*2021 PSE Integrated Resource Plan*

# H

# Electric Analysis Inputs and Results

*This appendix provides modeling inputs and outputs, as well as guidance for navigating the provided files.*

# Contents

# 1. 2021 IRP ELECTRIC ANALYSIS FILES

For the 2021 IRP, PSE is providing Microsoft Excel files containing input and output data in separate files instead of data tables directly in the IRP report. The direct access to the data provides usable files for stakeholders as opposed to static tables in a PDF format. Technical limitations on how PSE is able to submit files to the WUTC and host files online for stakeholder access has prevented PSE from keeping the files organized in a series of folders. To overcome this, a descriptive naming system has been developed in order to identify different files. Figure H-1 provides an example of how the provided files will be named. The same format is used for files from Appendix I, Natural Gas Analysis Results. Each Excel file also contains a "Read_Me" sheet with specific details related to the data contained in that file.

*Figure H-1: Naming Conventions for Appendix H and Appendix I Files*

Model Input
or Output

AppH_Input_AURORA Power Prices

Associated
Appendix

Descriptive Name of File
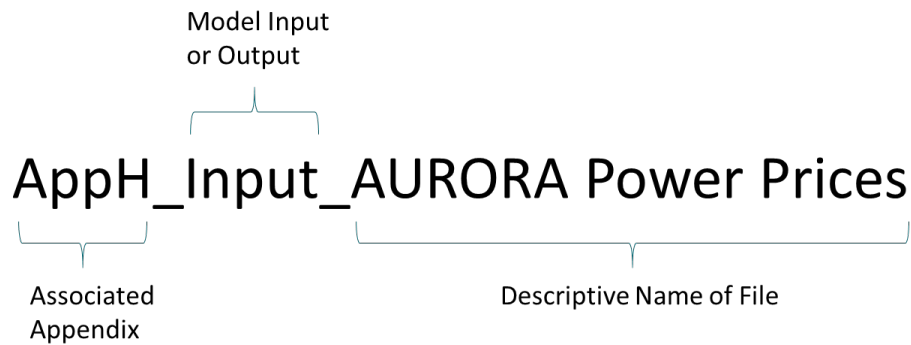
# 2. MODELING INPUTS

## Aurora Portfolio Model Inputs

The AURORA Long Term Capacity Expansion (LTCE) Portfolio Model files contain the data used in AURORA that PSE is able to share publicly. This includes generic resource assumptions, financial assumptions and specific settings used in AURORA. Figure H-2 provides a list of AURORA input files provided in this IRP.

*Figure H-2: AURORA Portfolio Model Input File Names*

| File Names | Description |
|---|---|
| **AppH_Input_AURORA LTCE Inputs** | Contains inputs for the AURORA LTCE model, including generic resource assumptions and modeling parameters. Existing resource information is not included. |
| **AppH_Input_AURORA LTCE Hourly Data** | Contains the hourly data inputs of the AURORA LTCE model for generic resources and DSR programs. |
| **AppH_Input_AURORA Power Prices** | Contains the results of the hourly power price model, which is used as the power price inputs for other models. |
| **AppH_Input_Demand Forecast** | Contains the annual summary of PSE's demand forecasts used in the 2021 IRP. |

**LTCE INPUTS.** This file contains the non-hourly inputs into the AURORA LTCE model, including generic resource assumptions and other modeling parameters. Confidential information regarding PSE's existing resources and other assets has been removed. All dollar values that are entered into AURORA are in 2012 dollars. More documentation of the AURORA modeling process can be found in Chapter 8 and Appendix G.

**LTCE HOURLY DATA.** This file contains the hourly data inputs for generic renewable resources and DSR in the AURORA LTCE model. Each hourly dataset has 8,784 entries, one for every hour of a leap year. Non-leap years exclude February 29th. More information about generic resources can be found in Chapter 5 and Appendix D. More information about DSR bundles can be found in Chapter 5 and Appendix E.

**POWER PRICES.** This workbook contains all of the hourly power price data developed for this IRP. For sensitivities that change the hourly dispatch, a new hourly price forecast is required. The AURORA power price forecast is run using the conditions of the scenario or sensitivity. Yearly and monthly prices are averages of those periods, and all prices are in $/MWh. More information about power prices can be found in Chapters 5 and Appendix G.

**DEMAND FORECAST.** This workbook contains the annual demand forecast data for the Electric and Gas systems. The forecasts include base and peak demand for the 2021 IRP timeline, 2022-2045.

## CO$_2$ Prices

The CO$_2$ Prices file contains the calculations of the Social Cost of Greenhouse Gases (SCGHG) used during the 2021 IRP. Figure H-3 provides the name of this file.

*Figure H-3: CO$_2$ Prices File Name*

| File Name | Description |
|---|---|
| **AppH_Input_Carbon Price** | Contains the calculations for the SCGHG values used in the 2021 IRP. |

**CARBON PRICE.** This workbook contains PSE's calculations for converting the SCGHG into a format compatible with AURORA. This includes the base SCGHG calculation and the H.R. 763 SCGHG calculation used in Electric Sensitivity L.

## Demand-side Resource (DSR) Data

These files contain the energy savings, costs and peak contributions of the DSR data in the Mid portfolio and Sensitivities F, G and H. Values that are broken down by sector (Industrial, Commercial, Residential) are recombined before being used in any model. The addition of these breakdowns was provided by Cadmus and are included in the files, but were not used separately in the 2021 IRP. Peak contributions are selected from the December values of the peak datasets to align with the PSE design system peak. The results of the electric DSR sensitivities can be found in Chapter 8. Figure H-4 provides the file names of these datasets. More information about the DSR data can be found in Appendix E.

Figure H-4: Electric System DSR Dataset File Names

| File Names | Description |
|---|---|
| **AppH_Input_Electric DSR Base** | Contains the conservation bundles, codes and standards (C&S), combined heat and power (CHP), and Solar DSR outputs for the electric system. |
| **AppH_Input_Electric DSR 6Yr** | Applies a 6-Year ramp rate to conservation measures implemented in the DSR dataset instead of 10 years. |
| **AppH_Input_Electric DSR NEI** | Includes additional non-energy impacts in the energy savings of the bundles. |
| **AppH_Input_Electric DSR SDR** | Applies a 2.5% discount rate to the conservation measures. |

**BASE ELECTRIC DSR DATA.** Contains the conservation bundles, codes and standards (C&S), combined heat and power (CHP) and Solar DSR outputs for the electric system.

**ELECTRIC SENSITIVITY F, 6-YEAR RAMP RATE.** Applies a 6-year ramp rate to conservation measures implemented in the DSR dataset instead of 10 years.

**ELECTRIC SENSITIVITY G, NON-ENERGY IMPACTS.** Includes additional non-energy impacts in the energy savings of the bundles.

**ELECTRIC SENSITIVITY H, 2.5% SOCIAL DISCOUNT RATE.** Applies a 2.5% discount rate to the conservation measures.

## AURORA Generic Wind and Solar Shapes

The generic wind and solar capacity factor shapes used to model utility-scale renewable resources all have the same format, which is described below. Figure H-5 provides the file names of these datasets.

*Figure H-5: Generic wind and Solar Shape File Names*

| File Names | Description |
| --- | --- |
| **AppH_Input_WY Anticline Solar** | Hourly input data for the WY Anticline solar resource. |
| **AppH_Input_ID Solar** | Hourly input data for the ID solar resource. |
| **AppH_Input_ID Wind** | Hourly input data for the ID wind resource. |
| **AppH_Input_MT Central Wind** | Hourly input data for the MT Central wind resource. |
| **AppH_Input_MT East Wind** | Hourly input data for the MT East wind resource. |
| **AppH_Input_Offshore Wind** | Hourly input data for the Offshore wind resource. |
| **AppH_Input_WA East Solar** | Hourly input data for the WA East solar resource. |
| **AppH_Input_WA East Wind** | Hourly input data for the WA East wind resource. |
| **AppH_Input_WY East Wind** | Hourly input data for the WY East wind resource. |
| **AppH_Input_WY West Solar** | Hourly input data for the WY West solar resource. |
| **AppH_Input_WY West Wind** | Hourly input data for the WY West wind resource. |

Each solar and wind shape file contains four different tabs. Each tab is titled with a combination of "Stochastic" or "Representative" with "8760" or "8784". Figure H-6 explains the meaning of each part of the title.

*Figure H-6: Naming Conventions for the Tabs in Each Renewable Generation File*

| Name | Meaning |
|---|---|
| **Stochastic** | This dataset contains 252 capacity factor profiles of the resource location for use in the stochastic modeling process. |
| **Representative** | This dataset contains the representative capacity factor profile of the resource location that was used in the deterministic portfolio model. |
| **8760** | Each capacity factor curve in this dataset contains 8760 hours, which corresponds to a non-leap year. |
| **8784** | Each capacity factor curve in this dataset contains 8760 hours, which corresponds to a leap year. The generation curves are the same as the non-leap year curves, with the exception that the February 28th values are copied to February 29th. |

Each tab has the following values:

**Index**: Column A, the 0-index of all data entries.

**Month, Day, Hour:** Date and time values for the hours beginning at each time step. (1,1,0 is the January 1st hour beginning at Midnight)

**NREL Site ID and Year**: The header for the capacity factor column represents the NREL site ID and year the data was collected ("75703_2009" is from site ID 75703 in the year 2009).

A detailed explanation of the generic renewable resource generation profiles can be found in Appendix D.

# 3. MODELING OUTPUTS

## AURORA

The AURORA output files contain the AURORA output data that PSE is able to share publicly. Figure H-7 provides the file names of these datasets.

*Figure H-7: AURORA Output Files*

| File Names | Description |
|---|---|
| AppH_Output_Portfolio Output Summary | Contains an overview of the output data from the AURORA LTCE and hourly dispatch models. |
| AppH_Output_Levelized Resource Costs | Contains the calculations of the levelized costs of new resources in the 2021 IRP. |
| AppH_Output_Stochastics Results | Contains an overview of the results from the AURORA stochastic model. |

**PORTFOLIO OUTPUT SUMMARY.** This workbook contains an overview of the output data from each electric portfolio modeled. The portfolio build data, emissions, annual revenue requirements, customer benefit indicators and overall portfolio costs are included. Plotting functionality is included for easy comparison between datasets. The analyses of the electric portfolios can be found in Chapter 8.

**LEVELIZED RESOURCE COSTS.** This workbook contains the calculations for the levelized costs of new resources in the 2021 IRP. The information from the raw data is processed in the resource-specific tabs. The processed data is then added to the charts and data summaries. More information on the levelized costs of resources can be found in Chapter 8.

**STOCHASTIC MODELING RESULTS.** This workbook contains the tables, charts and data from the AURORA stochastic modeling process used in the 2021 IRP. The portfolios examined in the stochastic modeling process are the Mid Scenario and Sensitivities W, WX, and Z. A full description of the stochastic portfolio analysis can be found in Chapter 8 and Appendix G.

## PLEXOS

The PLEXOS output files contain the PLEXOS output data that PSE is able to share publicly. Figure H-8 provides the file names of these datasets.

*Figure H-8: PLEXOS Output Files*

| File Names | Description |
|---|---|
| **AppH_Output_Flex Benefits** | Contains the calculation of the generic resource flexibility benefits using output data from the PLEXOS Flexibility Analysis model. |
| **AppH_Output_Flex Violations** | Contains data from the flexibility violations that occurred in the PLEXOS Flexibility Analysis model. |

**2025 FLEXIBILITY BENEFITS.** This workbook contains the calculations for the resource Flexibility Benefits. The difference in costs between the test cases and the base case provides the flexibility benefit of the test case resource. The full Flexibility Analysis (FA) methodology and results can be found in Chapter 5 and a description of the model can be found in Appendix G.

**2025 FLEX VIOLATIONS.** This workbook contains PLEXOS output data detailing the flexibility violations from the Flexibility Analysis model. All data was sourced from the 2025 Flexibility Analysis model. The full Flexibility Analysis (FA) methodology and results can be found in Chapter 5 and a description of the model can be found in Appendix G.