Dispatch Optimization for a Changing Power Generation Industry

How GE Digital’s Operations Performance Management (OPM) solution enables power generators to maximize dispatch and revenue in a challenging environment
THE PACE OF CHANGE IN THE POWER GENERATION INDUSTRY IS CONTINUING TO ACCELERATE AND IS MORE COMPLEX THAN EVER.

For example, according to the International Energy Agency (IEA), wind and solar PV are expected to be the fastest growing bulk power generation technologies through 2040 based on their growth rates in both electricity generated and installed capacity. The IEA expects global renewables installed capacity to nearly triple and installed capacity to more than double during this period. With this increase in variable renewables comes an acknowledgment by the IEA of the continuing but changing role that dispatchable gas power needs to play. During this same period the IEA projects gas power generation to increase by one-third and installed capacity to grow more than 40 percent. How this transition toward more renewables impacts the revenues and reliability of fossil fuel plants very much depends on decisions within the control of utilities and independent power producers (IPP). Indeed, careful planning and decision-making may enable these power producers to increase revenue in a complex environment.

For the operators of natural gas and coal power plants, the implications of this rapid and accelerating influx of variable renewable power generation are significant. The California Independent System Operator (CAISO) coined the term “duck curve” to describe the imbalance between peak electricity demand and renewable energy production through the course of a typical day. For thermal power plant operators, the importance of flexibility, rapidly restarting and ramping up production and dispatch quickly to meet short-term demand can’t be understated. The energy system will increasingly rely on the ability of natural gas plants to respond and reinforce stability given the challenges inherent in a world with more renewables. The challenge, of course, is that older natural gas power plants were designed to provide a steady supply of baseload power, switching on and off relatively infrequently. Operating a power plant in ways for which it wasn’t originally designed can create stresses on equipment and threaten plant reliability. For instance, cycling on and off repeatedly can result in thermal, mechanical and corrosion fatigue that threatens plant components. And that stress extends to the plant operators, who are uncomfortable with the operational gymnastics required to constantly adjust parameters.
Deregulated utilities have to make financially sound decisions about when to run the many power plants in their portfolios using assumptions that have a high degree of uncertainty. To do that well, traders at utilities need to have not only a clear understanding about demand and the availability of different power plants in a portfolio but also accurate projections of the fuel costs and price of energy hour by hour and a day in advance. This is what allows traders to profitably navigate the market bidding process.

If anything, the owners and operators of merchant power plants are even more keenly aware of the need to understand the most profitable times to sell electricity into the markets they serve. Their business model depends on predicting when demand and prices for energy are highest and being ready to quickly and reliably produce electricity during those windows, at the optimum costs.
As the electricity markets continue to evolve, there is a great need for increased flexibility from the owners and operators of traditional power plants. But this is difficult, in part because it’s a matter of physics. Power plants built to operate continuously were designed around baseload power conditions. They weren’t designed to start and stop as rapidly and as often as market demands require.

Beyond the actual design of power plants, other factors compound the inadequacy of the platform for plant operators and traders to cooperate: outdated control and communication systems, multiple competing sources of data and significant issues around visibility into shifting market dynamics. For example, traders may want to dispatch the maximum output of a plant to take advantage of a high electricity price, while plant operators may prefer to be more conservative, not wanting to compromise reliability.

Ultimately, though, what traders and plant operators have traditionally lacked are comprehensive, timely and accurate data and tools that provide an integrated single source of truth to make sense of it all. Only with a complete picture of the operations, maintenance and actual capability of a power plant, coupled with market and environmental conditions, is it possible to make decisions about dispatch that maximize revenues while reducing fuel and maintenance costs.
GE’s Digital Energy solutions provide the information and analytics necessary to operate and dispatch plants in a way that meets today’s complex and continuously evolving market dynamics. GE Digital’s OPM solution is a software suite that provides visibility into everything from the operation of an individual power plant to current and future market conditions to tools that can expand the capability of the plant. OPM analyzes historical data, plant operations and other sources to:

- Monitor and identify areas of improvement
- Predict capacity to improve day ahead and intraday planning
- Deliver executable advice
- Drive desired outcomes, including improved efficiency, flexibility, capacity and emissions
1. PERFORMANCE INTELLIGENCE

Plant operators are working in more flexible and challenging ways due to the continued rise in renewable generation. This makes it even more difficult to track and monitor their plant equipment and operational performance as they are continuously changing operational regimes, such as operating modes and load profiles. In addition, with the continuous cost pressure on plant support roles with increasing demands, operating management teams require digital tools to enable them to achieve their most efficient output.

OPM Performance Intelligence enables users to deliver improved power plant economic performance through improved plant operational and thermal performance over time. It provides monitoring and recovery advice, which facilitates improved O&M decision-making and includes more informed plant performance details, issue root causes, business impact analysis and recovery advice.

Performance Intelligence enables a consistent view of power plant and equipment operations, providing more informed and expeditious decision-making. It’s a highly configured application engineered to customer plant configuration and equipment design data and utilizes connected plant operating sensor data. Performance Intelligence uses advanced data handling and analytics to process, reduce and transform this significant and highly variable input into meaningful data and advice to assist the customer in tracking, maintaining and recovering the performance of their power plant system of equipment. In addition to the performance issue and recovery advisors and performance alerts, the module calculates and provides visibility Key Performance Indicators (KPIs), fleet and plant operational performance data, asset performance data, degradation impacts, as well as major component and subcomponent performance data.

The module also enables user-defined inputs for plant scenarios to determine the operational and performance impacts of various actions and conditions. Many factors that influence the performance, operations and output of the power plant are monitored, analyzed and visualized in a way that allows for fast and effective decisions.

The Performance Intelligence module leverages the knowledge and best practices GE has developed over 125 years of engineering, building and maintaining power plants owned and operated by the world’s largest utilities and independent power producers. That knowledge, coupled with advanced analytics and engineering practice, is at the foundation of the OPM solution.
2. PERFORMANCE OPTIMIZATION

Customers improve real-time productivity during plant operations with automation and optimization. By leveraging digital twins, power plants are able to safely expand the boundaries to increase performance, while understanding tradeoffs and driving economic generation and dispatch. Whether it’s increasing efficiency or output, reducing emissions or starting faster, the improved capability helps power plants seek out additional economic opportunity while reducing costs. Flexibility coupled with reduced costs becomes even more important as variable renewable generation becomes more prevalent on the grid. With better accuracy, more consistency and greater flexibility, gas plants are able to adapt to this new reality.

Timing has always been an important factor in maximizing the output and revenue of power plants. Think about the duck curve again: While solar generation will often be abundant throughout the middle of the day, in early morning and late afternoon traditional power plants will need to ramp up quickly to meet rising demand and then ramp down as renewables supplement energy supply.

OPM’s performance optimization module is a powerful tool that enables plants to operate automatically in ways that take full advantage of market opportunities while not stressing plant equipment to the point where reliability becomes a concern.

Performance can be adjusted automatically because OPM software is connected directly to the plant’s controls system.

That capability is paired with a modeling function that allows for a day-ahead projection of demand and a host of features that helps plant operators and traders take full advantage of opportunities. For instance, efficient and rapid startup is key to responding to opportunities presented by intermittent generation.

OPM’s Performance Optimization includes a startup feature that ensures that a plant is online and ready at the best time to generate electricity, saving up to 40% of start time and fuel. This is an advantage for power plant owners because it addresses the natural and understandable impulse by many operators to start a plant well before its output is actually needed — a practice that is inefficient, elevates fuel costs and unnecessarily increases emissions.
The Performance Optimization module also helps plants take advantage of peak fire opportunities without pushing outside of a safe operational envelope. This can be a delicate balancing act: When not done properly, fully leveraging a peak fire opportunity has a direct impact on turbine maintenance. Performance Optimization software monitors and adjusts power plant output in a way that banks energy credits when the plant runs at part load, with reduced gas turbine firing temperatures. The banked credits are used to offset the effects of peak fire. This allows customers to deliver extra capacity when the marketplace needs it most, without having to incur additional maintenance costs or worry about the maintenance interval changing and falling short in a peak operating season.

For example, going back to the duck curve scenario, Performance Optimization software can ensure that a plant is generating below its maximum potential output, with a reduced gas turbine firing temperature and reduced impact on the parts, at times when renewables are most abundant. This limits stress on the turbine and allows it to peak fire during morning demand after sunrise and during afternoon and evening demand when it begins to set.

With projections of when electricity prices will be highest, power plant operators and traders will know when banked hours can be tapped to produce the most revenue. Seizing these opportunities without sacrificing reliability comes down to having visibility into day-ahead demand and fully automating a power plant’s response.
3. PRODUCTION PLANNING

The OPM Production Planning module simultaneously enables traders to plan for the most effective bids while promoting information sharing that helps align the interests of traders and plant operators. Using information and insights about the plant derived from the Performance Intelligence and Performance Optimization modules, coupled with factors such as weather forecast and fuel prices, the Production Planning module incorporates machine learning analysis of a wide range of internal and external factors to help traders make the most informed decisions. For instance, environmental factors like air temperature and humidity, as well as projections about day-ahead market prices and demand, are combined to build a model that provides recommendations about the optimal plant capability, timing and pricing of bids.

This helps traders know the most profitable times to bid into the market and, in optimum cases, to use peak fire hours. It also helps dispatchers decide the most economical time to use the additional peak fire. At the same time, plant operators can look at the same information traders are using to make bids and commitments to schedule maintenance. For example, day-ahead market information and weather projections can help operators plan maintenance to take place when they know the plant won’t be needed. Not only does this planning help traders boost plant revenues, it can deliver the kind of O&M visibility and certainty that can reduce costs.

In addition, sometimes operations and capabilities aren’t as predicted a day ahead. Having a single source of truth that is continuously learning, adapting and updating can help traders, dispatchers and operators know what to do, with more time to react, when unexpected changes arise. For example, using the duck curve again, if a huge cloud covers the solar farm, knowing breakeven costs can help operators respond when prices become attractive enough, whether through supplementary firing or even peak firing the gas turbine.

By providing visibility to both plant operators and traders, the Production Planning module improves communication. Importantly, the system also boosts confidence that decisions that enhance plant reliability don’t diminish profits, and vice versa.
The need for continual adaptation

It’s possible to quantify what the implementation of OPM can mean to plant revenues. For example, consider what would have been possible with a 600-megawatt combined cycle gas plant operating in the Electric Reliability Council of Texas (ERCOT) wholesale market using 2018 data.

By shifting from traditional static performance models to the machine learning enabled models OPM provides, plant operators and traders could have reduced uncertainty around forecasting, available capacity and costs. The use of OPM would have allowed traders to make two additional energy offers and increase revenues by over $400,000 during peak summer months. Similarly, predictions of peak demand and visibility into energy bank hours that OPM makes possible would have resulted in an extra 17 peak fire megawatts and an additional $868,000 in revenue.

The reality is that power plant operators and traders haven’t historically needed sophisticated tools to understand the performance of their plants and changing market and weather conditions. That dynamism and visibility are less valuable when a power plant generates baseload power.

But the continued influx of variable renewable generation has elevated the importance of new modes of operation that take advantage of gas power’s flexibility. There is no reason to expect that the need to adapt will do anything but accelerate in the future. As more states and countries move aggressively to reduce reliance on fossil fuels, the demand for renewables, energy storage, dispatchable gas and other technologies will only increase.

To improve profitability and reliability while lowering O&M costs, plant operators also need to evolve and adapt. One readily achievable way to do that is by tapping digital tools that enhance flexibility, visibility and analytics for optimal dispatch.
GE Digital is transforming how industry solves its toughest challenges. GE Digital’s mission is to bring simplicity, speed and scale to its customers’ digital transformation activities, with software that helps them to better operate, analyze and optimize their business processes. GE Digital’s product portfolio – including grid optimization and analytics, asset and operations performance management, and manufacturing operations and automation – helps industrial companies in the utility, power generation, oil & gas and manufacturing sectors put their industrial data to work. For more information, visit www.ge.com/digital.
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