K. ANALYTICAL METHODS AND MODULES

The 2021 IRP used the Strategic Planning *powered by MIDAS Gold*® package of tools developed by Hitachi ABB Power Grids (HAPG). Strategic Planning includes a Financial and Risk modules.

The IRP used the Capacity Expansion module to produce unique resource portfolios across a range of different planning assumptions.

Capacity Expansion's database is used in conjunction with Portfolio Optimization for additional detailed modeling. The system allows resource portfolios created using Capacity Expansion to be used in the Portfolio Optimization solution where hourly chronological simulations provide operational detail.

Over the 20-year planning horizon, the Capacity Expansion model operates by minimizing operating costs for existing and prospective new resources. It optimizes resource additions subject to resource costs, capacity constraints (summer peak loads plus a planning reserve margin), and system reliability. For the planned retirement of an existing generating resource or contract expiration, Capacity Expansion selects additional resources as required to meet peak loads that include the 15 percent planning reserve margin.

To best optimize resource options, Capacity Expansion performs a time-of-day least-cost dispatch for existing and potential planned generation. It bases the resource dispatch on a representative-week. Dispatch determines optimal electricity flows between zones and includes spot market transactions for system balancing.

The model minimizes the system PVRR, including:

- Net present value cost of existing contracts.
- Spot market purchase costs.

- Generation costs (fuel, fixed and variable operation and maintenance, decommissioning, emissions, unserved energy, and unmet capacity).
- Amortized capital costs for potential new resources.

The IRP used the Portfolio Optimization module to analyze and report the optimal dispatch of the Capacity Expansion generation portfolios against either a load requirement. Portfolio Optimization produces optimal operating schedules for the entire portfolio of generation assets and transactions. The module optimizes a portfolio's operation by modeling detailed unit operating constraints and market conditions to provide a generation schedule for energy and ancillary services and fuel nominations.

Portfolio Optimization results facilitates the analysis and simulation of deterministic and stochastic scenarios. The mixed-integer linear programming optimizes thermal units, combined cycle units, and renewables, including battery storage, in a single solution.

The Portfolio Optimization Stochastic Analysis module simulates uncertainties in electric and fuel prices, loads, energy availability, and other factors that could impact the hourly simulation results. This module incorporates a Regression Tool, Draw Generation, and Stochastic Analysis.

The IRP also used Strategic Planning's Financial and Risk modules. The Financial module models costs external to unit operation and other valuable information necessary to thoroughly evaluate the economics of a generation fleet. The module produces bottom-line financial statements to evaluate profitability and earnings impacts. The Risk module performs stochastic analyses on all other modules and review results numerically and graphically. Stochastics can be performed on both production and financial variables.

Strategic Planning uses a Latin Hypercube-based stratified sampling program that takes into account statistical distributions, correlations, and volatilities for three time periods: short-term hour, mid-term month, and long-term annual) for each transact group. Stratified sampling can be thought of as "smart" Monte Carlo sampling. Instead of drawing each sample from the entire distribution—as in Monte Carlo sampling—the planning tool divides the sample space into equal probability ranges and then takes a sample from each range.