White Paper

# Optimizing Pipeline System Design Forecasts

An Integrated Data Management and Advanced Analytics Approach

THE POWER TO KNOW.

# Contents




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Generating a system design forecast for an energy company's pipeline operation is a challenging – but mandatory – regulatory procedure. In a capital-intensive industry with lengthy planning horizons, inaccurate forecasts can have serious financial consequences. But businesses can refine the system design process by using advanced analytics to optimize pipeline utilization forecasting and improve capital planning.

As the North American energy market has shifted away from historical norms of supply and demand, the industry has seen substantial changes in locational basis differentials driven by:

- Physical delivery infrastructure additions to access new markets.
- Pipeline flow reversals.
- The growth of shale production and "shalenomics."
- The globalization of the natural gas market from the proliferation of LNG terminals.

Improving the accuracy of forecasts can significantly increase confidence in business decisions, even when companies operate in a dynamic, complex market environment.

## The Challenge of Navigating Uncertainty

Despite the exponential increase in the exploitation of shale oil and gas in recent years, the future trajectory of North American shale production displays a wide range of potential outcomes, as shown in Figure 1. To navigate this uncertainty, a system design forecast must measure and evaluate a series of economic assumptions such as energy market shifts, commodity price fluctuations, supply and demand shifts, contractual obligations and field price estimates.

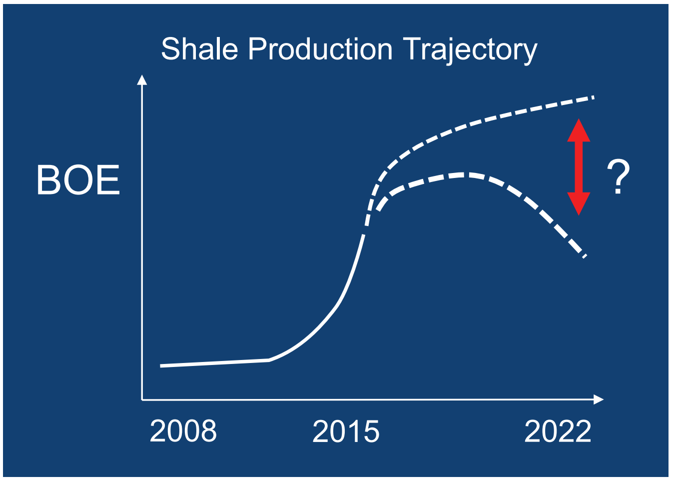


Figure 1: Understanding uncertainty in forecasting shale production (barrel of oil equivalent).

These and other metrics are used to generate a forecast of receipts and deliveries that assist a pipeline firm in determining:

- Where to build or upgrade facilities to accommodate new production and consumption realities.
- The capacity and direction of those proposed pipelines.
- The capital requirements to bring them online in time to meet business demands.

The resulting annual plan, which is filed with regulators to meet a yearly compliance mandate, is a detailed forecast that represents the company's best attempt at a long-term outlook for receipts and deliveries, design flow requirements and peak expected flows, maximum day delivery and facility investments for the next two to five years. Planning decisions can be enhanced by increasing forecast accuracy, optimizing the management of changing receipt and delivery volumes and improving the efficiency of capital spending.

# System Design Forecasting: A Big Data Problem

Creating an accurate system design forecast presents three challenges that fit Gartner's definition of a big data problem, described as "high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision-making and process automation."[1]

Pipeline firms can reap many benefits from adopting a corresponding big data solution that enables seamless integration of large quantities of siloed business data, an especially important factor in a competitive industry sector with a high rate of mergers and acquisitions.

## Managing the Volume and Complexity of Data Used in Supply Forecasts

The standard industry practice of extrapolating general conclusions from small sets of data limits both forecast accuracy and the ability to defend a forecast when making costly, real-world capital investments on a long planning horizon. New advances in big data integration, processing and modeling now enable energy companies to aggregate and access all the relevant data across multiple platforms and systems, then generate unambiguous predictions from this large volume of disparate data. The resulting analysis and projections give decision makers a sound footing on which to create forecasts and consider major capital expenditures.

> Using new advances in big data integration, processing and modeling, energy companies can aggregate and access all relevant data across multiple platforms and generate unambiguous forecasts.

## Reducing Data Management Requirements

The integration, cleansing, reconciliation and management of the large volumes of data required to generate an accurate forecast is a time-consuming manual process – one that detracts from the much more valuable process of data analysis. By automating the aggregation, processing and preparation of the data, companies can substantially reduce routine data staging efforts and increase the amount of time available for forecasting and balancing. Automation is particularly useful for tasks such as reconciling disparate data (e.g., natural gas volumes from multiple sources) and reducing reliance on specialty resources.

## Increasing Forecasting Analysis and Balancing Capabilities

Supply and demand is far from a simple equation. Uncertainty is a factor when modelling the many moving parts of oil and gas production and the complex set of economic pressures that create fluctuations in demand. In addition, accounting for constraints in the pipeline network and determining the availability of gas supply based on expected demand (which is influenced by a multiplicity of economic factors) is a complex endeavor. However, by applying advanced analytics, it is possible to consider all of these factors and generate balancing solutions that enable maximal price/cost results.

# Increasing Forecast Confidence With an Integrated Framework

Lack of confidence in a forecast frequently thwarts capital planning, balancing and regulatory compliance. Strategic planning is further compromised when companies are unable to run their forecasts in a timely and efficient manner. For many pipeline companies, the process can take the better part of a year.

But by implementing an integrated data management and analytics framework, companies can answer key questions – such as those in Table 1 – quickly and confidently.

[1] http://www.gartner.com/it-glossary/big-data/

TABLE 1.

| AN INTEGRATED APPROACH RESOLVES QUESTIONS SUCH AS: |
|---|
| What is the expected demand location, and is supply available to meet that demand? |
| What are the optimal delivery points, and how will this flow change over time? |
| What does a feasible balancing frontier look like? What is the optimal infrastructure to give confidence regarding the system tolerance to supply-demand scenario combinations? |
| What are the probabilities of profitability at potential demand locations? |
| Which new locations are most advantageous? Where does design capability fall short of expected peak flow, requiring new facilities to be built? What facilities should be deactivated or decommissioned? |
| In a demand-supply simulation, which locations show the most utilization and profitability over the forecast period? Which are least-cost? Which implies the highest net present value (NPV)? |

The optimal forecasting framework approach delivers value by making process improvements in the following areas:

## Data Management

The first step toward increasing forecasting confidence is to drastically reduce the amount of time spent managing data to produce the system design forecast – in particular, time spent reconciling data across wells, pools and meter stations. Advanced data management techniques significantly improve the quality of data applied to forecasts and shift the bulk of work-hours spent on the forecast from data processing to data analysis. Examples of effective process improvements include building centralized data repositories, defining business rules and automating workflows for integrating, cleansing and reconciling data.

## Supply Forecasting

Unconventional production's decline rates are markedly different and more complex than a conventional well. As the supply landscape shifts toward an increase in unconventional wells, reliance solely on traditional methods of supply forecasting can produce inaccurate results. For instance, decline curve analysis (DCA) is not well-suited to shale production. Augmenting DCA modeling with data-driven analytical methodologies, bounded by empirical models and first principles, generates faster and more reliable forecasts.

## Demand Forecasting

Generating accurate forecasts for delivery volumes at locations is one of the most important parts of a system design forecast. It is also one of the most challenging – changes in demand over time are not uniform, the factors driving those demand fluctuations are highly variable and the contribution to total demand shifts continuously.

Using advanced, automated forecasting processes that can consistently integrate all relevant factors – including the ability to forecast at the meter station level – is the most effective way to capture what drives demand changes. Companies can improve long-term forecasting accuracy by adding incremental customer intelligence and market data to the baseline forecast, as this enables "what if" scenario analysis and generates more accurate consensus forecasts.

## Balancing

Matching supply and demand is another complex task that benefits from more granular consideration of data. An economically optimized view of potential balancing solutions can be achieved by capturing data on feasible physical balancing quantities from the producing field at the meter, contract type and location level, as well as data on the constraints imposed by physical limits, pipeline sections, contractual obligations, market factors and strategic objectives. Using these data sets in simulations can determine how the forecast would be affected by changes in price, supply, demand and other factors. The result is a more robust estimate for pipeline infrastructure planning.

## Reporting

Implementing a highly integrated and scalable framework for generating forecasts is only half the battle. Successful forecasting also requires clear, comprehensible data visualizations that use all of the available data and that can distribute reports in a timely fashion. A flexible reporting solution makes it easier for forecasters to defend their conclusions to decision makers, and even enables those decision makers to explore the data themselves. This increases confidence in the conclusions of data-driven analyses and the mission-critical decisions they support.

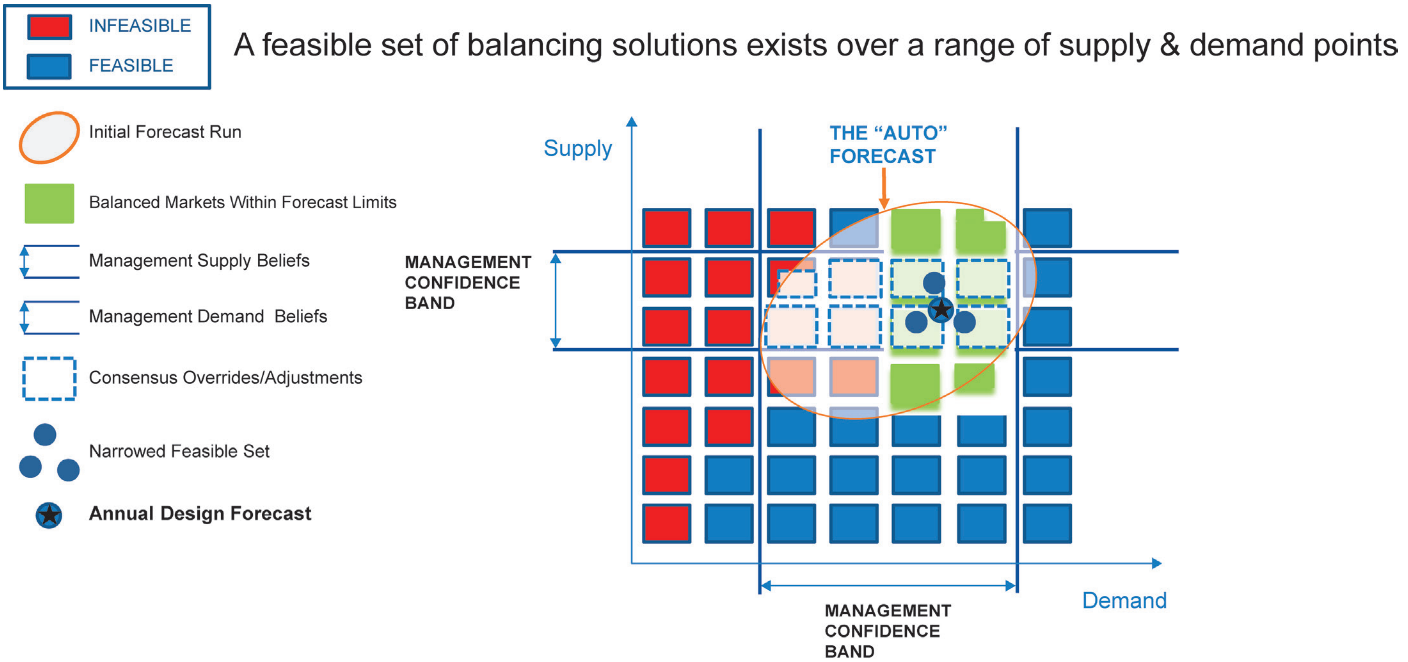


Figure. 2: The seven-factor planning method generates a more focused system design forecast.

# Applying the Framework in Real-World Business Contexts

Once company management has determined the range of forecast outcomes it deems most feasible, those results can be substantially refined and streamlined through the use of advanced analytics. This is a complex but vital endeavor. While a number of balancing solutions may exist over a range of supply and demand points, some combinations will prove to be infeasible due to economic or physical capacity limitations.

As Figure 2 shows, the initial forecasting run generates a set of feasible balancing points based on constrained mathematical optimization, as indicated by the green boxes in the diagram. The feasible set of solutions can be narrowed down based on management's confidence level, which may comprise subjective insights, contractual obligations or other known factors. When a consensus is reached on which of the potential solutions are most feasible, further analysis of this narrower group generates a highly focused system design forecast.

This process is distilled into the seven-factor planning method, which guides forecasters through a specific methodology to refine their projections:

1. A range of supply is possible from an industry capability perspective.
2. A range of demand is possible from a consumption standpoint.
3. Forecasting of supply and demand creates a boundary with statistical confidence around probable supply and demand combinations.
4. Feasible balanced supply and demand scenarios are discovered within the forecast bounds.
5. Management has consensus beliefs about supply that may override forecasts, which further bound the problem.
6. Management has consensus beliefs about demand that may override forecasts, which further bound the problem.
7. A narrowed feasible set of supply-demand combinations is selected on a basis of financial attractiveness that creates a robust target to drive capital plans. This is the system design forecast.

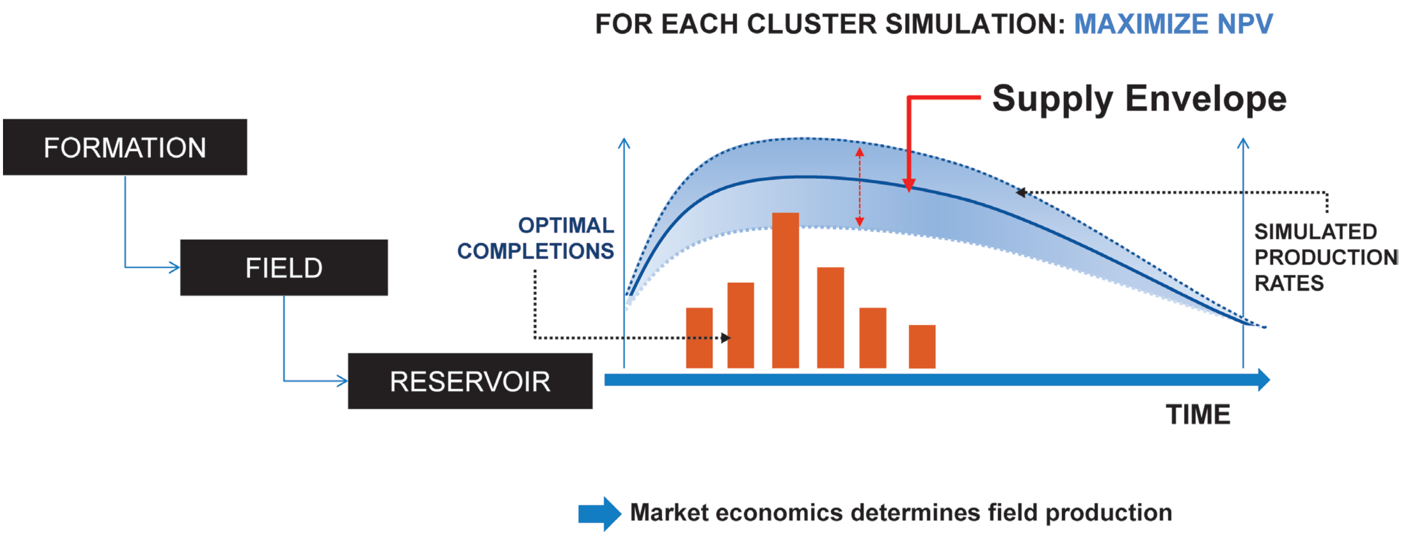


Figure 3: A simulation by cluster to forecast new wells by basin.

But to successfully implement this data-driven decision support process, companies must have an analytics platform that supports an integrated data management and analytics approach to pipeline optimization. When this is in place, it can be used to:

- Surface new production trends from existing and new supply basins.
- Generate robust probabilistic type curves for supply forecasting.
- Provide "what-if" simulations for agile strategies and tactics.
- Gauge demand-side forecasts that integrate economic data.
- Reduce decision-making cycles, as processes are optimized and become more reactive to the economic climate, maximizing operational expenditures.

Achieving this more focused system design forecast requires a forecasting solution that can automatically integrate supply forecasting, demand forecasting and balancing. Some of the critical elements needed in each of these three integral areas are detailed below.

## Supply Forecasting: How Much, Where and When?

Supply forecasting for existing wells must provide automated, large-scale decline forecasting for thousands of wells. The library of models used for supply forecasting must be easily extensible so that newer models can be incorporated seamlessly.

New supply, or new wells that have yet to be drilled, must be quantified to understand how much production is planned and when it will be available. In the "shalenomics" environment, this is essential for accurate forecasting.

Supply forecasting accuracy can be improved by applying advanced data analytics to a complex and large-scale set of factors such as multiple basins, technologies, varying break-even economics and varying decline rates. Distilling this complexity using analytics generates genuine insights that provide a better foundation for business planning than reliance on estimates and assumptions.

> Integrating the analysis of supply forecasting, demand forecasting and balancing generates a robust system design forecast.

As shown in Figure 3, simulating by statistical cluster allows the use of traditional financial economics such as net present value (NPV) based on clusters at the reservoir, field and formation level. The optimal number of completions through time is based on economic theory. The clustering allows an objective method of applying appropriate decline models to future wells. The aggregated supply envelope, shown as a strong blue line within the range of simulated production rates, indicates the total production expected through time, given the number of new wells and their respective decline rates, down to the reservoir level or as high as the formation level. This ability to forecast based on economic criteria provides clear insight into which wells are financially feasible.

## Demand Forecasting: How Much, Where and When?

When and where will demand be realized? This difficult question is another large-scale problem that requires process automation and the ability to quickly and easily build thousands of forecasts that take into account vast economic variables, as well as a multitude of other factors. This is also a hierarchal problem, meaning that a single forecasting framework must be able to capture a business plan's hierarchy of markets, geographies and facilities down to the meter level.

Each member of the hierarchy will have its own forecast, as shown in Figure 4. The lower chart indicates the formation of a hierarchy as determined by the user – in this case individual shipper (producer) forecasts are aggregated up to the feeder (midstream or gathering system company) level, commodity level and finally at the pipeline (main line operator) level. The top chart, indicating the shape of fitted forecasts (blue line) and actual values (circles), shows a three-year historical view and a 12-month forecast within the shaded 95 percent confidence interval envelope.

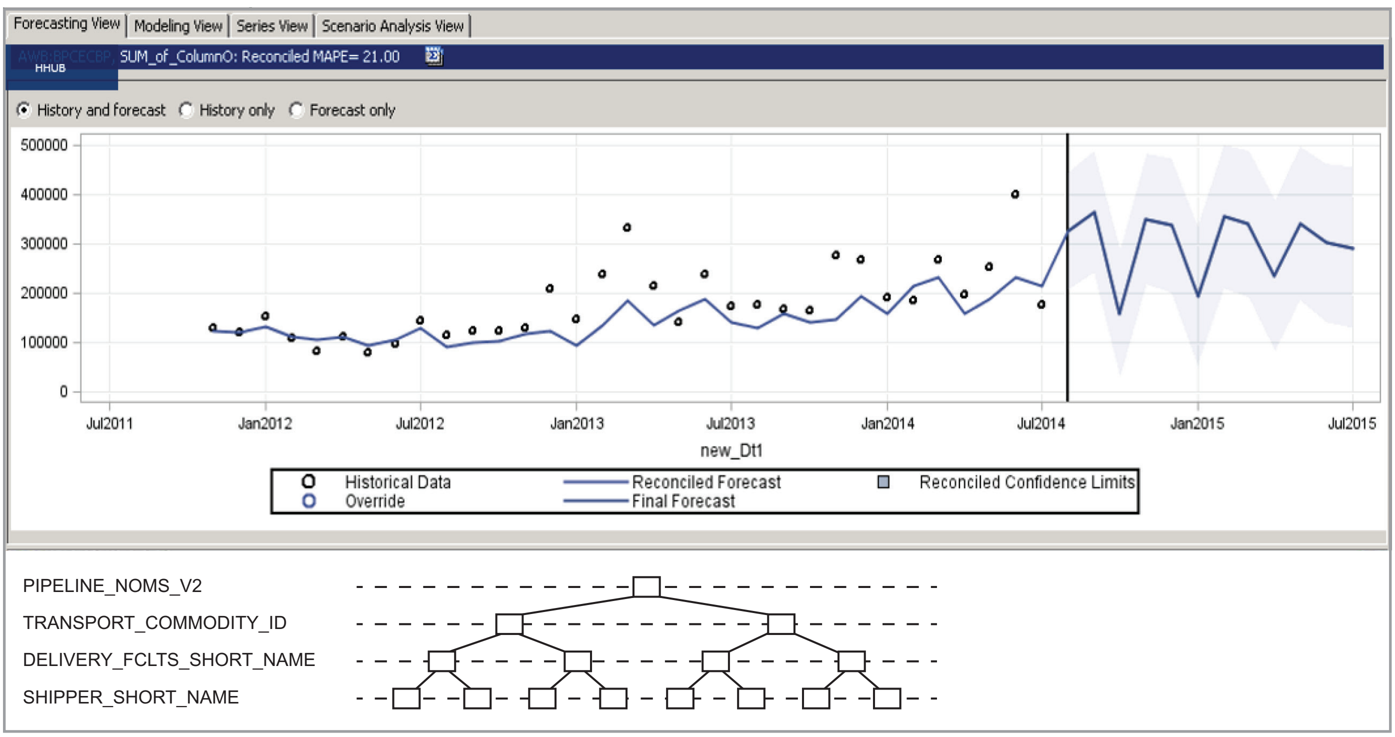


Figure 4: Hierarchal forecasting of delivery volumes.

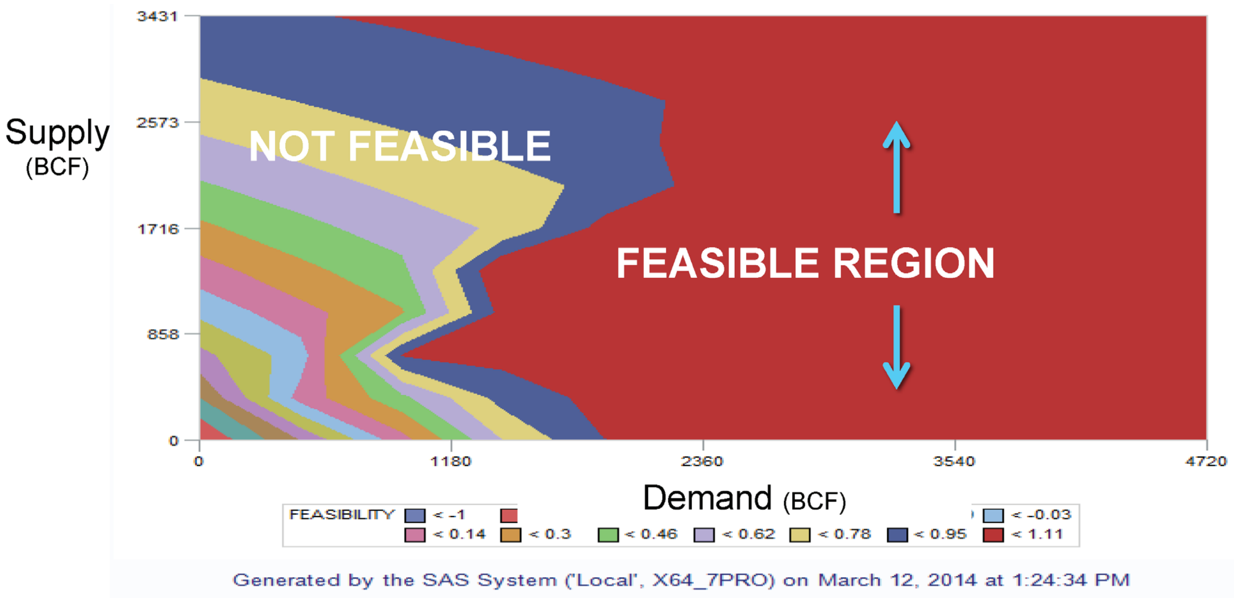


Figure 5: An optimized physical balancing simulation.

## Balancing: Which Infrastructure Scenario Maximizes Capital Use?

Matching supply and demand would be an arduous task without a forecasting solution that can generate multiple plausible scenarios with a high degree of statistical certainty. These complex scenarios must be tested against a balancing model that can yield an understanding of feasible and infeasible scenario evolution. The massive scale of the computation involved demands the use of an automated balancing solution.

Varying supply and demand requirements create a plethora of capacity requirements, but algorithm-based balancing planning can easily handle this complexity. The result is a clear understanding of the most robust infrastructure, which enables decision makers to develop optimum capital spending plans. For example, Figure 5 illustrates that approximately one-third of supply and demand scenarios are not feasible, allowing decision makers to disregard these and focus business planning only on feasible scenarios.

# Conclusion

The reality in today's energy industry is that large, established corporations have grown through acquisition in the increasingly competitive pipeline market, resulting in business silos – and silos of data – within an organization. These silos add new, unwelcome challenges to the already complex task of generating accurate forecasts in an environment of uncertainty. But as the industry adopts advanced analytics and high-performance computing technology, companies have an opportunity to create a powerful technology platform that can smoothly integrate siloed data and apply advanced analytics to achieve accelerated forecast generation. These forecasts provide decision makers with a higher level of confidence in capital planning and infrastructure development decisions.

*To learn more about how SAS can help streamline and improve the system design forecasting process, visit [sas.com/en_us/industry/oil-gas.html](sas.com/en_us/industry/oil-gas.html).*

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