GUIDE TO IPM RUN (Input/Output) FILES

The following information is meant to provide users with a general explanation of the different IPM run files that are made web ready and posted to EPA's website. It is intended to help users identify and interpret the data available in the model input and output files. The Documentation for EPA's Power Sector Modeling Platform using IPM (available at https://www.epa.gov/power-sector-modeling provides more comprehensive details regarding the assumptions and methodology used in the model.

Below is a brief overview of the non-unit level IPM inputs and outputs that are made publicly available through EPA's website. Because the System Summary Report is one of the more frequently referenced documents that summarizes many IPM key outputs, it is described in further detail in the remainder of this guide.

Once IPM Run files are downloaded and decompressed from EPA's website, the unzipped files will contain A DAT Replacement file, RPE Replacement file, RPT Replacement files, EIA Style Gas Report, State Emissions File, an Overview file, and an Excel spreadsheet that includes "System Summary Report" in the title. These files have information at the national level for all output years. When applicable, unit level "Parsed File"s and "Flat Files" for air quality modeling for a specific year are posted separately

Input and Output Files

DAT file[1] **(Model Inputs):** This file will have "DAT File" in the file name, e.g., "Post-IRA 2022 Reference Case dat file.xlsx." It contains the key input set-up data used to define the model run, including the definitions and specifications for run years, model regions, model plants, financial parameters, available fuels, and power system transmission and operating parameters. The "Index" worksheet provides a list of all other worksheets and data available in the file, and the "RunUniverse" worksheets includes a table of region names and IDs.

RPE file[2] **(Model Plant Outputs):** This file will have "RPE File" in the file name, e.g., "Post-IRA 2022 Reference Case rpe file.xlsx." For each model plant, this file shows the projections of fuel consumption, emissions, capacity, costs (capital, fixed operations and maintenance, and variable operations and maintenance), and generation.

In contrast to past RPE files, which only contained data on model plants that had generation

[1] This file replaces ".dat" file that was output by earlier versions of IPM and is easier to navigate.
[2] This file replaces ".rpe" file that was output by earlier versions of IPM and is easier to navigate.

(i.e. model plants that were idled, but not retired), the RPE file 1 contains data for model plants that were either idled or retired.

RPT files[3] (Detailed Model Operational Outputs): This is a zip file with "rpt files" in the file name, e.g., "Summer 2021 rpt files.zip." These files contain a variety of model outputs, including: regional summaries; costs, fuel supply, transportation, and use; electricity transmission and constraints; new and retrofit capacity; environmental constraints; and energy price.

State Emissions file: This file will have "State Emissions" in the file name, e.g., "Post-IRA 2022 Reference Case State Emissions.xlsx." This file shows EGU emissions at the state level for each run year. There are two tabs, one showing emissions from all EGUs, the other showing emissions from all EGUs, the other showing emissions only from fossil units greater than 25 MW.

Additionally, this file now contains data describing total state-level generation and heat input, both annual and ozone season.

Overview file (Regional Summary of Model Operational Outputs): This file will have "Overview" in the file name, e.g., "Post-IRA 2022 Reference Case Overview File.xlsx." It contains model operational outputs by run year at the regional level, including capacity, generation, costs, retrofits, and retirements. It is typically easier for users to refer to either the System Summary Report or the Regional Summary File.

System Summary Report

System Summary Report: The System Summary Report is available as a spreadsheet, e.g., "Post-IRA 2022 Reference Case SSR.xlsx." It contains system-wide power sector results for the lower continental U.S. for each run year. It reports forecasted generation, capacity, capacity additions, capacity factors, production costs, emissions, fuel consumption & cost, and allowance prices by model run year. Disaggregation of system-wide data to plant type data is provided for generation and capacity fields. The plant types are categorized based on fuel used (e.g., coal, oil/gas, nuclear, hydro), combustion technology (e.g., turbine, combined cycle gas), control technology (e.g., scrubber, post-combustion NO_x control), and retrofit structure (e.g., coal plant with existing SNCR retrofit with ACI). In addition to providing the above outputs forecasted for each model run year, it also gives information on the various regulatory and legal requirements that were inputted into the model as constraints. Below is a more detailed explanation of each worksheet in the System Summary Report.

The regional level equivalent of the System Summary Report Tables 1-16 is available in the "Regional Summary.xlsx" file that is included in the RPT replacement files.

[3] This file replaces ".rpt" file that was output by earlier versions of IPM and is easier to navigate.

Description of Worksheets and Data within the System Summary Report File

System Summary Report: When the Excel File is opened, it will contain six worksheets

1. "Summary" worksheet
2. "Retrofit Summary" worksheet
3. "All Constraints" worksheet
4. "Fuel Report" worksheet
5. "Tables 1-16_US" worksheet
6. "Coal Pivot Tables" worksheet
7. "Final Wholesale Price" worksheet
8. "Natural Gas" worksheet.

Summary Worksheet: The summary worksheet in the system summary file highlights some of the key data points from the IPM output, and is intended to be an ideal starting point for assessing fundamental environmental and operational projections for the power sector in any given IPM run. For first time users, it is one of the more user-friendly documents from which to view output data. It includes national level data for emissions, total system cost, fuel prices, total capacity, new capacity, retired capacity, generation, and fuel supply and consumption

Retrofit Summary: The "Retrofit Summary" worksheet provides data on the total installed capacity of pollution controls (FGD, SCR, SNCR, ACI, CCS, and DSI; as well as Coal-to-Gas (C2G) conversions, Natural Gas Cofiring (NGC), Heat Rate Improvements (HRI)) as well as controls retrofit in the given IPM run.

All Constraints: The "All Constraints" worksheet in the System Summary Report lists the various legal and policy requirements in the model.[4] Each constraint typically involves a "standard" that is imposed in the form of an emission limit, emission rate limit, or generation limit. The constraint can be applied at the unit, plant, system, state, regional or national level. The constraints also include a time dimension and may vary between model run years. The worksheet displays the shadow price of each constraint (i.e. the marginal cost of meeting the standard for a particular season or year, which is equal to the additional cost the model would have chosen to incur to allow for the constraint to be loosened by one unit of measure. For example, for a constraint on total NO_X emissions, the amount the model would be willing to pay to allow for one more ton of NO_X emissions). Constraints with shadow prices of zero are "non-binding", that is the model would have produced the same solution if the constraint did not exist. There are over 1000 constraints in the model. Section 3.10 (Existing Environmental Regulations) of the documentation and tables referenced therein provide details on the settlements and state rules.

[4] These constraints are detailed in the IPM Documentation and the Environmental Measures workbook that is part of the RPT Replacement Files.

with a comprehensive list of legal and policy requirements that are reflected in the model through various constraints.

Fuel Report: The "Fuel Report" worksheet provides consumption and cost data for major power sector fuel sources for each model run year. These fuels include coal, nuclear, natural gas, biomass, pet.coke (petroleum coke), natural gas, biomass, waste coal, and oil. For each fuel type the total consumption is given in TBtus (trillion Btus). Cost is provided in both MMUS$ (million US dollar units) and US$/MMBtu (U.S. dollar per million Btus).

Tables 1-16: The "Tables 1-16" worksheet in the System Summary Report provides information on controls, generation, capacity, and cost. The information in these tables is often the disaggregated value of the totals reported in the "Summary" worksheet. A user interested in better understanding the details behind the totals given in the "Summary" worksheet may wish to consult "Tables 1-16". For example, the "Summary" worksheet provides the total amount of generation from coal in each model run year. However, the "Tables 1-16" worksheet goes one step further and provides data on the portion of that generation total coming from coal plants with no pollution control and the portion coming from plants with specific pollution control configurations. In particular, tables 10 through14 provide generation and capacity data at the model plant type level. Tables 1–9 provide generation supply and demand data at the U.S. region wide level. The table below describes the data output reported in each table, and Appendix 1 and 2 provide more information on the acronyms and nomenclature used in the data fields.

Description Tables in "Tables 1-16" Worksheet

Table #	Title	Description
1	Reserve Margin Capacity Winter (MW)	Shows total electric generating capacity available to the U.S. region during winter period. Available supply of electricity in megawatts (MW).
2	Peak Load Winter (MW)	Shows total electricity demand during winter period by the U.S. region. Capacity reported in megawatts (MW).
3	Reserve Margin Winter (%)	Shows excess winter capacity supply as percentage of demand using total values reported from Tables 1 & 2. (supply - demand)/demand.
1	Reserve Margin Capacity Winter-Shoulder (MW)	Shows total electric generating capacity available to the U.S. region during winter-shoulder period. Available supply of electricity in megawatts (MW).
2	Peak Load Winter-Shoulder (MW)	Shows total electricity demand during winter-shoulder period by the U.S. region. Capacity reported in megawatts (MW).
3	Reserve Margin Winter-Shoulder (%)	Shows excess winter-shoulder capacity supply as percentage of demand using total values reported from Tables 1 & 2. (supply - demand)/demand.

1	Reserve Margin Capacity summer (MW)	Shows total electric generating capacity available to U.S. region during summer period. Available supply of electricity in megawatts (MW).
2	Peak Load summer (MW)	Shows total electricity demand during summer period by the U.S. region. Capacity reported in megawatts (MW).
3	Reserve Margin summer (%)	Shows excess summer capacity as percentage of demand using total values reported from Tables 1 & 2.
1	Reserve Margin Capacity annual (MW)	Shows total electric generating capacity available to U.S. region annually. Available supply of electricity in megawatts (MW).
2	Peak Load annual (MW)	Shows total electricity demand annually by the U.S. region. Capacity reported in megawatts (MW).
3	Reserve Margin annual (%)	Shows excess annual capacity as percentage of demand using total values reported from Tables 1 & 2.
4	Generation (GWh)	Gigawatt hours (GWh) of annual electricity that is produced domestically, imported, exported, and lost during pumping and storage.
5	Total Supply for Demand (GWh)	Gigawatt hours (GWh) of annual electricity generation supplied to the U.S. region. Summation of values in Table 4.
6	Projected Demand (GWh)	Gigawatt hours (GWh) of annual projected demand and projected net demand.
7	Dumped Energy	Typically not referenced.
8	Total Generation	Gigawatt hours (GWh) of annual electricity that is produced domestically, imported, exported, and lost during pumping and storage.
9	Total Sales (GWh)	Gigawatt hours (GWh) of annual electricity supply determined by subtracting projected transmission & demand losses from total supply.

10	Capacity by Capacity Reporting Type	Cumulative capacity (MW) of model plant types for each model run year. The model run plants are categorized by the unit's fuel, configuration, and online status (e.g., new, existing, retiring). Each control configuration combination is modeled as a separate plant type. The total capacity, retrofit capacity, new unit capacity, and retiring unit capacity values given in the summary table are disaggregated into model plant types in this table. Key difference between table 10 & 11 is that 10 is cumulative and 11 is incremental. Therefore, table 10 will show model plant capacity by a given year, and table 11 will show model plant capacity added during that run year.
11	Capacity Additions and Changes	Incremental capacity (MW) of model plant types for each model run year. The model run plants are categorized by the unit's fuel, configuration, and online status (e.g., new, existing, retiring). Each control configuration combination is modeled as a separate plant type. The total capacity, retrofit capacity, new unit capacity, and retiring unit capacity values given in the summary table are disaggregated into model plant types in this table.
12	Generation by Capacity Reporting Type (GWh)	Cumulative generation (GWh) of model plant types for each model run year. The model run plants are categorized by the unit's fuel, configuration, and online status (e.g., new, existing, retiring). Each control configuration combination is modeled as a separate plant type. The total generation by each plant type given in the summary table is disaggregated into model plant type generation in this table.
12a	Generation by Fuel Reporting Type (GWh)	Total gigawatt hours (GWh) of generation in each model run year by fuel type. Aggregation of the model plants pertaining to each fuel in table 12.
13	Generation by Capacity Reporting Type (TBtu)	Cumulative generation measured in Trillion Btus (TBtu) of model plant types for each model run year. The data corresponds to generation values given in Table 12, but is expressed in TBtus to provide the heat content of the power generated. Conversion factor of approximately 3,412 Btu/KWh is used.

14	Capacity factor by Capacity Reporting Type (%)	Capacity factor for each model plant type. Capacity factor is the actual generation expressed as a percentage of maximum generation possible if the plant was operated every hour of the year. Therefore, it is the generation / (capacity*8760). Generally, the model does not allow for 100% capacity factors because of maintenance, planned outage, and forced outage times. Intermittent generation sources (i.e., wind) also have their capacity factor limited by the availability of their fuel source.
15	Total Annual Production Cost	Provides total production cost in million U.S. dollar units (MMUS$) for each model run year. The production costs are disaggregated into variable operating and maintenance (variable O&M), fixed O&M, fuel, capital, and CO_2 transportation and storage cost.
16	Emissions	Provides total annual U.S. emissions for each model run year for several hazardous, criteria, and greenhouse gas pollutants. Emission totals are expressed in 1000 tons (Mtons); 1,000,000 tons (MMtons), regular tons, or pounds (in the case of mercury). All tons are short tons (2000 lbs/ton) unless otherwise noted.

Coal Pivot Tables: The "Coal Pivot Tables" worksheet in the System Summary Report provides information on coal prices and total coal consumption for each run year by coal region. Data is reported in both MMBtu and tons.

Final Wholesale Price: The "Final Wholesale Electricity Price" worksheet in the System Summary Report provides the wholesale electricity price for each region and model run year.

Natural Gas: The "Natural Gas" worksheet provides the delivered natural gas price and quantity consumed in each season (winter, winter-shoulder, and summer) in each year for each model region.

APPENDICES

Appendix1: Explanation of Model Plant Nomenclature

The field headers given in each row of Tables 10-14 represent model plant types. The model plant types are differentiated by fuel used (e.g., coal, oil/gas, nuclear, hydro), combustion technology (e.g., turbine, combined cycle gas), control technology (e.g., scrubber, post-combustion NO_X control), online status (e.g., new, existing, or retiring) and retrofit structure (e.g., coal plant with existing SNCR retrofit with ACI). It clarifies the nomenclature of model plants to recognize the significance of the "ret.", "exist" and "&" usage in the title. "Ret." suggests that the model plant is receiving a retrofit in or by the given run year. If there is no "exist" label that immediately follows the "ret." designation, then every control listed is a retrofit on a unit without any previously existing emission controls. The indicated are endogenous to the model.

If there is an "exist" that follows "ret." then each control listed after the "exist" and before the first ampersand (&) is an existing control and everything after the "&" is a retrofit that is added to that model plant by the model run year given. To illustrate the difference, let's look at plant types with the same controls shown but with the word "Exist" absent and when the word "Exist" is present, there will be variants in the placement of the first ampersand (&):

Sample Plant Types and Descriptions

Plant Type	Description
ExistSCR_WFGD_ACI	Existing Coal Steam with SCR, ACI and Wet FGD
Ret.ACI & SCR & WetFGD	Retrofit ACI, SCR, and Wet FGD on Existing Coal Steam
Ret.ExistACI & SCR & WetFGD	Retrofit SCR, and Wet FGD on Existing Coal Steam with ACI
Ret.ExistSCR_ACI & WetFGD	Retrofit Wet FGD on Existing Coal Steam with SCR and ACI
Ret.ExistWetFGD & ACI & SCR	Retrofit ACI, and SCR on Existing Coal Steam with Wet FGD
Ret.ExistWetFGD_ACI & SCR	Retrofit SCR on Existing Coal Steam with ACI and Wet FGD
Ret.ExistWetFGD_SCR & ACI	Retrofit ACI on Existing Coal Steam with SCR and Wet FGD

Appendix2: Abbreviations Appearing in Model Plant Naming

Abbreviation	Definition
ACI	Activated Carbon Injection
C2G	Coal-to-Gas
CC	Combined Cycle
CCS	Carbon Capture & Storage
CT	Combustion Turbine
Exist	Existing
FGD	Flue gas desulfurization
HRI	Heat Rate Improvement
IGCC	Integrated Gasification Combined Cycle
NGC	Natural Gas Cofiring
PV	Photovoltaic
Ret	Retrofit
SCR	Selective Catalytic Reduction
SNCR	Selective Non- Catalytic Reduction