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## Technical Notes

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This appendix describes how the U.S. Energy Information Administration collects, estimates, and reports electric power data in the Electric Power Annual.

### Data Quality and Submission

The Electric Power Annual (EPA) is prepared by the Office of Energy Production, Conversion, and Delivery (EPCD), U.S. Energy Information Administration (EIA), U.S. Department of Energy (DOE). EPCD performs routine reviews of the data collection respondent frames, survey forms, and reviews the quality of the data received.

Data are entered directly by respondents into the EIA's Internet Data Collection (IDC) system. A small number of hard copy forms are keyed into the system by EIA personnel. All data are subject to review via interactive edits built into the IDC system, internal quality assurance reports, and review by subject matter experts. Questionable data values are verified through contacts with respondents, and survey non-respondents are identified and contacted.

IDC edits include both deterministic checks, in which records are checked for the presence of data in required fields, and statistical checks, in which the data are checked against a range of values based on historical data values and for logical or mathematical consistency with data elements reported in the survey. Discrepancies found in the data, because of these checks, must either be corrected by the respondent or the respondent must enter an explanation as to why the data are correct. If these explanations are unsatisfactory the respondent is contacted by EIA for clarification or corrected data.

Those respondents unable to use the electronic reporting method provide the data in hard copy, typically via fax and email. These data are manually entered into the computerized database and are subjected to the same data edits as those performed during e-filing by the respondent.

### Reliability of Data

Annual survey data have non-sampling errors. Non-sampling errors can be attributed to many sources: (1) inability to obtain complete information about all cases (i.e., non-response); (2) response errors; (3) definitional difficulties; (4) differences in the interpretation of questions; (5) mistakes in recording or coding the data; and (6) other errors of collection, response, coverage, and estimation for missing data.

Although no direct measurement of the biases due to non-sampling errors can be obtained, precautionary steps were taken in all phases of the frame development and data collection, processing, and tabulation processes to minimize their influence.

**Imputation:** If the reported values appear to be in error and the data issue cannot be resolved with the respondent, or if the facility is a non-respondent, a regression methodology is used to impute for the facility. The regression methodology relies on other data to make estimates for erroneous or missing responses. The basis for the current methodology involves a 'borrowing of strength' technique for small domains.<sup>1</sup>

## Data Revision Procedure

The EPA presents the most current and complete data available to the EIA. The statistics may differ from those published previously in EIA publications due to corrections, revisions, or other adjustments to the data after its original release.

After data are disseminated as final, revisions will be considered if a correction would make a difference of 1 percent or greater at the national level. Revisions for differences that do not meet the 1 percent or greater threshold will be determined by the Office Director. In either case, the proposed revision will be subject to the EIA revision policy concerning how it affects other EIA products.

**Sensitive Data (Formerly Identified as Data Confidentiality):** Most of the data collected on the electric power surveys are not considered business sensitive. However, the data that are classified as sensitive are handled consistent with EIA's "Policy on the Disclosure of Individually Identifiable Energy Information in the Possession of the EIA" (45 Federal Register 59812 (1980)).

## Rounding and Percent Change Calculations

**Rounding Rules for Data:** To round a number to n digits (decimal places), add one unit to the nth digit if the (n+1) digit is 5 or larger and keep the nth digit unchanged if the (n+1) digit is less than 5.

**Percent Change:** The following formula is used to calculate percent changes:

$$\text{Percent Change} = \left( \frac{x(t_2) - x(t_1)}{x(t_1)} \right) \times 100,$$

where  $x(t_1)$  and  $x(t_2)$  denote the quantity at period  $t_1$  and subsequent period  $t_2$ .

## Data Sources for Electric Power Annual

Data published in the EPA are compiled from forms filed annually or aggregated to an annual basis from monthly forms (see figure on EIA Electric Industry Data Collection in Appendix A). The respondents to these forms include electric utilities, other generators and sellers of electricity, and North American Electric Reliability Corporation (NERC) reliability entities. The EIA forms used are:

- Form EIA-111, "Quarterly Electricity Imports and Exports Report;"
- Form EIA-860, "Annual Electric Generator Report;"
- Form EIA-861, "Annual Electric Power Industry Report;"
- Form EIA-861M, "Monthly Electric Power Industry Report;"
- Form EIA-861S, "Annual Electric Power Industry Report (Short Form);"
- Form EIA-923, "Power Plant Operations Report."

These forms can be found on the EIA Internet website at: <https://www.eia.gov/survey/>

Survey data from other Federal sources are also utilized for this publication. They include:

- FERC Form 1, "Annual Report of Major Electric Utilities, Licensees, and Others;"

Additionally, some data reported in this publication were acquired from public reports of the National Energy Board of Canada on electricity imports and exports.

### Form EIA-111

The Form EIA-111 is a mandatory census that collects import/export data from importers and exporters of electricity, border balancing authorities, and entities authorized to export electric energy and to construct, connect, operate, or maintain facilities for the transmission of electric energy at an international boundary. Respondents report monthly data quarterly. These data are used by EIA to track electricity being imported into and exported from the United States. There are currently 173 respondents to the EIA-111. These data were first collected for the 2016 data year.

### Form EIA-860

The Form EIA-860 is a mandatory annual census of all existing and planned electric generating facilities in the United States with a total generator nameplate capacity of 1 or more megawatts. The survey is used to collect data on existing power plants and 10-year plans for constructing new plants, as well as generating unit additions, modifications, and retirements in existing plants. Data on the survey are collected at the individual generator level. Certain power plant environmental-related data are collected at the boiler level. These data include environmental equipment design parameters and boiler air emission standards and boiler emission controls. There are approximately 5,700 respondents on the EIA-860 data collection.

**Instrument and Design History:** The Form EIA-860 was originally implemented in January 1985 to collect plant data on electric utilities as of year-end 1984. It was preceded by several Federal Power Commission (FPC) forms including the FPC Form 4, Form 12 and 12E, Form 67, and Form 411. In January 1999, the Form EIA-860 was renamed the Form EIA-860A and was implemented to collect data as of January 1, 1999.

In 1989, the Form EIA-867, "Annual Nonutility Power Producer Report," was initiated to collect plant data on unregulated entities with a total generator nameplate capacity of 5 or more megawatts. In 1992, the reporting threshold of the Form EIA-867 was lowered to include all facilities with a combined nameplate capacity of 1 or more megawatts. Previously, data were collected every 3 years from facilities with a nameplate capacity between 1 and 5 megawatts. In 1998, the Form EIA-867, was renamed Form EIA-860B, "Annual Electric Generator Report – Nonutility." The Form EIA-860B was a mandatory survey of all existing and planned nonutility electric generating facilities in the United States with a total generator nameplate capacity of 1 or more megawatts.

Beginning with data collected for the year 2001, the infrastructure data collected on the Form EIA-860A and the Form EIA-860B were combined into the new Form EIA-860 and the monthly and annual versions of the Form EIA-906. The Federal Energy Administration Act of 1974 (Public Law 93-275) defines the legislative authority to collect these data.

Starting with 2007, design parameters data formerly collected on Form EIA-767 were collected on Form EIA-860. These include design parameters associated with certain steam-electric plants' boilers, cooling systems, flue gas particulate collectors, flue gas desulfurization units, and stacks and flues.

**Estimation of EIA-860 Data:** No imputation is required for EIA-860 data.

**Issues within Historical Data Series Regarding Categorization of Capacity by Business Sector:** There are a small number of electric utility CHP plants, as well as a small number of industrial and commercial generating facilities that are not CHP. For the purposes of this report the data for these plants are included, respectively, in the following categories: “Electricity Generators, Electric Utilities,” “Combined Heat and Power, Industrial,” and “Combined Heat and Power, Commercial.”

Some capacity in 2001 through 2004 is classified based on the operating company's classification as an electric utility or an independent power producer. Starting in the EPA 2006, capacity by producer type was determined at the power plant level for 2005 and all subsequent data collections. This change required revisions to the original published 2005 data.

**Issues within Historical Data Series Regarding Planned Capacity:** Delays and cancellations may have occurred after respondent data reporting as of December 31 of the data year.

**Issues within Historical Data Series Regarding Capacity by Energy Source:** Prior to the EPA 2005, the capacity for generators for which natural gas or petroleum was the most predominant energy source was presented in the following three categories: petroleum only, natural gas only, and dual-fired. The dual-fired category, which was EIA's effort to infer which generators could fuel-switch between natural gas and fuel oil, included only the capacity of generators for which the most predominant energy source and second most predominant energy source were reported as natural gas or petroleum. Beginning in 2005, capacity is assigned to energy source based solely on the most predominant (primary) energy source reported for a generator. The “dual-fired” category was eliminated. Separately, summaries of capacity associated with generators with fuel-switching capability are presented for 2005 and later years. These summaries are based on data collected from new questions added to the Form EIA-860 survey that directly address the ability of generators to switch fuels and co-fire fuels.

In the EPA 2005, certain petroleum-fired capacity was misclassified as natural gas-fired capacity for 1995 – 2003. This was corrected in the EPA 2006. Corrections were noted as revised data.

**Prime Movers:** The Form EIA-860 sometimes represents a generator's prime mover by using the abbreviations in the table below.

| Prime Mover Code | Prime Mover Description  |
|------------------|--|
| BA               | Energy Storage, Battery  |
| BT               | Turbines Used in a Binary Cycle. Including those used for geothermal applications                |
| CA               | Combined-Cycle -- Steam Part   |
| CE               | Energy Storage, Compressed Air   |
| CP               | Energy Storage, Concentrated Solar Power   |
| CS               | Combined-Cycle Single-Shaft Combustion Turbine and Steam Turbine share of single generator       |
| CT               | Combined-Cycle Combustion Turbine Part   |
| ES               | Energy Storage, Other (Specify on Schedule 9, Comments)  |
| FC               | Fuel Cell  |
| FW               | Energy Storage, Flywheel   |
| GT               | Combustion (Gas) Turbine. Including Jet Engine design  |
| HA               | Hydrokinetic, Axial Flow Turbine   |
| HB               | Hydrokinetic, Wave Buoy  |
| HK               | Hydrokinetic, Other  |
| HY               | Hydraulic Turbine. Including turbines associated with delivery of water by pipeline.             |
| IC               | Internal Combustion (diesel, piston, reciprocating) Engine                                       |
| PS               | Energy Storage, Reversible Hydraulic Turbine (Pumped Storage)                                    |
| OT               | Other  |
| ST               | Steam Turbine. Including Nuclear, Geothermal, and Solar Steam (does not include Combined Cycle). |
| PV               | Photovoltaic   |
| WT               | Wind Turbine, Onshore  |
| WS               | Wind Turbine, Offshore   |

**Energy Sources:** The Form EIA-860 sometimes represents the energy sources associated with generators by using the abbreviations and/or groupings in the table below.

| Energy Source Grouping             | Energy Source Code | Energy Source Description   |
|------------------------------------|--------------------|---|
| <b>Fossil Fuels</b>                |                    |   |
| <b>Coal</b>                        | ANT                | Anthracite Coal   |
|                                    | BIT                | Bituminous Coal   |
|                                    | LIG                | Lignite Coal  |
|                                    | RC                 | Refined Coal (A coal product that is created when impurities and/or moisture are removed to improve heat content and reduce emissions. Includes any coal which meets the IRS definition of refined coal [Notice 2010-54 or any superseding IRS notices]. Does not include coal processed by coal preparation plants.) |
|                                    | SGC                | Coal-Derived Synthesis Gas  |
|                                    | SUB                | Subbituminous Coal  |
|                                    | WC                 | Waste/Other Coal (including anthracite culm, bituminous gob, fine coal, lignite waste, waste coal)  |
| <b>Petroleum Products</b>          | DFO                | Distillate Fuel Oil (including diesel, No. 1, No. 2, and No. 4 fuel oils)   |
|                                    | JF                 | Jet Fuel  |
|                                    | KER                | Kerosene  |
|                                    | PC                 | Petroleum Coke  |
|                                    | PG                 | Propane, gaseous  |
|                                    | RFO                | Residual Fuel Oil (including No. 5 and No. 6 fuel oils, and bunker C fuel oil)  |
|                                    | SGP                | Petroleum Coke Derived Synthesis Gas  |
| <b>Natural Gas and Other Gases</b> | BFG                | Blast Furnace Gas   |
|                                    | NG                 | Natural Gas   |
|                                    | OG                 | Other Gas (Specify the fuel in the text box in the applicable schedule.)  |
| <b>Renewable Fuels</b>             |                    |   |
| <b>Solid Renewable Fuels</b>       | AB                 | Agricultural By-products  |
|                                    | MSW                | Municipal Solid Waste   |
|                                    | OBS                | Other Biomass Solids  |

| Energy Source Grouping                   | Energy Source Code | Energy Source Description   |
|--|--------------------|---|
|  | WDS                | Wood/Wood Waste Solids (including paper pellets, railroad ties, utility poles, wood chips, bark, and wood waste solids)   |
| <b>Liquid Renewable (Biomass) Fuels</b>  | BLQ                | Black Liquor  |
|  | OBL                | Other Biomass Liquids   |
|  | SLW                | Sludge Waste  |
|  | WDL                | Wood Waste Liquids excluding Black Liquor (includes red liquor, sludge wood, spent sulfite liquor, and other wood-based liquids)  |
| <b>Gaseous Renewable (Biomass) Fuels</b> | LFG                | Landfill Gas  |
|  | OBG                | Other Biomass Gas (includes digester gas, methane, and other biomass gasses)  |
| <b>All Other Renewable Fuels</b>         | GEO                | Geothermal  |
|  | SUN                | Solar   |
|  | WAT                | Water at a Conventional Hydroelectric Turbine, and water used in Wave Buoy Hydrokinetic Technology, Current Hydrokinetic Technology, and Tidal Hydrokinetic Technology. |
|  | WND                | Wind  |
| <b>All Other Fuels</b>                   |                    |   |
|  | MWH                | Electricity used for energy storage   |
|  | NUC                | Nuclear Uranium, Plutonium, Thorium   |
|  | PUR                | Purchased Steam   |
|  | TDF                | Tire-derived Fuels  |
|  | WAT                | Pumping Energy for Reversible (Pumped Storage) Hydroelectric Turbine  |
|  | WH                 | Waste heat not directly attributed to a fuel source   |
|  | OTH                | Other   |

**Sensitive Data:** The tested heat rate and generator cost data collected on the Form EIA-860 are considered business sensitive.

## Form EIA-861

The Form EIA-861 is a mandatory annual census of electric power industry participants in the United States. Prior to data year 2012, the survey was used to collect information on power sales and revenue data from approximately 3,300 respondents. About 3,100 are electric utilities, and the remainders are nontraditional entities such as energy service providers or the unregulated subsidiaries of electric utilities and power marketers. The current frame has since expanded to about 3,400 respondents, with about 3,000 of those respondents being electric utilities and about 400 nontraditional entities.

For data year 2012 and forward, EIA modified the frame of the Form EIA-861, “Annual Electric Power Industry Report,” from a census to a sample, and EIA is using model-based methods to estimate the sales, revenues, and customer counts by sector and state for those respondents that have been removed from the frame. EIA created a new Form EIA-861S, “Annual Electric Power Industry Report (Short Form),” for the respondents that have been removed from the Form EIA-861 frame. Respondents removed from the EIA-861 frame and placed on the EIA-861S are smaller utilities with annual sales volumes. Form EIA-861S with fewer data elements compared to the EIA-861, collects limited data on total sales, revenues, and customer counts by state. Every eighth data year, EIA-861S respondents are required to fill out the full EIA-861 form. For data year 2019, EIA-861S respondents were required to complete the full EIA-861 form. There are about 1,700 respondents on the EIA-861S data collection.

**Transportation Sector:** Prior to 2003, sales of electric power for transportation (e.g., city subway systems) were included in a sector labeled other, along with sales to customers for public buildings, traffic signals and public street lighting. Beginning with the 2003 data collection, sales to the other sector was removed and the transportation was created. Non transportation that was previously reported in the sector other was reclassified as commercial.

The transportation sector is defined as electrified rail, primarily urban transit, light rail, automated guideway, and other rail systems whose primary propulsive energy source is electricity. Electricity sales to transportation sector consumers whose primary propulsive energy source is not electricity (i.e., gasoline, diesel fuel, etc.) are not included.

Benchmark statistics were reviewed from outside surveys, most notably the U.S. Department of Transportation (DOT) Federal Transit Administration’s National Transportation Database, a source previously used by EIA to estimate electricity transportation consumption. The DOT survey indicated the state and city locations of expected respondents. The Form EIA-861 survey methodology assumed that sales, revenue, and customer counts associated with these mass transit systems would be provided by the incumbent utilities in these areas, relying on information drawn routinely from rate schedules and classifications designed to serve the sector separately and distinctly.

**Data Reconciliation:** The Electric Power Annual reports total sales volumes (megawatthours) of electricity to ultimate consumers and customer counts in states with deregulated markets as the sum of bundled sales reported by full-service providers and delivery reported by transmission and distribution



utilities. EIA has concluded that the sales of electricity to ultimate consumers data reported by delivery utilities are more reliable than data reported by power marketers and Energy Service Providers (ESPs).

The reporting methodology change uses sales volumes and a customer count reported by distribution utilities, and modifies only an incremental revenue value, representing revenue associated with misreported sales assumed to be attributable to the ESPs that were under-represented in the survey frame.

**Instrument and Design History:** The Form EIA-861 was implemented in January 1985 for collection of data as of year-end 1984. The Federal Energy Administration Act of 1974 (Public Law 93-275) defines the legislative authority to collect these data.

**Average Retail Price of Electricity:** This value represents the average cost per unit of electricity sold and is calculated by dividing retail electric revenue by the corresponding sales of electricity. The average retail price of electricity is calculated for all consumers and for each end-use sector.

The electric revenue used to calculate the average retail price of electricity is the operating revenue reported by the electric power industry participant. Operating revenue includes energy charges, demand charges, consumer service charges, environmental surcharges, fuel adjustments, and other miscellaneous charges. Electric power industry participant operating revenues also include ratepayer reimbursements for state and federal income taxes and other taxes paid by the utility.

This computed average retail price of electricity reported in this publication by is a weighted average of consumer revenue and sales and does not equal the per kWh rate charged by the electric power industry participant to the individual consumers. Electric utilities typically employ several rate schedules within a single sector. These alternative rate schedules reflect the varying consumption levels and patterns of consumers and their associated impact on the costs of the electric power industry participant for providing electrical service.

**Issues within Historical Data Series:** Changes from year to year in consumer counts, sales, and revenues, particularly involving the commercial and industrial consumer sectors, may result from respondent implementation of changes in the definitions of consumers, and reclassifications. Utilities and energy service providers may classify commercial and industrial customers based on either NAICS codes or demands or usage falling within specified limits by rate schedule. The number of ultimate customers is an average of the number of customers at the close of each month. Also see the discussion of the transportation sector, above.

**Net-Metering:** This section was expanded in 2011. Previously, customer count by sector was the only data collected and published. In 2010, the EIA-861 started collecting the capacity of the net-metered installations by sector and technology. The technology types are photovoltaic (PV), wind, and other. Starting with the 2016 data collection year, storage and virtual net metering were added to the PV section.

**Demand-Side Management (DSM):** Prior to 2011, DSM data was separated into two categories, large and small utilities. Some tables contained data for just large utilities and others contained both

categories, published separately. Starting in 2011, there is no longer a division in the data. All tables now include all DSM data from utilities; this change is also reflected in the historical data.

Starting in 2011, a new category of respondents was added to the EIA-861, non-utility DSM administrators: Efficiency Maine Trust, Energytrust of Oregon, Focus on Energy, NYSERDA, and Vermont Energy Investment Corporation.

The following definitions are supplied to assist in interpreting DSM data. Utility costs reflect the total cash expenditures for the year, in nominal dollars, that used to support DSM programs.

- **Actual Peak Load Reduction** is the actual reduction in annual peak load achieved by all program participants during the reporting year, at the time of annual peak load, as opposed to the installed peak load reduction capability (potential peak load reduction). Actual peak load reduction is reported by large utilities only.
- **Energy Savings** is the change in aggregate electricity use (measured in megawatthours) for consumers that participate in a utility DSM program. These savings represent changes at the consumer's meter (i.e., exclude transmission and distribution effects) and reflect only activities that are undertaken specifically in response to utility-administered programs, including those activities implemented by third parties under contract to the utility.
- **Large Utilities** are those electric utilities with annual sales to ultimate customers or sales for resale greater than or equal to 150 million kilowatthours in 1998-2009 and, for years prior, the threshold was set at 120 million kilowatthours.
- **Potential Peak Load Reduction** is the potential peak load reduction that may occur if all demand response is called and/or participates.

**Advanced Metering:** New in 2011, Automated Meter Reading (AMR) and Advanced Metering Infrastructure (AMI), including historical data back to 2007. From 2007-2009, the count by sector is for number of customers, for 2010-2011, the count is the actual number of meters. For example, if an industrial customer had 12 meters, in 2007-2009 the count would have been 1, in 2010-2011, the count would be 12.

In 2013, the number of standard meters (non-AMR/AMI) was added to this schedule. Starting in 2020, EIA imputes the number of standard meters for the short form (EIA-861S) by estimating the number of total meters based on the revenue, sales, and customer count schedule and subtracting the number of advanced meters.

**Reliability:** New in 2021, reliability metrics SAIDI (System Average Interruption Duration Index), SAIFI (System Average Interruption Frequency Index), and CAIDI (Customer Average Interruption Duration Index) are reported in aggregate by the state, census, and U.S. level dating back to 2013. Data are weighted by customers reported on the schedule and divided by all customers who reported by that metric. For example,

$$SAIDI_{All\ Events} = \frac{\sum(SAIDI_{All\ Events} * customers\ reported_{All\ Events})}{\sum\ customers\ reported_{All\ Events}}$$

Some respondents may report SAIDI for all events, but not with major events removed. In this case their values would be included in the calculations for SAIDI<sub>All Events</sub> but their values (and customers reported) would not be included in the SAIDI<sub>w/o Major Events</sub>.

CAIDI is not collected on the form and is a derived value of SAIDI/SAIFI. If a utility reports only one of these values (such as SAIDI) and not the other (SAIFI), it would be included in the regional CAIDI value. The final metric of percent reporting in some of the tables is a sum of customers who reported at least one reliability metric divided by the total number of customers on the revenue, sales, and customer counts schedule.

### Form EIA-861M (formerly the EIA-826)

The Form EIA 861M, “Monthly Electric Power Industry Report,” is a monthly collection of data from a sample of approximately 650 of the largest electric utilities (primarily investor and publicly owned) as well as a census of energy service providers with sales to ultimate consumers in deregulated States. Form EIA-861 (see below), with approximately 3,400 respondents, serves as a frame from which the Form EIA-861M sample is drawn. Based on this sample, a model is used to estimate for the entire universe of U.S. electric utilities monthly.

**Instrument and design history:** The collection of electric power sales data and related information began in the early 1940’s and was established as FPC Form 5 by FPC Order 141 in 1947. In 1980, the report was revised with only selected income items remaining and became the FERC Form 5. The survey has gone by various other names, such as “Electric Utility Company Monthly Statement,” “Monthly Electric Utility Sales and Revenue Report with State Distributions,” and “Monthly Electric Utility Sales and Revenues with State Distributions Report.”

In 1993, EIA for the first time used a model sample for the Form EIA-861M. A stratified random sample, employing auxiliary data, was used for each of the four previous years. The sample for the Form EIA-861M was designed to obtain estimates of electricity sales and average retail price of electricity at the state level by end use sector.

Starting with data for January 2001, the restructuring of the electric power industry was considered by forming different schedules on the Form EIA-861M. These schedules group customers based on services provided by the utility: full service (or bundled) providers), electric service providers (energy) only, distribution service (delivery) only, and energy service providers that also provide the customers’ bill. -

With the revised definitions for the commercial and industrial sectors to include all data previously reported as ‘other’ data except transportation, and a separate transportation sector, all responses that would formerly have been reported under the “other” sector are now to be reported under one of the sectors that currently exist. This means there is probably a lower correlation between commercial and industrial data 2003 and after with data prior.

Average retail price of electricity represents the cost per unit of electricity sold and is calculated by dividing retail electric revenue by the corresponding sales of electricity. The average retail price of electricity is calculated for all consumers and for each end-use sector.

The electric revenue used to calculate the average retail price of electricity is the operating revenue reported by the electric utility. Operating revenue includes energy charges, demand charges, consumer service charges, environmental surcharges, fuel adjustments, and other miscellaneous charges. Electric utility operating revenues also include State and Federal income taxes and taxes other than income taxes paid by the utility.

The average retail price of electricity reported in this publication by sector represents a weighted average of consumer revenue and sales within sectors and across sectors for all consumers and does not reflect the per kWh rate charged by the electric utility to the individual consumers. Electric utilities typically employ several rate schedules within a single sector. These alternative rate schedules reflect the varying consumption levels and patterns of consumers and their associated impact on the costs to the electric utility for providing electrical service.

**Adjusting monthly data to annual data:** As a final adjustment based on our most complete data, use is made of final Form EIA-861 data, when available. The annual totals for Form EIA-861M data by state and end-use sector are compared to the corresponding Form EIA-861 values for sales and revenue. The ratio of these two values in each case is then used to adjust each corresponding monthly value.

### Form EIA-861S (Short Form)

The Form EIA 861S, “Annual Electric Power Industry Report (Short Form),” which started in year 2012. EIA-861S was created to lower the burden for bundled-service utilities with small annual sales that model-based estimation methods can be used to estimate the remaining parts of the survey. Starting in data year 2020, EIA raised the thresholds of utilities that could report on the short form and still ensure acceptable quality of statistical estimates. Respondents report on the long form (EIA-861) once every eight years. The most recent year all respondents were required to complete the full EIA-861 form was 2019. There are currently about 1,700 respondents on the Form EIA-861S.

Short form respondents report data on total sales, revenues, and customer counts by state. They answer a yes/no questions about demand side management (DSM) programs and the number of water heaters added to DSM programs. For time-based rate programs they provide the number of customers enrolled by state. Number of advanced meters are also provided by state, as well as a yes/no question about having any net-metering programs.

### Form EIA-923

Form EIA-923, “Power Plant Operations Report,” is used to collect information on receipts and cost of fossil fuels, fuel stocks, generation, consumption of fuel for generation, nonutility source and disposition of electricity, combustion by-product collection and disposal, and cooling systems, as well as operational data for flue gas desulfurization, particulates, and nitrous oxide controls. Data are collected from a monthly sample of approximately 2,600 plants, which includes a census of nuclear and pumped-storage hydroelectric plants. The plants in the monthly sample report their receipts, cost and stocks of fossil

fuels, electric power generation, and the total consumption of fuels for both electric power generation and, at combined heat and power (CHP) plants, useful thermal output. At the end of the year, the monthly respondents report their annual source and disposition of electric power (nonutilities only), operational data for air emissions controls and cooling systems, and the collection and disposal of combustion by-products on the Form EIA-923 Supplemental Form (Schedules 6, 7, and 8A to 8F). Approximately 8,400 plants, representing all generators not included in the monthly sample and with a nameplate capacity of 1 MW or more, report applicable data on the entire form annually. In addition to electric power generating plants, respondents include fuel storage terminals without generating capacity that receive shipments of fossil fuel for eventual use in electric power generation. The monthly data are due by the last day of the month following the reporting period.

Receipts of fossil fuels, fuel cost and quality information, and fuel stocks at the end of the reporting period are all reported at the plant level. Fuel receipts and costs are collected from plants with a total generator nameplate capacity of 50 megawatts or greater where coal is the primary fuel; or the total generator nameplate capacity is 200 megawatts or greater where the primary fuel is any combination of natural gas, petroleum coke, distillate fuel oil, or residual fuel oil. Plants that burn organic fuels and have a steam turbine capacity of at least 10 megawatts report consumption at the boiler level and generation at the generator level for each month, regardless of whether the plant reports in the monthly sample or reports annually. For all other plants, consumption is reported at the prime-mover level and generation is reported at the prime-mover level or, for noncombustible sources (e.g., wind, nuclear), at the prime-mover and energy source levels (including generating units for nuclear only). The source and disposition of electricity are reported annually for nonutilities at the plant level, as is revenue from sales for resale. Operational data for air emissions equipment are collected annually from facilities that have a steam turbine capacity of at least 10 megawatts, and operational data on cooling systems and data on the collection and disposal of combustion by-products are collected from facilities that have a steam turbine capacity of at least 100 megawatts.

**Instrument and Design History:** See discussion of predecessor forms (EIA-906, -920, -767, and -423, and FERC Form 423).

**Imputation:** For data collected monthly, regression prediction, or imputation, is done for all missing data including non-sampled units and any non-respondents. For data collected annually, imputation is performed for non-respondents. For gross generation and total fuel consumption, multiple regression is used for imputation (see discussion, above). Approximately 0.12 percent of the national total generation for is imputed, although this will vary by State and energy source.

When gross generation is reported and net generation is not available, or vice versa, net or gross generation is estimated by using a fixed ratio of net to gross generation by prime-mover type and installed emissions equipment. These ratios are:

|  |
|--|
| Net Generation = (Factor) x Gross Generation |
| <b>Prime Movers:</b>                         |
| Combined Cycle Steam - 0.97                  |
| Combined Cycle Single Shaft - 0.97           |
| Combined Cycle Combustion Turbine - 0.97     |
| Compressed Air - 0.97                        |
| Fuel Cell - 0.99                             |
| Gas Turbine - 0.98                           |
| Hydroelectric Turbine - 0.99                 |
| Hydroelectric Pumped Storage - 0.99          |
| Internal Combustion Engine - 0.98            |
| Other - 0.97                                 |
| Photovoltaic - 0.99                          |
| Steam Turbine - 0.97                         |
| Wind Turbine - 0.99                          |
| <b>Environmental Equipment:</b>              |
| Flue Gas Desulfurization - 0.97              |
| Flue Gas Particulate 0.99                    |
| All Others - 0.97                            |

For stocks, a linear combination of the prior month's ending stocks value and the current month's consumption and receipts values is used.

**Receipts of Fossil Fuels:** Receipts data, including cost and quality of fuels, are collected at the plant level from selected electric generating plants and fossil-fuel storage terminals in the United States. Power plants include independent power producers, electric utilities, and commercial and industrial CHP facilities. Power plants required to report receipts data are plants with 50 megawatts of capacity that has coal as its primary fuel, as well as plants with a combined capacity of 200 megawatts with its primary fuel being any combination of natural gas, petroleum coke, distillate fuel oil, or residual fuel oil. The data on cost and quality of fuel shipments are used to produce aggregates and weighted averages for each fuel type at the State, Census division, and U.S. levels.

The units for receipts are: 1) coal and petroleum coke, tons and million Btu per ton; 2) petroleum, barrels and million Btu per barrel.; and gases, thousand cubic feet (Mcf) and million Btu per thousand cubic feet.

**Net and Gross Generation and Fuel Consumption and Stocks:** Generation data are collected in megawatthours from all power plants with a sum of nameplate capacity at least 1 MW. The fuels consumed are collected in tons (solids), barrels (liquids) and thousand cubic feet (gases). Fuels are grouped into coal, petroleum liquids, petroleum coke, natural gas, other gases, and other miscellaneous fuels. Energy consumption is not collected for nuclear, wind, solar, geothermal, or other plants that do not burn fuels. For information on fuel groupings, see the instructions to the Form EIA-923 at [http://www.eia.gov/survey/form/eia\\_923/instructions.pdf](http://www.eia.gov/survey/form/eia_923/instructions.pdf).

**Combustion By-Product Collection and Disposal:** Data are collected in thousand tons. Associated financial data for by-products (O&M and capital expenses and revenue) are collected in thousand dollars.

**Air Emissions Equipment:** Operational efficiencies and emission rates are collected for flue gas desulfurization, particulate matter, and nitrous oxide control equipment for steam-electric units with at least 10 MW nameplate capacity.

**Cooling Systems:** Operational data on water use is collected from steam-electric plants, including nuclear plants, with at least 100 MW nameplate capacity.

**Methodology to Estimate Biogenic and Non-biogenic Municipal Solid Waste:**<sup>2</sup> Municipal solid waste (MSW) consumption for generation of electric power is split into its biogenic and non-biogenic components beginning with the 2001 data year.

The tonnage of MSW consumed is reported on the Form EIA-923. The composition of MSW and categorization of the components were obtained from the U.S. Environmental Protection Agency (USEPA). For data years 2001 through 2009, the MSW composition was based on the USEPA annual publication, *Municipal Solid Waste in the United States: Facts and Figures*. The compositions developed for the 2009 data year were carried forward for the 2010 through 2018 data years. The most updated composition and categorization of MSW (for the 2019 data year) were also derived from a USEPA publication: *Advancing Sustainable Materials Management: Facts and Figures Report: 2015 Data Tables*. The updated composition values were applied in the October EPM 2019 on the preliminary 2019 values and will be applied going forward in future data years until EIA revises the MSW composition ratios again. The Btu contents of the components of MSW were obtained from various sources.

The numbers in Tables 1 and 2 illustrate two interrelated trends in the composition of the MSW stream. First, the heat content (per unit weight) of the waste stream has been steadily increasing overtime due to higher concentrations of non-biogenic materials. Second, the shares of energy contributed to the waste stream by biogenic and non-biogenic components have been changing over time with the percentage of biogenic materials falling and the share of non-biogenic materials rising.

The potential quantities of combustible MSW discards (which include all MSW material available for combustion with energy recovery, discards to landfill, and other disposal) were multiplied by their respective Btu contents. The EPA-based categories of MSW were then classified into renewable and non-renewable groupings. From this, EIA calculated how much of the energy potentially consumed from MSW was attributed to biogenic components and how much was attributed to non-biogenic components (see Tables 1 and 2, below). Note, biogenic components include newsprint, paper, containers and packaging, leather, textiles, yard trimmings, food wastes, and wood. Non-biogenic components include plastics, rubber, and other miscellaneous non-biogenic waste.

These values are used to allocate net generation published in the Electric Power Monthly generation tables. The tons of biogenic and non-biogenic components were estimated with the assumption that

glass and metals were removed prior to combustion. The average Btu/ton for the biogenic and non-biogenic components is estimated by dividing the total Btu consumption by the total tons. Published net generation attributed to biogenic MSW and non-biogenic MSW is classified under Other Renewables and Other, respectively.

**Table 1. Btu consumption for biogenic and non-biogenic municipal solid waste (percent)**

|              | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | ... | 2018 | 2019 |
|--------------|------|------|------|------|------|------|------|------|------|-----|------|------|
| Biogenic     | 57   | 56   | 55   | 55   | 56   | 57   | 55   | 54   | 51   | 51  | 51   | 45   |
| Non-biogenic | 43   | 44   | 45   | 45   | 44   | 43   | 46   | 46   | 49   | 49  | 49   | 55   |

**Table 2. Tonnage consumption for biogenic and non-biogenic municipal solid waste (percent)**

|              | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | ... | 2018 | 2019 |
|--------------|------|------|------|------|------|------|------|------|------|-----|------|------|
| Biogenic     | 77   | 77   | 76   | 76   | 75   | 67   | 65   | 65   | 64   | 64  | 64   | 61   |
| Non-biogenic | 23   | 23   | 24   | 24   | 25   | 34   | 35   | 35   | 36   | 36  | 36   | 39   |

**Useful Thermal Output (UTO):** With the implementation of the Form EIA-923, “Power Plant Operations Report,” in 2008, combined heat and power (CHP) plants were required to report total fuel consumed and electric power generation. Beginning with preliminary January 2008 data, EIA estimated the allocation of the total fuel consumed at CHP plants between electric power generation and UTO.

The estimated allocation methodology is summarized in the following paragraphs. The methodology was retroactively applied to 2004-2007 data. Prior to 2004, UTO was collected on the Form EIA-906 and an estimated allocation of fuel for electricity was not necessary.

First, an efficiency factor is determined for each plant and prime mover type. Based on data for electric power generation and UTO collected in 2003 (on Form EIA-906, “Power Plant Report”), efficiency was calculated for each prime mover type at a plant. The efficiency factor is the total output in Btu, including electric power and UTO, divided by the total input in Btu. Electric power is converted to Btu at 3,412 Btu per kilowatthour.

Second, to calculate the amount of fuel for electric power, the gross generation in Btu is divided by the efficiency factor. The fuel for UTO is the difference between the total fuel reported and the fuel for electric power generation. UTO is calculated by multiplying the fuel for UTO by the efficiency factor.

In addition, if the total fuel reported is less than the estimated fuel for electric power generation, then the fuel for electric power generation is equal to the total fuel consumed, and the UTO will be zero.



Beginning with 2016 Form EIA-923 data, reported efficiency factors by survey respondents replaced the previously EIA estimated efficiency factors used in the fuel allocation process. For the processing of 2016 CHP data, EIA used for each plant an average of the efficiency factors reported by the CHP plants on the 2013, 2014, and 2015 Form EIA-923, “Power Plant Operations Report” surveys. An average was used to smooth out variations in any one year’s data. Once efficiency of each plant was established, the value was input into the above methodology to allocate the consumption of fuel between electric power and UTO. This update applies to the 2016 data and going forward but was not retroactively applied to previous years.

**Issues within Historical Data Series for Receipts and Cost and Quality of Fossil Fuels:** Values for receipts of natural gas for 2001 forward do not include blast furnace gas or other gas.

Historical data collected on FERC Form 423 and published by EIA have been reviewed for consistency between volumes and prices and for their consistency over time. However, these data were collected by FERC for regulatory rather than statistical and publication purposes. EIA did not attempt to resolve any late filing issues in the FERC Form 423 data. In 2003, EIA introduced a procedure to estimate for late or non-responding entities that were required to report on the FERC Form 423. Due to the introduction of this procedure, 2003 and later data cannot be directly compared to previous years’ data.

Prior to 2008, regulated plants reported receipts data on the FERC Form 423. These plants, along with unregulated plants, now report receipts data on Schedule 2 of Form EIA-923. Because FERC issued waivers to Form 423 filing requirements to some plants who met certain criteria, and because not all types of generators were required to report (only steam turbines and combined cycle units reported), a significant number of plants either did not submit fossil fuel receipts data or submitted only a portion of their fossil fuel receipts. Since Form EIA-923 does not have exemptions based on generator type, or reporting waivers, receipts data from 2008 and later cannot be directly compared to previous years’ data for the regulated sector. Also beginning with January 2008 data, tables for total receipts included imputed quantities for plants with capacity one megawatt or more, to be consistent with other electric power data. Previous published receipts data were from plants at or over a 50 megawatt threshold, which was a legacy of their original collection as information for a regulatory agency, not as a survey to provide more meaningful estimates of totals for statistical purposes. Totals appeared to become smaller as more electric production came from unregulated plants, until the Form EIA-423 was created to help fill that gap. As a further improvement, estimation of all receipts for the universe normally depicted in the Electric Power Annual (i.e., one megawatt and above), with associated relative standard errors, provides a more complete assessment of the market.

**Issues within Historical Data Series for Generation and Consumption:** Beginning in 2008, a new method of allocating fuel consumption between electric power generation and UTO was implemented (see above). This new methodology evenly distributes a CHP plant’s losses between the two output products (electric power and UTO). In the historical data, UTO was consistently assumed to be 80 percent efficient and all other losses at the plant were allocated to electric power. This change causes the fuel for electric power to be lower while the fuel for UTO is higher as both are given the same

efficiency. This results in the appearance of an increase in efficiency of production of electric power between periods.

**Sensitive Data:** The total delivered cost of fuel delivered to nonutilities, the commodity cost of fossil fuels, and fuel stocks are considered business sensitive.

## Capacity Factors and Usage Factors

This section describes the methodology for calculating capacity factors and usages factors by fuel and technology type for operating electric power plants. Capacity factor is a measure (expressed as a percent) of how often an electric generator operates over a specific period, using a ratio of the actual output to the maximum possible output over that period.

The monthly capacity factor calculation includes all operating electric generators which operated for the entire month using the net generation reported on the Form EIA-923 and the net summer capacity reported on the Form EIA-860. The capacity factor for a particular fuel/technology type is given by:

$$\text{capacity factor} = \frac{\sum_{x,m} \text{net generation}_{x,m}}{\sum_{x,m} \text{capacity}_{x,m} * \text{hours in month}_m}$$

where x represents generators of that fuel/technology combination and m represents individual months. Net generation and capacity are specific to a generator, and the generator is categorized by its primary fuel type as reported on the EIA-860. All generation from that generator is included, regardless of other fuels consumed. Net generation and capacity for a generator is excluded from the summations during the month that the generator initially began operation and if applicable during the month that the generator retired. Therefore, these published capacity factors will differ from a simple calculation using annual generation and capacity totals from the appropriate tables in this publication.

Usage factors are calculated for energy storage technologies using gross generation instead of net generation:

$$\text{usage factor} = \frac{\sum_{x,m} \text{gross generation}_{x,m}}{\sum_{x,m} \text{capacity}_{x,m} * \text{hours in month}_m}$$

## Air Emissions

This section describes the methodology for calculating estimated emissions of carbon dioxide (CO<sub>2</sub>) from electric generating plants for 1989 through the present, as well as the estimated emissions of sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) from electric generating plants for 2001 through the present. For a description of the methodology used for other years, see the technical notes to the EPA 2003.

**Methodology Overview:** Initial estimates of uncontrolled SO<sub>2</sub> and NO<sub>x</sub> emissions for all plants are made by applying an emissions factor to fuel consumption data collected by EIA on the Form EIA-923. An emission factor is the average quantity of a pollutant released from a power plant when a unit of fuel is burned, assuming no use of pollution control equipment. The basic relationship is:

$$\text{Emissions} = \text{Quantity of Fuel Consumed} \times \text{Emission Factor}$$

Quantity is defined in physical units (e.g., tons of solid fuels, million cubic feet of gaseous fuels, and thousands of barrels of liquid fuels) for determining NO<sub>x</sub> and SO<sub>2</sub> emissions. As discussed below, physical quantities are converted to millions of Btus for calculating CO<sub>2</sub> emissions.

For some fuels, the calculation of SO<sub>2</sub> emissions requires including in the formula the sulfur content of the fuel measured in percentage of weight. Examples include coal and fuel oil. In these cases, the formula is:

$$\text{Emissions} = \text{Quantity of Fuel Consumed} \times \text{Emission Factor} \times \text{Sulfur Content}$$

The fuels that require the percent sulfur as part of the emissions calculation are indicated in Table A.1., which lists the SO<sub>2</sub> emission factors used for this report.

In the case of SO<sub>2</sub> and NO<sub>x</sub> emissions, the factor applied to a fuel can also vary with the combustion system: a steam-producing boiler, a combustion turbine, or an internal combustion engine. In the case of boilers, NO<sub>x</sub> emissions can also vary with the firing configuration of a boiler and whether the boiler is a wet-bottom or dry-bottom design.<sup>3</sup> These distinctions are shown in Tables A.1. and A.2.

For SO<sub>2</sub> and NO<sub>x</sub>, the initial estimate of uncontrolled emissions is reduced to account for the plant's operational pollution control equipment, when data on control equipment are available from the historical Form EIA-767 survey (i.e., data for the years 2005 and earlier) and the EIA-860 and EIA-923 surveys for the years 2007 through 2010. A special case for removal of SO<sub>2</sub> is the fluidized bed boiler, in which the sulfur removal process is integral with the operation of the boiler. The SO<sub>2</sub> emission factors shown in Table A.1. for fluidized bed boilers already account for 90 percent removal of SO<sub>2</sub> since, in effect, the plant has no uncontrolled emissions of this pollutant.

Although SO<sub>2</sub> and NO<sub>x</sub> emission estimates are made for all plants, in many cases the estimated emissions can be replaced with actual emissions data collected by the U.S. Environmental Protection Agency's (U.S. EPA's) Continuous Emissions Monitoring System (CEMS) program. (CEMS data for CO<sub>2</sub> are incomplete and are not used in this report.) The CEMS data account for the bulk of SO<sub>2</sub> and NO<sub>x</sub> emissions from the electric power industry. For those plants for which CEMS data are available, the EIA estimates of SO<sub>2</sub> and NO<sub>x</sub> emissions are employed for the limited purpose of allocating emissions by fuel, since the CEMS data itself do not provide a detailed breakdown of plant emissions by fuel. For plants for which CEMS data are unavailable, the EIA-computed values are used as the final emissions estimates.

There are several reasons why the historical data are periodically revised. These include data revisions, revisions in emission and technology factors, and changes in methodology. For instance, the 2008 Electric Power Annual report features a revision in historic CO<sub>2</sub> values. This revision occurred due to a change in the accepted methodology regarding adjustments made for the percentage combustion of fuels.

The emissions estimation methodologies are described in more detail below.

**CO<sub>2</sub> Emissions:** CO<sub>2</sub> emissions are estimated using the information on fuel consumption in physical units and the heat content of fuel collected on the Form EIA-923 and predecessors. Heat content information

is used to convert physical units to millions of Btu (MMBtu) consumed. To estimate CO<sub>2</sub> emissions, the fuel-specific emission factor from Table A.3. is multiplied by the fuel consumption in MMBtu.

The estimation procedure calculates uncontrolled CO<sub>2</sub> emissions. CO<sub>2</sub> control technologies are currently in the early stages of research and there are no commercial systems installed. Therefore, no estimates of controlled CO<sub>2</sub> emissions are made.

**SO<sub>2</sub> and NO<sub>x</sub> Emissions:** To comply with environmental regulations controlling SO<sub>2</sub> emissions, many coal-fired generating plants have installed flue gas desulfurization (FGD) units. Similarly, NO<sub>x</sub> control regulations require many fossil-fueled plants to install low-NO<sub>x</sub> burners, selective catalytic reduction systems, or other technologies to reduce emissions. It is common for power plants to employ two or even three NO<sub>x</sub> control technologies; accordingly, the NO<sub>x</sub> emissions estimation approach accounts for the combined effect of the equipment (Table A.4.). However, control equipment information is available only for plants that reported on the Form EIA-923 and for historical data from the Form EIA-767. The Form EIA-860, EIA-923, and the historical EIA-767 surveys are limited to plants with boilers fired by combustible fuels<sup>4</sup> with a minimum generating capacity of 10 megawatts (nameplate). Pollution control equipment data are unavailable from EIA sources for plants that did not report on the historical EIA-767 survey, or the Forms EIA-860 and EIA-923.

The following method is used to estimate SO<sub>2</sub> and NO<sub>x</sub> emissions:

- For steam electric plants, uncontrolled emissions are estimated using the emission factors shown in Tables A.1. and A.2. as well as reported data on fuel consumption, sulfur content, and boiler firing configuration. Controlled emissions are then determined when pollution control equipment is present. Although information on control equipment was not collected in 2006, updates for new installations during this period were made based on EPA data. Beginning in 2007, these data were collected on the Forms EIA-860 and EIA-923. For SO<sub>2</sub>, the reported efficiency of the plant's FGD units is used to convert uncontrolled to controlled emission estimates. For NO<sub>x</sub>, the reduction percentages shown in Table A.4. are applied to the uncontrolled estimates.
- For plants and prime movers not reported on the historical Form EIA-767 survey or Forms EIA-860 and EIA-923, uncontrolled emissions are estimated using the Table A.1. and Table A.2. emission factors and the following data and assumptions:
  - Fuel consumption is taken from the Form EIA-923 and predecessors.
  - The sulfur content of the fuel is estimated from fuel receipts for the plant reported on the Form EIA-923. When plant-specific sulfur content data are unavailable, the national average sulfur content for the fuel, computed from the Form EIA-923 is applied to the plant.
  - As noted earlier, the emission factor for plants with boilers depends in part on the type of combustion system, including whether a boiler is wet-bottom or dry-bottom, and the boiler firing configuration. However, this boiler information is unavailable for steam electric plants that did not report on the historical Forms EIA-767 or EIA-860. For these cases, the plant is assumed to have a dry-bottom, non-cyclone boiler using a firing method that falls into the "All Other" category shown on Table A.1.<sup>5</sup>

For the plants that did not report on the historical Form EIA-767 or EIA-860, pollution control equipment data are unavailable and the uncontrolled estimates are not reduced.

- If actual emissions of SO<sub>2</sub> or NO<sub>x</sub> are reported in the EPA's CEMS data, the EIA estimates are replaced with the CEMS values, using the EIA estimates to allocate the CEMS plant-level data by fuel. If CEMS data are unavailable, the EIA estimates are used as the final values.

### Conversion Factors for Propane, Petroleum Coke, and Synthesis Gases.

The quantity conversion for petroleum coke is 5 barrels (of 42 U.S. gallons each) per short ton (2,000 pounds), propane is 1.53 thousand cubic feet per barrel, coal-derived synthesis gas is 98.06 thousand cubic feet per ton, and petroleum coke-derived synthesis gas is 107.31 thousand cubic feet per ton.

### Relative Standard Error

The relative standard error (RSE) statistic, usually given as a percent, describes the magnitude of sampling error that might reasonably be incurred. The RSE is the square root of the estimated variance, divided by the variable of interest. The variable of interest may be the ratio of two variables, or a single variable.

The sampling error may be less than the non-sampling error. In fact, large RSE estimates found in preliminary work with these data have often indicated non-sampling errors, which were then identified and corrected. Non-sampling errors may be attributed to many sources, including response errors, definitional difficulties, differences in the interpretation of questions, mistakes in recording or coding data obtained, and other errors of collection, response, or coverage. These non-sampling errors also occur in complete censuses.

Using the Central Limit Theorem, which applies to sums and means such as are applicable here, there is approximately a 68 percent chance that the true total or mean is within one RSE of the estimated total. Note that reported RSEs are always estimates, themselves, and are usually, as here, reported as percents. As an example, suppose that a net generation from coal value is estimated to be 1,507 total million kilowatthours with an estimated RSE of 4.9 percent. This means that, ignoring any non-sampling error, there is approximately a 68 percent chance that the true million kilowatthour value is within approximately 4.9 percent of 1,507 million kilowatthours (that is, between 1,433 and 1,581 million kilowatthours). Also under the Central Limit Theorem, there is approximately a 95 percent chance that the true mean or total is within 2 RSEs of the estimated mean or total.

Note that there are times when a model may not apply, such as in the case of a substantial reclassification of sales, when the relationship between the variable of interest and the regressor data does not hold. In such a case, the new information represents only itself, and such numbers are added to model results when estimating totals. Further, there are times when sample data may be known to be in error or are not reported. Such cases are treated as if they were never part of the model-based sample, and values are imputed.

### Business Classification

Nonutility power producers consist of entities that own or operate electric generating units but are not subject to direct economic regulation of rates, such as by state utility commissions. Nonutility power

producers do not have a designated franchised service area. In addition to entities whose primary business is the production and sale of electric power, entities with other primary business classifications can and do sell electric power. These can consist of, for example, manufacturing facilities and paper mills.

The EIA, in the Electric Power Annual and other data products, classifies nonutility power producers into the following categories:

- **Electric Utility (Sector 1):** All regulated plants with a primary purpose of selling electricity in the public markets (NAICS = 22).
- **Independent Power Producers (Sector 2):** All non-regulated plants with a primary purpose of electric power generation and a primary purpose of selling electricity in the public markets (NAICS = 22) with no ability to cogenerate heat and power.
- **Electric Power, Combined Heat and Power (Sector 3):** All non-regulated plants with a primary purpose of electric power generation and a primary purpose of selling electricity in the public markets (NAICS = 22) with the ability to cogenerate heat and power.
- **Commercial, Non-Combined Heat and Power (Sector 4):** All plants with a commercial primary purpose with no ability to cogenerate heat and power.
- **Commercial, Combined Heat and Power (Sector 5):** All plants with a commercial primary purpose with the ability to cogenerate heat and power.
- **Industrial, Non-Combined Heat and Power (Sector 6):** All plants with an industrial primary purpose with no ability to cogenerate heat and power.
- **Industrial, Combined Heat and Power (Sector 7):** All plants with an industrial primary purpose with the ability to cogenerate heat and power.

The following is a list of the North American Industry Classification System (NAICS) classifications used by EIA.

|       |   |
|-------|---|
|       | <b>Agriculture, Forestry, Fishing and Hunting</b>   |
| 111   | Crop Production   |
| 112   | Animal Production   |
| 113   | Forestry and Logging  |
| 114   | Fishing, Hunting and Trapping   |
| 115   | Support Activities for Agriculture and Forestry   |
|       | <b>Mining, Quarrying, and Oil and Gas Extraction</b>  |
| 211   | Oil and Gas Extraction  |
| 2121  | Coal Mining   |
| 2122  | Metal Ore Mining  |
| 2123  | Nonmetallic Mineral Mining and Quarrying  |
|       | <b>Utilities</b>  |
| 22    | Electric Power Generation, Transmission and Distribution (other than 2212, 2213, 22131, 22132 or 22133) |
| 2212  | Natural Gas Distribution  |
| 22131 | Water Supply and Irrigation Systems   |
| 22132 | Sewage Treatment Facilities   |

|        |  |
|--------|--|
| 22133  | Steam and Air-Conditioning Supply  |
|        | <b>Manufacturing</b>   |
| 311    | Food Manufacturing   |
| 312    | Beverage and Tobacco Product Manufacturing   |
| 313    | Textile Mills (Fiber, Yarn, Thread, Fabric, and Textiles)  |
| 314    | Textile Product Mills  |
| 315    | Apparel Manufacturing  |
| 316    | Leather and Allied Product Manufacturing   |
| 321    | Wood Product Manufacturing   |
| 322    | Paper Manufacturing (other than 322122 or 32213)   |
| 322122 | Newsprint Mills  |
| 32213  | Paperboard Mills   |
| 323    | Printing and Related Support Activities  |
| 324    | Petroleum and Coal Products Manufacturing (other than 32411)   |
| 32411  | Petroleum Refineries   |
| 325    | Chemical Manufacturing (other than 32511, 32512, 325193, 325188, 3252 325211, 3253 or 325311)            |
| 32511  | Petrochemical Manufacturing  |
| 32512  | Industrial Gas Manufacturing   |
| 325193 | Ethyl Alcohol Manufacturing (including Ethanol)  |
| 325188 | Industrial Inorganic Chemicals   |
| 3252   | Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing (other than 325211) |
| 325211 | Plastics Material and Resin Manufacturing  |
| 3253   | Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing (other than 325311)                 |
| 325311 | Nitrogenous Fertilizer Manufacturing   |
| 326    | Plastics and Rubber Products Manufacturing   |
| 327    | Nonmetallic Mineral Product Manufacturing (other than 32731)   |
| 32731  | Cement Manufacturing   |
| 331    | Primary Metal Manufacturing (other than 331111 or 331312)  |
| 331111 | Iron and Steel Mills   |
| 331312 | Primary Aluminum Production  |
| 332    | Fabricated Metal Product Manufacturing   |
| 333    | Machinery Manufacturing  |
| 334    | Computer and Electronic Product Manufacturing  |
| 335    | Electrical Equipment, Appliance, and Component Manufacturing   |
| 336    | Transportation Equipment Manufacturing   |
| 337    | Furniture and Related Product Manufacturing  |
| 339    | Miscellaneous Manufacturing  |
| 421    | <b>Wholesale Trade</b>   |
| 441    | <b>Retail Trade</b>  |
|        | <b>Transportation and Warehousing</b>  |
| 481    | Air Transportation   |
| 482    | Rail Transportation  |
| 483    | Water Transportation   |
| 484    | Truck Transportation   |
| 485    | Transit and Ground Passenger Transportation  |
| 486    | Pipeline Transportation  |
| 487    | Scenic and Sightseeing Transportation  |

|        |   |
|--------|---|
| 488    | Support Activities for Transportation (other than 4881, 4882, 4883 or 4884)                   |
| 4881   | Support Activities for Air Transportation (including Airports)                                |
| 4882   | Support Activities for Rail Transportation (including Rail Stations)                          |
| 4883   | Support Activities for Water Transportation (including Marinas)                               |
| 4884   | Support Activities for Road Transportation  |
| 491    | Postal Service  |
| 492    | Couriers and Messengers   |
| 493    | Warehousing and Storage   |
|        | <b>Information</b>  |
| 511    | Publishing Industries (except Internet)   |
| 512    | Motion Picture and Sound Recording Industries   |
| 515    | Broadcasting (except Internet)  |
| 517    | Telecommunications  |
| 518    | Data Processing, Hosting, and Related Services  |
| 519    | Other Information Services  |
| 521    | <b>Finance and Insurance</b>  |
| 53     | <b>Real Estate and Rental and Leasing (including Convention Centers and Office Buildings)</b> |
| 541    | <b>Professional, Scientific, and Technical Services</b>                                       |
| 55     | <b>Management of Companies and Enterprises</b>  |
|        | <b>Administrative and Support and Waste Management and Remediation Services</b>               |
| 561    | Administrative and Support Services   |
| 562    | Waste Management and Remediation Services (other than 562212 or 562213)                       |
| 562212 | Solid Waste Landfill  |
| 562213 | Solid Waste Combustors and Incinerators   |
| 611    | <b>Educational Services</b>   |
|        | <b>Health Care and Social Assistance</b>  |
| 621    | Ambulatory Health Care Services   |
| 622    | Hospitals   |
| 623    | Nursing and Residential Care Facilities   |
| 624    | Social Assistance   |
|        | <b>Arts, Entertainment, and Recreation</b>  |
| 711    | Performing Arts, Spectator Sports, and Related Industries                                     |
| 712    | Museums, Historical Sites, and Similar Institutions   |
| 713    | Amusement, Gambling, and Recreation Industries  |
|        | <b>Accommodation and Food Services</b>  |
| 721    | Accommodation   |
| 722    | Food Services and Drinking Places   |
|        | <b>Other Services (except Public Administration)</b>  |
| 811    | Repair and Maintenance  |
| 812    | Personal and Laundry Services   |
| 813    | Religious, Grantmaking, Civic, Professional, and Similar Organizations                        |
| 814    | Private Households  |



|       |  |
|-------|--|
| 92    | <b>Public Administration (other than 921, 922, 92214 or 928)</b>       |
| 921   | Executive, Legislative, and Other General Government Services          |
| 922   | Justice, Public Order and Safety Activities (other than 92214)         |
| 92214 | Correctional Facilities  |
| 928   | National Security and International Affairs (including Military Bases) |

## Multiple Survey Programs- Small Scale PV Solar Estimation of Generation

Monthly generation from small scale PV solar resources is an estimation of the generation produced from PV solar resources and not the results of a data collection effort for generation directly, except for “Third Party Owned” or (TPO) solar installations which has direct data collection. TPO data however is not comprehensive. TPOs do not operate in every state, TPO collected data is not a large portion of the estimated amount, and the data has been collected for limited period. The generation estimate is based on data collected for PV solar capacity.

Capacity of PV solar resources is collected directly from respondents. These data are collected on several EIA forms and from several types of respondents. Monthly data for net-metered PV solar capacity is reported on the Form EIA-861M. Form EIA-61M is a cutoff sample drawn from the annual survey Form EIA-861 which collects this data from all respondents. Using data from both surveys we have a regression model to impute for the non-sampled monthly capacity.

The survey instruments collect solar net metering capacity from reporting utilities by state and customer class. There are four customer classes: residential, commercial, industrial and transportation. However, the estimation process included only the residential, commercial, and industrial customers.<sup>1</sup> Data for these customer classes were further classified by U.S. Census Regions, to ensure adequate number of customer observations in for each estimation group.

**Estimation Model:** The total PV capacity reported by utilities in the annual EIA-861 survey is the single primary input (regressor) to the monthly estimation of PV capacity by state. The model tested for each census region was of the form:

$$y_{i,2015,m} = \beta_1 x_{i,2013} + w_i^{-1/2} e_i, \text{ where}$$

$x_{i,2013}$  is the  $i^{\text{th}}$  utility’s 2013 (or the last published year) solar PV capacity

$y_{i,2015,m}$  is the  $i^{\text{th}}$  utility’s month  $m$ , 2015 (or the current year) reported solar PV capacity

$w_i$  is the weight factor, which is the inverse of  $x_{i,2013}$

$\beta_1$  is effectively the growth rate of reported month  $m$  solar PV capacity

$e_i$  is the error term

The model checks for outliers and removes them from the regression equation inputs. The model calculates RSEs by sector, state, census region, and U.S. total. Once we have imputed for all the monthly net-metered PV solar capacity we add to total net metered capacity, the PV solar capacity collected for the non net-metered capacity.

We use a second model to estimate the generation using this capacity as an input. The original methodology was developed for the “Annual Energy Outlook” based on our “NEMS” modelled projections several years ago. The original method underwent a calibration project designed to develop PV production levels for the NEMS projections consistent with simulations of a National Renewable Energy Laboratory model called PVWatts, which is itself embedded in PC software under the umbrella of the NREL’s System Advisor Model (SAM).

The PVWatts simulations require, panel azimuth orientations and tilts, something that the NEMS projections do not include. Call the combinations of azimuths and tilts “orientations.” The orientation and solar insolation (specific to a location) have a direct effect on the PV production level. The calibration project selected the 100 largest population Metropolitan Statistical Areas (MSAs) and relied on weights derived from orientation data from California Solar Initiative dataset to develop typical outputs for each of the 100 MSAs. It then was expanded from an annual estimate to a monthly estimate. A further description of this model is located here. A listing of the MSAs is included in Appendix 1.

Using Form EIA-861 data for service territories, which lists the counties that each electric distribution company (EDC) provides service, and NREL solar insolation data by county a simple average of insolation values by EDC is calculated.

Using the estimation model, we produce by utility, by state and by sector an estimate of generation. All the utilities’ capacity and generation estimates are summed by state and sector and a KWh/KW rate by state and sector is calculated.

Capacity from the Form EIA-860 that is net metered is subtracted from the total capacity by state and sector as well as the capacity reported on the EIA-861M from TPOs, resulting in a new “net” capacity amount. This capacity amount is multiplied by the KWh/KW rate to produce the non-TPO generation estimate and then it is added to the TPO reported sales to ultimate customers from the EIA-861 to obtain a final estimate for generation and a blended KWh/KW rate is calculated. The estimate for generation is aggregated by US census regions and US totals. The RSEs for capacity are checked for level of error and if they pass, the summary data by state, US census region and US total are reported in the EPM.

Appendix 2 contains a flow diagram of the data inputs, data quality control checks and data analysis required to perform this estimation.

## Appendix 1- MSAs

### TMY3 (1991-2005) Weather Stations by MSA

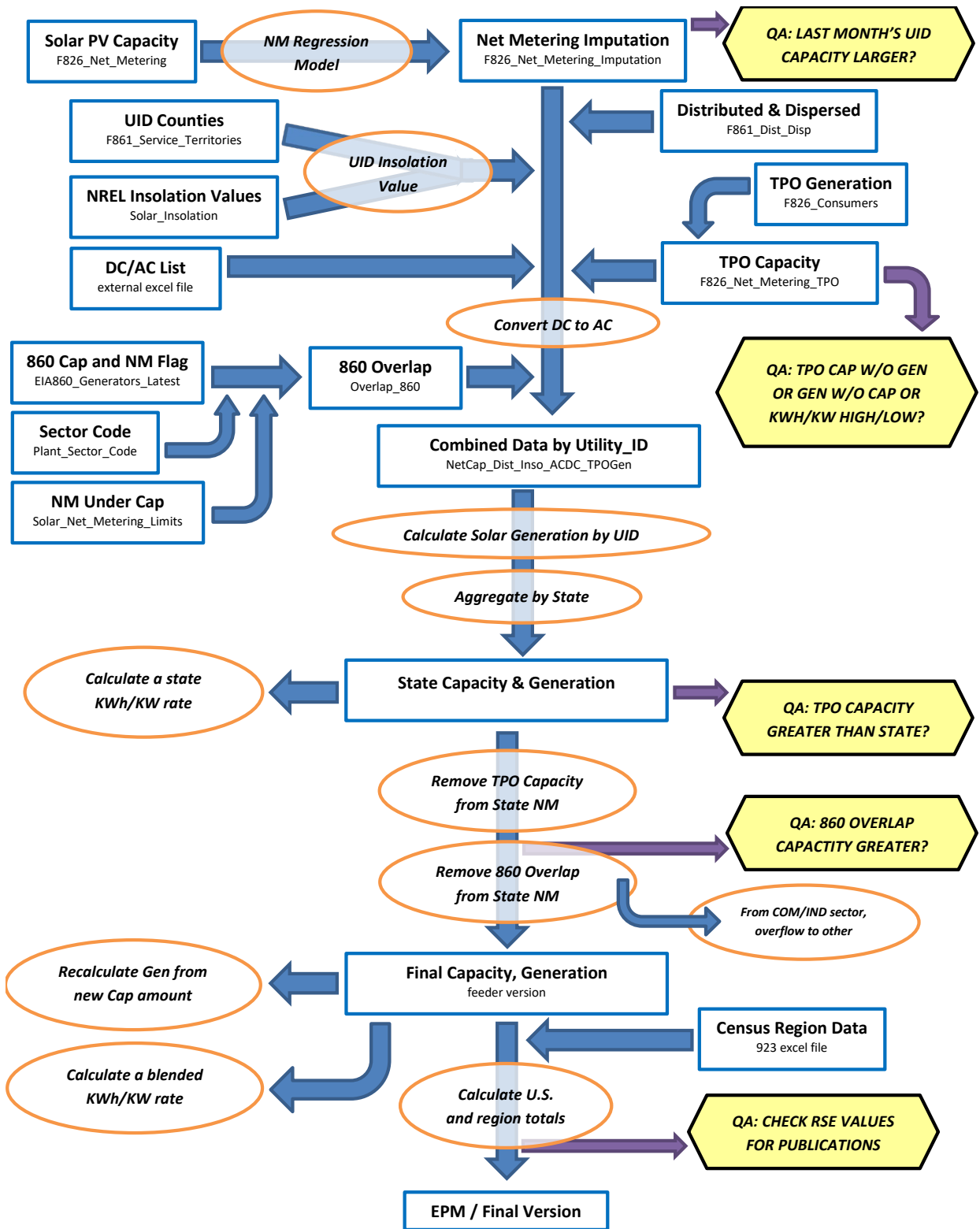
| Site | Weather Location                           | MSA  |
|------|--|--|
| 1    | USA NY New York Central Park Obs.          | New York-Newark-Jersey City, NY-NJ-PA MSA        |
| 2    | USA CA Los Angeles Intl Airport            | Los Angeles-Long Beach-Anaheim, CA MSA           |
| 3    | USA IL Chicago Midway Airport              | Chicago-Naperville-Elgin, IL-IN-WI MSA           |
| 4    | USA TX Dallas-Fort Worth Intl Airport      | Dallas-Fort Worth-Arlington, TX MSA              |
| 5    | USA TX Houston Bush Intercontinental       | Houston-The Woodlands-Sugar Land, TX MSA         |
| 6    | USA PA Philadelphia Int'l Airport          | Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA  |
| 7    | USA VA Washington Dc Reagan Airport        | Washington-Arlington-Alexandria, DC-VA-MD-WV MSA |
| 8    | USA FL Miami Intl Airport                  | Miami-Fort Lauderdale-West Palm Beach, FL MSA    |
| 9    | USA GA Atlanta Hartsfield Intl Airport     | Atlanta-Sandy Springs-Roswell, GA MSA            |
| 10   | USA MA Boston Logan Int'l Airport          | Boston-Cambridge-Newton, MA-NH MSA               |
| 11   | USA CA San Francisco Intl Airport          | San Francisco–Oakland–Hayward, CA MSA            |
| 12   | USA AZ Phoenix Sky Harbor Intl Airport     | Phoenix-Mesa-Scottsdale, AZ MSA                  |
| 13   | USA CA Riverside Municipal Airport         | Riverside-San Bernardino-Ontario, CA MSA         |
| 14   | USA MI Detroit City Airport                | Detroit-Warren-Dearborn, MI MSA                  |
| 15   | USA WA Seattle Seattle-Tacoma Intl Airport | Seattle-Tacoma-Bellevue, WA MSA                  |
| 16   | USA MN Minneapolis-St. Paul Int'l Arp      | Minneapolis-St. Paul-Bloomington, MN-WI MSA      |
| 17   | USA CA San Diego Lindbergh Field           | San Diego-Carlsbad, CA MSA                       |
| 18   | USA FL Tampa Int'l Airport                 | Tampa-St. Petersburg-Clearwater, FL MSA          |
| 19   | USA MO St Louis Lambert Int'l Airport      | St. Louis, MO-IL MSA                             |
| 20   | USA MD Baltimore-Washington Int'l Airport  | Baltimore-Columbia-Towson, MD MSA                |
| 21   | USA CO Denver Centennial [Golden - NREL]   | Denver-Aurora-Lakewood, CO MSA                   |
| 22   | USA PA Pittsburgh Allegheny Co Airport     | Pittsburgh, PA MSA                               |
| 23   | USA NC Charlotte Douglas Intl Airport      | Charlotte-Concord-Gastonia, NC-SC MSA            |
| 24   | USA OR Portland Hillsboro                  | Portland-Vancouver-Hillsboro, OR-WA MSA          |
| 25   | USA TX San Antonio Intl Airport            | San Antonio-New Braunfels, TX MSA                |
| 26   | USA FL Orlando Intl Airport                | Orlando-Kissimmee-Sanford, FL MSA                |
| 27   | USA CA Sacramento Executive Airport        | Sacramento–Roseville–Arden-Arcade, CA MSA        |
| 28   | USA OH Cincinnati Municipal Airport        | Cincinnati, OH-KY-IN MSA                         |
| 29   | USA OH Cleveland Hopkins Intl Airport      | Cleveland-Elyria, OH MSA                         |
| 30   | USA MO Kansas City Int'l Airport           | Kansas City, MO-KS MSA                           |
| 31   | USA NV Las Vegas McCarran Intl Airport     | Las Vegas-Henderson-Paradise, NV MSA             |
| 32   | USA OH Columbus Port Columbus Intl A       | Columbus, OH MSA                                 |
| 33   | USA IN Indianapolis Intl Airport           | Indianapolis-Carmel-Anderson, IN MSA             |
| 34   | USA CA San Jose Intl Airport               | San Jose-Sunnyvale-Santa Clara, CA MSA           |
| 35   | USA TX Austin Mueller Municipal Airport    | Austin-Round Rock, TX MSA                        |

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|----|--|--|
| 36 | USA TN Nashville Int'l Airport                 | Nashville-Davidson–Murfreesboro–Franklin, TN MSA |
| 37 | USA VA Norfolk Int'l Airport                   | Virginia Beach-Norfolk-Newport News, VA-NC MSA   |
| 38 | USA RI Providence T F Green State              | Providence-Warwick, RI-MA MSA                    |
| 39 | USA WI Milwaukee Mitchell Intl Airport         | Milwaukee-Waukesha-West Allis, WI MSA            |
| 40 | USA FL Jacksonville Craig                      | Jacksonville, FL MSA                             |
| 41 | USA TN Memphis Int'l Airport                   | Memphis, TN-MS-AR MSA                            |
| 42 | USA OK Oklahoma City Will Rogers               | Oklahoma City, OK MSA                            |
| 43 | USA KY Louisville Bowman Field                 | Louisville/Jefferson County, KY-IN MSA           |
| 44 | USA VA Richmond Int'l Airport                  | Richmond, VA MSA                                 |
| 45 | USA LA New Orleans Alvin Callender             | New Orleans-Metairie, LA MSA                     |
| 46 | USA CT Hartford Bradley Intl Airport           | Hartford-West Hartford-East Hartford, CT MSA     |
| 47 | USA NC Raleigh Durham Int'l                    | Raleigh, NC MSA                                  |
| 48 | USA UT Salt Lake City Int'l Airport            | Salt Lake City, UT MSA                           |
| 49 | USA AL Birmingham Municipal Airport            | Birmingham-Hoover, AL MSA                        |
| 50 | USA NY Buffalo Niagara Intl Airport            | Buffalo-Cheektowaga-Niagara Falls, NY MSA        |
| 51 | USA NY Rochester Greater Rochester             | Rochester, NY MSA                                |
| 52 | USA MI Grand Rapids Kent County Int'l Airport  | Grand Rapids-Wyoming, MI MSA                     |
| 53 | USA AZ Tucson Int'l Airport                    | Tucson, AZ MSA                                   |
| 54 | USA HI Honolulu Intl Airport                   | Urban Honolulu, HI MSA                           |
| 55 | USA OK Tulsa Int'l Airport                     | Tulsa, OK MSA                                    |
| 56 | USA CA Fresno Yosemite Intl Airport            | Fresno, CA MSA                                   |
| 57 | USA CT Bridgeport Sikorsky Memorial            | Bridgeport-Stamford-Norwalk, CT MSA              |
| 58 | USA MA Worcester Regional Airport              | Worcester, MA-CT MSA                             |
| 59 | USA NM Albuquerque Intl Airport                | Albuquerque, NM MSA                              |
| 60 | USA NE Omaha Eppley Airfield                   | Omaha-Council Bluffs, NE-IA MSA                  |
| 61 | USA NY Albany County Airport                   | Albany-Schenectady-Troy, NY MSA                  |
| 62 | USA CA Bakersfield Meadows Field               | Bakersfield, CA MSA                              |
| 63 | USA CT New Haven Tweed Airport                 | New Haven-Milford, CT MSA                        |
| 64 | USA TN Knoxville McGhee Tyson Airport          | Knoxville, TN MSA                                |
| 65 | USA SC Greenville Downtown Airport             | Greenville-Anderson-Mauldin, SC MSA              |
| 66 | USA CA Oxnard Airport                          | Oxnard-Thousand Oaks-Ventura, CA MSA             |
| 67 | USA TX El Paso Int'l Airport                   | El Paso, TX MSA                                  |
| 68 | USA PA Allentown Lehigh Valley Intl            | Allentown-Bethlehem-Easton, PA-NJ MSA            |
| 69 | USA LA Baton Rouge Ryan Airport                | Baton Rouge, LA MSA                              |
| 70 | USA TX McCallen Miller Intl Airport            | McAllen-Edinburg-Mission, TX MSA                 |
| 71 | USA OH Dayton Int'l Airport                    | Dayton, OH MSA                                   |
| 72 | USA SC Columbia Metro Airport                  | Columbia, SC MSA                                 |
| 73 | USA NC Greensboro Piedmont Triad Int'l Airport | Greensboro-High Point, NC MSA                    |
| 74 | USA FL Sarasota Bradenton                      | North Port-Sarasota-Bradenton, FL MSA            |
| 75 | USA AR Little Rock Adams Field                 | Little Rock-North Little Rock-Conway, AR MSA     |
| 76 | USA SC Charleston Intl Airport                 | Charleston-North Charleston, SC MSA              |

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|-----|---|--|
| 77  | USA OH Akron Akron-canton Reg. Airport    | Akron, OH MSA                              |
| 78  | USA CA Stockton Metropolitan Airport      | Stockton-Lodi, CA MSA                      |
| 79  | USA CO Colorado Springs Muni Airport      | Colorado Springs, CO MSA                   |
| 80  | USA NY Syracuse Hancock Int'l Airport     | Syracuse, NY MSA                           |
| 81  | USA FL Fort Myers Page Field              | Cape Coral-Fort Myers, FL MSA              |
| 82  | USA NC Winston-Salem Reynolds Airport     | Winston-Salem, NC MSA                      |
| 83  | USA ID Boise Air Terminal                 | Boise City, ID MSA                         |
| 84  | USA KS Wichita Mid-continent Airport      | Wichita, KS MSA                            |
| 85  | USA WI Madison Dane Co Regional Airport   | Madison, WI MSA                            |
| 86  | USA MA Worcester Regional Airport         | Springfield, MA MSA                        |
| 87  | USA FL Lakeland Linder Regional Airport   | Lakeland-Winter Haven, FL MSA              |
| 88  | USA UT Ogden Hinkley Airport              | Ogden-Clearfield, UT MSA                   |
| 89  | USA OH Toledo Express Airport             | Toledo, OH MSA                             |
| 90  | USA FL Daytona Beach Intl Airport         | Deltona-Daytona Beach-Ormond Beach, FL MSA |
| 91  | USA IA Des Moines Intl Airport            | Des Moines-West Des Moines, IA MSA         |
| 92  | USA GA Augusta Bush Field                 | Augusta-Richmond County, GA-SC MSA         |
| 93  | USA MS Jackson Int'l Airport              | Jackson, MS MSA                            |
| 94  | USA UT Provo Muni                         | Provo-Orem, UT MSA                         |
| 95  | USA PA Wilkes-Barre Scranton Intl Airport | Scranton-Wilkes-Barre-Hazleton, PA MSA     |
| 96  | USA PA Harrisburg Capital City Airport    | Harrisburg-Carlisle, PA MSA                |
| 97  | USA OH Youngstown Regional Airport        | Youngstown-Warren-Boardman, OH-PA MSA      |
| 98  | USA FL Melbourne Regional Airport         | Palm Bay-Melbourne-Titusville, FL MSA      |
| 99  | USA TN Chattanooga Lovell Field Airport   | Chattanooga, TN-GA MSA                     |
| 100 | USA WA Spokane Int'l Airport              | Spokane Spokane Valley, WA MSA             |

## Appendix 2 – Flow diagram of data sources and analysis



## Endnotes

<sup>1</sup> The basic technique employed is described in the paper “Model-Based Sampling and Inference,” on the EIA website. Additional references can be found on the InterStat website (<http://interstat.statjournals.net/>). See the following sources: Knaub, J.R., Jr. (1999a), “Using Prediction-Oriented Software for Survey Estimation,” InterStat, August 1999, <http://interstat.statjournals.net/>; Knaub, J.R. Jr. (1999b), “Model-Based Sampling, Inference and Imputation,” EIA web site: <http://www.eia.gov/cneaf/electricity/forms/eiawebme.pdf>; Knaub, J.R., Jr. (2005), “Classical Ratio Estimator,” InterStat, October 2005, <http://interstat.statjournals.net/>; Knaub, J.R., Jr. (2007a), “Cutoff Sampling and Inference,” InterStat, April 2007, <http://interstat.statjournals.net/>; Knaub, J.R., Jr. (2008), “Cutoff Sampling.” Definition in Encyclopedia of Survey Research Methods, Editor: Paul J. Lavrakas, Sage, to appear; Knaub, J.R., Jr. (2000), “Using Prediction-Oriented Software for Survey Estimation - Part II: Ratios of Totals,” InterStat, June 2000, <http://interstat.statjournals.net/>; Knaub, J.R., Jr. (2001), “Using Prediction-Oriented Software for Survey Estimation - Part III: Full-Scale Study of Variance and Bias,” InterStat, June 2001, <http://interstat.statjournals.net/>.

<sup>2</sup> See the following sources: Bahillo, A. et al. Journal of Energy Resources Technology, “NOx and N2O Emissions During Fluidized Bed Combustion of Leather Wastes.” Volume 128, Issue 2, June 2006. pp. 99-103; U.S. Energy Information Administration. *Renewable Energy Annual 2004*. “Average Heat Content of Selected Biomass Fuels.” Washington, DC, 2005; Penn State Agricultural College Agricultural and Biological Engineering and Council for Solid Waste Solutions. Garth, J. and Kowal, P. Resource Recovery, Turning Waste into Energy, University Park, PA, 1993; Utah State University Recycling Center Frequently Asked Questions

<sup>3</sup> A boiler’s firing configuration relates to the arrangement of the fuel burners in the boiler, and whether the boiler is of conventional or cyclone design. Wet- and dry-bottom boilers use different methods to collect a portion of the ash that results from burning coal. For information on wet- and dry-bottom boilers, see the EIA Glossary at <http://www.eia.gov/glossary/index.html>. Additional information on wet- and dry-bottom boilers and on other aspects of boiler design and operation, including the differences between conventional and cyclone designs, can be found in Babcock and Wilcox, *Steam: Its Generation and Use*, 41<sup>st</sup> Edition, 2005.

<sup>4</sup> Boilers that rely entirely on waste heat to create steam, including the heat recovery portion of most combined cycle plants, did not report on the historical Form EIA-767 or EIA-923.

<sup>5</sup> The “All Other” firing configuration category includes, for example, arch firing and concentric firing. For a full list of firing method options for reporting on the historical Form EIA-767, see the form instructions, page xi, at [http://www.eia.gov/survey/form/eia\\_767/instructions\\_form.pdf](http://www.eia.gov/survey/form/eia_767/instructions_form.pdf).