

The Intelligent Generation Plant: Using Low-Cost Optimization Analytics to Manage the Carbon Footprint

WHITE PAPER

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IN THIS WHITE PAPER

High energy prices, aging assets and an aging workforce, and reliability and the carbon footprint are driving energy companies to further develop strategies for increasing margins and reducing costs. This white paper examines the challenges faced by generators and the technologies being used to address those challenges, and it provides a landscape of vendors with offerings in the space. Key findings are:

- The trend is toward more stringent regulation of greenhouse gases.
- Environmental concerns are driving investment in controls.
- Presentation of data is not enough to gain efficiencies; analytics are required.
- Analytics, especially optimization technologies, have proven to be a low-cost approach to achieving greater plant efficiency.

With greater efficiency come reduced fuel and other operating costs, as well as reduced emissions. With most environmental regulations now focused on annual tons as opposed to emissions rates, every incremental efficiency improvement also improves a generator's position in cap and trade markets.

When compared with the cost of installing pollution control devices, analytics are orders of magnitude less expensive. This is not to say that analytics can substitute for investment in emissions control instrumentation and new, cleaner power plant technologies. However, analytics can help a company prioritize and in some cases reduce such capital investments.

SITUATION OVERVIEW

High energy prices, aging assets and an aging workforce, and reliability and the carbon footprint are driving energy companies to further develop strategies for increasing margins and reducing costs. Power generators have always been focused on operational efficiency. However, challenges have intensified since 2005. Power generators must now weigh the cost and availability of feedstock versus the magnitude of emissions versus the market price when making both long-term portfolio planning decisions and day-to-day operational decisions. The use of analytic applications, especially optimization analytics, is becoming an increasingly attractive way for generators to have optionality — the ability to manage these trade-offs.

Business Environment

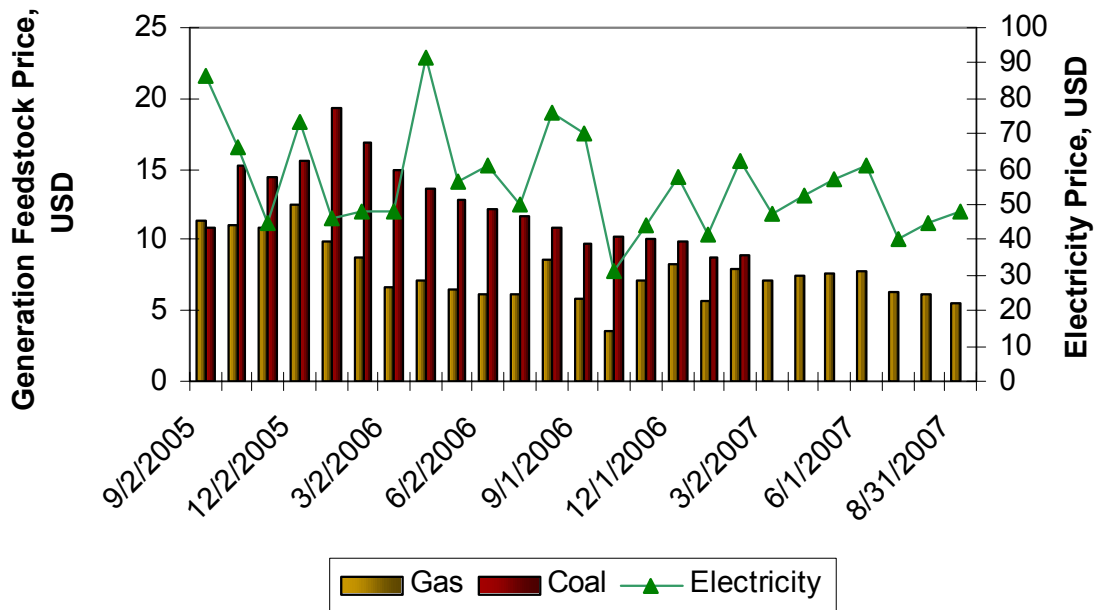
Feedstock Prices Will Remain High and Volatile

Power generators have always had to consider the cost of fuel as part of the cost of operations. Depending on the type of generation, fuel costs have had greater impact on the total cost of operations. For example, the cost of fuel for gas-, oil-, and coal-fired generation makes up the largest percentage of the cost of operations and maintenance, unlike nuclear or hydro.

Although natural gas and oil prices have varied considerably since their first initial big upswing in the fall of 2005 and have since dropped somewhat, it is unlikely that there will be a return to the lower prices of 10 years ago, especially now that emerging economies are growing and competing for energy resources (see Figure 1). Coal has also recently seen increases in price, especially in the Appalachian and Uinta Basins, as well as increased futures prices, due to high demand from emerging economies.

FIGURE 1

High Price of Generation Feedstock



Note: Electricity price is ISO wholesale price average, gas price is spot median at Henry Hub, and coal is short ton.

Source: Energy Insights, 2008

The Trend Is Toward More Stringent Regulation of Greenhouse Gases

Attention has recently been riveted on the prospect of global climate change and the pressure to reduce the emissions of greenhouse gases (GHG) such as carbon dioxide (CO₂), methane, and nitrogen oxides (NO_x). According to the Department of Energy's Energy Information Administration report *Emissions of Greenhouse Gases in the United States 2005*, utilities made up 40% of the energy-related carbon dioxide emissions in 2005, compared with 33% for transportation, and is the largest industry segment when it comes to CO₂ emissions.

Laws regulating emissions are not new to the energy industry. Going back as far as the Energy Policy Act of 1992, the federal government has required utilities to report GHG emissions. Most states have some laws on the books to regulate emissions such as mercury, nitrogen oxides, and sulfur dioxide, while only 14 states have currently set GHG targets.

However, many more states are covered by regional initiatives to reduce GHG. With the expected announcement of the Midwest Accord, combined with the Regional Greenhouse Gas Initiative (RGGI) and

the Western Climate Initiative (WCI), more than 30 states and several Canadian provinces are or will soon be operating in binding CO₂ cap and trade allowance markets.

Basically, a cap and trade market allows market participants to buy or sell emissions credits, based on whether they are long or short on emissions. The European Union Emissions Trading Scheme (EU ETS) is the largest existing mandatory market. The EU ETS experience is that the price per ton of carbon could range from as low as \$5 per ton to as high as \$40 per ton of carbon dioxide equivalent depending on how credits are allocated. In early 2008, the EU ETS price of carbon was about \$30. Assuming average heat content of 10,000Btu/lb (Powder River Basin is 8,000–9,000, bituminous is 11,000–13,000) and a heat rate of 10,000Btu/kWh, it would take a half ton of coal to produce 1MWh of electricity. On average, 1MWh of electricity produced by coal-fired generation produces one ton of carbon. Assuming the price of emissions is \$30 and the cost of coal to produce 1MWh (half ton of coal) is \$15, the price of emissions would be twice the price of coal.

Business Drivers for Investment

The Cost of Fuel Impacts Financial Performance

An example of the adverse impact of high fuel prices on financial performance is the Tennessee Valley Authority (TVA). TVA recently reported that despite production records and an increase in revenue of \$261 million over 2004 to reach \$7.8 billion for 2005, net income was only \$85 million, compared with \$386 million in 2004. The company cited increases in the costs of coal, natural gas, and purchased power.

Oftentimes regulated companies with base load generation can get rate recovery to handle increases in fuel costs. Many states in the United States have fuel clause escalators. Where these escalators are not in force, electric utilities have requested rate relief to handle increased fuel costs. In the example of TVA, regulators are considering how to handle the increased expenses. However, competitive generation does not have the luxury of fuel pass-throughs, especially for long-term contracts.

This applies not only to independent power producers but also, in many cases, to investor-owned utilities operating in organized locational marginal price (LMP) markets. Even for regulated utilities, efficiency increases go directly to the bottom line during the time between fuel price increases and when regulatory relief is sought and granted, generally months and sometimes even years.

Environmental Concerns Are Driving Investment in Controls

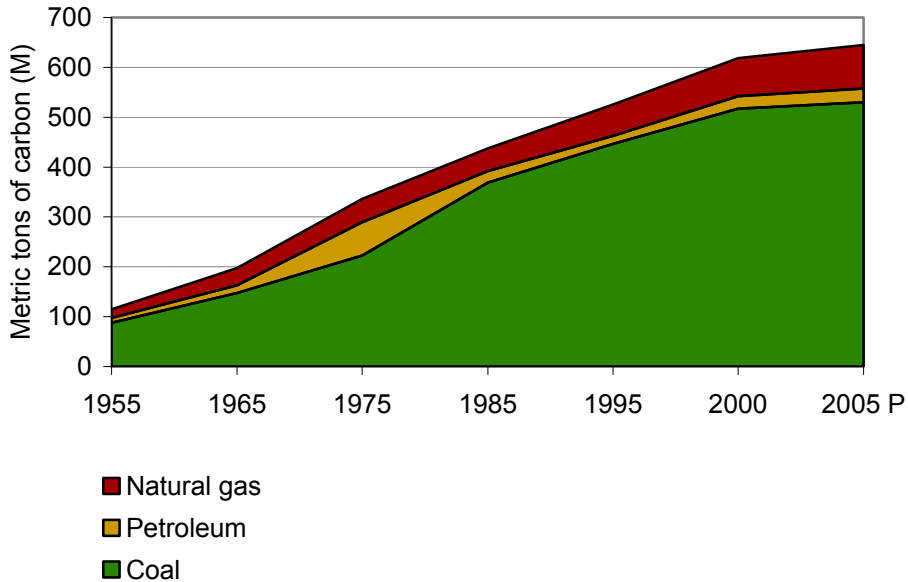
Generation companies are responding to environmental concerns and emission standards in several ways: by exploring development of clean technologies for future power plant development, by investing in emission controls, and by trading emission certificates. Although clean technologies and emission trading are promising, the immediate challenge is with existing generation.

To address environmental concerns and regulations, generation companies are making significant investments in emissions control. For example, Southern Company plans to invest more than \$6 billion over 10 years in pollution control equipment. The investment is expected to reduce sulfur dioxide, nitrogen oxides, and mercury emissions by 70% from today's levels.

Coal-fired generation currently accounts for 49.7% of generation in the United States, and it produces considerably more emissions than other fuel sources (see Figure 2). Environmental compliance project spending for U.S. coal-fired power plants is expected to exceed \$15 billion in 2007, according to Industrial Info Resources. This includes \$3.7 billion for NO_x reduction, over \$8 billion in desulphurization scrubbers, and \$3 billion for bag houses, electrostatic precipitators, and activated carbon injection systems.

FIGURE 2

Total Energy-Related Carbon Dioxide Emissions by End-Use Sector — the Electric Power Sector by Fuel Type, 1949–2005



Notes:

- Emissions from the electric power sector are apportioned to each end-use sector according to their share of electricity sales. P = Preliminary.
- Environmental Protection Agency, 1990–2005 estimates are documented in *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*.
1960–1989 data is calculated from energy data in the State Energy Data Report.
1949–1959 is calculated from energy data in the Annual Energy Review.

Source: Environmental Protection Agency, 1990–2005

These costs will likely have an effect on the credit ratings of the utilities at a time when utility credit ratings have stabilized. According to Denise Furey, senior director, Fitch Ratings:

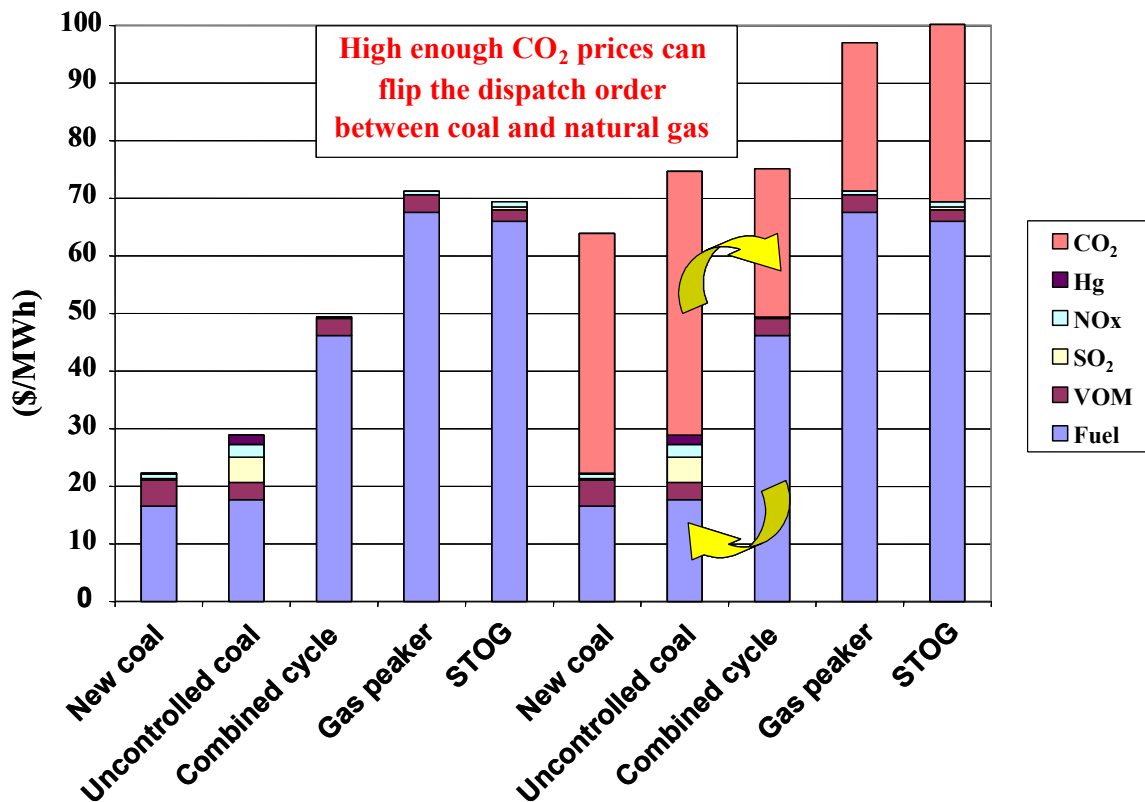
Credit rating implications of increased compliance costs will depend on a utility's ability to recover these costs from consumers through higher prices. Utilities will also need financial flexibility to absorb costs that cannot be passed through in a timely manner. Nonregulated generators with long-term contracts with no mechanisms for price changes in emissions requirements could see significant reduction in margins. Owners of nuclear and renewable generation in disaggregated power markets should enjoy increased profits because of the cost of carbon, which should at least be reflected in wholesale.

As mandatory carbon cap and trade provisions begin to be more widely adopted, generation margins will feel the impact. Michel Verschuere of Electrabel sets forth a possible example of a gas-fired peaking plant in "Managing Spreads in Power Portfolios" in *WorldPower 2007*. Assuming that operating and maintenance costs are €2/MWh, power prices are €50/MWh, natural gas prices are €19/MWh, and emissions allowances — a new element for most generation companies — cost €10/tonne, the generator would make a profit of €6/MWh, contrasted with €10/MWh without emission caps.

In fact, the price of carbon can force a change in the dispatch order of generation. According to CRA International, the price of carbon can change the order from coal to natural gas (see Figure 3).

FIGURE 3

Dispatch Costs of Different Generation Types



Note: Cost of dispatch for CO₂ is at \$40/ton CO₂ and for gas is at \$6.50/MMBtu.

Source: CRA International, 2008

Business Strategies

Greater Drive for Efficiency

In the past two years, with high and volatile fuel costs, generators began to focus on greater plant efficiency. The more efficient the production of electricity, the less fuel is required. In 2005, high gas prices had owners of gas-fired generation looking at ways to reduce their gas consumption. Shortly after, constrained rail capacity from areas such as Powder River Basin led some utilities to look at how to make their coal-fired plants run efficiently on coal of lower quality. Some generation companies began to use a combination of Six Sigma techniques and information technology to help increase unit efficiency. With stepped-up enforcement of state and federal regulations on emissions, generators are starting to look at how plant efficiency can be managed in the context of emissions as well.

For instance, Jacksonville Electric Authority (JEA) had committed to a voluntary emissions reduction plan of 20% while increasing generation by 40%. Unit 3 of its Northside Power plant was a combined oil/gas unit. When the price of gas started to go up in 2002, there was a business case to be made for increasing the oil over gas usage at the unit. However, regression analysis showed that each 10% reduction in the gas fuel ratio increased NO_x by 10%. To meet emissions targets, Unit 3 was faced with additional fuel costs of \$10 million to \$16 million to operate during the summer months.

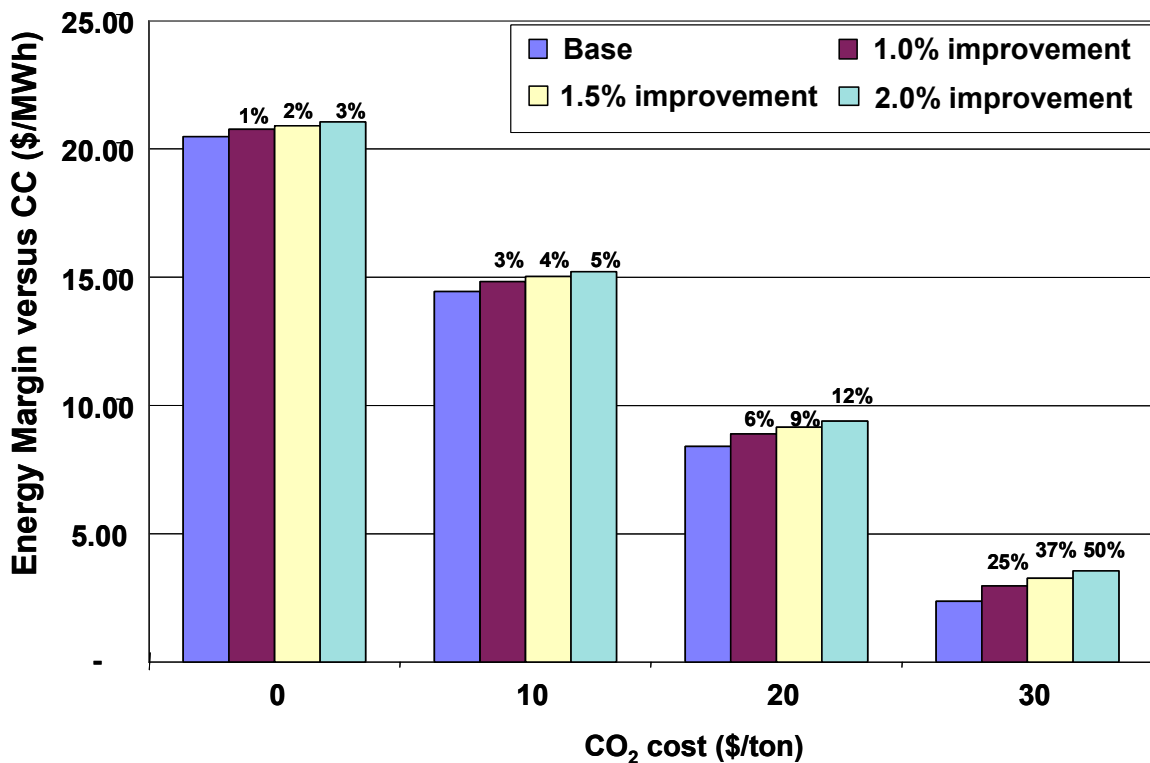
Faced with this problem, JEA embarked on a number of projects to improve combustion on Unit 3. A cross-functional Six Sigma team was assembled to identify inefficiencies and establish best practices by defining, measuring, analyzing, improving, and controlling operations. After improving efficiency through targeted repairs, JEA focused on realizing greater emissions reductions by installing a neural network optimizer. The optimizer enabled Unit 3 to reduce its gas usage from 20% to 10% while meeting NO_x targets. This resulted in a two-week payback during gas price spikes of \$11/MMBtu.

Plant efficiency efforts can also reduce a generator's exposure on the carbon market. Steve Hanawalt, professional engineer and former vice president of plant optimization at Calpine, a merchant generating company, has calculated the impact of energy efficiency at the plant level. He estimates that a 500MW gas-fired plant that achieves a 1% increase in efficiency could save \$1.6 million in the first year. This is assuming that at the baseline, the plant used 3,650MMBtus at a cost of \$6/MMBtu and produced 484,546 tons of carbon dioxide emissions a year at a carbon credit price of \$25/ton and an 80% capacity factor and a heat rate of 7,300Btu/kWh.

CRA International also provided a view of the impact of plant efficiency at different carbon price points for coal unit margins (see Figure 4). Notable is that at a \$30/ton price for carbon, with only a 1% gain in efficiency, a generator can realize a 25% improvement in margin.

FIGURE 4

Impact of Efficiency Improvements on Coal Unit Margins



Source: CRA International, 2008

Fleetwide Performance Focus

Improved efficiency and decision support are being tackled not just on a unit-by-unit basis; generators are realizing that even greater efficiencies and operating flexibility can be achieved with a fleetwide performance focus. Some generators — Entergy, Reliant, DTE, FPL, and Duke are examples — have developed performance centers or centers of excellence to improve the performance of the generation fleet. The centers are typically staffed by engineers who analyze data from across numerous plants and are often tasked with developing equipment diagnostics, maintenance strategies, and operational best

practices. To achieve this, the traditional "every plant for itself" mentality is being challenged. Information technology provides the way for data and information to be shared on a fleetwide basis.

CHALLENGES AND OPPORTUNITIES

While generation companies are now collecting much of the data necessary to support operational and planning decisions that lead to greater plant and fleet efficiency, it is not easy to access data that resides in different applications, control systems, or external sources. Data on its own is not necessarily useful unless it is in context; then it becomes information. But even information is limited without the ability to analyze the information so that it becomes actionable knowledge. Finally, wisdom comes with the ability to evaluate options and make the best decisions based on corporate priorities. Companies that achieve this holy grail of priority-based decision making stand to gain the most toward achieving their objectives.

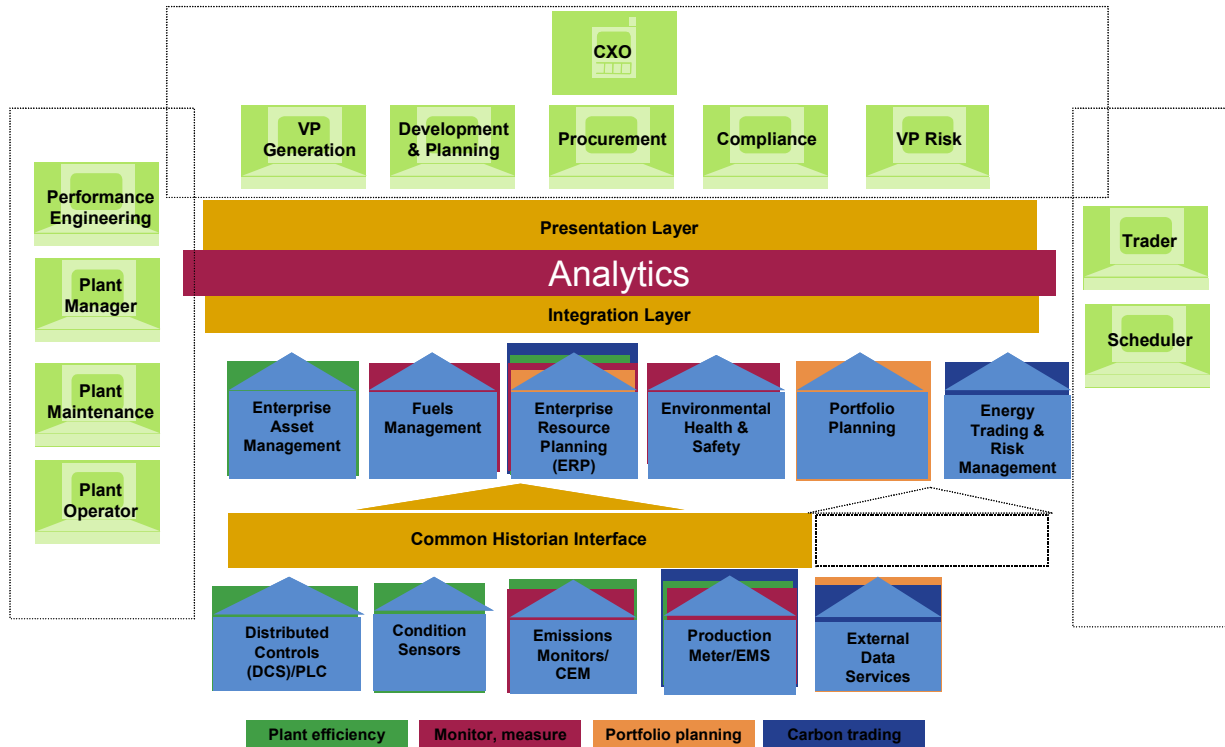
Fortunately, many systems and applications now exist to provide efficiency benefits to generation companies that seek decision support for generation portfolio planning, general operating policies, and real-time operational control. Figure 5 displays the technology stack supporting greater plant efficiencies, along with other strategies related to emissions reductions. The full technology stack need not be implemented all at once. Retrofitting the entire plant with sensing devices can be costly. In fact, much of the technology stack is already in place at most generation plants. However, there are a few essentials.

To support real-time operations, information technology must be able to:

- Access appropriate data sources — applications, distributed control systems (DCS), continuous emission monitoring systems (CEMS), condition sensors, production meters, energy management systems (EMS), and external data sources.
- Deliver and support analysis of both "real-time" and historical data.
- Extract action-oriented information relevant to efficiency, emissions, and availability.

FIGURE 5

Technology Stack to Support the Intelligent Generation Plant



Source: Energy Insights, 2008

Presentation Is Not Enough; Analytics Are Required

A number of generation executives now have access to real-time plant production meter data via mobile devices such as smart phones or the now ubiquitous BlackBerry. The focus of this effort is on the presentation. However, presentation of status is limited — it does not reach enough personnel who need to make operational decisions (see Table 1 to view the personnel involved in operational decisions at the power plant). In addition, presentation is limited in that it does not provide the means to analyze the data or information presented to make the best decisions in the context of corporate goals.

Even when analytical tools such as spreadsheets are used, they require personnel with a high degree of technical competence. Spreadsheets and other tools that accompany data historians are often not well-documented, cannot be exposed to the rest of the organization, and are not auditable or repeatable. Then, too, with increasing shortages of experienced technical personnel, the staff to create models is in short supply.

Analytical applications, rather than tools, are an essential element of operational decision making. Table 1 defines the types of analytics and the personnel who can best utilize these methods.

TABLE 1

Analytics Definitions

Analytics	Definition	Personnel
Alerting	Provides warnings based on conditional logic	Plant engineers, operators, planners/coordinators
Equipment diagnostics	Provides analysis of equipment operational conditions to identify sources of potential problems; typically supplied by original equipment manufacturer (OEM) and used onsite at or near the equipment	Plant engineers
Predictive diagnostics	A more sophisticated method of comparing historical conditions with actual conditions to identify deviations and predict potential failures	Plant engineers, centers of excellence/performance centers
Simulation	Uses complex models of systems to simulate alternative scenarios using methods such as Monte Carlo, stochastic modeling, etc.	Plant engineers, centers of excellence/performance centers, capital planning
Optimization	Mathematical routines used to maximize or minimize a set of weight objectives by changing various variable inputs; examples of optimization techniques include linear and nonlinear such as neural nets, stochastic, or dynamic programming	Multiple
Optimization – Unit Performance	Optimization focused on the operational performance of a generation unit within a plant	Plant engineers, centers of excellence/performance centers, regulatory compliance officers
Optimization – Maintenance	Optimization focused on the asset life cycle and the best maintenance approach to an asset (run to failure, repair versus replace, etc.) within a business context	Plant managers, maintenance managers, maintenance supervisors, (physical) asset managers
Optimization – Market	Optimization focused on the economic dispatch of a fleet of generation plants within a market	Fleet analytics group, commodity and emissions traders

Source: Energy Insights, 2008

Optimization Provides the Only Means of Making Trade-offs

The following limitations are associated with some of the analytic methods described earlier:

- **Alerting and predictive diagnostics.** These methods provide only a conditional notice of potential failure. They may not provide enough information to perform root cause analysis or execute on the optimal approach to a potential problem. In that respect, this approach requires existence of a dedicated performance center to provide the next level of problem solving.
- **Simulation.** While providing an indication of the magnitude of potential risks given various scenarios, this method does not provide the means for optimizing decisions or making trade-offs.

Only optimization provides a means of making the trade-offs in the context of corporate goals and business unit objectives. These analytics allow business unit leaders to assess the risk of failure or inaction in the context of the priorities of the company, whether they be reducing costs, taking advantage of market opportunities, deferring capital investments, or managing emissions in the generation portfolio.

Optimization Spotlight

Optimization Defined

Optimization is a part of the rapidly maturing field of artificial intelligence (AI), the science and engineering of intelligent machines — particularly computer programs. These intelligent machines are modeled after neural processes used by living systems: They have the ability to learn, remember, adapt, prioritize, and optimize in a complex environment. The goal of optimization is to create computer programs that can consistently solve problems that are too large or complex for humans alone to address or to tackle problems, which, if automated, could free people to focus on other things.

Changes in plant operations in real time are what deliver the efficiency. For instance, some systems support closed loop operations that do not require human intervention for decision making. Others are advisory systems that save time by alerting personnel to issues that require attention and providing the context for making more informed decisions. Decision makers can also use simulations as a means for identifying problem areas or to gauge the impact of various alternative solutions.

The two primary types of optimization, which is broadly defined as taking actions to extract the best possible result from a process for a set of objectives and constraints, are defined as follows:

- **Direct optimization.** With direct optimization, the optimizer improves a process by taking an action and comparing the result with the process' previous state. If the action improved performance against its objective, the optimizer would take another action in the same direction. This trial-and-error approach is repeated, as the optimizer continually searches for improved operating performance.
- **Model-based optimization.** With model-based optimization, the optimizer searches a model of a process to determine what actions will provide the best results. This allows a more complete search to be carried out before an action is taken. Numeric optimization and rule-based optimization are model-based approaches. Numeric optimization uses a mathematical engine called a solver to search possible action combinations for the one that leads to the best result. Rule-based optimization is driven by an inference engine, which provides a way to rank a set of possible actions that are described in the form of situation-action rules.

Modeling techniques include:

- **First principles.** First principle models use proven equations based on the laws of physics and chemistry to represent processes. This type of modeling is possible only when there is a complete understanding of the physical laws governing the process in question. A thermodynamic model of the boiler and steam cycle is an example of first principle modeling.
- **Neural networks.** Neural network models start with data and "learn" relationships between a process' inputs and outputs, in much the same way that the brain does. A neural network model is able to map complex action-response relationships by observing the process in action. This type of model is flexible and able to adapt its own structure based on its experience. Neural networks are often used to model the highly complex, nonlinear combustion process.
- **Heuristics.** Heuristic models represent knowledge in the form of situation-action rules. Instead of attempting to fully represent a process, heuristic models use knowledge to opportunistically represent situations in which experts know what to do. For instance, a soot-cleaning optimizer might use heuristic models to describe what soot-blowing actions will achieve a desired response.

Analytics Suppliers

A Diverse Range of Suppliers Offer Analytics

A diverse group of suppliers provides the analytics that are currently required. This group includes original equipment manufacturers, service companies, application vendors, and IT infrastructure vendors. Energy Insights expects this level of diversity in terms of suppliers to continue to serve the generation industry due to the complex nature of the needs of the industry (see Table 2). Of course, the service companies typically use the analytics for their own purposes in becoming more efficient in serving multiple generation customers.

TABLE 2

Diversity of Suppliers Supporting Generation

Type of Vendor	Example Companies	Alerting	Equipment and Predictive Diagnostics	Unit Performance Optimization	Maintenance Optimization	Market Optimization
Original equipment manufacturer	<ul style="list-style-type: none"> • GE • Hitachi • Siemens 	X	X	X		
Control systems	<ul style="list-style-type: none"> • Emerson Process • Honeywell 	X	X			
Enterprise applications	<ul style="list-style-type: none"> • SAP • IBM • Ventyx 	X				
Analytics	<ul style="list-style-type: none"> • Meridium • Oniqua • SmartSignal • Ventyx • NeuCo 	X	X	X	X	X (Ventyx)
Service companies	<ul style="list-style-type: none"> • Data Systems & Solutions • GE • Siemens 	X	X	X	X	
Data historians	<ul style="list-style-type: none"> • InStep • OSI • Emerson 	X				

Source: Energy Insights, 2008

NeuCo's Offerings

NeuCo Inc. specializes in real-time optimization. The company offers many of the optimization and modeling technologies described earlier to improve power generation processes from combustion to soot cleaning to maintenance. The most relevant systems in improving emissions and efficiencies (and thereby improving the carbon footprint) are:

- **CombustionOpt[®]** has been providing closed loop optimization of fuel and air mixing for more than a decade. By manipulating relevant fuel and air injection points by biasing DCS setpoints, the systems reduce NOx and other emissions and improve fuel efficiency, resulting in less carbon output.
- **SootOpt[®]** dynamically determines the optimal boiler cleaning actions to improve heat rate and thereby reduce CO₂, minimize NOx, and reduce the risk of slagging and tube erosion.
- **PerformanceOpt[®]** combines a first principle thermal model of a unit with real-time simulation and rules to identify gaps between actual and achievable efficiency and capacity, alerting users to performance improvement opportunities and prioritizing which problems should be resolved first.
- **MaintenanceOpt[®]** uses intelligent technologies to detect equipment and process anomalies and help users more quickly verify problems, determine their root causes, define actions needed for resolution, and assign priority based on criticality and cost impacts. These systems are able to be integrated with centralized maintenance management systems (CMMS.)

Table 3 indicates how these optimization systems make use of the analytic approaches discussed earlier in the document.

TABLE 3

Mapping Product Capabilities to Analytics Definitions

Analytics	Capabilities
Alerting	MaintenanceOpt uses neural network technology to model processes, continuously search for equipment and process anomalies, and alert users when an anomaly occurs. PerformanceOpt alerts users to discrepancies between actual and achievable efficiency and capacity, based on a real-time mass and energy balance of the unit combined with online simulations. CombustionOpt and SootOpt also contain triggers that alert users to opportunities to improve boiler performance.
Equipment diagnostics	MaintenanceOpt's heuristics knowledge base contains hundreds of diagnostic rules that are applied, along with contextual data, to determine root causes of equipment-related anomalies.
Predictive diagnostics	MaintenanceOpt is essentially a diagnostics clearinghouse for equipment and process anomalies. Once anomalies are detected by MaintenanceOpt, other optimizers, or other anomaly detectors, MaintenanceOpt's heuristics knowledge base helps users quickly determine whether the anomalies point to real problems and, if so, their most likely causes and remedial actions. SootOpt also uses heuristic models to determine what soot-blowing actions will achieve a desired response.
Simulation	In addition to running a first principle model of the entire unit in real-time mode, PerformanceOpt runs the same online model in predictive simulation mode to find discrepancies between actual and achievable performance and to evaluate the impact of individual performance changes. Simulations are also used by other NeuCo optimizers. For instance, the benchmarking feature of each optimizer uses simulations to determine the discrepancy between benefits currently achieved versus those that could be achieved if the optimizer's advice were followed. Likewise, impact estimates of triggered conditions that are presented on each product's home page use simulations.
Optimization	CombustionOpt and SootOpt are predominantly closed loop optimizers, while PerformanceOpt and MaintenanceOpt are predominantly advisory systems. All leverage appropriate optimization techniques to determine the best set of operating parameters for a given objective within a set of constraints and either directly adjust the parameters or recommend specific actions to users.
Optimization – Unit Performance	CombustionOpt, SootOpt, and PerformanceOpt are unit-level optimizers designed to improve boiler efficiency and emissions, as well as net unit efficiency and capacity. These systems share models and provide, through a single user interface, knowledge needed to make unit trade-off decisions.
Optimization – Maintenance	MaintenanceOpt enriches maintenance practices by detecting equipment problems that may require maintenance, helping to determine the cause, criticality, and remediation of the problems to aid in scheduling and facilitating the plant's operations-maintenance workflow. MaintenanceOpt also integrates with NeuCo's other optimizers as well as other companies' anomaly detection systems to provide a single alerting and diagnostic interface.

Source: Energy Insights, 2008

FUTURE OUTLOOK

Traditionally, there has been a division between engineering systems and information technology in the plants. Engineering has handled and owned control systems and some applications related to operations, while information technology has been the owner of applications related to business information and processes. Now, information technology is being called to plants to support servers and other hardware required to support engineering control systems.

Energy Insights foresees the increased use of technologies, especially emerging technologies, in support of plant efficiency and emissions reductions. Emerging technologies include RFID tags, sensors, portable sensors, and wireless networks, along with the increased use of videocameras and mashup technologies to increase the amount of data and information available to decision makers or automated systems. To make use of this data — much of the time series data — it must be stored, extracted, transported, and analyzed. Those functions are all supported by information technology, so much so that the distinction between engineering and information technology is less clear. Energy Insights predicts that there will be a convergence of the management of technologies in the next 10 years.

As discussed earlier, generators are realizing that even greater efficiencies and operating flexibility can be achieved with a fleetwide performance focus. At this point in time, the emissions have primarily been optimized on a unit, not a regional fleet basis. Generators are clearly evaluating their portfolio of generation plants in light of potential carbon taxes or cap and trade programs; however, generators have not yet invested in information technology that will provide the ability to optimize emissions across a regional fleet of generators as a part of day-to-day operations. Energy Insights expects generators to begin to demand this capability as carbon markets become more widespread.

CONCLUSION

Analytics are a low-cost approach to achieving greater plant efficiency in terms of reducing fuel and other operating costs, as well as reducing emissions. When compared with the cost of installing pollution control devices, analytics are orders of magnitude less expensive. This is not to say that analytics can substitute for investment in emissions control instrumentation and new, cleaner power plant technologies. However, analytics such as optimization can help a company prioritize its more expensive capital investments.

As previously discussed, analytics can work with technology already present at the plants — data historians, process controls, instrumentation, and enterprise applications. Analytics work on the

data that is already being collected to produce operational intelligence. Costs of most analytics packages range from \$500,000 to \$2 million, including implementation, but not integration. These applications can be installed fairly quickly, although fine-tuning to the circumstances of the unit operation will require additional work.

Generators seeking to implement information technology to support more efficient plant operations and better long-term planning should consider the implementation of analytics. When considering these analytics, generators should keep in mind the following checklist:

- Drilldown capabilities to understand how conclusions are reached (This helps both seasoned and new employees negotiate the learning curve.)
- Workflow to ensure analysis is vetted and executed
- Ability to incorporate costs associated with a specific unit or plant, not generic costs when performing optimization
- Viewing and testing sensitivities for prioritization of many variables
- Ability to easily feed results from one optimization application into another
- Continuous improvement capabilities that allow lessons learned to be automated into closed loop actions
- Repeatable calculations and archiving
- Role-based views and security

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