White Paper

What Your Wastewater Operation Needs From a Power Management System

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The next generation of PC-based power management applications should have the capability to not only integrate an active blueprint of the system including system topology, engineering parameters, and other pertinent information such as GIS assets with time-synchronized-data acquired for the purpose of visualizing and depicting the actual operation of the system.

Managers understand the correlation between an unpredictable electrical system and its impact on profitability. In a perfect world a reliable and high quality power supply would be available to guarantee successful operation, profitability, safety, and environmental preservation. Often, this is not the case, and electrical systems are subjected to disturbances of various magnitudes and at various locations. These disturbances either cause minor interruption in the production process and when they are not managed correctly, they may linger long enough to cause a more severe outage that has a substantial impact on revenue in the tune of millions of dollars per incident. For example, an electrical fault or any other type of electrical disturbance that disrupts the power supply in a 24/7 water treatment operation can lead to a major loss of revenue in the process especially in today’s high priced environment.
This paper will explore the vital features and benefits of the modern power management software.

**Intelligent Monitoring**

System monitoring is the base function for any power management software. In addition, seamless integration with metering devices, data acquisition, and archiving systems are essential to monitoring software. Real-time or snapshot data are linked to an online model of the system for proper presentation of actual operating status.

All this information should be accessible to the system operator through advance man-machine interfaces such as an interactive one-line diagram that provides logical system-wide view.

The next step is to process the telemetry data and determine the missing or faulty meter values using advance techniques such as *State and Load Estimator (SLE)*.
The system should also be able to compensate for absence of physical meters by providing virtual metering of devices. Graphic watch windows summarize and record alarm conditions in case of unusual activity and provide continuous visual monitoring of user-selected parameters in any mode of operation. This provision would allow early detection and display of problems before a critical failure takes place. Periodic validation of the measuring devices is critical to any power management solution. Online real time validation of these devices with deviation alarming is part of the technology that differentiates the next generation power management solutions available today.

Online Predictive Simulation

Take the intelligent monitoring a step further with the ability to analyze the acquired data. System engineers and operators must have instant access to energy information and analysis tools that allow them to predict an outcome before actions are taken on the system.

In order to design, operate, and maintain a power system, one must first understand its behavior. The operator must have first hand experience with the system under various operating conditions to effectively react to changes. This will avoid the inadvertent plant outage caused by human error and equipment overload. The cost of an unplanned outage can be staggering.
See Figure 1 for a graph of Estimated Production Loss $ per Outage Event for Large (50 MW) Industrial Users. The graph shows the increasing loss in revenue for longer outage times.

**Estimated Production Loss $ per Outage Event**

Production Loss per Event = $/kW x Recorded Peak kW

![Graph of Estimated Production Loss](image)

Figure 1

For industrial and generation facilities that utilize power system analysis applications, the ability to perform system studies and simulate “What If” scenarios using real-time operating data on demand is of the essence. For example, using real-time data, the system operator could iteratively simulate the impact of starting a large motor without actually starting the motor.
Sequence of Events Playback

The ability to recover from a system disturbance depends on the time it takes to establish the cause of problem and take remedial action. This requires a fast and complete review and analysis of the sequence of events prior to the disturbance. Power management software should assist your operation and engineering staff to quickly identify the cause of operating problems and determine where energy costs can be reduced. The software should also be able to reconstruct exact system conditions to check for operator actions and probe for alternative actions after-the-fact. This important tool serves as an on-going learning process for the operator.

Besides reducing losses and improving data gathering capability, such an application should assist in increase plant reliability and control costs. The event playback feature is especially useful for root cause and effect investigations, improvement of system operations, exploration of alternative actions, and replay of “What If” scenarios. Event playback capability translates into savings. These savings for a typical 50 MW plant are illustrated in Figure 2. For example, a conservative estimate of 10% reduction in downtime for an outage that lasts an hour yields about $33,000 in savings.

Online Control

An advanced power management system should provide the options for full remote control to the system elements such as motors, generators, breakers, load tap changers, and other protection devices directly or through existing Supervisory Control and Data Acquisition (SCADA) system.

In addition, the software should provide user-definable actions that can be added or superimposed on the existing system for automating system control. This is similar to adding PC-based processors/controllers (kV, kW, kvar, PF, etc.) or simple breaker interlocks to any part of the system by means of the software.
Supervisory and Advisory Controls

State-of-the-art supervisory and advisory control capabilities should be used to control and optimize in real-time various parameters throughout the system. Using optimization algorithms, the user could program the power management system (i.e., assist energy consumers by automatically operating their system to minimize system losses, reduce peak load consumption, or minimize control adjustment). For energy producers, this energy management system could be set up to minimize generation fuel costs, and optimize system operation.

In a recent study performed for a large industrial facility (150MVA), advanced optimization algorithms, native to the energy management system, were utilized to reduce real and reactive power losses. Assuming a conservative power loss reduction of only 0.1% at an average electrical energy cost of US$0.103/kWh, an energy management system would yield savings of more than US$135,000 per year and would pay for itself through the immediate realization of savings in operating and maintenance costs.

Intelligent Energy Management

An intelligent energy management software control system is designed to reduce energy consumption, improve the utilization of the system, increase reliability, and predict electrical system performance as well as optimize energy usage to reduce cost. The next generation Wastewater energy management applications will use real-time data such as frequency, actual generation, tie-line load flows, and plant units' controller status to provide system changes.

There are many objectives of energy management software including an application to maintain the frequency of a Power Distribution System and to keep tie-line power close to the scheduled values. In intelligent energy management software scheduled values will be maintained by adjusting the MW outputs of the AGC generators so as to accommodate fluctuating load demands. The energy management software application will also calculate the required parameters to optimize the operation of the generation units under energy management action. Provide a user interface that allows for Interchange Scheduling and the operator has the capability to schedule energy transfer from one control area to another while considering wheeling, scheduling ancillary services, and financial tracking of energy transactions.
Energy Accounting

Predicting system-wide energy usage can avoid unnecessary peak demand charges and penalties. Energy accounting software provides energy usage analysis and cost allocation for individual process units, areas, and the entire system. The plant management can track and create energy billing reports based on user-definable energy cost functions and energy tariffs. The energy cost / profit analysis and energy consumption billing are reported for each process area of the plant and can provide useful information to decision makers and improve energy usage of existing plant facilities.

Intelligent Load Shedding

A major disturbance in an electrical power system may result in certain areas becoming isolated and experiencing low frequency and voltage, which can result in an unstable operation. The power management system should have the intelligence to initiate load shedding based on a user-defined Load Priority Table (LPT) and a pre-constructed Stability Knowledge Base (SKB) in response to electrical or mechanical disturbances in the system. Load shedding schemes by conventional frequency relays are generally a static control with fixed frequency settings. Based on Neural Networks, a power management system would be able to adapt to all real-time situations and provide a true dynamic load shedding control. This would allow the operator to optimize load preservation, reduce downtime for critical loads, and simulate/test the load shedding recommendations.

Another significant cost component of operations is demand charge of the energy bill. The demand charge is 40%-60% of the bill for sites without peak shaving generation. A single unmanaged demand charge can produce a very large hike in the power bill each month and with “ratcheting” demand charges (the Eskom Network Access (NAC) charge applies to the highest recorded demand above the notified demand for 12 consecutive months), the penalty then has a bearing for a whole year. An intelligent combination of smart applications can provide the current and predicted demand for each day thus managing peak demands on a continuous basis. Loads can be shed intelligently and automatically, peak-shaving generators can be started, load startup can be postponed or sequenced, or penalty can be paid if certain processes are vital.
Conclusion

A typical power management system evaluates collected data in a non-electrical system environment without recognizing the interdependencies of equipment. Extending the power monitoring system by equipping it with an appropriate electrical system context, simulation modules, and playback routines will provide the system operator and engineer with a powerful new set of tools. Using these tools, the user can accurately predict the behavior of the electrical system in response to a variety of changes. The playback of recorded message logs into the simulator-equipped monitoring system provides the operator with an invaluable means of exploring the effects of alternative actions during historical events.

These simulation techniques will provide a revolutionary training tool to effectively prepare the Mining operators of the future. Never before has the industry been able to take an electrical system model from the design environment and readily extend it as an operator training asset.

Finally, all of these capabilities should be included in one application with the flexibility and compatibility that allows you to expand and upgrade your power management system as your needs grow.

Operation Technology, Inc. develops and markets a full range of real-time simulation, monitoring and supervisory control services, including design, engineering, and consulting services. The company’s premier real-time simulation platform, the ETAP® Power System Monitoring & Simulation (PSMS™), offers energy efficiency improvements with Energy Management System (EMS™), intelligent load shedding (ILS™), and automatic supervisory control to help customers manage the Wastewater operations investment.