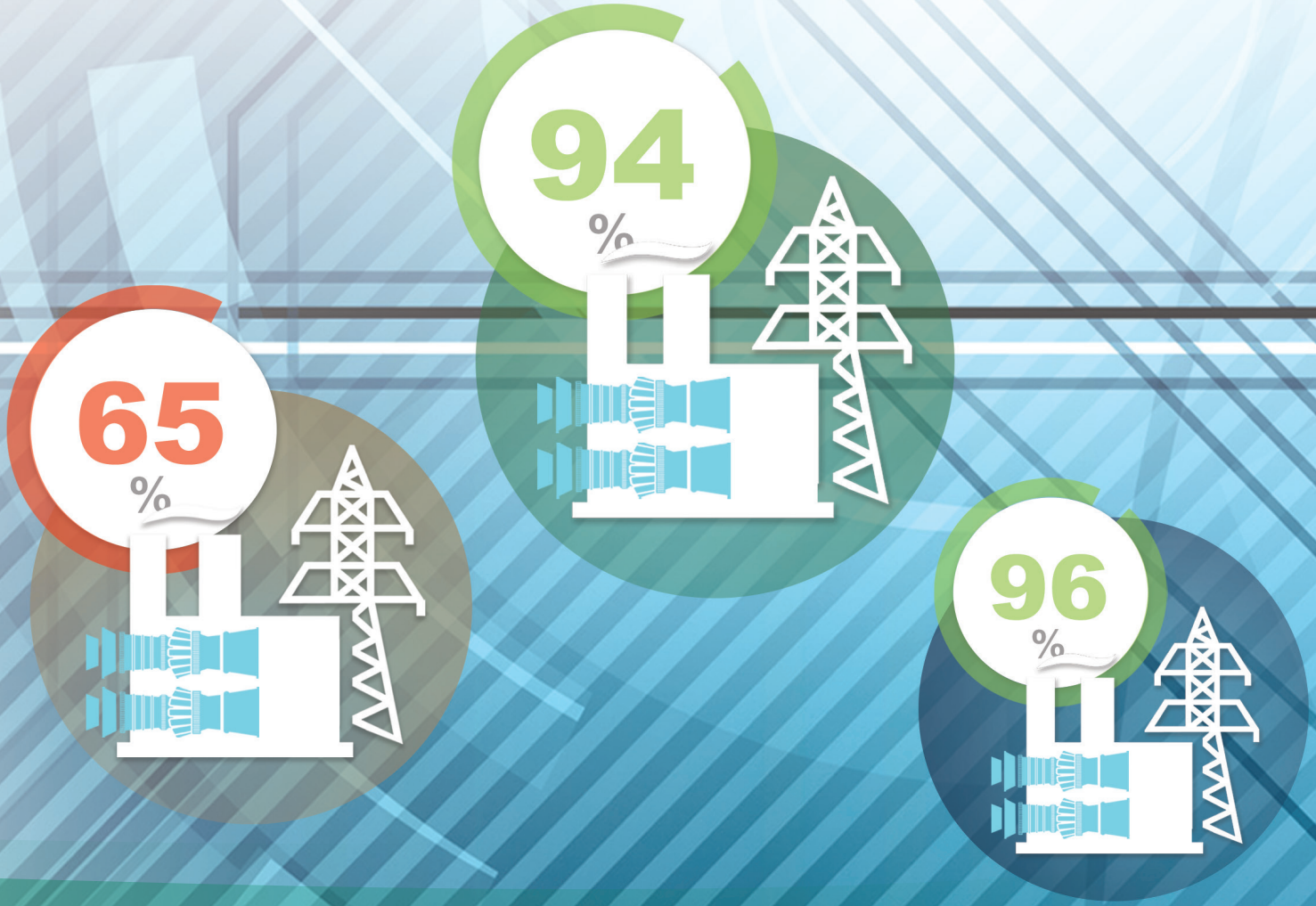
camfil

WHITEPAPER

Using predictive analytics to improve gas turbine power forecasting



Clean air solutions for turbomachinery

Using predictive analytics to improve gas turbine power forecasting

Abstract

Power facility operators are responsible for every detail of the plant, including improving power output and reducing expenses. An important strategy to achieve these critical goals is to use predictive analytics to forecast how local site ambient conditions and filter behavior will affect gas turbine performance. By monitoring these factors and collecting data in real time, predictive analytics tools and services help power facility operators understand the impact of environmental conditions, changing weather patterns and filter status on the health and performance of gas turbines. This whitepaper examines how calculating the impact of local site conditions can improve gas turbine power forecasting.

Power forecasting and predictive analytics

Predicting future power output with a high degree of accuracy enables facilities to efficiently make commitments and deliver power to the grid, meet contractual obligations and avoid penalties and other associated costs when falling short of predicted power capacity.

Utility plants sell energy to the market every day in the form of hourly bids. Accuracy of these bids is impacted by ambient conditions around the facility, gas turbine degradation, filter condition and electricity used to produce energy (parasitic load). Most plants have some sort of system in place to predict day ahead power. Often, these systems are often outdated and rarely maintained. Or they lack a standard on how to use the tool and interpret the data. Error rates increase because static tools do not take into consideration the constantly changing condition of the engine and inlet filters.

To more precisely project near-term or next-day engine performance, advanced analytics tools provide up-to-the-hour insights on how temperature, humidity and particulate levels in the air will affect the condition of the filters and, therefore, the performance of engines. This insight provides a current snapshot of engine status. All of this data enables a more valid basis for forecasting power output. Just a few megawatts of improvement in accuracy could result in hundreds of thousands of dollars of extra revenue per turbine annually.

Impact of local environmental conditions

Most often gas turbine fleets are spread across many locations with different weather and environmental conditions– like sand, industrial pollution or salt water – that pose unique challenges on the performance of the intake filters and the engines.

Most of these conditions vary throughout the year. Figure 1 shows the increase in pressure drop due to seasonal increases in dust load. Some of these contaminant-inducing conditions are seasonal. Dust storm season, for example, is a regular occurrence in many regions of the world. Other events that generate high dust concentrations are unpredictable, like forest fires and volcanic eruptions. Yet, other sources are more constant, such as nearby industrial plants that generate air pollution.

In addition to these seasonal or one-off changes, there are also daily variations in ambient conditions, such as humidity, which can have a significant impact on the intake system behaviour. Figure 2 illustrates this point with a site that saw a two-fold increase in pressure drop with the advent of fog and humid conditions. This represents .75% reduction in turbine nameplate capacity[1].

Figure 1: How seasonal dust load impacts pressure drop increase

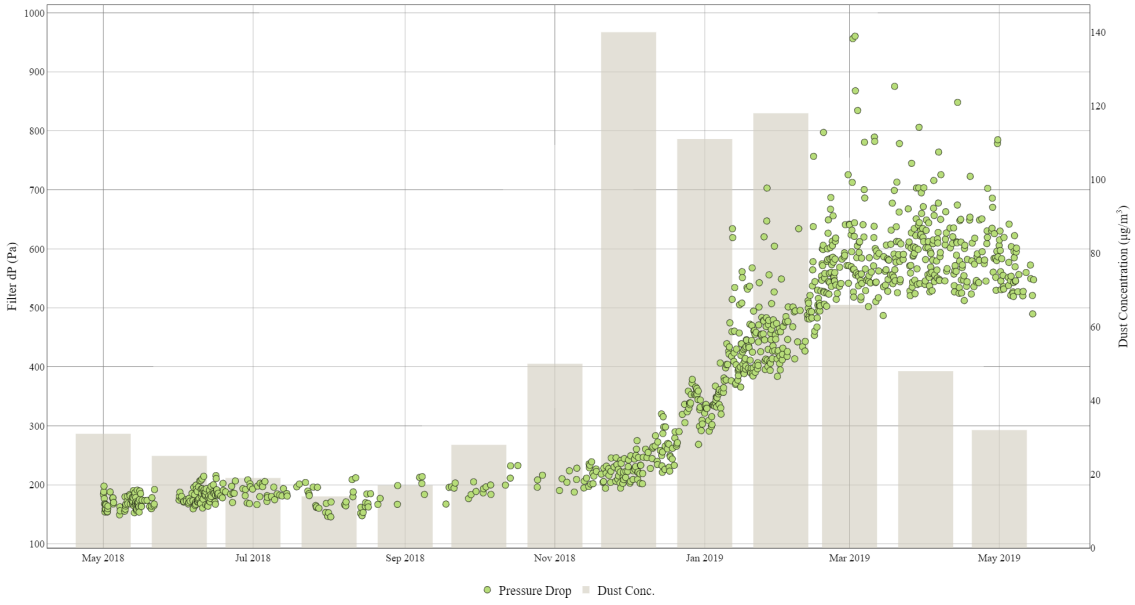
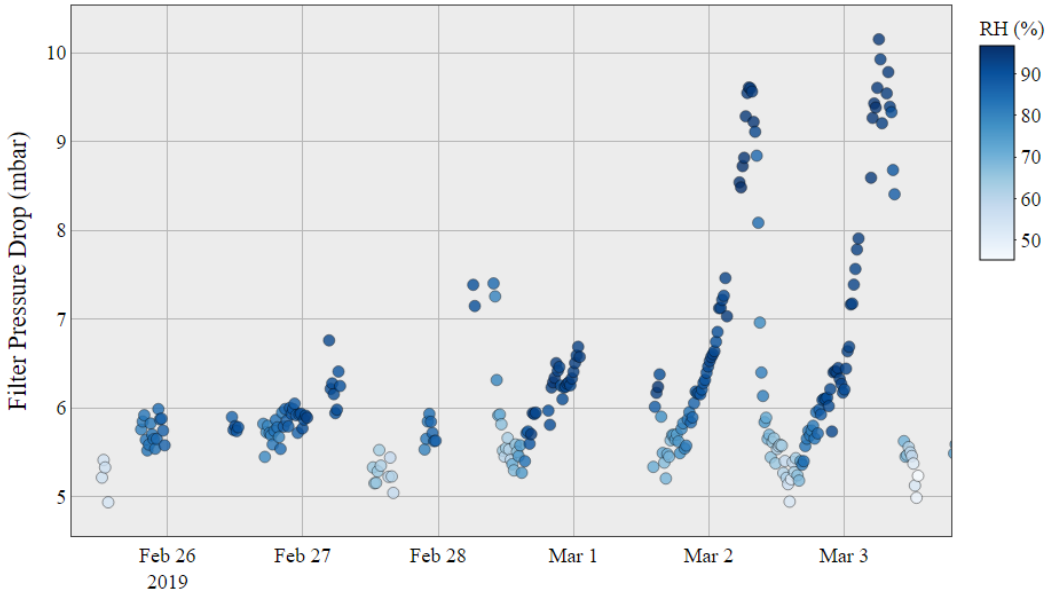


Figure 2: Daily fluctuations of pressure drop to pressure drop, humidity, and dust



Other considerations include power output fluctuations due to varying temperatures throughout the day, as shown in Figure 3.

While operators are aware these conditions produce contaminants that degrade their gas turbine, effectively dealing with them is a challenge. Sophisticated monitoring tools and analytics that provide continuous real-time data on existing and near-term ambient conditions can predict the impact on the filters with a great deal of precision.

Because plant conditions like temperature, humidity and especially ambient dust levels are not static over time, algorithms used in these advanced analytical systems update automatically to reflect these changes on your turbine performance data, pressure drop trends, filter life predictions, filter change recommendations and optimal offline water wash schedules.

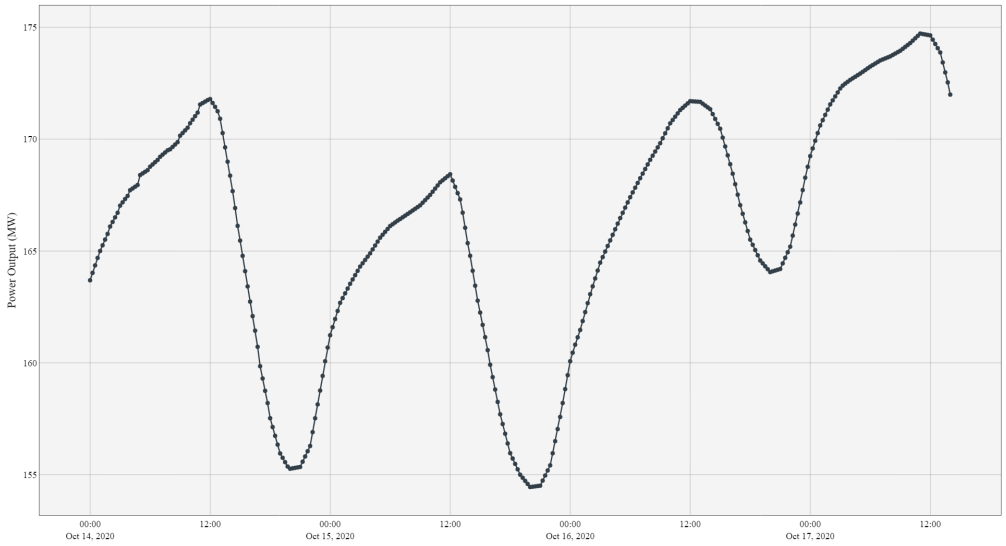
Armed with this information, operators can better calculate filter performance across the fleet in all types of circumstances, prepare filer optimization tactics accordingly and better forecast day-ahead power output.

Capacity forecasting site example

We compared a forecast made using a plant's static internal tool versus one generated by a more sophisticated system that uses the actual power output. This comparison was made for ~70 hours. (Figure 4).

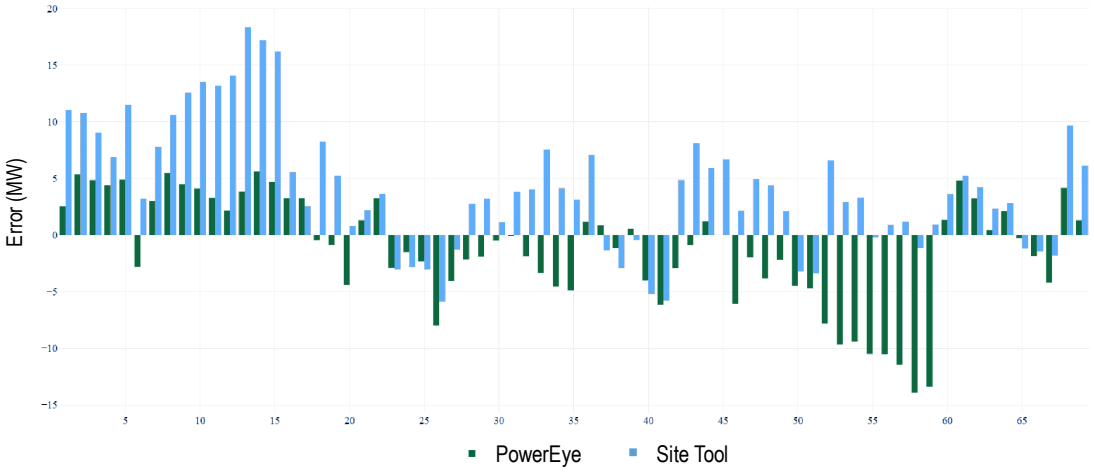
On average, the tool that used actual power output was more accurate by ~3MW, which is an increase of potential revenue of approximately $7,000 USD. This estimate is based on $35 USD/MWh, then calculated as 3MW x 70h x 35 USD/MWh = $7,350 USD. Extrapolating this increase over a full year would yield a potential gain of approximately $800,000 USD, per gas turbine. Because plant conditions like temperature, humidity and especially ambient dust levels are not static over time, algorithms used in these advanced analytical systems update automatically to reflect these changes.

Figure 3: Power output variation with temperature



1 *Assuming 1000 Pa (4") = 1.54% reduction in power output*

Figure 4: Comparison of errors in megawatts made by PowerEye and internal site tool



Comparison over 70 baseload hours

- Avg. **3 MW** improvement in accuracy
- Over **800,000 USD/year** potential increase in revenue

**Estimate based on 35 USD/MWh*

Identifying and handling predictive data

A proven way to collect the information necessary information to create accurate predictive models is to collect data from three main sources. The PowerEye™ predictive analytics engine pulls data from Camfil's proprietary PowerEye Air Monitoring Station telemetry device (installed at each facility), the facility site historian and independent third-party online weather services.

The air monitoring station, an IIOT device, tracks real-time ambient temperature, air pressure, humidity and the dust content to characterize the environment. An air monitoring device is mounted near the intake for each turbine, where it can report on the condition of the air flowing into each turbine.

To monitor engine performance and accurately forecast power output, the PowerEye system accesses a set of site data points from the site historian server fed by sensors in the turbines. Data points include fuel consumption, power outputs and engine efficiencies.

Data transmission

As the data is collected, it is transferred back to the central PowerEye server for analysis. Intake air data from the air monitoring device is sent directly via a wireless connection in the device. Engine performance data is sent from the historian via a cloud-based, hyper-secure, one-way, read-only connection.

Data security

To ensure data security, the connection architecture is designed to maximize the safety of the data, equipment and facility. It is important that data is not sent directly to the operator systems in the facility's control room. The data collection tools never connect directly to any the facility's systems. All secure connections are established by a process information system that is already vetted, used and trusted by major power generation utilities worldwide.

When predictive insights data is pulled from the site historian, no direct connection is established to the turbine control software or the facility control system. The PI data is encrypted and sent via a read-only link so Camfil's server cannot send any data back to the facility's system. Analysis and predictions are delivered back to the facility operators via an encrypted, web-based dashboard.

Conclusion

Advanced predictive analytic tools gather intelligence, then provide valuable analysis and critical insights into the status of filters that affect the performance of gas turbines.

By using data-driven analytics to accurately project how local site conditions will affect turbine performance and power availability, plant operators can maintain better control of their facilities and make strategic decisions to improve power output forecasts across the fleet.

Learn more about the innovative PowerEye predictive analytics service designed for this purpose, and how it can provide additional actionable insights, at https://www.camfil.com/powereye.

Camfil – a global leader in air filters and clean air solutions

For more than half a century, Camfil has been helping people breathe cleaner air. As a leading manufacturer of premium clean air solutions, we provide commercial and industrial systems for air filtration and air pollution control that improve worker and equipment productivity, minimize energy use, and benefit human health and the environment. We firmly believe that the best solutions for our customers are the best solutions for our planet, too. That's why every step of the way – from design to delivery and across the product life cycle – we consider the impact of what we do on people and on the world around us. Through a fresh approach to problem-solving, innovative design, precise process control and a strong customer focus, we aim to conserve more, use less and find better ways – so we can all breathe easier.

The Camfil Group is headquartered in Stockholm, Sweden, and has 30 manufacturing sites, six R&D centres, local sales offices in 30 countries, and 4,500 employees and growing. We proudly serve and support customers in a wide variety of industries and in communities across the world. To discover how Camfil can help you to protect people, processes and the environment, visit us at www.camfil.com.