Particulate Matter Emissions for eGRID2019

DRAFT White Paper

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Introduction

EPA's Emissions & Generation Resource Integrated Database (eGRID) is a comprehensive source of data on air pollution emissions and electricity generation for virtually all electric generating units in the United States. Currently, eGRID includes emissions data on carbon dioxide (CO_2), nitrogen oxides (NO_X), sulfur dioxide (SO_2), methane (CH_4), and nitrous oxide (N_2O), but does not include information on particulate matter (PM). PM pollution—principally fine particulate matter 2.5 microns in diameter or smaller ($PM_{2.5}$)—can lead to negative health impacts, including asthma exacerbations, heart attacks, and premature mortality. For example, Lelieveld et al. (2015) estimated that in 2010, 55,000 premature deaths in the United States were attributable to two types of air pollution – $PM_{2.5}$ and ozone.[1] Additionally, EPA's retrospective analysis of the Clean Air Act found that approximately 85 percent of the public health benefits of air quality regulations are due to $PM_{2.5}$ reductions, rather than ozone (EPA 2011a).[2] $PM_{2.5}$ can also lead to reduced visibility, known as haze, which negatively affects much of the country, including national parks.

In an effort to start including $PM_{2.5}$ emissions in eGRID, EPA released draft $PM_{2.5}$ emissions and emissions rates for eGRID2018 and requested feedback. This white paper provides an overview of the methodology used to develop the draft $PM_{2.5}$ emissions rates and the emissions rates for eGRID2019.

eGRID uses CAMD's Power Sector Emissions Data reported to EPA's Clean Air Markets Division (CAMD)[3] to determine the CO_2, NO_X, and SO_2 emissions at many electric generating units. For electric generating units that do not report to CAMD, eGRID estimates emissions based on fuel use, as reported to the Energy Information Administration (EIA).[4] Neither CAMD nor EIA collect data on $PM_{2.5}$ emissions.[5] For this reason, it is not possible to use PM data from either CAMD or EIA to estimate the $PM_{2.5}$ emissions and $PM_{2.5}$ emission rates from power plants.

EPA's National Emissions Inventory (NEI) is a source of $PM_{2.5}$ emissions data. The annual emissions of air pollutants, including $PM_{2.5}$, from most electric generating units get reported to the NEI.[6] While EPA has not previously used the NEI data for eGRID, EPA is proposing to use NEI data to determine $PM_{2.5}$ emissions at electric generating units. The most recent data year for both eGRID and NEI data is 2018.

This paper discusses EPA's proposed methods to determine $PM_{2.5}$ emission rates for each power plant, including steps to estimate emissions for units that may not report to the NEI. First, 2018 $PM_{2.5}$ emission rates were calculated and then applied to the eGRID2019 data to estimate 2019 $PM_{2.5}$ emissions. The accompanying Excel data file lists the unit- and plant-level heat input, plant-level generation, and unit-, plant-, and eGRID subregion-level $PM_{2.5}$ emissions and emission rates for 2018 and 2019.

Note that PM can be emitted in two forms—as particles (filterable PM) or as a gas that later condenses

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[1] Lelieveld, J., J.S. Evans, M. Fnais, D. Giannadaki, and A. Pozzer. 2015. The contribution of outdoor air pollution sources to premature mortality on a global scale. *Nature* 525: 367–371.

[2] EPA. 2011a. *The Benefits and Costs of the Clean Air Act from 1990 to 2020.* U.S. Environmental Protection Agency Office of Air and Radiation. Final Report – Rev. A. April. Available: https://www.epa.gov/sites/production/files/2015-07/documents/fullreport_rev_a.pdf. U.S. Environmental Protection Agency.

[3] These data are reported to EPA under chapter 40 of the Code of Federal Regulations part 75 (40 CFR part 75) for several Clean Air Act programs, including the Acid Rain Program and Cross-state Air Pollution Rule.

[4] These data are reported to EIA through form EIA-923.

[5] EIA collects some data on PM emission rates, but it does not specify whether the rates are for $PM_{2.5}$ or PM_{10} (particulate matter 10 microns in diameter or smaller).

[6] Electric generating units and other point sources of air pollution emissions do not report emissions directly to the NEI. Rather they report to state, local, or tribal agencies, which then report the data to the NEI.

into particles when it enters the atmosphere (condensable PM). The eGRID methodology is designed to include both types of PM, also known as primary $PM_{2.5}$.[7]

Methodology

The most recent year in which both eGRID and NEI data are available is 2018.[8] To estimate $PM_{2.5}$ emissions and emission rates for 2018, unit-level $PM_{2.5}$ emission rates (lb/MMBtu) were developed using the 2018 NEI $PM_{2.5}$ mass data and the 2018 EIA heat input data. The unit-level $PM_{2.5}$ emission rates developed for 2018 were then multiplied by the 2019 unit-level heat input to estimate 2019 unit-level $PM_{2.5}$ emissions. The 2019 unit-level $PM_{2.5}$ emissions were summed to the plant-level and eGRID subregion-level to estimate 2019 plant-level $PM_{2.5}$ emissions and eGRID subregion $PM_{2.5}$ output emission rates.

The following methodology discusses how the 2018 unit-, plant-, and eGRID subregion-level $PM_{2.5}$ emissions and emission rates were calculated. The NEI contains annual $PM_{2.5}$ emissions data for electric generating units, but the first step in integrating NEI data is to match the electric generating units to the eGRID data. The NEI uses Emissions Inventory System (EIS) codes to identify facilities and units, while eGRID uses Office of Regulatory Information Systems Plant (ORISPL) codes to identify facilities and units. EPA's Office of Air Quality Planning and Standards (OAQPS), which compiles the NEI, has matched electric generating units between EIS identifiers used in the NEI and the ORISPL identifiers used in eGRID.[9] The EIS and ORISPL systems do not always have a one-to-one relationship; in some cases, multiple EIS IDs are used to refer to a single unit in eGRID (or vice versa). In order to use the NEI data in eGRID, the NEI data are mapped to the appropriate ORISPL plant and unit ID. Multiple units in the NEI that are reported as matching to one eGRID unit are grouped and summed to determine the total emissions for each eGRID unit. For units that cannot be matched directly to the NEI, EPA estimated the $PM_{2.5}$ emissions using a series of emissions factors. In general, the process of determining the $PM_{2.5}$ emissions for each unit follows a four-step process:

1. **Direct match.** First the EPA matched operational combustion units with positive heat input directly between the 2018 NEI and 2018 eGRID. Units that could not be matched directly between the NEI and eGRID either do not report to the NEI as point sources or an adequate match between NEI and eGRID could not be determined.

2. **Average emissions factors by fuel type, unit firing type, and prime mover.** EPA developed average emissions factors by grouping the units from the NEI that can be matched to eGRID by fuel type (e.g., bituminous coal), unit firing type (e.g., wall-fired), and prime mover (e.g., steam turbine). The $PM_{2.5}$ emissions and heat input, expressed as million British thermal units (MMBtu), for all units in each group were summed. The emissions factor was calculated by dividing the total emissions in each group by the total heat input in each group. This emissions factor was multiplied by the heat input reported by EIA for all units that could not be matched to a unit in the NEI, but which have the same fuel type, firing type, and prime mover.

3. **Average emissions factors by fuel type and prime mover.** For units that could not be matched directly between eGRID and the NEI or that could not be matched using the emissions factors

[7] In addition to primary $PM_{2.5}$ emitted by electric generating units, secondary $PM_{2.5}$ can form in the atmosphere based on reactions of gases, such as NO_X, SO_2, and ammonia. This proposed method only addresses primary $PM_{2.5}$.

[8] The National Emissions Inventory is compiled for all sources every three years, and the most recent release is for 2017 data. However, data on point sources, including electricity generating units, is collected annually, and the most recent data for the point source emissions is 2018.

[9] This analysis uses the data from the 2016v1 air emissions modeling platform (available at https://www.epa.gov/airemissions-modeling/2016v1-platform) to identify PM2.5 emissions from power plants.

developed under step 2, EPA next developed more general average emissions factors by grouping the units from the NEI by fuel and prime mover. To capture more units, firing type was not included in this step because not all units have firing type data.

4. **Emissions factors from AP-42.** For the remaining units, EPA estimated the $PM_{2.5}$ emissions using an emissions factor reported in EPA's AP-42.[10] The emissions factors from AP-42 are specific to the unit's fuel, firing type, and prime mover. For some of these units, EPA was able to match the units to a PM control efficiency reported in the EIA-923. Therefore, for these units, the $PM_{2.5}$ emissions estimated using the emissions factor were adjusted to account for the control efficiency. Since the NEI emissions included in step 1 and the average emissions factors developed in steps 2 and 3 are based on reported emissions to the NEI, the control efficiency is already accounted for in these emissions factors. The emissions in steps 1 through 3 therefore did not need to be further adjusted for any control efficiencies.

There are some fuel types for which there are no emissions factors in AP-42 or another source. For these factors, an emissions factor from a similar fuel type was applied. For example, there is no emission factor for other gas (OG), so the emissions factor for natural gas (NG) was used. For some fuel types, including lignite coal, petroleum coke, and waste oil, the $PM_{2.5}$ emissions factors depend on the ash content of the fuel. For the units combusting these fuels that could not be directly matched to the NEI, an ash content of the fuel was first estimated. EIA-923 reports ash content at the unit-level for each month. A weighted average ash content was calculated for each unit that uses lignite, petroleum coke, or waste oil, weighted by the amount of heat input for each unit in each month, which were used with equations from AP-42 to determine unit-specific emissions factors for those three fuel types.

Unit-level $PM_{2.5}$ emission rates were developed with the 2018 data and applied to eGRID2019 unit-level heat input to determine the 2019 $PM_{2.5}$ unit- and plant-level emissions and emission rates. For any new plants in 2019, steps 2-4 (listed above) were repeated to develop emissions factors to estimate $PM_{2.5}$ emissions. Unit- and plant-level $PM_{2.5}$ emission rates were then calculated for 2019.

Results

Figure 1 displays the 27 eGRID subregions, including the new subregion for Puerto Rico (PRMS), added for eGRID2019. The 2019 subregion-level annual net generation, $PM_{2.5}$ emissions, and $PM_{2.5}$ output emission rates are shown in Figure 2 and in Table 1. The 2018 and 2019 unit-, plant-, and subregion-level annual net generation, $PM_{2.5}$ emissions, and $PM_{2.5}$ output emission rates are included in the Excel data file.

The 2019 subregion-level $PM_{2.5}$ output emission rates range from 0.017 lbs/MWh in the NYUP subregion to 0.825 lbs/MWh in the AKMS subregion. The highest output emission rates are in the subregions in Alaska and Hawaii, which have a higher percentage of generation from oil and a lower percentage of generation from natural gas when compared to the subregions in the contiguous United States. These higher output emission rates are explained by the fact that oil has a high $PM_{2.5}$ output emission rate compared to natural gas.

[10] United States Environmental Protection Agency, Office of Air Quality Planning and Standards. Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources

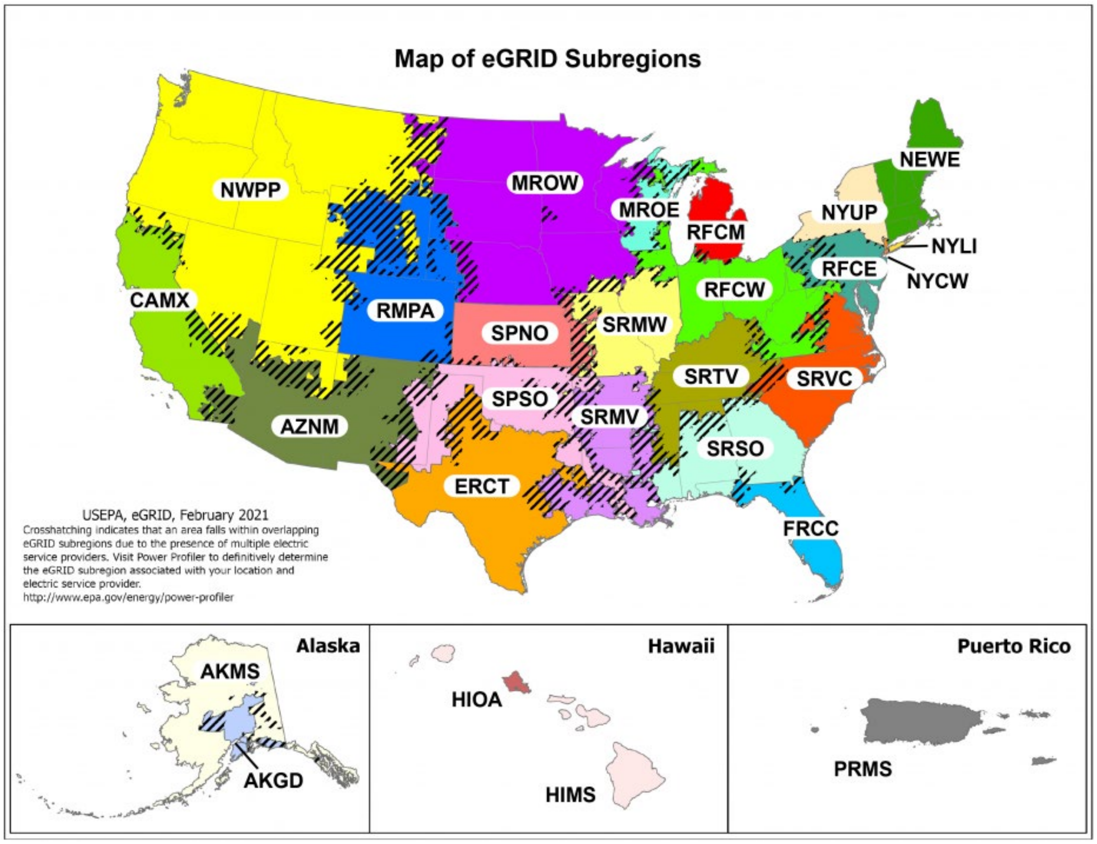

Figure 1. eGRID subregion map

Figure 2. eGRID Subregion-level 2019 generation, $PM_{2.5}$ emissions, and $PM_{2.5}$ emission rates

Table 1. eGRID Subregion-level 2019 generation, $PM_{2.5}$ emissions, and $PM_{2.5}$ output emission rates

Subregion	Annual Generation (MWh)	Annual $PM_{2.5}$ Emissions (short tons)	Annual $PM_{2.5}$ Output Emission Rate (lbs/MWh)
AKGD	4,513,906	582	0.2578
AKMS	1,554,337	641	0.8247
AZNM	169,846,256	6,099	0.0718
CAMX	204,484,755	2,957	0.0289
ERCT	418,830,337	8,631	0.0412
FRCC	235,320,760	6,759	0.0574
HIMS	2,758,699	1,095	0.7940
HIOA	6,991,299	2,060	0.5892
MROE	20,844,888	293	0.0281
MROW	232,826,410	14,550	0.1250
NEWE	100,011,791	2,301	0.0460
NWPP	282,811,235	7,934	0.0561
NYCW	41,509,809	1,109	0.0534
NYLI	8,943,357	239	0.0534
NYUP	87,477,873	761	0.0174
PRMS	18,166,188	836	0.0920
RFCE	296,156,271	13,923	0.0940
RFCM	97,428,154	3,032	0.0622
RFCW	514,167,896	57,725	0.2245
RMPA	66,259,360	1,262	0.0381
SPNO	70,052,261	1,924	0.0549
SPSO	157,750,108	3,447	0.0437
SRMV	173,701,305	5,062	0.0583
SRMW	121,427,325	5,347	0.0881
SRSO	260,293,360	4,949	0.0380
SRTV	216,125,641	18,419	0.1704
SRVC	328,960,224	12,223	0.0743
U.S.	**3,810,253,579**	**184,157**	**0.0890**

eGRID2018 Comparison

EPA previously estimated eGRID2018 $PM_{2.5}$ emissions using 2016 NEI data. Now that actual reported 2018 $PM_{2.5}$ emissions are available from the NEI, EPA can compare the projected eGRID2018 $PM_{2.5}$ emissions rates to the rates calculated using 2018 $PM_{2.5}$ emissions reported to the NEI. Figure 3 compares the projected eGRID2018 $PM_{2.5}$ emissions rates to those calculated using the actual NEI reported 2018 $PM_{2.5}$ emissions.

For most subregions, the projected and actual emission rates are very similar—to within 0.01 lbs./MWh. There are some notable differences, however, between the projected and actual emission rates, such as in the MROW, RFCW, and SRTV regions, where the actual 2018 emission rates were higher than the projected emission rates in eGRID. In these cases, the differences in the rates are driven largely by differences in the actual and projected emissions in a small number of plants. For example, in MROW there were five plants (out of 1,139) that had significantly higher emission rates in 2018 than in 2016. If these five plants are excluded, the overall MROW $PM_{2.5}$ emission rates would be similar between the projected eGRID2018 values and the calculated values using the actual NEI reported 2018 $PM_{2.5}$ emissions. Such plant-level differences are difficult to predict year-to-year and can have a noticeable impact on the subregion-level rates. However, for most plants and subregions, the eGRID $PM_{2.5}$ projection methodology accurately estimates emissions.

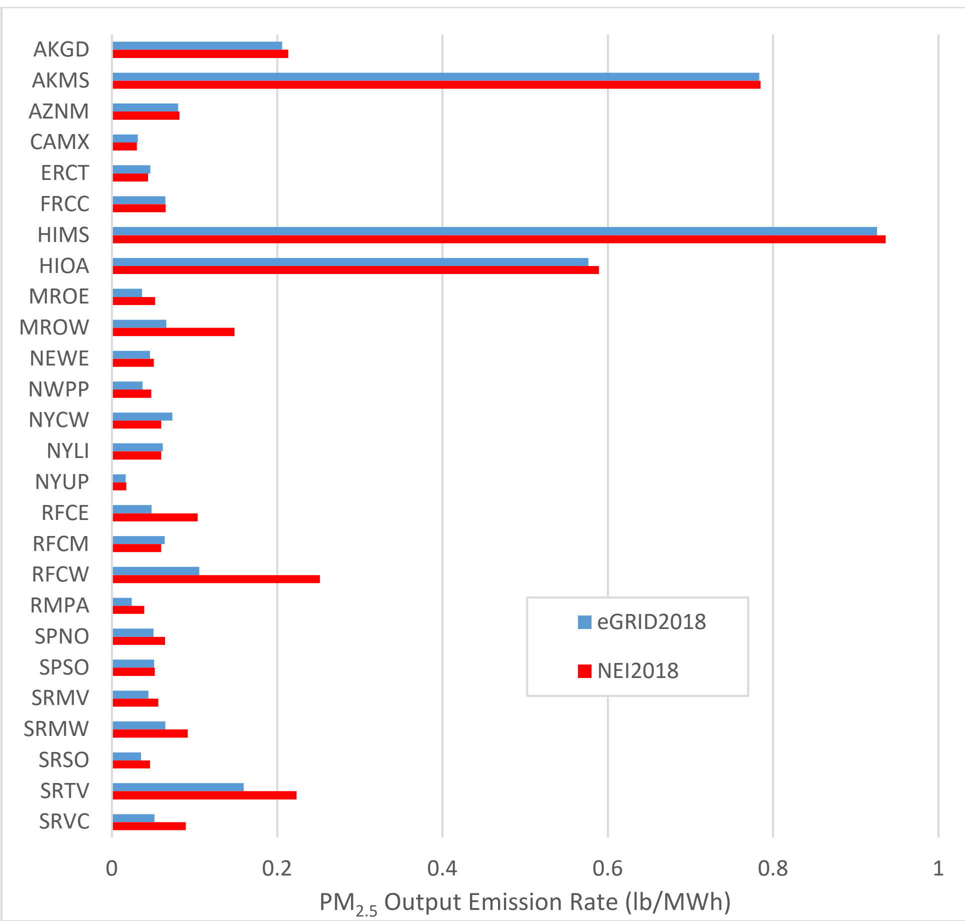

Figure 3. Comparison of $PM_{2.5}$ output emission rates between eGRID2018 and NEI2018.