The efficiency of each plant’s fuel, and prime mover combinations, $\eta_{p,f,q}$ are calculated by summing matching fuel-prime mover pairs using Equation 1.

$$\eta_{p,f,q} = \sum_{p}\sum_{f}\sum_{pm} \frac{e_{p,f,q} \times MWh2MMBtu}{h_{p,f,q} \times \frac{LHV_f}{HHV_f}} \times 100\% \quad \textbf{Equation 1}$$

where

$\eta_{p,f,q}$	is the LHV-based energy efficiency (%) for plant *p*, with fuel type *f*, and prime mover *q*;
$e_{p,f,q}$	is the net electricity generation (MWh) for plant *p*, with fuel type *f*, and prime mover *q*;
MWh2MMBtu	is the unit conversion of MWh electricity to MMBtu, which is 3.412 MMBtu per MWh;
$h_{p,f,q}$	is the heat input for electricity (MMBtu) for plant *p*, with fuel type *f*, and prime mover *q*;
LHV_f/HHV_f	is the LHV to HHV ratio for fuel type *f*.

Finally, using the efficiency of each plant's fuel-prime mover pairs, a filtration is applied to identify and eliminate any of those pairs that violate certain conditions. Specifically, any combined cycle plant with an efficiency below 0% or above 65% is eliminated, and any other plants with an efficiency below 0% or above 45% are also eliminated. The remaining plant's fuel-prime mover pairs are retained for determination of regional technology shares, ts_r, and the efficiencies of those fuel-prime mover pairs, $\eta_{r,f,q}$, within region, *r*, as described in Equation 2 and Equation 3. Additionally, those eliminated pairs are also used to eliminate certain boiler data, as described in the next section.

$$ts_{r,f} = \frac{\sum_r \sum_f \sum_{PM} e_{r,f,Q}}{\sum_r \sum_F \sum_{PM} e_{r,F,Q}} \quad \textbf{Equation 2}$$

where

$ts_{r,f}$	is the technology share (%) within region *r* of fuel *f*;
$e_{r,f,Q}$	is the net electricity generation (MWh) within region *r* of fuel *f* and all prime movers *Q*;
$e_{r,F,Q}$	is the net electricity generation (MWh) within region *r* for all fuel types *F* and all prime movers *Q*.

The regional aggregation, Equation 3, is similar to Equation 1, but instead of summing within plants, the summation occurs within the various regions described previously.

$$\eta_{r,f,q} = \sum_{r}\sum_{f}\sum_{pm} \frac{e_{r,f,q} \times MWh2MMBtu}{h_{r,f,q} \times \frac{LHV_f}{HHV_f}} \times 100\% \quad \textbf{Equation 3}$$

where

$\eta_{r,f,q}$	is the LHV-based energy efficiency (%) within region *r*, for fuel type *f*, and prime mover *q*;

$e_{r,f,q}$	is the net electricity generation (MWh) within region *r*, for fuel type *f*, and prime mover *q*;
MWh2MMBtu	is the unit conversion of MWh electricity to MMBtu, which is 3.412 MMBtu per MWh;
$h_{r,f,q}$	is the heat input for electricity (MMBtu) within region *r*, for fuel type *f*, and prime mover *q*;
LHV_f/HHV_f	is the LHV to HHV ratio for fuel type *f*.

The regional aggregations for both technology share and technology efficiency are integrated within GREET.net for the 2016 release. The results of the technology share and technology efficiency for each regional aggregation are presented in Appendix A.

Note that for some technologies there may not be enough data within a specific region to obtain an efficiency. In those cases the national GREET average is applied, in these instances values are marked with a warning indicating that they represent the US average and not the regional characteristic.

2.4 Emissions Characterization

Using a similar aggregation approach as described above, boiler data (EIA 923's "Page 3 Boiler Fuel Data") and emissions control technology data (EIA 923's "8C Emissions Control Info") are utilized in order to determine the emissions associated with each boiler fuel-prime mover pair. The boiler data is organized by plant ID, boiler ID, prime mover and fuel type. It contains the quantity of fuel consumed and the energy content and sulfur content of that fuel on a monthly basis. The emissions control information is organized by technology control, it includes a plant ID, control ID, technology type, hours of operation, NO_x emissions rate, particulate matter (PM) emissions rate (we assume this to be $PM_{2.5}$), and SO_x removal efficiency.

First, we collect the total annual energy consumed by that plant by summing the monthly quantity of fuel multiplied by the monthly heat content of the fuel. This provides the HHV for that plant-boiler-prime mover-fuel type entry. Then, just like in the electricity generation case, the HHV provided for each heat input must be converted to the LHV. Equation 4 shows the whole process.

$$lh_{p,b,q,f} = \frac{LHV_f}{HHV_f} \sum_{M} q_{p,b,q,f,m} h_{p,b,q,f,m} \qquad \textbf{Equation 4}$$

where

$lh_{p,b,q,f}$	is the total LHV (MMBtu) of consumed fuel associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$h_{p,b,q,f,m}$	is the HHV (MMBtu) per unit of quantity associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry for month *m;*
$q_{p,b,q,f,m}$	is the monthly quantity of fuel *f* for month *m* associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
LHV_f/HHV_f	is the LHV to HHV ratio for fuel type *f*.

This *lh* data is used to determine the NO_x and $PM_{2.5}$ emissions associated with each boiler's fuel-prime mover pairs.

Next we need to determine the total (maximum possible) SO_x emissions associated with each plant-boiler-prime mover-fuel type entry (since we know the efficiency of the desulfurization technology, we must know the maximum SO_x throughput). This is done according to Equation 5. Note that we multiply by 2 as that is roughly the molar ratio of SO_x to S (SO_x contains multiple species, but using the 2:1 ratio to represent SO_2:S is reasonable).

$$maxSOX_{p,b,q,f} = 2d_f \sum_{M} q_{p,b,q,f,m} S_{p,b,q,f,m} \qquad \textbf{Equation 5}$$

where

$maxSOX_{p,b,q,f}$	is the maximum SO_x associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
d_f	is the density of fuel *f*;
$q_{p,b,q,f,m}$	is the monthly quantity of fuel *f* for month *m* associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$S_{p,b,q,f,m}$	is the monthly sulfur content of fuel *f* for month *m* associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry.

As noted, each boiler has a unique identifying boiler ID. Additionally, within "8C Emissions Control Info", each control technology has an associated plant number, and a control ID. We assume that control IDs are matched to boiler IDs, though we note that these data sets are not perfectly aligned in naming convention. Additionally, some control IDs have names that match no boiler IDs, but they do have the same number of operational hours as other control technologies associated with the same boiler ID. Therefore, to better identify all technologies which are used to control emissions, if control technologies (control IDs) within a plant of the same number have the same hours of use, then, as a conservative approach, the emissions rate of the worst performing control technology is applied to that control ID. This holds for NO_x and PM2.5 emission, which are provided as lbs/MMBtu. For SO_x, an SO_2 removal efficiency is provided, thus we conservatively use the worst performing technology (i.e. lowest percentage), as long as that technology is not zero. Thus, if no control technology is reported then maximum SO_x emissions are used based on the sulfur content. For NO_x and PM this provides the most conservative approach for emissions, while for SO_x it is conservative within the bounds that technology is applied.

So to calculate the PM2.5 or NO_x emissions associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry Equation 6 is used,

$$totEm_{p,b,q,f} = lh_{p,b,q,f,m} \max(Em_{p,c}) \quad \forall\, c = b \qquad \textbf{Equation 6}$$

where

$totEm_{p,b,q,f}$	is the total emissions of NOx or PM associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;

$lh_{p,b,q,f}$	is the total LHV (MMBtu) associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$max(Em_{p,c})$	is the maximum emissions rate of NO_x or PM for plant *p* and control *c*, where $c = b$.

While to calculate the toal SO_x emissions associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry Equation 7 is used

$$totSOX_{p,b,q,f} = maxSOX_{p,b,q,f,m}\min(Rem_{p,c}) \quad \forall\, c = b, Rem_{p,c} > 0 \qquad \textbf{Equation 7}$$

where

$totSOX_{p,b,q,f}$	is the total emissions of SO_x associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$maxSOX_{p,b,q,f}$	is the maximum SO_x associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$max(Rem_{p,c})$	is the minimum SO_2 removal percentage for plant *p* and control *c*, where $c = b$ and the removal percentage is greater than zero.

It should be noted that even with the relaxation of using operational hour equality to identify control technologies that are associated with a boiler, there are still situations where boilers have no matching control technologies. To increase data availability for plants, if the above condition was met (i.e. a plant's boiler has no matching control technology) then a search was conducted within available control technologies to identify those control ID's within each plant that are dominated by a specific fuel and prime mover type (i.e. a plant-boiler-prime mover-fuel entry that is above 80% MMBtu production compared to the other fuel entries for that plant-boiler-prime mover). Then, similar to Equation 6 and Equation 7, the worst performing technology within that plant, associated with the same prime mover-fuel type, is conservatively applied to the associated boiler, see Equation 8 for NO_x and PM2.5. The same approach is used for SO_x, though the calculation follows Equation 7 with the nuance of Equation 8,

$$totEm_{p,b,q,f} = lh_{p,b,q,f,m}\max(Em_{p,c,q,f}) \quad where\ b\ not\ in\ C, \qquad \textbf{Equation 8}$$

where

$totEm_{p,b,q,f}$	is the total emissions estimation of NO_x or PM associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$lh_{p,b,q,f}$	is the total LHV (MMBtu) of consumed fuel associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$max(Em_{p,c,q,f})$	is the maximum emissions rate of NO_x or PM for plant *p* and control *c*, where *b* was not within *C*, and where $Em_{p,c,q,f}/Em_{p,c,q,f} \geq 80\%$.

These calculations provide the total emissions of NO_x, PM, and SO_x for all viable boiler entries. These can then be aggregated according to location, fuel and prime mover to develop characteristic emissions rates for each state or region, according to Equation 9.

$$rateEm_{q,f,r} = \sum_{pm}\sum_{f}\sum_{r}\sum_{P}\sum_{B}\frac{totEm_{p,b,q,f,r}}{lh_{p,b,pm,f,r}}$$ **Equation 9**

where

$rateEm_{q,f,r}$	is the rate of emissions estimation of NO_x, SO_x, or PM associated with the prime mover *q*, and fuel *f* within region *r*;
$totEm_{p,b,q,f,r}$	is the total emissions of NO_x, SO_x, or PM associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry;
$lh_{p,b,q,f,r}$	is the total LHV (MMBtu) of consumed fuel associated with the plant *p*, boiler *b*, prime mover *q*, and fuel *f* entry.

The characteristic emissions rate for each technology and fuel within each region can be found in Appendix B.

For PM_{10} calculations, we applied a ratio specific to each technology, fuel type for the current simulation year and calculated these emissions from our $PM_{2.5}$ value calculated from EIA 923

3 DISCUSSION

The resultant emissions rates for the various regional aggregations were compared with to emissions rates from the U.S. Environmental Protection Agency's (EPA) Air Market Program (U.S. Environmental Protection Agency 2016a). While not all rates were consistent, especially at the state levels, the larger the aggregation, the better the agreement between the two data sets. It is not surprising that these rates are not exactly equal, the primary reason is that the plants contained within the two data sets had minimal overlap. But, the general agreement between the data serves as an independent check of the results developed from this analysis.

It should be noted that state level data may not always be representative when the sampling rate is small. The state level data do allow researchers to conduct analyses, but the larger aggregations (eGrid subregions, NERC regions, and national) have better data coverage and are likely more representative of their aggregation than the state is of its smaller sample. Moreover while the state data may represent the generation within a state, it does not represent the final user consumption mix because electricity grids are usually larger than state level boundaries and many plants are aggregated. When no data is available for a region's emission profile for a specific fuel and technology, then the US average is used in that case. Further, it should be reiterated that the emissions updates only cover characteristic rates for NO_x, SO_x and PM (including $PM_{2.5}$ and PM_{10}). All others are derived based on previous technology characterizations (Cai et al. 2012; Cai et al. 2013). As noted previously, the reported PM emissions in EIA are not specified as $PM_{2.5}$ or PM_{10}, we assumed that they are $PM_{2.5}$ and the calculate PM_{10} from that. Regionalized emissions rates are only updated for the data that is available from the "Boiler" files. This means that only combined cycle plants and steam turbines have updated emissions factors for a regional approach, all other technology emissions factors in GREET remain the same as before.

APPENDIX A

Table A- 1 Fuel shares within the electrical grid by NERC region (%)

Fuel	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Biomass	0.2	0.5	0.0	0.5	0.0	1.6	0.1	0.4	0.1	0.6
Coal	45.2	29.7	54.9	51.1	3.3	4.2	41.0	21.6	51.4	0.0
Geothermal	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9
Hydroelectric	3.6	24.0	1.6	7.0	27.4	15.1	0.1	0.1	0.9	0.6
Natural Gas	21.4	25.4	25.1	4.5	57.6	35.5	33.2	62.4	13.6	0.0
Nuclear	28.6	8.6	4.0	15.2	0.0	36.4	13.1	13.1	30.2	0.0
Oil	0.3	0.0	1.6	0.1	9.8	1.7	0.0	0.9	0.6	82.6
Other	0.2	0.4	0.1	0.8	0.0	2.6	0.2	1.3	0.7	0.0
Solar	0.1	2.1	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.3
Wind	0.4	7.0	12.9	20.8	1.9	2.7	12.1	0.0	2.4	8.8

Table A- 2 Technology shares of coal within each NERC region (%)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Coal ST	100	100	100	100	100	100	100	97	99	99*
Coal IGCC	0	0	0	0	0	0	0	3	1	1*

* Value it taken as national average from GREET data from 2015

Table A- 3 Technology shares of natural gas within each NERC region (%)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
NG ST	8.1	5.0	18.7	4.0	0.0	14.1	4.8	4.5	4.4	8.8*
NG CC	86.8	90.2	77.1	83.1	85.3	83.4	93.1	93.5	88.8	84.2*
NG GT	5.0	4.5	3.5	12.8	14.2	2.5	1.8	2.0	6.8	6.1*
NG ICE	0.0	0.3	0.6	0.1	0.5	0.0	0.4	0.0	0.0	0.9*

* Value it taken as national average from GREET data from 2015

Table A- 4 Technology shares of oil within each NERC region (%)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Oil ST	48.6	76.9	85.1	56.9	0.1	68.4	95.2	63.2	48.5	74.1
Oil GT	49.9	11.6	12.7	36.7	58.6	31.0	4.4	36.5	50.3	19.5
Oil ICE	1.5	11.4	2.2	6.4	41.4	0.7	0.4	0.3	1.2	6.4

Table A- 5 Efficiency of each technology and fuel within each NERC region

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Coal IGCC	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.34	0.31	0.40*
Coal ST	0.35	0.35	0.35	0.35	0.29	0.34	0.37	0.35	0.35	0.36*
Oil GT	0.32	0.25	0.22	0.24	0.40	0.40	0.25	0.35	0.34	0.39
Oil ICE	0.31	0.36	0.19	0.29	0.36	0.33	0.32	0.21	0.28	0.37
Oil ST	0.33	0.34	0.34	0.31	0.26	0.33	0.32	0.32	0.33	0.34
NG ST	0.33	0.32	0.32	0.28	0.34*	0.34	0.31	0.32	0.30	0.34*
NG CC	0.52	0.51	0.51	0.50	0.41	0.51	0.50	0.52	0.50	0.55*
NG GT	0.32	0.34	0.30	0.31	0.26	0.33	0.29	0.33	0.32	0.34*
NG ICE	0.32	0.34	0.38	0.31	0.36	0.33	0.35	0.32	0.31	0.34*

* Value it taken as national average from GREET data from 2015

Table A- 6 Fuel shares within the electrical grid by eGrid primary subregion (%)

Fuel	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Biomass	0.0	0.0	0.4	1.7	0.1	0.4	0.0	0.9	0.3	0.5	3.1	0.1	0.0	0.0	0.5	0.0	1.1	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.1	0.6
Coal	4.3	0.0	21.7	0.0	36.9	21.6	0.0	0.0	51.4	40.1	4.8	37.5	0.0	0.0	6.1	23.3	66.1	65.5	72.2	60.0	54.9	34.4	74.4	39.4	53.8	32.4
Geothermal	0.0	0.0	2.8	5.7	0.0	0.0	9.6	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydroelectric	12.8	72.5	6.6	11.0	0.1	0.0	1.6	0.0	3.9	7.0	6.9	41.5	0.0	0.0	36.6	1.6	0.8	0.4	2.8	0.0	1.1	3.1	0.9	2.9	8.6	2.1
Natural Gas	72.2	11.1	38.0	54.8	36.2	62.5	0.0	0.0	11.3	3.6	41.5	9.5	48.0	84.4	13.3	27.2	6.9	10.1	13.7	5.8	30.3	35.0	1.3	33.8	13.2	19.5
Nuclear	0.0	0.0	24.1	11.7	14.1	13.1	0.0	0.0	28.7	25.5	35.9	2.9	49.0	0.0	36.2	44.2	17.9	20.6	0.0	15.2	0.0	27.3	19.9	23.5	23.6	44.0
Oil	7.8	14.0	0.0	0.0	0.0	0.9	65.4	93.8	0.1	0.1	1.9	0.1	1.9	7.7	0.6	0.7	1.1	0.6	0.0	0.1	2.1	0.1	0.1	0.1	0.6	0.6
Other	0.0	0.0	0.1	1.1	0.2	1.3	0.0	0.0	0.3	0.7	3.6	0.3	1.1	7.3	1.2	1.4	1.1	0.4	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.6
Solar	0.0	0.0	4.6	5.5	0.1	0.1	0.6	0.6	0.0	0.0	0.3	0.0	0.0	0.6	0.0	0.2	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.2
Wind	2.9	2.4	1.8	8.5	12.4	0.0	14.9	4.7	3.8	22.4	2.0	7.1	0.0	0.0	5.6	1.4	5.0	2.3	10.9	18.8	11.5	0.0	3.4	0.0	0.0	0.0

Table A- 7 Technology shares of coal within each eGrid primary subregion (%)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Coal ST	100	99*	100	99*	100	97	99*	99*	100	100	100	100	99*	99*	100	100	100	99	100	100	100	100	100	100	100	100
Coal IGCC	0	1*	0	1*	0	3	1*	1*	0	0	0	0	1*	1*	0	0	0	1	0	0	0	0	0	0	0	0

* Value it taken as national average from GREET data from 2015

Table A- 8 Technology shares of natural gas within each eGrid primary subregion (%)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
NG ST	0.0	0.0	5.2	6.6	4.8	4.5	8.8*	8.8*	1.9	4.1	0.8	1.8	30.7	43.1	16.7	5.9	9.4	1.6	2.0	25.2	19.2	39.2	3.5	0.8	0.2	1.0
NG CC	88.9	0.0	92.4	87.9	93.0	93.5	84.2*	84.2*	91.7	81.9	98.7	94.6	65.8	46.2	81.4	88.1	76.4	91.7	83.0	53.9	78.2	58.6	77.1	96.0	90.9	91.0
NG GT	11.1	88.7	2.3	5.0	1.8	2.0	6.1*	6.1*	6.4	13.8	0.5	3.4	3.4	10.7	1.9	6.0	14.2	6.6	14.3	19.1	2.1	2.2	19.3	3.2	8.9	8.0
NG ICE	0.0	11.3	0.0	0.5	0.4	0.0	0.9*	0.9*	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.7	1.8	0.6	0.0	0.1	0.0	0.0	0.0

* Value it taken as national average from GREET data from 2015

Table A- 9 Technology shares of oil within each eGrid primary subregion (%)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Oil ST	0.1	0.0	86.4	4.9	92.2	63.2	19.7	99.6	79.3	52.7	69.8	91.4	43.3	72.2	95.9	29.9	98.2	77.8	80.8	80.3	97.0	91.7	87.7	51.5	66.3	39.9
Oil GT	96.7	0.1	13.6	21.8	7.2	36.5	60.4	0.4	19.2	40.6	29.0	6.7	56.7	27.6	4.1	68.8	1.1	21.1	19.0	15.0	2.2	8.3	9.4	47.7	32.8	58.5
Oil ICE	3.2	99.9	0.0	73.3	0.6	0.3	20.0	0.0	1.5	6.7	1.2	1.9	0.0	0.2	0.0	1.3	0.7	1.1	0.1	4.7	0.7	0.0	2.8	0.8	0.9	1.6

Table A- 10 Efficiency of each technology and fuel within each eGrid primary subregion

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Coal IGCC	0.40*	0.40*	0.40*	0.40*	0.40*	0.34	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.31	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*	0.40*
Coal ST	0.29	0.36*	0.35	0.36*	0.37	0.35	0.36*	0.36*	0.35	0.35	0.34	0.35	0.36*	0.36*	0.34	0.35	0.35	0.35	0.35	0.34	0.35	0.36	0.35	0.35	0.34	0.36
Oil GT	0.40	0.19	0.28	0.23	0.25	0.35	0.40	0.15	0.26	0.24	0.40	0.28	0.44	0.33	0.43	0.35	0.11	0.29	0.23	0.20	0.22	0.23	0.23	0.23	0.31	0.34
Oil ICE	0.37	0.35	0.38*	0.36	0.32	0.21	0.36	0.38*	0.34	0.29	0.33	0.34	0.38*	0.33	0.38*	0.31	0.07	0.31	0.31	0.18	0.33	0.24	0.28	0.32	0.34	0.31
Oil ST	0.26	0.35*	0.35	0.20	0.31	0.32	0.26	0.35	0.33	0.30	0.32	0.34	0.34	0.35	0.34	0.31	0.34	0.35	0.33	0.33	0.33	0.35	0.35	0.30	0.33	0.33
NG ST	0.34*	0.34*	0.32	0.32	0.31	0.32	0.34*	0.34*	0.30	0.27	0.29	0.30	0.34	0.34	0.34	0.31	0.30	0.27	0.34	0.25	0.32	0.33	0.35	0.34	0.33	0.33
NG CC	0.41	0.55*	0.50	0.52	0.51	0.52	0.55*	0.55*	0.52	0.49	0.51	0.51	0.51	0.49	0.51	0.49	0.49	0.51	0.49	0.50	0.51	0.51	0.49	0.53	0.51	0.52
NG GT	0.26	0.24	0.35	0.36	0.29	0.33	0.34*	0.34*	0.29	0.32	0.30	0.30	0.33	0.34	0.33	0.34	0.29	0.31	0.34	0.29	0.32	0.30	0.28	0.32	0.31	0.33
NG ICE	0.34*	0.36	0.30	0.35	0.35	0.32	0.34*	0.34*	0.31	0.31	0.32	0.31	0.34*	0.22	0.32	0.33	0.28	0.32	0.35	0.34	0.39	0.32	0.33	0.31	0.34	0.32

* Value it taken as national average from GREET data from 2015

Table A- 11 Fuel shares within the electrical grid by state (%)

	Biomass	Coal	Geothermal	Hydroelectric	Natural Gas	Nuclear	Oil	Other	Solar	Wind
AK	0.0	3.3	0.0	27.2	57.1	0.0	9.8	0.0	0.0	2.7
AL	0.0	36.1	0.0	7.2	25.0	31.6	0.1	0.0	0.0	0.0
AR	0.0	56.5	0.0	4.5	14.1	24.7	0.0	0.1	0.0	0.0
AZ	0.2	38.1	0.0	5.5	24.1	28.9	0.1	0.1	2.8	0.4
CA	1.8	0.0	7.8	10.8	52.7	11.1	0.0	1.0	6.4	8.5
CO	0.1	61.0	0.0	3.3	21.2	0.0	0.0	0.1	0.5	13.9
CT	0.3	2.5	0.0	1.3	41.8	48.8	1.5	3.7	0.0	0.0
DE	0.0	13.3	0.0	0.0	82.4	0.0	2.7	0.9	0.7	0.0
FL	0.4	22.8	0.0	0.1	61.8	12.6	0.8	1.3	0.1	0.0
GA	0.4	36.8	0.0	2.5	33.2	26.8	0.1	0.1	0.1	0.0
HI	0.6	0.0	3.9	0.6	0.0	0.0	82.4	0.0	0.6	8.8
IA	0.1	38.8	0.0	2.4	3.3	11.2	0.1	0.3	0.0	43.9
ID	0.0	0.0	0.5	62.6	16.6	0.0	0.0	0.7	0.0	19.5
IL	0.0	43.1	0.0	0.1	2.0	49.4	0.0	0.3	0.0	5.1
IN	0.0	87.9	0.0	0.4	6.7	0.0	1.3	0.3	0.1	3.3
KS	0.0	57.9	0.0	0.0	2.9	17.2	0.1	0.1	0.0	21.8
KY	0.0	92.6	0.0	3.5	2.5	0.0	1.3	0.1	0.0	0.0
LA	0.1	25.4	0.0	1.7	41.3	26.5	5.0	0.0	0.0	0.0
MA	0.4	9.8	0.0	3.2	54.4	20.4	3.1	6.9	1.0	0.7
MD	0.0	47.1	0.0	4.7	2.8	41.8	1.3	1.2	0.3	0.9
ME	12.5	0.0	0.0	35.1	36.4	0.0	2.8	1.3	0.0	11.9
MI	1.0	54.0	0.0	1.6	5.5	32.2	0.9	0.9	0.0	4.0
MN	0.9	33.3	0.0	1.3	8.4	30.8	0.1	1.7	0.0	23.4
MO	0.0	82.8	0.0	0.8	4.3	10.6	0.1	0.1	0.0	1.3
MS	0.0	20.6	0.0	0.0	59.7	19.6	0.0	0.0	0.0	0.0
MT	0.0	52.2	0.0	38.5	1.7	0.0	0.1	0.9	0.0	6.6
NC	0.4	38.7	0.0	3.8	23.0	32.9	0.4	0.3	0.5	0.0
ND	0.0	67.2	0.0	9.2	0.8	0.0	0.1	0.1	0.0	22.6
NE	0.0	62.9	0.0	3.0	1.0	25.9	0.1	0.1	0.0	7.0
NH	7.3	6.7	0.0	7.1	22.3	52.3	1.4	0.7	0.0	2.1
NJ	0.0	1.3	0.0	0.0	41.5	53.9	0.6	2.0	0.7	0.0
NM	0.0	63.8	0.0	0.3	26.9	0.0	0.2	0.0	1.6	7.1
NV	0.0	19.6	8.2	7.1	61.1	0.0	0.0	0.1	2.9	0.9
NY	0.3	3.7	0.0	22.3	30.2	36.8	1.6	1.7	0.1	3.4
OH	0.0	67.4	0.0	0.4	17.8	12.2	0.9	0.3	0.0	0.8
OK	0.0	41.1	0.0	2.1	39.3	0.0	0.0	0.0	0.0	17.5
OR	0.4	6.0	0.3	65.9	12.7	0.0	0.0	0.6	0.0	14.1
PA	0.0	36.1	0.0	1.3	21.9	37.7	0.3	1.1	0.0	1.7
RI	0.0	0.0	0.0	0.1	95.3	0.0	1.1	3.3	0.2	0.0
SC	0.3	30.1	0.0	2.7	11.1	55.4	0.2	0.2	0.0	0.0
SD	0.0	0.0	0.0	66.2	5.6	0.0	0.1	0.0	0.0	28.1
TN	0.0	43.3	0.0	11.8	7.8	36.6	0.2	0.1	0.0	0.1
TX	0.1	42.0	0.0	0.1	35.1	11.1	0.0	0.2	0.1	11.3
UT	0.0	77.3	1.2	1.5	18.3	0.0	0.1	0.2	0.0	1.5
VA	1.5	27.0	0.0	1.3	26.5	40.8	1.5	1.5	0.0	0.0
VT	6.1	0.0	0.0	16.7	0.0	72.1	0.1	0.3	0.2	4.4
WA	0.2	5.9	0.0	70.7	8.0	8.4	0.0	0.3	0.0	6.4
WI	0.7	63.2	0.0	4.0	12.0	16.5	0.1	0.7	0.0	2.8
WV	0.0	96.2	0.0	0.9	0.8	0.0	0.2	0.0	0.0	1.8
WY	0.0	88.8	0.0	1.8	0.2	0.0	0.1	0.0	0.0	9.1

Table A- 12 Technology shares of coal within each state (%)

	Coal ST	Coal IGCC
AK	100	0
AL	100	0
AR	100	0
AZ	100	0
CA	100	0
CO	100	0
CT	100	0
DE	100	0
FL	97	3
GA	100	0
HI	99*	1*
IA	100	0
ID	99*	1*
IL	100	0
IN	97	3
KS	100	0
KY	100	0
LA	100	0
MA	100	0
MD	100	0
ME	99*	1*
MI	100	0
MN	100	0
MO	100	0
MS	100	0
MT	100	0
NC	100	0
ND	100	0
NE	100	0
NH	100	0
NJ	100	0
NM	100	0
NV	100	0
NY	100	0
OH	100	0
OK	100	0
OR	100	0
PA	100	0
RI	99*	1*
SC	100	0
SD	99*	1*
TN	100	0
TX	100	0
UT	100	0
VA	100	0
VT	99*	1*
WA	100	0
WI	100	0
WV	100	0
WY	100	0

* Value it taken as national average from GREET data from 2015

Table A- 13 Technology shares of natural gas within each state (%)

	NG ST	NG CC	NG GT	NG ICE
AK	0.0	85.3	14.2	0.5
AL	0.5	98.7	0.8	0.0
AR	2.7	96.6	0.7	0.0
AZ	3.3	94.8	1.9	0.0
CA	6.6	87.9	5.0	0.5
CO	1.7	83.4	14.2	0.7
CT	1.2	98.0	0.8	0.0
DE	15.7	83.6	0.7	0.0
FL	4.4	93.6	2.0	0.0
GA	0.3	94.9	4.8	0.0
HI	8.8*	84.2*	6.1*	0.9*
IA	7.4	88.7	3.8	0.1
ID	0.0	94.2	5.8	0.0
IL	1.8	67.7	30.4	0.1
IN	1.8	92.5	5.3	0.4
KS	53.3	0.0	42.5	4.2
KY	2.6	0.0	97.4	0.0
LA	37.4	61.2	1.4	0.0
MA	1.0	98.4	0.5	0.0
MD	55.2	0.0	44.8	0.0
ME	0.0	100.0	0.0	0.0
MI	9.8	76.1	14.1	0.0
MN	1.6	90.9	7.3	0.2
MO	3.8	85.6	10.5	0.0
MS	1.4	97.2	1.4	0.0
MT	0.9	0.0	91.1	8.0
NC	0.0	93.7	6.3	0.0
ND	1.2	0.0	98.8	0.0
NE	18.0	48.9	32.8	0.3
NH	0.7	99.3	0.0	0.0
NJ	4.1	84.8	11.1	0.1
NM	24.2	67.3	7.8	0.8
NV	1.5	97.4	1.1	0.0
NY	30.0	65.1	4.9	0.0
OH	2.0	94.7	3.3	0.0
OK	13.9	84.9	1.2	0.0
OR	0.0	99.5	0.5	0.0
PA	3.6	93.9	2.5	0.1
RI	0.0	100.0	0.0	0.0
SC	1.3	90.5	8.2	0.0
SD	0.0	77.1	22.9	0.0
TN	0.0	91.8	8.1	0.1
TX	12.6	84.8	2.1	0.5
UT	2.5	92.7	4.6	0.3
VA	2.2	88.4	9.4	0.0
VT	100.0	0.0	0.0	0.0
WA	0.0	98.6	1.2	0.2
WI	2.6	92.5	4.8	0.0
WV	9.0	0.0	91.0	0.0
WY	15.7	58.1	26.2	0.0

* Value it taken as national average from GREET data from 2015

Table A- 14 Technology shares of oil within each state (%)

	Oil ST	Oil GT	Oil ICE
AK	0.1	58.5	41.4
AL	65.4	33.7	0.9
AR	98.2	1.8	0.0
AZ	98.1	1.9	0.0
CA	4.9	21.6	73.5
CO	48.0	51.7	0.3
CT	74.1	24.6	1.3
DE	27.5	72.5	0.0
FL	63.4	36.3	0.3
GA	48.1	51.9	0.0
HI	74.1	19.5	6.4
IA	47.1	37.4	15.6
ID	0.0	0.0	100.0
IL	80.1	15.0	4.9
IN	92.4	7.1	0.4
KS	88.5	8.3	3.2
KY	93.9	5.3	0.8
LA	84.0	15.9	0.1
MA	74.5	25.0	0.5
MD	45.2	51.7	3.2
ME	99.1	0.7	0.2
MI	97.2	1.5	1.3
MN	10.5	79.7	9.8
MO	81.6	16.6	1.8
MS	83.4	11.1	5.5
MT	62.3	37.7	0.0
NC	31.2	67.7	1.1
ND	96.5	3.2	0.3
NE	84.1	12.3	3.6
NH	38.5	61.5	0.0
NJ	3.8	96.0	0.3
NM	90.1	9.9	0.0
NV	100.0	0.0	0.0
NY	66.9	33.0	0.1
OH	74.2	25.1	0.7
OK	96.0	0.0	4.0
OR	98.7	1.3	0.0
PA	49.5	49.6	0.9
RI	0.0	85.0	15.0
SC	29.6	69.8	0.6
SD	0.0	98.7	1.3
TN	64.6	34.3	1.2
TX	96.1	3.6	0.3
UT	98.2	0.0	1.8
VA	38.8	59.1	2.1
VT	0.0	68.8	31.2
WA	57.1	27.2	15.7
WI	58.1	40.1	1.7
WV	85.3	14.7	0.0
WY	99.4	0.0	0.6

Table A- 15 Efficiency of each technology and fuel within each state

	Coal IGCC	Coal ST	Oil GT	Oil ICE	Oil ST	NG ST	NG CC	NG GT	NG ICE
AK	0.40*	0.29	0.40	0.36	0.26	0.34*	0.41	0.26	0.36
AL	0.40*	0.35	0.27	0.38	0.30	0.37	0.52	0.30	0.35
AR	0.40*	0.37	0.41	0.38*	0.36	0.32	0.50	0.31	0.30
AZ	0.40*	0.35	0.17	0.38*	0.35	0.32	0.50	0.34	0.30
CA	0.40*	0.22	0.23	0.36	0.20	0.32	0.52	0.36	0.35
CO	0.40*	0.35	0.24	0.32	0.26	0.34	0.49	0.34	0.35
CT	0.40*	0.34	0.38	0.36	0.32	0.30	0.52	0.32	0.31
DE	0.40*	0.30	0.42	0.38*	0.29	0.32	0.47	0.38	0.33
FL	0.34	0.34	0.35	0.21	0.32	0.32	0.52	0.32	0.32
GA	0.40*	0.35	0.21	0.33	0.29	0.32	0.53	0.33	0.30
HI	0.40*	0.36*	0.39	0.36	0.34	0.34*	0.55*	0.34*	0.34*
IA	0.40*	0.34	0.28	0.27	0.31	0.24	0.51	0.21	0.33
ID	0.40*	0.36*	0.32*	0.01	0.35*	0.34*	0.54	0.34	0.34
IL	0.40*	0.35	0.27	0.32	0.34	0.34	0.49	0.30	0.31
IN	0.31	0.34	0.29	0.31	0.34	0.34	0.50	0.29	0.32
KS	0.40*	0.34	0.17	0.31	0.34	0.28	0.55*	0.29	0.34
KY	0.40*	0.34	0.25	0.33	0.33	0.35	0.55*	0.31	0.31
LA	0.40*	0.36	0.23	0.24	0.34	0.33	0.52	0.30	0.26
MA	0.40*	0.35	0.37	0.30	0.34	0.29	0.50	0.30	0.33
MD	0.40*	0.34	0.28	0.31	0.33	0.33	0.55*	0.33	0.31
ME	0.40*	0.36*	0.22	0.31	0.31	0.17	0.52	0.34*	0.32
MI	0.40*	0.35	0.11	0.11	0.34	0.30	0.49	0.29	0.28
MN	0.40*	0.35	0.29	0.33	0.27	0.30	0.49	0.31	0.32
MO	0.40*	0.36	0.23	0.13	0.35	0.20	0.50	0.27	0.35
MS	0.40*	0.35	0.27	0.26	0.34	0.31	0.52	0.33	0.35
MT	0.40*	0.34	0.28	0.38*	0.33	0.30	0.55*	0.33	0.40
NC	0.40*	0.36	0.32	0.27	0.33	0.34*	0.54	0.32	0.36
ND	0.40*	0.36	0.13	0.36	0.32	0.33	0.55*	0.39	0.34*
NE	0.40*	0.36	0.18	0.30	0.30	0.35	0.44	0.29	0.27
NH	0.40*	0.31	0.45	0.38*	0.29	0.26	0.51	0.20	0.26
NJ	0.40*	0.31	0.37	0.33	0.31	0.30	0.49	0.36	0.34
NM	0.40*	0.35	0.31	0.38*	0.33	0.34	0.49	0.34	0.41
NV	0.40*	0.33	0.32*	0.38*	0.33	0.31	0.51	0.34	0.34
NY	0.40*	0.34	0.39	0.33	0.34	0.34	0.51	0.34	0.32
OH	0.40*	0.35	0.28	0.32	0.35	0.23	0.50	0.31	0.31
OK	0.40*	0.34	0.32*	0.33	0.35	0.32	0.51	0.34	0.30
OR	0.40*	0.37	0.18	0.38*	0.36	0.16	0.53	0.33	0.28
PA	0.40*	0.35	0.35	0.35	0.31	0.30	0.50	0.33	0.32
RI	0.40*	0.36*	0.45	0.33	0.35*	0.34*	0.48	0.34*	0.34*
SC	0.40*	0.36	0.30	0.35	0.36	0.35	0.51	0.31	0.31
SD	0.40*	0.36*	0.18	0.27	0.35*	0.34*	0.49	0.33	0.34*
TN	0.40*	0.35	0.36	0.36	0.35	0.34*	0.52	0.32	0.35
TX	0.40*	0.37	0.25	0.32	0.32	0.33	0.50	0.30	0.36
UT	0.40*	0.36	0.32*	0.28	0.36	0.26	0.52	0.31	0.30
VA	0.40*	0.35	0.36	0.32	0.33	0.33	0.50	0.34	0.31
VT	0.40*	0.36*	0.19	0.37	0.35*	0.26	0.55*	0.34*	0.35
WA	0.40*	0.33	0.23	0.39	0.33	0.25	0.50	0.21	0.36
WI	0.40*	0.35	0.20	0.25	0.31	0.28	0.53	0.26	0.30
WV	0.40*	0.36	0.35	0.38*	0.37	0.39	0.55*	0.35	0.34*
WY	0.40*	0.35	0.32*	0.35	0.34	0.34	0.43	0.26	0.34*

* Value it taken as national average from GREET data from 2015

.

APPENDIX B

Table B- 1 Emissions of NO_x by fuel and technology for each NERC region (g/MMBtu)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Coal Boiler	74.7	97.4	64.6	82.1	132.9	98.1	49.3	69.6	87.5	116.0*
NG ST	48.5	48.0	56.5	86.7	81.9*	38.2	34.8	46.6	59.5	81.9*
Coal IGCC	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	34.0	11.9*
Oil GT	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*
Oil ICE	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*
Oil ST	63.7	101.3	62.2	81.1	132.9	53.3	57.3	26.5	90.0	433.5*
NG CC	6.6	7.6	8.6	23.3	17.4*	9.6	17.9	7.4	7.0	17.4*
NG ST	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*
NG ICE	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*

Table B- 2 Emissions of $PM_{2.5}$ by fuel and technology for each NERC region (g/MMBtu)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Coal Boiler	9.05	6.75	16.52	11.25	4.54	16.89	9.99	6.62	12.45	20.28*
NG ST	0.68	0.27	2.34	11.15	4.04*	7.36	0.29	0.48	5.01	4.04*
Coal IGCC	73.41*	73.41*	73.41*	73.41*	73.41*	73.41*	73.41*	73.41*	0.00	73.41*
Oil GT	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*
Oil ICE	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*
NG CC	1.67	0.13	0.93	2.25	4.54	3.53	6.11	0.03	1.95	13.49*
NG ST	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*
NG ICE	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*

Table B- 3 Emissions of PM_{10} by fuel and technology for each NERC region (g/MMBtu)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Coal Boiler	12.87	9.59	23.49	15.99	6.45	24.00	14.21	9.42	17.70	6.48*
NG ST	0.68	0.27	2.34	11.15	4.04*	7.36	0.29	0.48	5.01	4.04*
Coal IGCC	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	0.00	198.88*
Oil GT	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*
Oil ICE	1.40*	1.40*	1.40*	1.40*	1.40*	1.40*	1.40*	1.40*	1.40*	1.40*
Oil ST	15.45	11.76	14.53	22.67	5.84	16.00	16.69	2.95	14.67	17.38*
NG CC	0.94	0.00	0.14	0.00	0.13*	0.00	6.04	0.00	0.87	0.13*
NG ST	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*
NG ICE	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*

Table B- 4 Emissions of SO_x by fuel and technology for each NERC region (g/MMBtu)

Fuel/Tech	SERC	WECC	SPP	MRO	ASCC	NPCC	TRE	FRCC	RFC	HICC
Coal Boiler	315.09	135.25	175.28	247.46	163.56	246.10	215.99	298.72	509.82	325.41*
NG ST	0.00	0.00	0.00	0.00	16.52*	0.00	0.00	0.00	0.00	16.52*
Coal IGCC	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4102.00	4.11*
Oil GT	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*
Oil ST	193.75	53.15	118.97	140.56	171.75	252.73	90.08	325.21	151.00	369.65*
NG CC	0.00	0.00	0.00	0.00	0.26*	0.00	0.00	0.00	0.00	0.26*
NG ST	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*
NG ICE	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*

Table B- 5 Emissions of NO_x by fuel and technology for each eGrid primary subregion (g/MMBtu)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI
Coal Boiler	132.9	116.0*	93.2	95.1	45.1	69.6	116.0*	116.0*	60.3	89.5	93.1	103.8	135.3	86.4
NG ST	81.9*	81.9*	88.0	27.5	30.8	46.6	81.9*	81.9*	73.8	90.5	62.1	116.2	34.3	25.7
Coal IGCC	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*
Oil GT	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*
Oil ICE	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*
Oil ST	132.9	433.5*	87.1	88.4	48.5	26.5	433.5*	433.5*	69.9	88.6	57.1	108.7	33.0	34.2
NG CC	17.4*	17.4*	6.3	7.7	18.1	7.4	17.4*	17.4*	5.3	23.3	8.3	9.1	3.2	30.9
NG ST	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*
NG ICE	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*

(cont.)

Fuel/Tech	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Coal Boiler	105.5	132.8	76.3	83.0	84.3	71.8	66.0	62.2	71.6	75.1	77.2	69.8
NG ST	62.1	53.2	116.9	78.6	80.7	62.8	56.5	48.4	45.4	95.7	108.6	12.5
Coal IGCC	11.9*	11.9*	11.9*	34.0	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*	11.9*
Oil GT	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*	256.4*
Oil ICE	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*	504.7*
Oil ST	74.2	101.7	80.9	81.1	83.9	73.9	72.7	61.8	56.0	117.7	71.3	52.1
NG CC	9.2	5.8	9.5	7.6	8.8	32.8	8.9	10.1	8.8	5.0	7.5	6.8
NG ST	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*
NG ICE	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*	296.4*

Table B- 6 Emissions of $PM_{2.5}$ by fuel and technology for each eGrid primary subregion (g/MMBtu)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI
Coal Boiler	4.54	4.56*	4.79	3.20	9.02	6.62	4.56*	4.56*	18.56	10.04	17.89	8.09	4.54	4.54
NG ST	4.04*	4.04*	0.80	0.02	0.29	0.48	4.04*	4.04*	8.09	11.91	6.77	0.43	0.00	16.08
Coal IGCC	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*
Oil GT	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*
Oil ICE	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*
NG CC	4.54	13.49*	0.02	0.01	5.97	0.03	13.49*	13.49*	13.33	1.63	3.76	0.58	0.00	15.49
NG ST	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*
NG ICE	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*

(cont.)

Fuel/Tech	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Coal Boiler	17.85	9.84	36.70	9.51	4.67	11.71	19.81	7.65	7.77	12.71	11.43	3.21
NG ST	0.49	2.44	38.58	7.36	2.02	6.30	2.14	0.00	16.08	7.91	13.12	0.54
Coal IGCC	57.97*	57.97*	57.97*	0.00	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*	57.97*
Oil GT	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*	6.57*
Oil ICE	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*	1.38*
NG CC	0.59	0.61	5.00	2.63	0.17	11.80	0.38	0.29	2.71	3.11	0.61	1.78
NG ST	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*	0.13*
NG ICE	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*

Table B- 7 Emissions of PM_{10} by fuel and technology for each eGrid primary subregion (g/MMBtu)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI
Coal Boiler	6.45	6.48*	6.82	4.55	12.82	9.42	6.48*	6.48*	26.35	14.27	25.44	11.50	6.45	6.45
NG ST	4.04*	4.04*	0.80	0.02	0.29	0.48	4.04*	4.04*	8.09	11.91	6.77	0.43	0.00	16.08
Coal IGCC	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*
Oil GT	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*
Oil ICE	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*
Oil ST	5.84	17.38*	3.60	13.48	13.56	2.95	17.38*	17.38*	28.47	19.75	16.19	14.88	0.00	25.71
NG CC	5.84	17.38*	3.60	13.48	13.56	2.95	17.38*	17.38*	28.47	19.75	16.19	14.88	0.00	25.71
NG ST	0.13*	0.13*	0.00	0.00	5.94	0.00	0.13*	0.13*	0.00	0.00	0.00	0.00	0.00	0.00
NG ICE	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*

(cont.)

Fuel/Tech	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Coal Boiler	25.35	14.00	52.17	13.53	6.64	16.64	28.18	10.88	11.05	18.07	16.26	4.56
NG ST	0.49	2.44	38.58	7.36	2.02	6.30	2.14	0.00	16.08	7.91	13.12	0.54
Coal IGCC	198.88*	198.88*	198.88*	0.00	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*	198.88*
Oil GT	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*	15.94*
Oil ICE	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*	0.90*
Oil ST	5.80	8.35	46.49	13.41	6.46	25.52	16.68	10.17	7.58	20.03	13.29	16.83
NG CC	0.00	0.00	0.00	1.79	0.00	4.54	0.00	0.00	0.00	2.84	0.00	0.00
NG ST	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*	3.57*
NG ICE	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*	45.35*

Table B- 8 Emissions of SO_x by fuel and technology for each eGrid primary subregion (g/MMBtu)

Fuel/Tech	AKGD	AKMS	AZNM	CAMX	ERCT	FRCC	HIMS	HIOA	MROE	MROW	NEWE	NWPP	NYCW	NYLI
Coal Boiler	163.56	325.41*	84.37	0.00	195.06	298.72	325.41*	325.41*	190.73	257.73	281.28	144.98	0.00	0.00
NG ST	16.52*	16.52*	0.00	0.00	0.00	0.00	16.52*	16.52*	0.00	0.00	0.00	0.00	0.00	0.00
Coal IGCC	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*
Oil GT	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*
Oil ST	171.75	369.65*	11.73	20.70	76.18	325.21	369.65*	369.65*	181.74	133.90	232.57	53.94	152.35	334.11
NG CC	0.26*	0.26*	0.00	0.00	0.00	0.00	0.26*	0.26*	0.00	0.00	0.00	0.00	0.00	0.00
NG ST	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*
NG ICE	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*

(cont.)

Fuel/Tech	NYUP	RFCE	RFCM	RFCW	RMPA	SPNO	SPSO	SRMV	SRMW	SRSO	SRTV	SRVC
Coal Boiler	239.77	502.56	252.40	566.68	160.67	117.82	235.70	274.17	222.72	312.58	397.03	334.67
NG ST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal IGCC	4.11*	4.11*	4.11*	4102.00	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*	4.11*
Oil GT	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*	40.66*
Oil ST	238.68	202.95	183.77	97.22	110.58	78.58	163.97	213.88	117.88	124.36	71.07	256.42
NG CC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NG ST	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*	0.26*
NG ICE	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*	0.59*

Table B- 9 Emissions of NO_x by fuel and technology for each state (g/MMBtu)

	Coal Boiler	NG ST	Coal IGCC	Oil GT	Oil ICE	Oil ST	NG CC	NG ST	NG ICE
AK	132.90	81.9*	11.9*	256.4*	504.7*	132.90	17.4*	32.0*	296.4*
AL	82.14	88.63	11.9*	256.4*	504.7*	148.01	5.73	32.0*	296.4*
AR	63.82	19.96	11.9*	256.4*	504.7*	69.86	15.45	32.0*	296.4*
AZ	87.38	139.93	11.9*	256.4*	504.7*	87.30	6.70	32.0*	296.4*
CA	93.86	27.49	11.9*	256.4*	504.7*	88.39	7.52	32.0*	296.4*
CO	98.67	81.70	11.9*	256.4*	504.7*	115.69	8.79	32.0*	296.4*
CT	97.23	64.60	11.9*	256.4*	504.7*	68.86	3.82	32.0*	296.4*
DE	36.74	40.21	11.9*	256.4*	504.7*	42.14	17.4*	32.0*	296.4*
FL	70.79	46.71	11.9*	256.4*	504.7*	28.27	7.37	32.0*	296.4*
GA	62.56	28.00	11.9*	256.4*	504.7*	103.48	4.64	32.0*	296.4*
HI	116.0*	81.9*	11.9*	256.4*	504.7*	433.5*	17.4*	32.0*	296.4*
IA	78.76	84.78	11.9*	256.4*	504.7*	74.56	17.42	32.0*	296.4*
ID	116.0*	81.9*	11.9*	256.4*	504.7*	433.5*	53.07	32.0*	296.4*
IL	44.59	46.18	11.9*	256.4*	504.7*	40.09	16.34	32.0*	296.4*
IN	89.48	59.93	34.02	256.4*	504.7*	95.63	7.50	32.0*	296.4*
KS	70.70	205.34	11.9*	256.4*	504.7*	68.04	17.4*	32.0*	296.4*
KY	87.77	116.41	11.9*	256.4*	504.7*	78.49	17.4*	32.0*	296.4*
LA	66.84	59.19	11.9*	256.4*	504.7*	70.85	7.64	32.0*	296.4*
MA	73.14	59.40	11.9*	256.4*	504.7*	44.79	9.80	32.0*	296.4*
MD	56.24	76.07	11.9*	256.4*	504.7*	84.54	17.4*	32.0*	296.4*
ME	108.41	108.41	11.9*	256.4*	504.7*	66.34	17.4*	32.0*	296.4*
MI	78.93	113.83	11.9*	256.4*	504.7*	83.79	9.46	32.0*	296.4*
MN	79.19	138.11	11.9*	256.4*	504.7*	61.84	38.08	32.0*	296.4*
MO	99.98	31.47	11.9*	256.4*	504.7*	70.74	9.63	32.0*	296.4*
MS	127.28	129.55	11.9*	256.4*	504.7*	147.06	6.78	32.0*	296.4*
MT	96.79	98.62	11.9*	256.4*	504.7*	97.43	17.4*	32.0*	296.4*
NC	69.92	81.9*	11.9*	256.4*	504.7*	75.46	3.72	32.0*	296.4*
ND	116.28	91.29	11.9*	256.4*	504.7*	107.08	17.4*	32.0*	296.4*
NE	81.57	71.37	11.9*	256.4*	504.7*	87.13	15.94	32.0*	296.4*
NH	142.02	63.36	11.9*	256.4*	504.7*	65.49	14.06	32.0*	296.4*
NJ	72.30	35.62	11.9*	256.4*	504.7*	128.98	7.06	32.0*	296.4*
NM	170.40	84.15	11.9*	256.4*	504.7*	124.95	7.20	32.0*	296.4*
NV	106.32	96.40	11.9*	256.4*	504.7*	120.32	6.76	32.0*	296.4*
NY	105.06	36.79	11.9*	256.4*	504.7*	48.32	11.04	32.0*	296.4*
OH	77.12	78.11	11.9*	256.4*	504.7*	79.31	7.57	32.0*	296.4*
OK	58.96	84.95	11.9*	256.4*	504.7*	70.18	10.01	32.0*	296.4*
OR	93.76	140.88	11.9*	256.4*	504.7*	92.53	7.35	32.0*	296.4*
PA	144.82	65.09	11.9*	256.4*	504.7*	118.62	4.71	32.0*	296.4*
RI	116.0*	81.9*	11.9*	256.4*	504.7*	433.5*	21.52	32.0*	296.4*
SC	44.40	138.45	11.9*	256.4*	504.7*	40.71	17.4*	32.0*	296.4*
SD	116.0*	81.9*	11.9*	256.4*	504.7*	433.5*	4.54	32.0*	296.4*
TN	39.97	81.9*	11.9*	256.4*	504.7*	35.80	3.69	32.0*	296.4*
TX	52.91	42.11	11.9*	256.4*	504.7*	61.19	17.09	32.0*	296.4*
UT	105.15	81.9*	11.9*	256.4*	504.7*	113.20	4.92	32.0*	296.4*
VA	97.20	4.17	11.9*	256.4*	504.7*	47.67	7.97	32.0*	296.4*
VT	116.0*	31.75	11.9*	256.4*	504.7*	433.5*	17.4*	32.0*	296.4*
WA	85.81	86.36	11.9*	256.4*	504.7*	86.48	4.54	32.0*	296.4*
WI	40.77	76.64	11.9*	256.4*	504.7*	58.04	7.35	32.0*	296.4*
WV	85.73	103.47	11.9*	256.4*	504.7*	59.65	17.4*	32.0*	296.4*
WY	68.09	59.64	11.9*	256.4*	504.7*	75.45	17.4*	32.0*	296.4*

Table B- 10 Emissions of $PM_{2.5}$ by fuel and technology for each state (g/MMBtu)

	Coal Boiler	NG ST	Coal IGCC	Oil GT	Oil ICE	NG CC	NG ST	NG ICE
AK	4.54	4.04*	57.97*	6.57*	1.38*	4.54	0.13*	3.57*
AL	8.99	9.47	57.97*	6.57*	1.38*	0.61	0.13*	3.57*
AR	9.09	4.54	57.97*	6.57*	1.38*	2.59	0.13*	3.57*
AZ	5.54	4.52	57.97*	6.57*	1.38*	0.06	0.13*	3.57*
CA	3.23	0.02	57.97*	6.57*	1.38*	0.01	0.13*	3.57*
CO	1.23	0.63	57.97*	6.57*	1.38*	0.01	0.13*	3.57*
CT	1.62	8.21	57.97*	6.57*	1.38*	0.44	0.13*	3.57*
DE	4.54	0.00	57.97*	6.57*	1.38*	1.19	0.13*	3.57*
FL	6.84	0.54	57.97*	6.57*	1.38*	0.04	0.13*	3.57*
GA	18.51	12.71	57.97*	6.57*	1.38*	1.34	0.13*	3.57*
HI	4.56*	4.04*	57.97*	6.57*	1.38*	13.49*	0.13*	3.57*
IA	21.56	20.33	57.97*	6.57*	1.38*	0.37	0.13*	3.57*
ID	4.56*	4.04*	57.97*	6.57*	1.38*	0.00	0.13*	3.57*
IL	9.72	25.19	57.97*	6.57*	1.38*	6.50	0.13*	3.57*
IN	10.94	7.47	0.00	6.57*	1.38*	5.15	0.13*	3.57*
KS	12.26	5.98	57.97*	6.57*	1.38*	20.96	0.13*	3.57*
KY	14.90	14.39	57.97*	6.57*	1.38*	14.91	0.13*	3.57*
LA	3.29	0.07	57.97*	6.57*	1.38*	0.00	0.13*	3.57*
MA	3.68	4.89	57.97*	6.57*	1.38*	2.67	0.13*	3.57*
MD	4.48	7.77	57.97*	6.57*	1.38*	7.90	0.13*	3.57*
ME	0.00	0.00	57.97*	6.57*	1.38*	40.94	0.13*	3.57*
MI	35.16	35.32	57.97*	6.57*	1.38*	5.00	0.13*	3.57*
MN	9.93	8.85	57.97*	6.57*	1.38*	0.35	0.13*	3.57*
MO	20.45	51.89	57.97*	6.57*	1.38*	2.69	0.13*	3.57*
MS	5.03	3.59	57.97*	6.57*	1.38*	2.07	0.13*	3.57*
MT	11.57	17.17	57.97*	6.57*	1.38*	10.25	0.13*	3.57*
NC	3.35	4.04*	57.97*	6.57*	1.38*	0.60	0.13*	3.57*
ND	4.63	4.50	57.97*	6.57*	1.38*	4.63	0.13*	3.57*
NE	6.40	7.35	57.97*	6.57*	1.38*	24.87	0.13*	3.57*
NH	78.28	9.05	57.97*	6.57*	1.38*	9.38	0.13*	3.57*
NJ	10.94	8.23	57.97*	6.57*	1.38*	0.22	0.13*	3.57*
NM	10.32	0.00	57.97*	6.57*	1.38*	2.32	0.13*	3.57*
NV	12.69	1.22	57.97*	6.57*	1.38*	0.03	0.13*	3.57*
NY	15.50	7.39	57.97*	6.57*	1.38*	3.26	0.13*	3.57*
OH	7.85	0.14	57.97*	6.57*	1.38*	2.42	0.13*	3.57*
OK	10.66	1.52	57.97*	6.57*	1.38*	0.10	0.13*	3.57*
OR	0.06	2.65	57.97*	6.57*	1.38*	0.00	0.13*	3.57*
PA	9.77	0.20	57.97*	6.57*	1.38*	0.53	0.13*	3.57*
RI	4.56*	4.04*	57.97*	6.57*	1.38*	0.00	0.13*	3.57*
SC	3.27	0.00	57.97*	6.57*	1.38*	6.41	0.13*	3.57*
SD	4.56*	4.04*	57.97*	6.57*	1.38*	0.00	0.13*	3.57*
TN	10.74	4.04*	57.97*	6.57*	1.38*	1.01	0.13*	3.57*
TX	9.70	0.12	57.97*	6.57*	1.38*	5.67	0.13*	3.57*
UT	3.79	4.04*	57.97*	6.57*	1.38*	1.41	0.13*	3.57*
VA	2.61	0.58	57.97*	6.57*	1.38*	1.86	0.13*	3.57*
VT	4.56*	4.54	57.97*	6.57*	1.38*	13.49*	0.13*	3.57*
WA	17.90	4.54	57.97*	6.57*	1.38*	0.20	0.13*	3.57*
WI	11.17	4.51	57.97*	6.57*	1.38*	11.20	0.13*	3.57*
WV	6.87	6.08	57.97*	6.57*	1.38*	7.60	0.13*	3.57*
WY	8.52	26.31	57.97*	6.57*	1.38*	5.67	0.13*	3.57*

Table B- 11 Emissions of PM_{10} by fuel and technology for each state (g/MMBtu)

	Coal Boiler	NG ST	Coal IGCC	Oil GT	Oil ICE	Oil ST	NG CC	NG ST	NG ICE
AK	6.45	4.04*	198.88*	15.94*	1.40*	5.84	0.13*	3.57*	45.35*
AL	12.78	9.47	198.88*	15.94*	1.40*	15.23	0.00	3.57*	45.35*
AR	12.92	4.54	198.88*	15.94*	1.40*	11.02	0.00	3.57*	45.35*
AZ	7.88	4.52	198.88*	15.94*	1.40*	5.57	0.00	3.57*	45.35*
CA	4.55	0.02	198.88*	15.94*	1.40*	13.48	0.00	3.57*	45.35*
CO	1.75	0.63	198.88*	15.94*	1.40*	1.99	0.00	3.57*	45.35*
CT	2.30	8.21	198.88*	15.94*	1.40*	4.08	0.00	3.57*	45.35*
DE	6.45	0.00	198.88*	15.94*	1.40*	1.53	0.13*	3.57*	45.35*
FL	9.73	0.54	198.88*	15.94*	1.40*	3.15	0.00	3.57*	45.35*
GA	26.33	12.71	198.88*	15.94*	1.40*	27.27	0.00	3.57*	45.35*
HI	6.48*	4.04*	198.88*	15.94*	1.40*	17.38*	0.13*	3.57*	45.35*
IA	30.67	20.33	198.88*	15.94*	1.40*	18.19	0.00	3.57*	45.35*
ID	6.48*	4.04*	198.88*	15.94*	1.40*	17.38*	0.00	3.57*	45.35*
IL	13.83	25.19	198.88*	15.94*	1.40*	9.26	0.00	3.57*	45.35*
IN	15.55	7.47	0.00	15.94*	1.40*	17.69	0.00	3.57*	45.35*
KS	17.44	5.98	198.88*	15.94*	1.40*	27.00	0.13*	3.57*	45.35*
KY	21.18	14.39	198.88*	15.94*	1.40*	19.21	0.13*	3.57*	45.35*
LA	4.68	0.07	198.88*	15.94*	1.40*	0.00	0.00	3.57*	45.35*
MA	5.24	4.89	198.88*	15.94*	1.40*	8.53	0.00	3.57*	45.35*
MD	6.37	7.77	198.88*	15.94*	1.40*	10.18	0.13*	3.57*	45.35*
ME	0.00	0.00	198.88*	15.94*	1.40*	52.73	0.13*	3.57*	45.35*
MI	49.96	35.32	198.88*	15.94*	1.40*	44.52	0.00	3.57*	45.35*
MN	14.12	8.85	198.88*	15.94*	1.40*	15.33	0.00	3.57*	45.35*
MO	29.08	51.89	198.88*	15.94*	1.40*	8.53	1.08	3.57*	45.35*
MS	7.15	3.59	198.88*	15.94*	1.40*	6.52	2.07	3.57*	45.35*
MT	16.46	17.17	198.88*	15.94*	1.40*	13.20	0.13*	3.57*	45.35*
NC	4.76	4.04*	198.88*	15.94*	1.40*	4.19	0.00	3.57*	45.35*
ND	6.58	4.50	198.88*	15.94*	1.40*	5.96	0.13*	3.57*	45.35*
NE	9.10	7.35	198.88*	15.94*	1.40*	32.06	0.00	3.57*	45.35*
NH	111.34	9.05	198.88*	15.94*	1.40*	12.53	0.00	3.57*	45.35*
NJ	15.56	8.23	198.88*	15.94*	1.40*	52.89	0.00	3.57*	45.35*
NM	14.68	0.00	198.88*	15.94*	1.40*	24.62	0.00	3.57*	45.35*
NV	18.05	1.22	198.88*	15.94*	1.40*	8.71	0.00	3.57*	45.35*
NY	22.01	7.39	198.88*	15.94*	1.40*	15.74	0.00	3.57*	45.35*
OH	11.16	0.14	198.88*	15.94*	1.40*	10.12	2.15	3.57*	45.35*
OK	15.16	1.52	198.88*	15.94*	1.40*	18.57	0.00	3.57*	45.35*
OR	0.08	2.65	198.88*	15.94*	1.40*	0.00	0.00	3.57*	45.35*
PA	13.90	0.20	198.88*	15.94*	1.40*	6.25	0.00	3.57*	45.35*
RI	6.48*	4.04*	198.88*	15.94*	1.40*	17.38*	0.00	3.57*	45.35*
SC	4.65	0.00	198.88*	15.94*	1.40*	8.26	0.13*	3.57*	45.35*
SD	6.48*	4.04*	198.88*	15.94*	1.40*	17.38*	0.00	3.57*	45.35*
TN	15.27	4.04*	198.88*	15.94*	1.40*	15.05	0.00	3.57*	45.35*
TX	13.80	0.12	198.88*	15.94*	1.40*	14.90	5.59	3.57*	45.35*
UT	5.39	4.04*	198.88*	15.94*	1.40*	5.55	0.00	3.57*	45.35*
VA	3.71	0.58	198.88*	15.94*	1.40*	21.66	0.00	3.57*	45.35*
VT	6.48*	4.54	198.88*	15.94*	1.40*	17.38*	0.13*	3.57*	45.35*
WA	25.46	4.54	198.88*	15.94*	1.40*	23.37	0.00	3.57*	45.35*
WI	15.89	4.51	198.88*	15.94*	1.40*	26.67	0.00	3.57*	45.35*
WV	9.77	6.08	198.88*	15.94*	1.40*	9.79	0.13*	3.57*	45.35*
WY	12.11	26.31	198.88*	15.94*	1.40*	7.30	0.13*	3.57*	45.35*

Table B- 12 Emissions of SO_x by fuel and technology for each state (g/MMBtu)

	Coal Boiler	NG ST	Coal IGCC	Oil GT	Oil ST	NG CC	NG ST	NG ICE
AK	163.56	16.52*	4.11*	40.66*	171.75	0.26*	0.26*	0.59*
AL	265.70	0.00	4.11*	40.66*	157.70	0.00	0.26*	0.59*
AR	255.85	0.00	4.11*	40.66*	183.17	0.00	0.26*	0.59*
AZ	44.64	0.00	4.11*	40.66*	11.67	0.00	0.26*	0.59*
CA	0.00	0.00	4.11*	40.66*	20.70	0.00	0.26*	0.59*
CO	174.32	0.00	4.11*	40.66*	221.69	0.00	0.26*	0.59*
CT	42.20	0.00	4.11*	40.66*	110.40	0.00	0.26*	0.59*
DE	743.61	0.00	4.11*	40.66*	114.27	0.26*	0.26*	0.59*
FL	374.02	0.00	4.11*	40.66*	323.83	0.00	0.26*	0.59*
GA	154.32	0.00	4.11*	40.66*	105.06	0.00	0.26*	0.59*
HI	325.41*	16.52*	4.11*	40.66*	369.65*	0.26*	0.26*	0.59*
IA	217.08	0.00	4.11*	40.66*	95.62	0.00	0.26*	0.59*
ID	325.41*	16.52*	4.11*	40.66*	369.65*	0.00	0.26*	0.59*
IL	249.93	0.00	4.11*	40.66*	114.92	0.00	0.26*	0.59*
IN	684.04	0.00	4,102	40.66*	133.33	0.00	0.26*	0.59*
KS	107.35	0.00	4.11*	40.66*	75.37	0.26*	0.26*	0.59*
KY	381.57	0.00	4.11*	40.66*	69.88	0.26*	0.26*	0.59*
LA	240.11	0.00	4.11*	40.66*	230.82	0.00	0.26*	0.59*
MA	49.07	0.00	4.11*	40.66*	277.35	0.00	0.26*	0.59*
MD	460.41	0.00	4.11*	40.66*	231.03	0.26*	0.26*	0.59*
ME	0.00	0.00	4.11*	40.66*	288.73	0.26*	0.26*	0.59*
MI	252.38	0.00	4.11*	40.66*	185.77	0.00	0.26*	0.59*
MN	115.82	0.00	4.11*	40.66*	105.55	0.00	0.26*	0.59*
MO	183.76	0.00	4.11*	40.66*	132.60	0.00	0.26*	0.59*
MS	1048.17	0.00	4.11*	40.66*	181.72	0.00	0.26*	0.59*
MT	122.12	0.00	4.11*	40.66*	32.38	0.26*	0.26*	0.59*
NC	483.30	16.52*	4.11*	40.66*	58.73	0.00	0.26*	0.59*
ND	403.12	0.00	4.11*	40.66*	64.55	0.26*	0.26*	0.59*
NE	238.38	0.00	4.11*	40.66*	177.54	0.00	0.26*	0.59*
NH	1234.19	0.00	4.11*	40.66*	244.67	0.00	0.26*	0.59*
NJ	24.12	0.00	4.11*	40.66*	368.28	0.00	0.26*	0.59*
NM	98.93	0.00	4.11*	40.66*	12.05	0.00	0.26*	0.59*
NV	128.24	0.00	4.11*	40.66*	138.12	0.00	0.26*	0.59*
NY	197.48	0.00	4.11*	40.66*	279.77	0.00	0.26*	0.59*
OH	799.43	0.00	4.11*	40.66*	93.67	0.00	0.26*	0.59*
OK	237.33	0.00	4.11*	40.66*	222.72	0.00	0.26*	0.59*
OR	215.45	0.00	4.11*	40.66*	172.26	0.00	0.26*	0.59*
PA	673.51	0.00	4.11*	40.66*	176.43	0.00	0.26*	0.59*
RI	325.41*	16.52*	4.11*	40.66*	369.65*	0.00	0.26*	0.59*
SC	186.96	0.00	4.11*	40.66*	61.22	0.26*	0.26*	0.59*
SD	325.41*	16.52*	4.11*	40.66*	369.65*	0.00	0.26*	0.59*
TN	353.27	16.52*	4.11*	40.66*	72.35	0.00	0.26*	0.59*
TX	212.02	0.00	4.11*	40.66*	116.37	0.00	0.26*	0.59*
UT	272.17	16.52*	4.11*	40.66*	109.36	0.00	0.26*	0.59*
VA	322.95	0.00	4.11*	40.66*	342.97	0.00	0.26*	0.59*
VT	325.41*	0.00	4.11*	40.66*	369.65*	0.26*	0.26*	0.59*
WA	34.96	0.00	4.11*	40.66*	17.74	0.00	0.26*	0.59*
WI	142.97	0.00	4.11*	40.66*	177.77	0.00	0.26*	0.59*
WV	178.15	0.00	4.11*	40.66*	24.54	0.26*	0.26*	0.59*
WY	130.43	0.00	4.11*	40.66*	64.59	0.26*	0.26*	0.59*

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