

Using Prescriptive Analytics to Optimize Your Energy Supply Chain

How to decide “what’s best” with integrated business planning and analytics



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Executive summary

Developments such as the Paris Agreement on climate change, increasing electric vehicle use, globalization of natural gas and emergence of renewables are introducing new market dynamics. All of these factors need to be considered for energy trading operations in order to optimize supply chains and manage risk.

Increasingly, energy companies are using prescriptive analytics to integrate the planning of all supply chain components. The results of each option can be viewed all the way to various financial statements, to ensure that the optimization of all business functions in the supply chain have a positive impact on financial reporting. All constraints across the supply chain can be incorporated into the prescriptive analysis.

Prescriptive analytics also can be incorporated into integrated business planning (IBP) to make better decisions, faster and with superior execution from production to finance. IBP reconciles and harmonizes strategy and execution by aligning strategic plans into operational plans and bringing the practical aspects of execution into the creation of strategic plans.

This paper discusses how IBP powered by prescriptive analytics can help trading operations maximize the value of the entire supply chain.

Introduction: Decarbonizing the global energy supply chain

In seeking to reduce the risks of climate change, The Paris Agreement aims to limit global temperature increase to well below 2°C while pursuing efforts to limit the increase to 1.5°C.¹ Companies across a wide range of sectors are required to decarbonize their supply chains over the next 30 years, but this will be more challenging for those involved in the energy value chain. Supply chain carbon emissions increasingly will be regulated and numerous policy developments are underway.

The link between carbon emissions and energy cost is a key driver for decarbonization. Within transportation and logistics supply chains, for example, there are many initiatives to reduce costs by decreasing fossil fuel usage. Reduced fossil fuel consumption decreases exposure to volatility in the cost base in an operating environment that has seen, and will continue to see, significant price volatility.

The energy sector is working to reduce its carbon intensity in a number of ways, from increasing the share of low-carbon energy sources, such as renewables and nuclear, to capping greenhouse gas emissions from fossil fuel power stations.

Companies able to develop innovative, flexible energy solutions that successfully forecast the right mix of supply, demand, trading and hedging strategies will have an advantage in providing economically feasible products that meet emission criteria.



¹http://unfccc.int/paris_agreement/items/9485.php

KEY DRIVERS OF CHANGE

The evolving natural gas value chain

Natural gas is rapidly transitioning to the primary source of power generation. It is also becoming a global commodity, with the aggressive expansion of liquefied natural gas (LNG). LNG has made natural gas a clean burning form of exportable electricity.

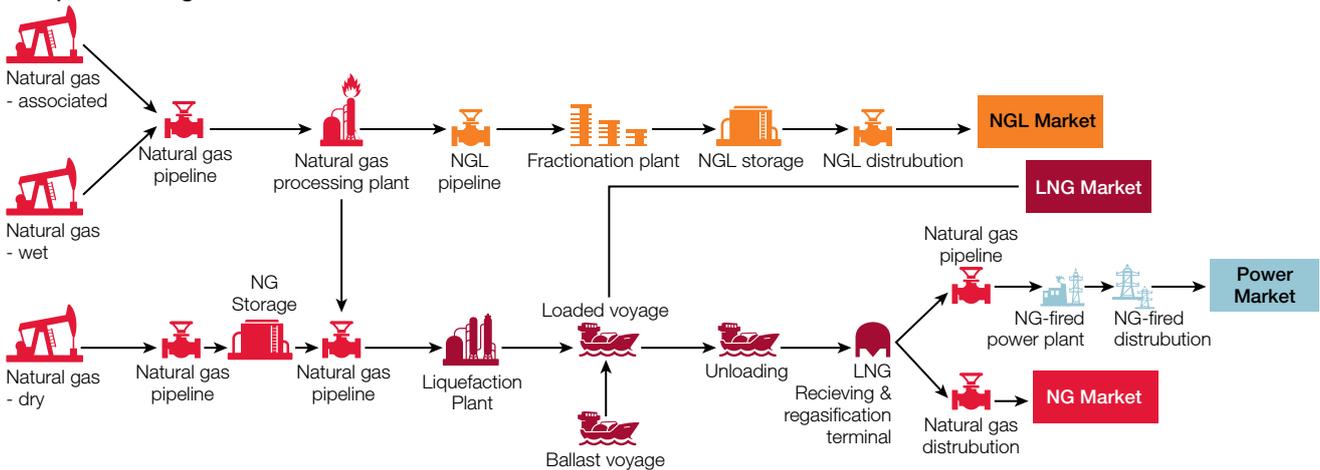
Global gas markets have become more integrated as a result of expanded LNG trade, increased market-

today's regulatory environment, but energy companies need to think about where policy and regulation will likely move in the future. An energy company that remains dependent on hydrocarbons may find itself starved of capital, customers and regulatory support.³

Changing reporting requirements

Global energy markets are undergoing a structural shift toward less polluting and low-carbon energy sources; and energy companies must learn to succeed in an increasingly carbon-constrained economy. In fact,

Sample natural gas value chain



related pricing, and the development of gas hubs. It is expected that global gas prices will converge due to increasing arbitrage possibilities and further market integration.²

Impact of future regulation and pricing

It is in the best interest of all participants in the global energy market to consistently evaluate their carbon footprint and emissions output. As governments encourage moves from high-carbon footprints toward renewables, energy companies able to decarbonize their supply chain will benefit most from future regulations. Investing in a gas plant or pipeline might make sense in

they may be required to report their reserves in British Thermal Units (BTUs), an internationally recognized, source-neutral metric of energy, in addition to the current carbon-based barrels of oil equivalent and cubic feet of gas. Reporting in BTUs will provide shareholders and markets with comparable and assessable information about a company's full range of energy assets, including resources other than oil and gas.

Currently, oil and gas companies are valued on whether carbon-based oil and gas reserves are replaced annually. If 100% reserve replacement is not fully achieved each year, their stock market value may be impaired. Under this traditional reporting and reserve

²Christopher Hopkinson, first deputy chairman of KazMunayGas, Kazakhstan's state-owned oil and gas company, has stated a high-oil-price environment could easily be a double-edged sword: "A few years ago we were making a lot of money. It was good for [Kazakhstan] and there was really no incentive to move away [from oil]. And now we're in a situation where the CAPEX [capital expenditure] required to move away from the dependency on oil and gas is very difficult to find."

³The economic theory of Law of One Price states that, in a perfect market, potential arbitrage opportunities between countries are immediately exploited by market participants, leading to convergence to a single price.

valuation system, companies are incentivized to prioritize investments in oil and gas resources and disincentivized to pursue renewable energy resources.

Once efficient and affordable energy storage is a reality, demand for natural gas is likely to drop. There will be an immediate decrease in carbon dioxide emissions as systems powered by fossil fuels are replaced, an increase in the economic value of wind and solar usage, new income sources for rural landowners and commercial and residential buildings that generate wind and solar power.

Coal mining and gas drilling are being surpassed by innovation: the disruptive effect of natural gas fracking has made that fuel more economically attractive and, now, renewables are becoming more attractive than natural gas.

Giant shifts are getting ready to disrupt the energy market from now through 2030. Some may be “closer than they appear in the mirror.”

Driving issues for energy trading operations include:

- Which shifts will become realities?
- When will these shifts become realities?
- What will be their impact to the market?
- How can we position ourselves to take advantage of the new realities?

Renewables have overtaken coal as the largest source of power generation capacity and are the second largest source of electricity supply. Renewables are forecast to provide nearly 60% of power capacity additions and become the largest source of electricity supply before 2030.

Power marketing and trading operations will need to calculate the outcomes of the following scenarios to optimize the value of their assets:

- How to integrate variable and dispatchable renewables
- How to manage centralized and distributed generation
- How to manage increasingly flexible demand
- What are the effects of power markets when storage makes renewables dispatchable

Energy trading operations will need to develop advanced decision-making agility. This will help analysts determine the best course of action in the face of unprecedented amounts of data, constraints and objectives.

Finding the winning solutions

Addressing the challenges of today's energy environment is very difficult. Oil and gas executives participating in the CGI Client Global Insights⁵ indicated that responding to revenue pressures was their top trend, but that investment capital for modernization and innovation is scarce. More than half (81%) are looking to optimize operations to increase efficiency and agility, and 58% are looking to harness the power of data analytics to increase business value.

They are looking for answers beyond “what has happened and how,” and even “what will happen,” to understand “what is the best path forward and why.” Due to the many variables, constraints and objectives involved in making decisions about managing energy supply chains, 46% of these companies are seeking tools that help them calculate real-time answers to “what is best.”

The winners will be those who can answer what's best to navigate emerging trends such as the transition to a low-hydrocarbon footprint and providing low-carbon energy solutions that make economic sense. With so many moving pieces in the energy world, it is very difficult to determine the correct way forward. However, this can be achieved by setting corporate objectives in energy supply chain expected margins, costs and growth.

Trading operations play a very large role in an energy company's ability to manage the entire supply chain from a physical, financial and regulatory perspective. Therefore, it is very important to have the correct tools and methodologies to know what happened yesterday and what might happen tomorrow. Trading operations also need the ability to invest large quantities of variables and determine the best decisions to maximize the value of the entire supply chain. Currently, trading operations tend to isolate the optimization of each energy asset due to a lack of user-friendly tools. This forces analysts to rely heavily on spreadsheets for optimization calculations.

Navigating the energy transition with supply chain optimization

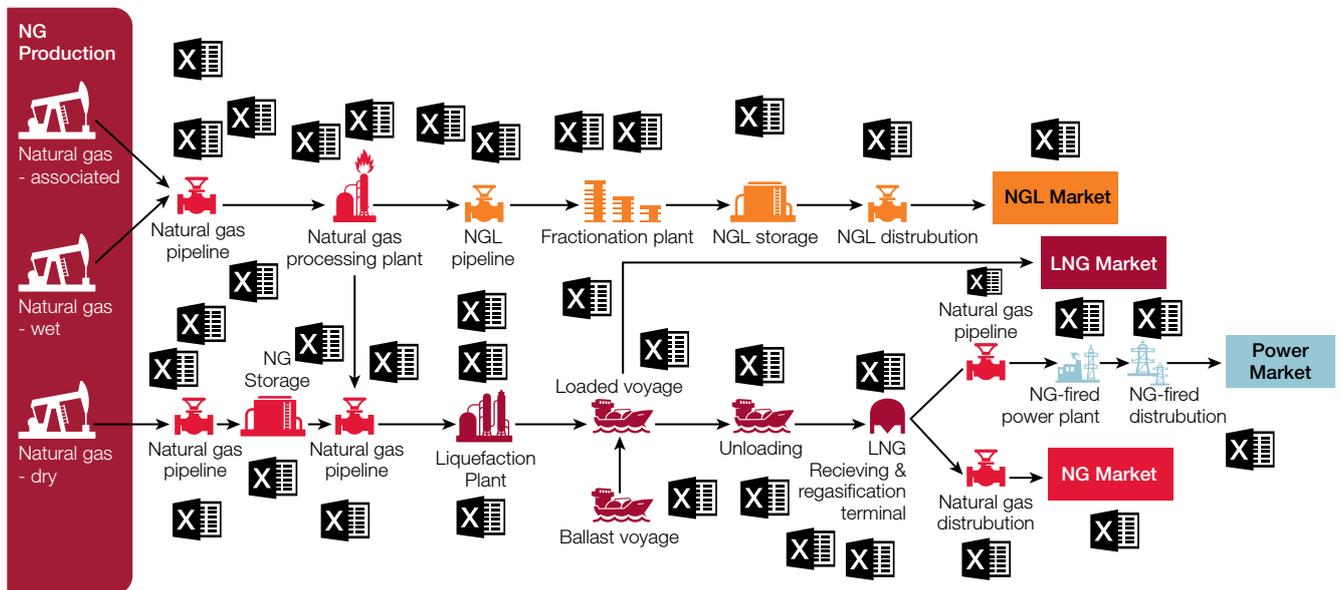
Getting it right has never been more critical. Any energy value chain transformation requires a top-notch trading operation that can determine the most economically profitable activities while minimizing credit, price and regulatory risks. Trading analysts and originators need to start developing new models. These must be able to take into account all data, current contracts, constraints and company objectives and then determine the best way to manage the entire energy supply chain through global shifts in supply, demand, technology and regulations. The output of these models will help trading operations make crucial decisions involving hedging strategies, storage management, allocating inventory, transportation routes, product optionality and blending decisions.

A company's primary profit-making goal can be forgotten as a result of siloed operations. Each part of the business has its own metrics and, all too often, will narrowly pursue them to the detriment of the company. For example:

- The supply chain unit strives for increasing demand forecast accuracy or reducing lead-times.
- The storage and processing group aims to maximize its capacity utilization.
- The procurement team wants to reduce the cost of raw materials.

Optimization is often done by spreadsheet and focuses on solving a simple set of decision variables within a single functional silo. None of the models are integrated, despite the fact that these critical planning decisions are most certainly inter-related in the real world. With enough practice, an Excel expert can get one optimization model to work. However, maintaining this model over time with so many changing variables becomes too onerous and costly. Any high-level optimization requires a compilation of output from various spreadsheets and applications across the enterprise.

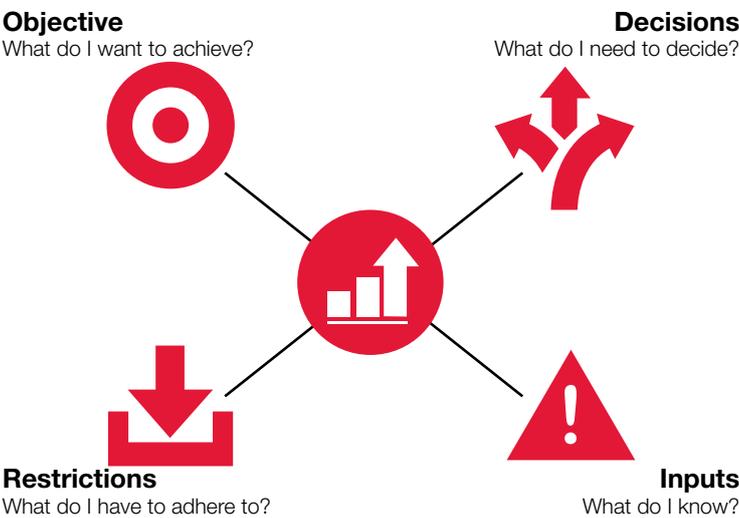
Example of how the natural gas value chain is optimized today



Prescriptive analytics and energy supply chain optimization

While predictive analytics tells the multiple likely outcomes of what might happen in the future, prescriptive analytics takes it a step further by analyzing the impacts of each of those likely outcomes, then identifying the best possible outcome, thus prescribing the decision.

Finding the best combinations possible



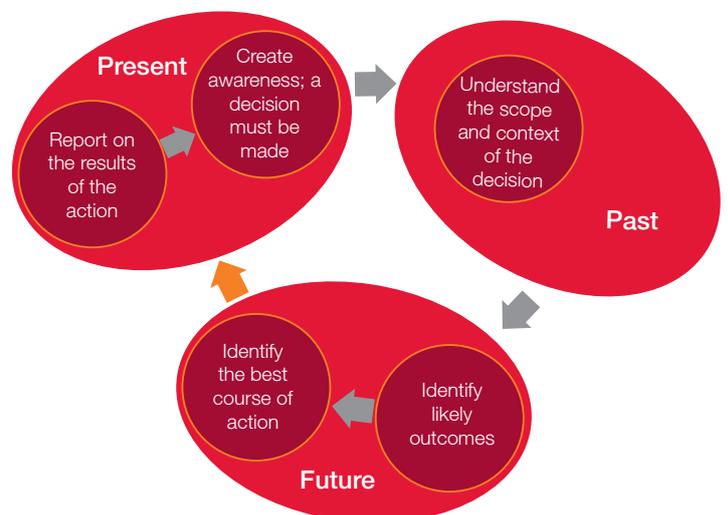
Prescriptive analytics solves the basic problem of finding the best solution based on a set objective against a background of many variables and constraints. The trading operation trying to determine the best way to produce, hedge, store, transport, process and sell a commodity within contractual, regulatory and risk restrictions requires methodologies and tools for optimization.

These tools make it possible to capture the financial objectives and develop a model that calculates the overall optimal scenario. The end result: maximum profit for the entire supply chain.

Prescriptive analytics uses metaheuristic optimization solver algorithms to minimize or maximize an objective (e.g., refine margins, increase revenue 5%, etc.), while meeting global business constraints (e.g., contractual, credit, risk and regulatory). Prescriptive analytics is not statistical modeling: it is deterministic. The purpose is to quantify trade-offs and understand the impact of various positions before action is taken. Trading business leaders can discover significant value by applying optimization to these scenarios.

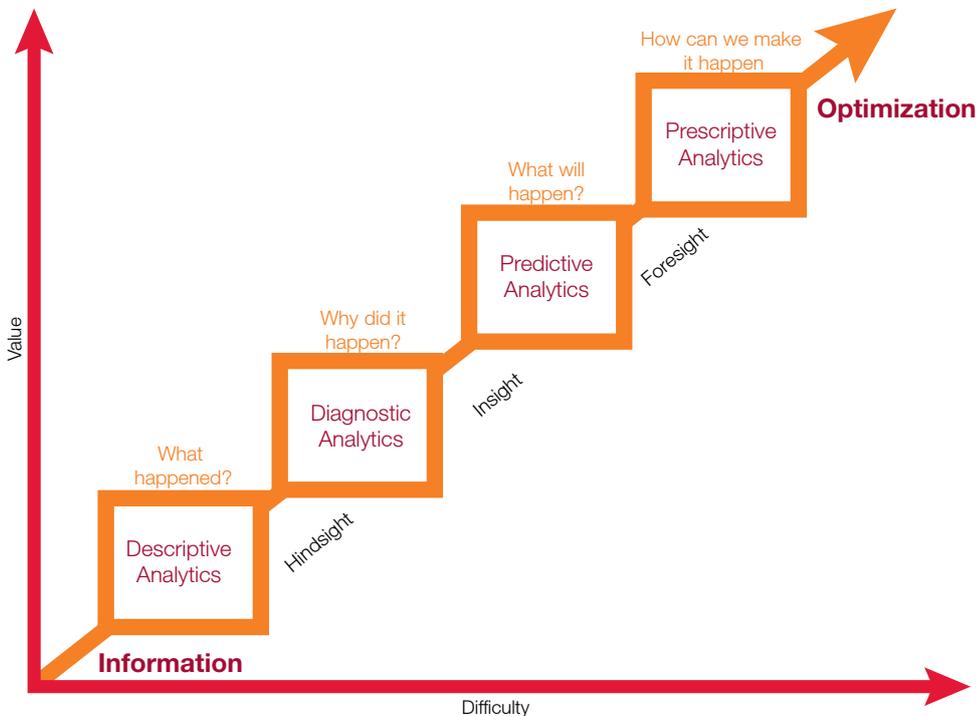
Prescriptive analytics synthesizes big data, multiple disciplines of mathematical and computational sciences, and business rules, to make predictions and then suggest decision options to take advantage of the predictions. The algorithms transform the trading and supply chain management function with transformative characteristics which lead to significant performance improvements:

- Providing forward-looking insights aligning the enterprise to the optimal course of action
- Quantifying trade-offs rapidly and with a low cost of ownership
- Increasing the ability to communicate and collaborate across functions



Most businesses can be broken down into a complex set of nonlinear relationships with constraints across demand, supply and financials. Senior management must gain clarity and determine which actions are to be taken at all levels. They must:

- Determine where to allocate capital
- Decide which trading strategies to execute
- Establish policies across the business
- Create operational schedules



These actions all have the same purpose: to maximize the company’s primary objective. Companies gain tremendous value when applying prescriptive analytics to make better decisions.

- Users gain accuracy by modeling business processes and constraints in greater detail
- Decisions improve as the software will deal with complexity to find a better answer and support what-if analyses.
- The business gains agility by spending time analyzing only the best scenarios and through deeper organizational learning.

These themes — accuracy by modeling, software to handle business complexities and business gains by analyzing best scenarios — are central to an organization’s finance function. Other departments often look to the trading function for its expertise in these areas.

Prescriptive analytics can suggest decision options to take advantage of a future opportunity or mitigate a future risk. In practice, it can continually and automatically process new data to improve prediction accuracy and provide better decision options. Data inputs may come from multiple internal and external sources. Data may be structured (including numerical and categorical data) as well as unstructured (such as text, images, audio and video, including big data).

Business rules define the business process and include constraints, preferences, policies, best practices and boundaries. Mathematical models are derived from mathematical sciences and related disciplines including applied statistics, machine learning, operations research, and natural language processing.

Prescriptive analytics in the energy market

Energy prices fluctuate dramatically depending on supply, demand, geo-politics and weather conditions. Producers have a keen interest in more accurately predicting prices so that they can lock in favorable terms while hedging downside risk. Prescriptive analytics can accurately predict prices by modeling internal and external variables simultaneously. It can also provide decision options and show the impact of each decision option.

Energy supply chain strategic planning can benefit from using prescriptive analytics to leverage operational and supply and consumption data, combined with data of external factors such as market prices, supply and demand, congestion, weather, exchange rates and volatility.

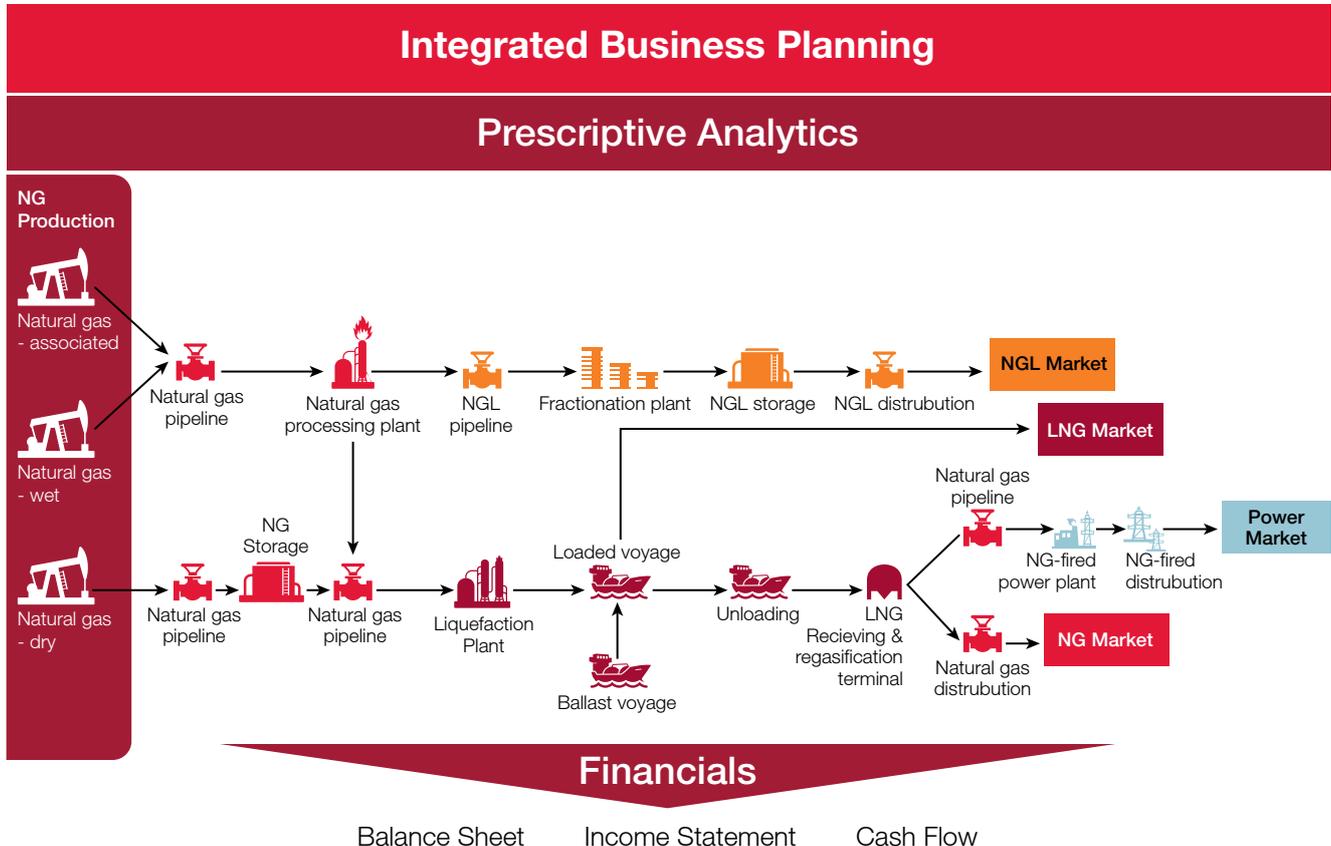


Integrating prescriptive analytics and business planning

Prescriptive analytics can be incorporated into integrated business planning (IBP) to make better decisions, faster and with superior execution from production to finance. IBP reconciles and harmonizes strategy and execution by aligning strategic plans into operational plans and bringing the practical aspects of execution into the creation of strategic plans (e.g., constraints, capacity available, realistic throughput rates achieved, detailed unit cost and profitability).

The outcome of IBP is a true business plan, rather than a demand plan, supply plan, production plan or a financial budget. Through IBP, enterprises gain a single holistic plan that unifies the business, seamlessly connecting corporate performance management, financial planning processes and operational planning systems. This holistic plan increases business alignment through the sharing of performance strategies and helps quantify business risk so enterprises can rapidly adapt to meet challenges.

Using prescriptive analytics enables energy companies to integrate the planning of all supply chain components. The results of each option can be viewed all the way to various financial statements, to ensure that the optimization of all business functions in the supply chain have a positive impact on financial reporting. All constraints across the supply chain can be incorporated into the prescriptive analysis (e.g., credit exposure, position limits, capacity, Value at Risk (VaR) limits, regulatory compliance, etc.).

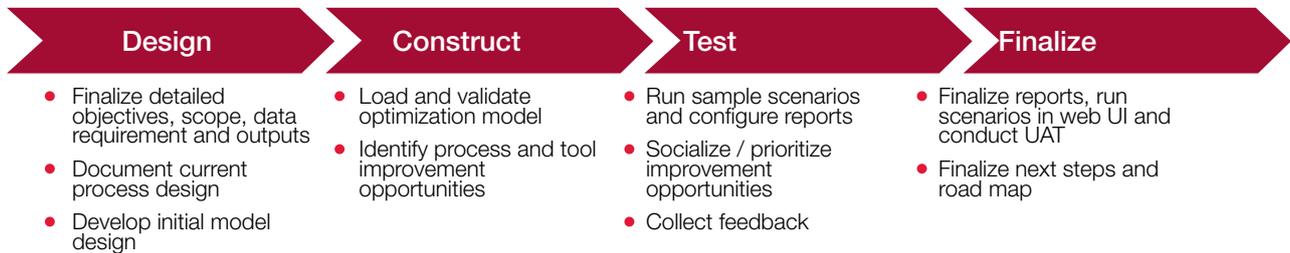


How CGI can help

Putting prescriptive analytics to the test: achieving rapid results

CGI's energy supply chain optimization experts offer a proven methodology for helping clients understand the benefits and capabilities of prescriptive analytics and IBP. By engaging in a short proof of concept (POC), clients can see the value of prescriptive analytics for themselves and understand how it can help them improve revenue and optimize their operations.

CGI's Energy Supply Chain Optimization POC Methodology



Deliverable	Description
Optimization Model	A working, validated model capable of supporting what-if optimization analyses
User Interface	A web-based user interface for running scenarios, managing data and viewing output
Model I/O Diagram	A input/output diagram of the model data flow for executing trading optimization within current trading processes (eventually to include a full planning workflow)
User Training	Conduct initial training of the end-user (eventually to include training documentation)

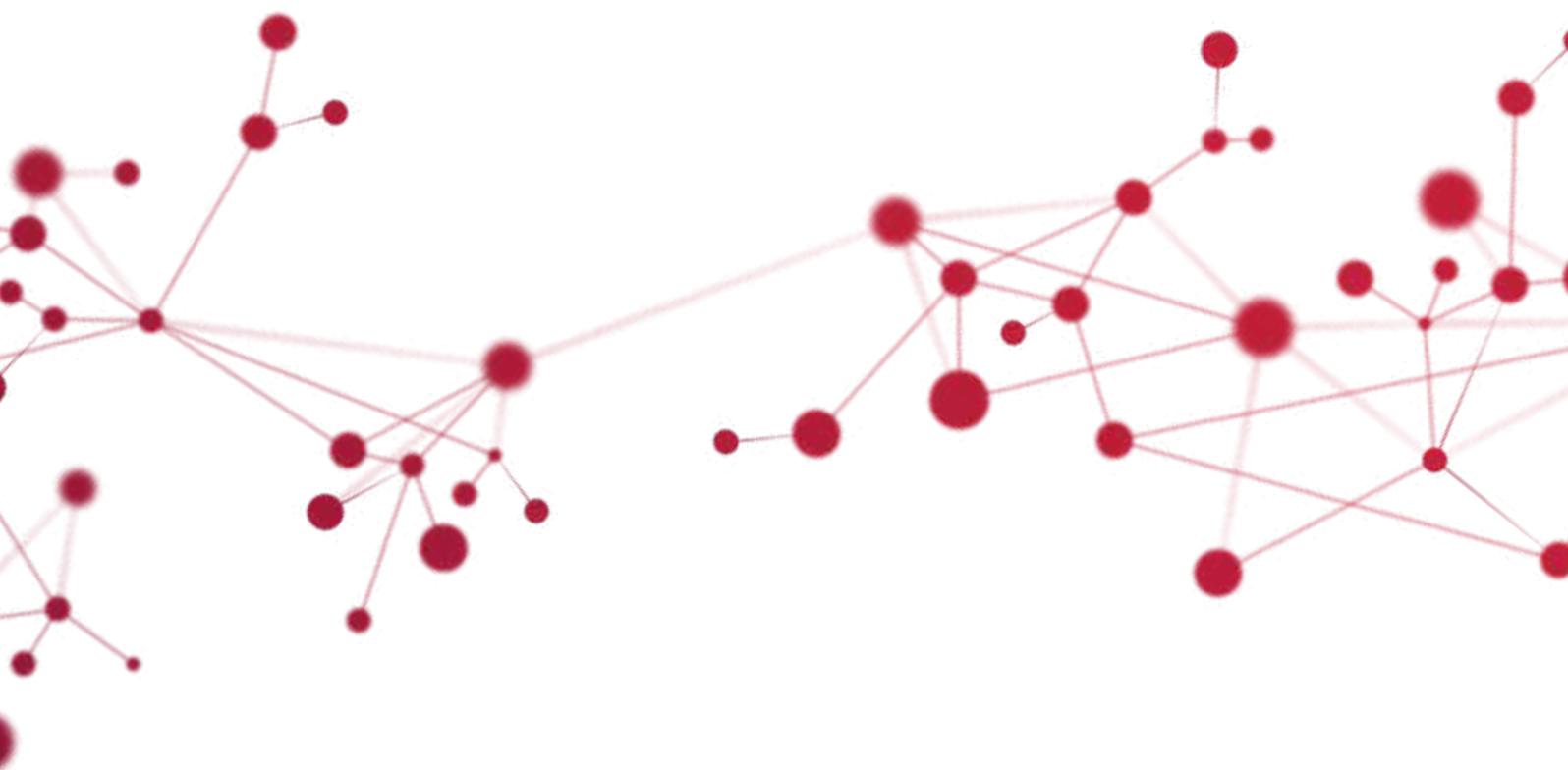


At a time of dramatic transformation, energy companies need powerful insights to guide their strategies and achieve business value. Business analysts across the trading operation need to create optimization models that reflect real-world complexity and deliver measurable value in weeks, instead of months or years, as with older-generation programming languages. Analysts require optimization tools that offer a drag and drop interface so they can rely on embedded knowledge and never need to write code to define equations.

CGI Energy Supply Chain Optimization is an innovative modeling and prescriptive analytics solution that enables data-driven insights for managing and forecasting resources, increasing efficiency and improving supply chain management decisions.

Today, trading analysts need to consume unprecedented amounts volume of data and different scenarios. The only way to arrive at the correct solution is by accurately framing the actual optimization problem(s).

CGI works with clients to model the complexity of the power and natural gas markets and run the scenarios on a daily basis for validation against past, current and future data. Clients can now develop approximations based on simple models unhindered by technology constraints.





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About CGI

Founded in 1976, CGI is one of the largest IT and business consulting services firms in the world. Operating in hundreds of locations across the globe, CGI professionals help clients to achieve their goals, including becoming customer-centric digital organizations. We deliver an end-to-end portfolio of capabilities, from high-end IT and business consulting to systems integration, outsourcing services and intellectual property solutions that help accelerate clients' results. CGI works with clients around the world through a unique client proximity model complemented by a global delivery center of excellence network to help clients accelerate results, transform their organizations and drive competitive advantage.

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