RESULTS

As explained in the introduction, Questar Gas has utilized for a number of years, a computer-based linear-programming modeling tool to evaluate both supply-side and demand-side resources. This software product, marketed under the name of "SENDOUT" was developed and is maintained by New Energy Associates (NEA) headquartered in Atlanta, Georgia.

Questar Gas is utilizing the most recent release of SENDOUT, Version 12.1.1, which was installed during January 2008. Version 12.1.1 has the capability of performing Monte Carlo simulations thereby better facilitating risk analysis. The Monte Carlo method utilizes repeated random sampling to generate probabilistic results. It is best applied where relative frequency distributions of key variables can be developed or where draws can be made from historic data. Because of the need for numerous random draws, this method has been greatly facilitated by the availability of high-speed computer technology.

During January 2008, Questar Gas Company representatives participated in a three-day training session conducted by an expert consultant from NEA. Included in this training was instruction on the use of the Monte Carlo capabilities of SENDOUT. During this training session, the consultant evaluated how Questar Gas was utilizing and had configured the SENDOUT model. While the consultant acknowledged that the linear-programming problem being solved by Questar Gas was among the "more complex" he had seen modeled, it was his opinion that "Questar was using SENDOUT reasonably" (see Exhibit 9.1).

Constraints and Linear Programming

While the concepts of linear programming date back to at least the early 19th century, it was not until the middle of the 20th century that this approach began to be more widely accepted as a method for achieving optimal solutions in practical applications. In a nutshell, linear programming problems involve the optimization of a linear objective function subject to linear constraints. Constraints are necessary in the determination of a maximum or minimum solution. Constraints must be linear functions and can either represent equalities or inequalities. An example of an inequality constraint in the natural gas business would be that the quantity of natural gas that can be transported over a certain segment of an interstate pipeline must be "less than or equal to" a certain level previously contracted for with that pipeline company. Another example of an inequality constraint would be the production available from a group of wells providing cost-of-service natural gas. The levels of this resource that can be taken can never exceed the maximum level available as production naturally declines over time. All resources are defined by constraints including purchased gas. Some peaking contracts have minimum levels that must be taken during an agreed-upon period of time which would be translated into a "greater than or equal to" constraint. Constraints must be carefully defined to accurately reflect the problem being solved. The arbitrary removal of required constraints results in an inaccurate solution. For example, if the constraint on how quickly the Company's capacity at the Clay Basin storage facility can be refilled were to be removed, the model would assume that it could be done instantaneously, resulting in an unrealistic solution. The removal of all constraints in a linear programming problem results in no solution being obtained. Questar Gas periodically reevaluates the constraints in its SENDOUT model to determine if they accurately reflect the realities of the problem being solved. After reviewing Questar Gas use of the SENDOUT model during January of 2008, the consultant from NEA indicated that he “saw no evidence that the Questar model was unduly constrained.” (See Exhibit 9.1).

Monte Carlo Method

When performing Monte Carlo analysis, the length of computer run times can become an issue. To have a meaningful simulation, it is important to have a sufficient number of draws (typically hundreds). Each draw consists of one deterministic linear programming computer run. With the complexity of the Company’s modeling approach, one simulation usually takes several days to run using a multiplicity of computers (ten to twenty).[1] The base Monte Carlo simulation developed by the Company this year utilized 944 draws.

When the developers of SENDOUT incorporated the Monte Carlo methodology, they limited the number of variables for which stochastic analysis can be applied to avoid excessive computer run times. The two variables which they appropriately determined should be included are price and demand (within SENDOUT demand is modeled as a function of weather). No other variables have a more profound impact on the cost minimization problem being solved by SENDOUT than these two.

The output reports generated from the SENDOUT modeling results consist primarily of data and graphs. Most of the graphs are frequency distribution profiles from a Monte Carlo simulation. Many of the numerical-data reports show probability distributions for key variables in a simulation run. The heading “max” in these reports refers to the value of the draw in a simulation with the highest quantity. The heading “min” refers to the value of the draw in a simulation with the lowest quantity. The heading “med” refers to the median draw (or the draw in the middle of all draws). Questar Gas believes that the median value is a good indicator of the most likely occurrence, given the underlying assumptions in a simulation. Also in these data reports are the headings “p95,” “p90,” “p10,” and “p5.” The label “p95” on an output report means, based on input assumptions, that a 95 percent confidence exists that the resulting variable will be less than or equal to that number. Likewise, a “p10” number suggests that there is a 10 percent likelihood that a variable will be less than or equal to that number. These statistics and/or the shape of a frequency curve help define the range and likelihood of potential outcomes.

Natural Gas Price

The price for which natural gas supplies can be purchased in the future is extremely difficult to model with any level of accuracy. It is not atypical for the best industry forecasts

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[1] When using multiple computers not configured together to perform a grid analysis, the seed for starting the random number generator must be different for each machine.

to be off for periods of time by orders of magnitude. Most of the natural gas purchased by Questar Gas is tied contractually to one or more of seven area price indices. Three of those indices are published first-of-month prices for deliveries to the following interstate pipeline systems; Kern River, Questar Pipeline, and Northwest Pipeline. The remaining four are published daily indices for Kern River, Questar Pipeline, Northwest Pipeline, and Colorado Interstate Gas. To develop a future probability distribution, Questar Gas assembled three years of historical data and determined the means and standard deviations associated with each price index. Questar Gas then utilized long-term price forecasts developed by Global Insights as the basis for projecting the stochastic modeling inputs. Forecasted standard deviations have been scaled up pro rata with price increases to more accurately mirror reality. Exhibits 9.2 through 9.25 show, for the first model year, the resulting monthly price distribution curves for the first-of-month prices and the daily prices for each of the seven price indices used in the base simulation.

Weather and Demand

In addition to the price of natural gas, the other single most unpredictable variable in natural gas resource modeling is weather induced demand. Questar Gas makes available to the SENDOUT model 78 years of weather data. When forecasting future demands, heating degree days are calculated from the weather data base which, along with usage-per-customer-per-degree-day and the number of customers, is used to calculate the customer demand profile used by the model. For each month of simulation, the model randomly selects a monthly-degree-day standard-deviation multiplier to create a draw-specific monthly-degree-day total. It then scans through 78 years of monthly data to find the closest match. Then the model allocates daily degree-day values from the draw-specific monthly value. Exhibits 9.26 through 9.38 show first the annual and then the monthly demand distribution curves for the first year of the base simulation. The wide variability in weather-induced demand is broader than any reasonable range of load growth scenarios.

Peak Day and Base Load Purchase Contracts

An important consideration in the modeling process is the need to have adequate resources sufficient to meet a design-peak day. The design-peak day for the 2008/2009 winter-heating season has been determined to be 1.196 million Dth per day at the city gates. The design-peak day for many years has been defined to be a 1-in-20-year weather occurrence. The most likely day for a design peak to occur is on January 2, although, the probability of a design peak occurring on any day between mid-December and mid-February is relatively flat. Even though it is unlikely that a design-peak day will occur this year, the Company must be prepared to meet such a need should it occur. Selecting a draw from a Monte Carlo simulation that utilizes on the maximum demand day a level of resources approximately equaling the design-peak day proved to be problematic in that the SENDOUT model selected too much base-load purchased gas for a typical weather year. The draws which have a design-peak-day occurrence are also much colder than normal throughout the entire year. The solution to this dilemma was to perform a deterministic model run with the design-peak day overlaid on a typical weather year. The results of this exercise were used to determine the optimal mix of base-load purchased-gas resources. All the purchased gas resources for the design-peak-day-deterministic scenario that were not selected were then turned off (made not available) in the base Monte Carlo simulation. This procedure ensured that adequate base-load purchased gas resources would be available in the remote event that a design-peak day were to occur. Most of the base-load-purchased-gas resources, with their associated time-availabilities, must be committed to during the springtime, prior to the beginning of the gas supply year, to be ready for cold weather in the fall. Patterns of usage for storage resources, spot gas, and cost-of-service gas do not need to be committed to before the gas year begins. This modeling approach also lends itself to performing operational analysis periodically during the year as natural gas prices change.

Exhibit 9.39 shows the resources utilized to meet the design-peak day. Exhibit 9.40 shows the firm-peak-day demand distribution for the base simulation for the first plan year. Understandably, the design-peak day for Questar Gas is in the upper tail of the curve. Exhibits 9.41 through 9.52 show the probability distributions for purchased gas for each month of the first plan year from the base simulation. Exhibit 9.53 shows the annual distribution from the simulation. Exhibit 9.54 shows the numerical monthly data with confidence limits. The sum of the median monthly totals for purchased gas for the first plan year from the base simulation is approximately 65.3 million Dth. Questar Gas is confident that for a colder-than-normal year, sufficient purchased-gas resources will be available in the market. Likewise, Questar Gas is confident that in the event of a warmer-than-normal year, it has not “over-bought” base-load purchase contracts.

Cost-of-Service Gas

Another important output from the SENDOUT modeling exercise each year is a determination of the level of cost-of-service gas to be produced during the upcoming gas-supply year. Exhibits 9.55 through 9.66 show the distributions for cost of service gas for each month of the first plan year from the base simulation. Exhibit 9.67 shows the annual distribution from the simulation. Exhibit 9.68 shows the numerical monthly data with confidence limits. The sum of the median monthly totals for cost-of-service production for the first plan year from the base simulation is approximately 51.6 million Dth.

First-Year and Total System Costs

The linear-programming objective function for the SENDOUT model is the minimization of variable cost. A distribution curve for first-year total cost from the base simulation is shown in Exhibit 9.69. The first year median total from the base simulation is approximately $789 million. A similar curve for the total 21-year modeling time horizon is shown in Exhibit 9.70. The first year median cost of this time period is approximately $12.3 billion.