Memorandum

TO: UNION OF CONCERNED SCIENTISTS

FROM: PAT KNIGHT, SYNAPSE ENERGY ECONOMICS

DATE: JANUARY 26, 2017

RE: POWER PLANT DATABASE DOCUMENTATION

This memo serves as the documentation for the Excel workbook "Synapse Power Plant Database.xlsx". It details the sources, methodology, and caveats used in this workbook. For more information about the development of the file or data contained within it, please contact Pat Knight at Synapse Energy Economics (pknight@synapse-energy.com or 617-453-7051).

Development of the Synapse Power Plant Database

The purpose of this power plant database is to provide a record of all the emitting power plants in the United States, along with data on their historical electricity production, pollutant emissions, and other key attributes from 1995 to 2016.[1]

Data sources

This database was designed with an eye towards assembling the most detailed dataset possible, given constraints on source data structure. The main sources of data for this dataset are as follows:

- **EIA Form 860:** The Energy Information Administration (EIA) publishes this dataset annually. The dataset contains a list of all electric generating units currently in operation or recently retired, along with data on generator type (what the EIA calls the "prime mover"), unit location and ownership, and online year and retirement year. This dataset also contains detailed information on environmental controls and control online years. EIA Form 860 is available at http://www.eia.gov/electricity/data/eia860/

- **EIA Form 923:** EIA also releases a dataset each year containing data on power plant electricity production and fuel consumption. Net electric generation data in this dataset is reported for

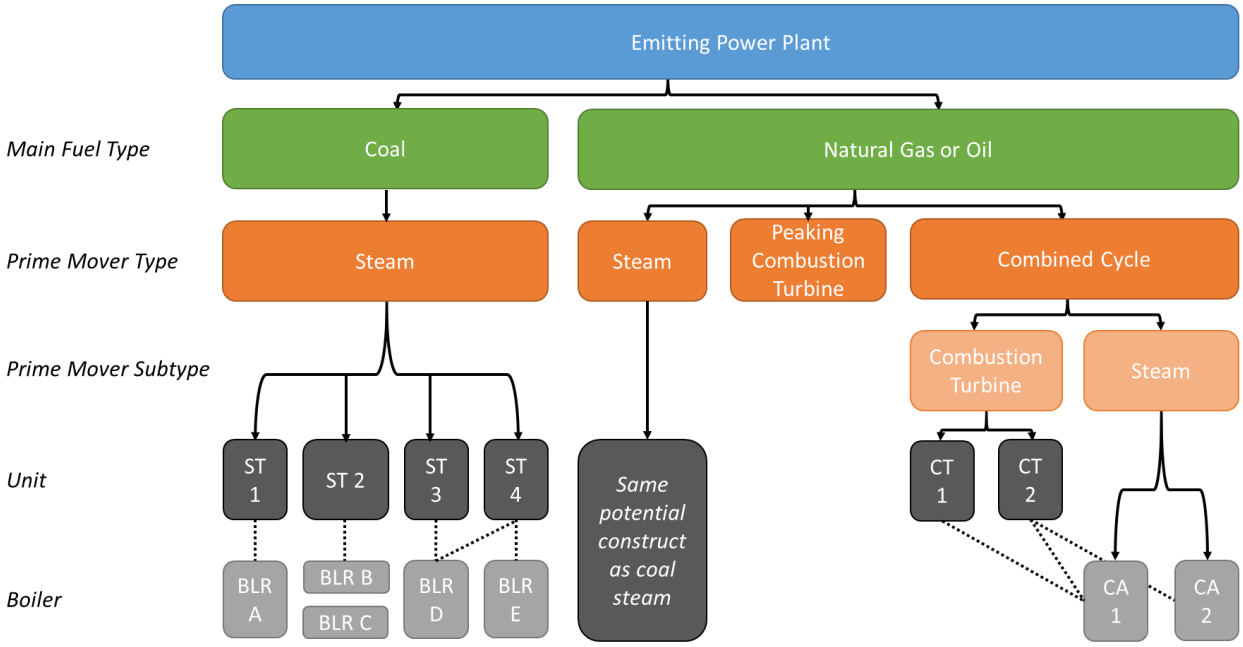
[1] Note that as of January 2016, only partial year data for 2016 is available.

each plant by fuel type and generator type.[2] Generator-specific generation data is only released for certain kinds of plants and is only available for a few recent years. EIA Form 923 is available at http://www.eia.gov/electricity/data/eia923/.

- **EPA AMP:** The Environmental Protection Agency (EPA) releases an annual dataset on emissions called the Air Market Programs (AMP). This dataset contains information on emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulfur dioxide (SO_2). This dataset also contains information on gross generation, fuel input, and environmental controls. All data is reported at the boiler level. EIA AMP data is available at https://ampd.epa.gov/ampd/.

The key difficulty in aggregating facility attributes, generation, and emissions from each of these datasets is that they are published at different levels of generation. A single power plant may consist of several electric generators—called "units"—which may or may not produce electricity through different physical mechanisms (i.e., prime movers) or by using different types of fuels (see Figure 1). Each one of these units will be powered by one or more boilers, which may in turn power more than one unit. As a result, we have aggregated data to the fuel / prime mover-type level, the highest level of resolution to the which the disparate datasets may be easily combined.

Figure 1. Schematic of potential fuel type, prime mover, unit, and boiler configurations at a single power



[2] "Net" electric generation refers to the electricity that flows out of a power plant, after accounting for all internal uses. "Gross" electric generation refers to electricity produced by individual boilers and generators, before the internal use at that facility is accounted for.

Developing the records and capacity data

The first step in developing this dataset was to assemble a list of prime movers at each power plant that has the potential to directly produce emissions of CO_2, NO_X, or SO_2. Using EIA 860 datasets from 2001 to 2016, we produced a list of every single generating unit reported as operational from 1995 to 2016. We also matched data on nameplate capacity (i.e., MW size), prime mover type, and primary fuel type. We then coded each unit as "emitting" if the unit primarily used coal, natural gas, oil, or biomass.[3] All other fuel types were coded as "non-emitting" and excluded from the analysis.[4] Remaining units were then sorted into two groups: units with capacities below 25 MW and units with capacities of 25 MW or greater. Units smaller than 25 MW (or their affiliated boilers) are typically not required to report generation or emissions data to EIA or EPA.

This set of emitting units then had all duplicates removed, leaving a set of about 5,900 records, each with a unique combination of plant ID number (ORSPL), prime mover, and capacity (i.e., <25 MW or ≥25 MW). Each record is made up of one or more generating units. For each record, we coded the relevant data on location (both by state, county, and latitude and longitude), first year of operation (for the earliest constituent unit within that record to have come online), and final year of operation for all units within the record. In this stage, data on total nameplate capacity from 1995 to 2016 was also summed and appended to each record.[5]

Environmental controls

Next, we used Synapse's Coal Asset Valuation Tool (CAVT) to link information on environmental controls for each unit.[6] This environmental control data itself was assembled using EIA Form 860 and EPA AMP and is available from these sources at the environmental control level (some units may be linked to more than one control of the same type, and some environmental controls may remove pollutants from one or more units). Within CAVT, Synapse has attributed the correct controls to each unit. Using this data, Synapse then matched this unit-specific data to each of it the 5,900 records in the Power Plant Database.

Environmental control data is reported for: SO_2 controls, including wet flue-gas desulfurization (wet FGD) systems, dry flue-gas desulfurization (dry FGD) systems, and dry sorbent injection (DSI) systems; NO_X controls, including selective non-catalytic reactor (SNCR) systems and selective catalytic reactor (SCR) systems; particulate controls, including electrostatic precipitators (ESP) and baghouses; and mercury controls, including activated carbon injection(ACI) systems. Each record contains data on the

[3] This step was performed for an initial screening—the final fuel type for each record was determined in a later state. Note that "biomass" includes plants that burn wood or wood products, landfill gas, municipal solid waste, or other miscellaneous biomass fuels.

[4] This includes units that may use trace amounts of coal, oil, natural gas, or biomass to produce electricity, as well as units that primarily rely on concentrating solar power (which may use some amount of natural gas in certain hours).

[5] Nameplate capacity is used for every year except 2016, where only summer capacity is available from EIA.

[6] More information on CAVT available at http://www.synapse-energy.com/tools/coal-asset-valuation-tool-cavt

environmental controls associated with each unit, as well as the year those environmental controls were put into place.

Generation and fuel type

In the next step, Synapse matched data from EIA Form 923 to each record to determine annual net generation and main fuel type. For each record, we compiled data on net electricity generation from coal, natural gas, oil, and biomass for each year from 1995 to 2016. This data was summed to provide a total number of MWh. We designated the master fuel type for each record based on the type with the largest generation value in that year. For example, if the record showed that 100 MWh of electricity was produced from coal, and zero MWh from all other fuel types, the record would be given the fuel type attribute "coal" in that year. If a record showed 10 MWh produced from coal, 10 MWh from natural gas, 10 MWh from oil, and 11 MWh from biomass, the record would be given the fuel type attribute "biomass" for that year.

Note that 2001 and 2002 are exceptions. In these two years, EIA Form 923 did not report generation by fuel type and prime mover. Instead, only information on fuel type only was reported. For these two years, we aggregated electric generation data by fuel type for each plant, then apportioned it to each unit which shared those same fuel types in 2000 and 2003.

Also note that this exercise was only performed for (a) records containing units greater than or equal to 25 MW and (b) records containing units smaller than 25 MW where there was no other record for that plant and prime mover type with units greater than or equal to 25 MW.

For many records, the predominant type of fuel changes over time. For this reason, we also report data on the main fuel type for each year between 1995 and 2016, and the share of generation from each of the four fuel types for each record in each of the years. We also give each record a "main" fuel type, based on the fuel type for the most recent year for which generation data was recorded.

For 1999, 2000, and 2003 through 2016, this methodology results in matching all but 0.2 percent of emitting generation. For 1995 through 1998, an average of 14 percent of generation reported by EIA Form 923 was not matched to records. This discrepancy can be explained by non-utility-owned generators, who for these four years did not have to report generation data by prime mover. For 2001 and 2002, an average of 6 percent of generation reported by EIA Form 923 was not matched to records. This generation can be attributed to non-utility generators which have had their plant ID numbers (ORSPLs) changed in more recent years.

Emissions

Finally, we matched emissions data for each record for CO_2, NO_X, and SO_2. The methodology for all three pollutants is largely identical. First, we assembled EPA AMP emissions data from 1995 to 2016. Next, we matched emissions data for each year to each record, based on the plant ID, prime mover, and fuel type attributes. As with generation, this exercise was only performed for records containing units greater

than or equal to 25 MW and records containing units smaller than 25 MW where there was no other record for that plant and prime mover type with units greater than or equal to 25 MW.

This methodology resulted in 0.3 percent of all reported CO_2, 0.3 percent of all reported NO_X, and 0.5 percent of all reported SO_2 being allocated to records in the Power Plant Database.

Note that there are roughly 120 records that appear in the EPA AMP database but do not appear as part of the EIA-based list of plants. These are mostly industrial cogenerating facilities that may have different reporting responsibilities to EIA and EPA.