Generator Management

White Paper

The Need for Back-up Power

The use of cellular telephones and Internet access from non-traditional sources has increased dramatically over the last decade. According to the International Telecommunications Union (ITU), the number of cell phone subscriptions worldwide reached 4.6 billion by the end of 2009 and is expected to reach five billion during 2010. The increase has been driven not only by developed countries but also in developing countries where services like mobile banking and social networking have become important.

In addition to the increase in cell phone use, the demand for mobile access to the Internet has also dramatically increased. At the end of 2009, there were more than 600 million mobile broadband subscriptions, and this is expected to exceed one billion subscribers during 2010. The ITU expects that more people will use the Web from laptops and mobile devices during the next five years than from desktop computers.

The success of telecommunications providers is driven by subscribers: the more subscribers, the more revenue. Because such a large number of people already use cellular services, one main way for service providers to obtain more subscribers is to "steal" them from a competitor. A major reason customers switch providers is because of poor quality and reliability (bad connections, dropped calls, and other service quality issues), so improving these factors is critical.

One important means to ensure reliability and maintain quality is providing back-up power to cell sites, such as with generators or fuel cell power systems. As countries have experienced numerous times, when commercial power fails, such as during natural disasters, communications are vital. Whether it is an ice storm in Canada, a tornado in Oklahoma, or a hurricane in the Caribbean, the telecommunications industry often experiences heavy losses due to the loss of power to much of its infrastructure. By having a contingency plan that utilizes portable or fixed back-up power systems, revenue loss and network downtime are minimized.

Because generators are the primary source of back-up power, the remainder of this whitepaper explores what should be managed and how to manage generators efficiently and cost-effectively. This paper focuses on the telecommunications industry, but the concepts apply to other industries that utilize generators, such as hospitality, transportation, and utilities.

What is Generator Management?

There are many aspects of generator management that telecommunications providers should consider when preparing a new recommendation or adjusting their current model for diesel generators, portable generators, or cell site on wheels (COW)s:

- Preventative maintenance
- Remote access
- Fuel management
- Alarm notification and reporting
- Regulations

Preventative Maintenance

Many businesses have internal objectives to perform preventative maintenance on generators, batteries, and rectifiers. This requires a physical site visit to inspect fuel levels, alarm conditions, and to manually start and stop a generator, ensuring it is ready when required.

Unfortunately, due to the increased responsibilities of field technicians, preventative maintenance is often postponed to focus on revenue-generating activities, such as infrastructure build-out or technology upgrades. Because these sites are either business critical or geographically remote, the operational cost is higher due to physical site visits. Having a preventative maintenance schedule for generators helps prevent downtime, increases reliability, and protects your business.

A comprehensive generator management solution should provide the ability to schedule an automatic or manual start/stop of the generator and run it for a defined period of time. Additionally, the service provider should be able to monitor real-time fuel levels. These preventative maintenance activities ensure the generator is ready to use when it is needed.

Remote Access

Generators must be continually monitored to ensure optimal performance. Unfortunately, in many areas of the world, sending technicians to a cell site is difficult and expensive because of poor roads, weather, safety, and the remoteness of the tower location. The ability to remotely access the cell site to check on generator status (and other items such as HVAC, batteries, temperature, security systems, etc.) greatly reduces the operating expenses, improves service quality, and increases security.

Remote management and access to generators at a cell site or COWs is designed to address diagnostic, repair, and preventative maintenance activities required to control operational costs and improve network quality, security, and availability. Remote access and monitoring can be used to retrieve generator information such as runtime, oil and water temperatures, field current, and fuel remaining. Providers should also be able to schedule maintenance events, provide immediate correction of service-affecting problems, and remotely start/stop the generator as part of regular preventative maintenance.

Fuel Management

Understanding and managing the generator fuel level is critical, especially during emergency situations such as natural disasters or when cell sites are located in remote areas. With the increasing cost of fuel, providers need to manage the operating expense both at individual sites and across the network. It is important to monitor fuel levels to facilitate timely refills and know how much time remains while under load.

To manage fuel effectively, thresholds should be user-definable for low fuel remaining, and once the low level is reached, automatic notification to the relevant personnel should be initiated. If fuel consumption is higher than the "normal" consumption rate (often caused by a leak or fuel theft), an alarm should be automatically generated. Alarms should also occur if a fuel cap is opened or if the fuel becomes contaminated.

To better understand the fuel situation at a remote site, reporting is required. Running reports remotely enables the provider to understand the site fuel requirements without dispatching a costly technician, ultimately reducing operating expenses. Reports should include the following:

- Fuel level
- Fuel consumption
- Estimated time until refuel

Managing fuel is extremely important when preparing for a storm or after an outage occurs. For example, if a hurricane causes a commercial power outage, providers should be able to utilize reports to quickly determine which sites have the highest priority for refueling based on fuel remaining and estimated time to refuel. The provider can then dispatch resources based on valid data to minimize operating costs and network downtime.

Alarm Notification and Reporting

Managing generators, especially at remote cell sites, can be challenging. However, with the right alarm notifications and reporting capabilities, information should be easy to access and issues can be resolved quickly.

Whether for preventative maintenance or issue resolution, understanding that a problem exists is the first step to operating a generator effectively and efficiently. Alarming should be utilized to understand various aspects of the generator, such as start/stop failures, fuel levels or abnormal fuel consumption, if the generator is running or stopped, if service is needed, or if there is a mains power failure, as examples. The alarms should be automated to provide immediate notification to the relevant personnel of impending issues.

With the proper tools installed, reporting on generator activity should be easy and provide both real-time and historical information. Reports can be used not only for making the generator as efficient as possible but also for providing relevant information to government or regulatory bodies on compliance issues. An example of information that should be provided from reports include generator runtime, temperature, voltage, oil pressure, engine speed, fuel level, and time remaining until load transfer.

Regulations

The increased awareness and concern for global warming and carbon dioxide (CO_2) emissions and its long term effects have spurred countries around the world to take action. For example, the South African government has a vision and mitigation strategy for drastically reducing their impact on the climate. Since the early 1990s, Europe has been reducing the amount of emissions allowed for many types of vehicles. There are seven Western states in the United States (US) and four Canadian provinces that have created the Western Climate Initiative (WCI) to create a plan for use throughout the region to reduce greenhouse gas emissions to 15 percent below 2005 levels by 2020.

Telecommunications providers are not exempt from helping protect the environment. According to the Environmental Protection Agency (EPA), light duty vehicles account for 62% of all greenhouse gas emissions in the United States. Each gallon of gas a car burns emits 19.4 pounds of carbon dioxide. Reducing the number of truck rolls related to onsite repairs by performing these repairs remotely will drastically reduce emissions.

In the US, there are regulations that mandate commercial owners of diesel generators to report excessive use (more than 20 hours per year). For example, in California, service providers must provide the EPA with generator runtime numbers. It is also critical for providers to be EPA and Federal Communications Commission (FCC) compliant to eliminate the possibility of fines. If a generator is tested or running on an EPA's designated "Bad Air Day", the fine could be thousands of dollars per instance. If a generator isn't checked at designated intervals per state or national standards, the service provider can also be fined.

The initiatives to reduce greenhouse gas emissions are more prevalent today than just a decade ago, and service providers will need to ensure they understand how their daily activities may need to change to meet new mandates, such as reducing vehicle mileage and reporting on generator usage.

Westell Generator Management Solution

Reducing operating expenses while improving network quality is critical to the success of service providers in today's competitive marketplace. The comprehensive Westell generator management solution helps providers understand and manage generators to their maximum efficiency, substantially minimizing costs and easily providing information required to meet regulatory needs. The Westell solution consists of the Optima management system and Remote suite of products.

The Optima management system provides complete visibility and control of network infrastructure sites, such as cell sites, cell sites on wheels, switch sites on wheels (SOWs), cell sites on light truck (COLTs), and remote communication huts. Optima delivers these site benefits by providing remote monitoring, control, and automation over the maintenance and management of infrastructure and physical elements with an easy-to-use Graphical User Interface. (See Appendix A for more information regarding Optima.)

The Remote product family includes monitoring and control site devices that provide IP management to remote locations and equipment. Remote provides site alarm monitoring, protocol conversion and equipment connectivity and acts as an intelligent extension of your Operations Support Systems (OSS). It is designed to enhance your network management strategy, reduce operational costs, and improve operational efficiency with reduced truck rolls. (See Appendix A for more information regarding the Remote family of products).

Preventative Maintenance to Ensure Availability

Westell gives solution providers the tools necessary to implement preventative maintenance on generators, ensuring it is ready and available when required. Using the Westell Remote, a service provider can remotely start and stop the generator either automatically on a predetermined schedule (customizable) or manually. A timer can be programmed for a designated time but can easily be altered when necessary. Some governments require a generator to run for a designated amount of time each month. For example, if it is required to run a generator once a month for 30 minutes, Westell can automate this process to occur at a particular time each month. This can also be completed manually, which may be important for areas that have restricted emissions when air pollutants are high (sometimes referred to as "Bad Air Days"). The routine cycling of the generator ensures it will be ready for use when necessary (see Figure 1 for generator runtime report).

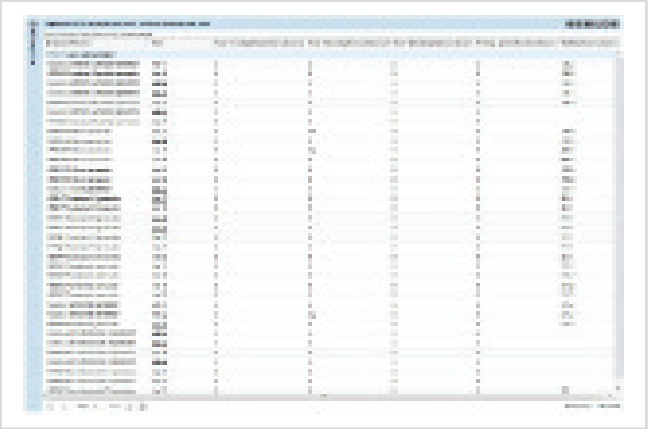

Figure 1: Optima generator runtime report

Fuel is critical for running a generator, and understanding fuel status provides valuable information. Westell supports both ultrasonic and pressure-based fuel sensors mounted either on top of or placed in a fuel tank. Reports on fuel level (see Figure 2), fuel consumption value, time until refill, and time remaining while under load can be performed on a cell site or on multiple sites throughout a network. Based on this information, service providers can schedule fuel delivery on an "as needed" basis instead of a defined period of time. This ensures there is enough fuel to run the generator in the current situation and proactively plan accordingly during stressed periods, such as natural disasters. Because Remote and Optima support one to many, multiple tanks of varying sizes and shapes can be managed in parallel.

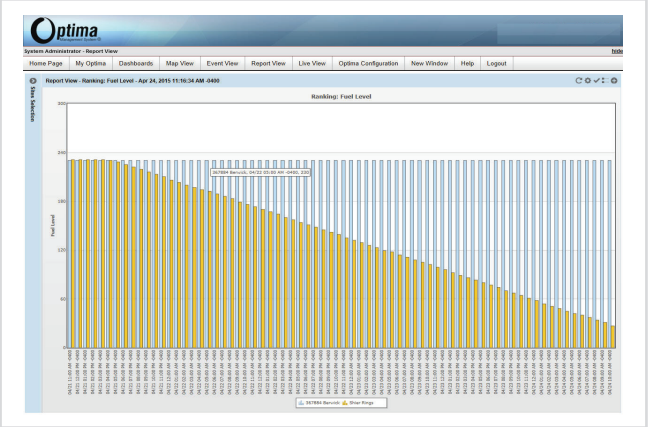

Figure 2: Optima fuel level report

Preventive maintenance on the generators can be automated, and on-site maintenance can be scheduled and combined with other local site visits rather than dispatched on an emergency basis. Most preventative maintenance activities on the generator can be conducted remotely, ultimately reducing operating expenses while improving technician efficiencies. Understanding the fuel situation at any given time ensures continual availability of the generators.

Reduce and Improve Truck Rolls with Remote Management

Using the remote management capabilities available with Optima and Remote, diagnostic truck rolls can be reduced or eliminated. If a truck roll is required, the technician has information regarding the issue and will be better prepared to fix the issue on the first site visit. Additionally, because Westell collects generator data with a time and date stamp, it is not necessary for a technician to manually update a binder on generator runtime, eliminating potential inaccuracies.

Ensuring the generator is in good working condition is critical to network availability. The Westell Remote provides alarming that will notify the relevant personnel if an issue arises. Some of these generator alarms are listed below, and additional controller-specific alarms are also available (contact Westell for more details):

- Start/stop failures
- Generator running
- Generator service needed
- Abnormal fuel consumption (total consumption exceeds expected consumption)
- Refueling
- Fuel theft
- Low fuel level
- Fuel cap open/closed
- Fuel contamination (water in fuel)
- Mains power failure/restore

It is not uncommon for a generator to stop responding. If this happens, the Westell solution sends an alarm to the relevant personnel via email or SMS. The technician can log into the Remote from any location having a network connection, review the issue, and fix it remotely. If it is a “generator stop failure”, for example, the technician can take the appropriate corrective action without having to drive to the site.

Instant problem detection and remote repair provide immediate correction of common site conditions. This can drastically reduce operating costs by eliminating a site visit, especially if the cell site is in a remote location such as on top of a mountain where traditional vehicular access is difficult or impossible or access to the site is limited due to landlord restrictions and notification clauses.

Remote also monitors the generator key switch state: Auto, Off, or Manual. If the switch is moved to the manual state, the relevant personnel are alerted. This may signify that a technician or contractor is at the site, and therefore, no updates to the system should be made at this time. This notification often prevents a false dispatch.

Using Optima to review all remote and unmanned sites in the service provider’s network, required on-site maintenance can be scheduled and combined with other local site visits rather than dispatched on an emergency basis. Degrading conditions can be repaired proactively before service is affected or an outage can occur, resulting in improved network availability and a superior customer experience.

Optima can provide reports (see Figure 3) on the following generator items in order to ensure the back-up power is available when required:

- Runtime
- Oil pressure
- Temperature
- Voltage
- Current
- Start battery voltage
- Engine speed
- Fuel level
- Fuel consumption value
- Time until refill
- Time until load transfer

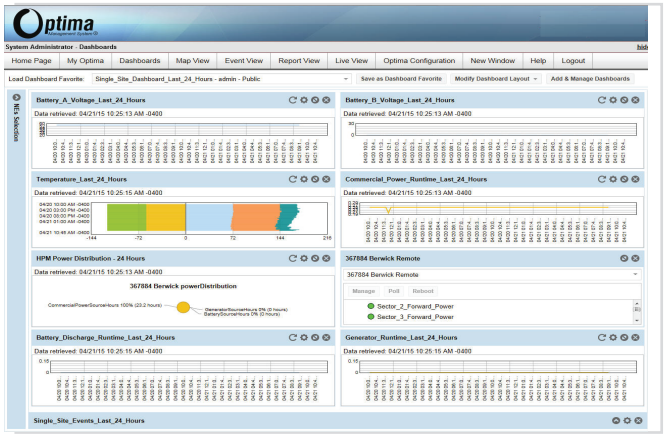

Figure 3: Optima report to review performance and network status

In addition to monitoring and managing generators, service providers can also use the same Westell products to proactively and remotely monitor and manage all critical site elements, including security and AC/DC power systems, environmental equipment and conditions, local loop equipment, radios, antennas, and backhaul circuits, regardless of technology or manufacturer (see Figure 4). For example, Westell remotely monitors HVAC systems, allowing for the customization of HVAC behavior without having to dispatch a technician to a site. It allows the remote adjustment of set-points and runtime parameters to ensure optimal running conditions based on site assets and capacity requirements. The ability to remotely monitor and control the HVAC system creates the opportunity to reduce operating expenses through proactive management of these systems.

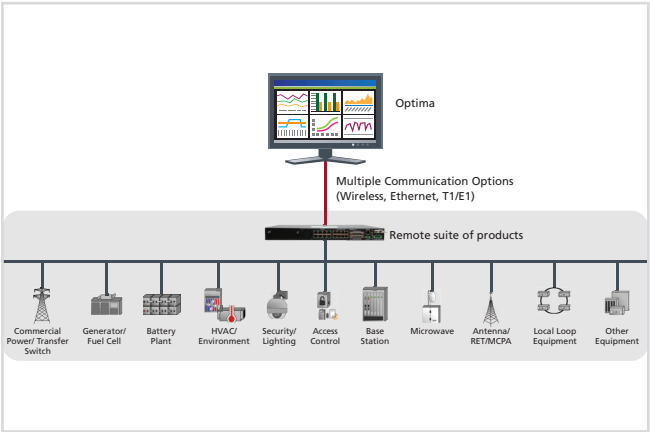

Figure 4: Westell remote site management solution

Meet Regulatory Requirements with Accurate Reporting

Many government or regulatory agencies require documented proof and accuracy of generator activity to ensure compliance with regulations. The Westell generator management solution enables operators to show regulatory compliance with agency mandates (such as the EPA and FCC), and these activities can be managed without driving to a remote site. For instance, assume that generators in a given area are scheduled to start every Monday as part of a provider's internal preventative maintenance objectives. Using Westell remote site monitoring and management, a technician can start the generator remotely, eliminating a site visit. If Monday is a "Bad Air Day", the testing can be altered remotely and rescheduled as necessary, reducing the risk of a compliance fine.

Reports can be automated or manually generated to show generator runtime and provide the documentation to the regulatory agency for compliance. In addition to generator runtime, a report can also be created to show time of day, providing proof that generators are not running when inappropriate. The historical and real-time reporting (see Figures 5 and 6) allows service providers to gain a single, consolidated view of generator status as well as all primary and back-up power. This improves technician efficiency because labor is not needed to collect runtime readings, and accuracy is ensured.

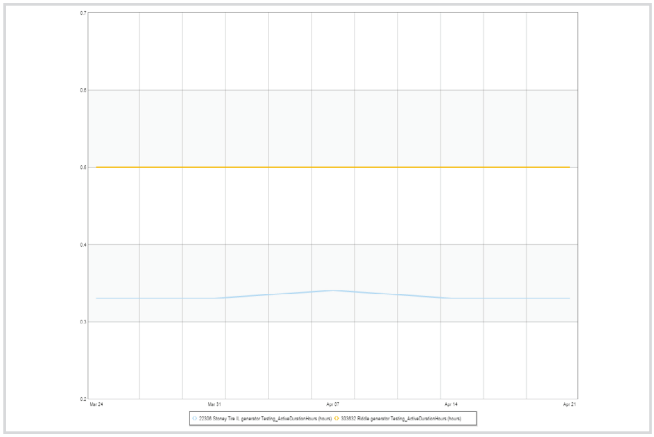

Figure 5: Optima generator real-time runtime reports

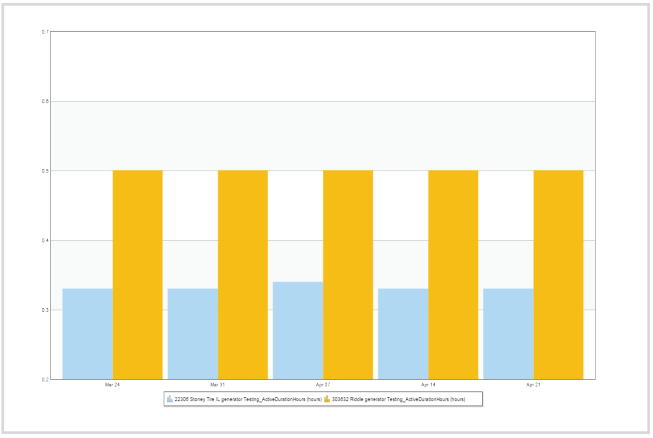

Figure 6: Optima historical generator runtime report

Reduce Energy Consumption and Environmental Impact

In addition to managing and monitoring generators, Westell also provides a comprehensive view of cell site power by measuring site power suppliers (generated and commercial power) and large power consumers (HVAC and rectifier/DC plant). The Westell monitoring and management capabilities can help identify conclusions on the following:

- Commercial power reliability
- Generator performance
- Generator run due to commercial power failure
- Generator run due to maintenance
- Rectifier performance
- AC power performance
- HVAC performance

Westell can provide historical fuel consumption reports that may be useful in determining whether a different generator model should be deployed in the future as a result of underperformance. By viewing detailed consumption reports across multiple cell sites, indicators may be found as to whether a generator should be replaced that is either operating under specification or unable to effectively manage the site load. By optimizing the generator size, energy consumption can be minimized.

Westell can monitor the performance of the HVAC and power systems and provide all necessary site status and reporting. This will result in a more complete understanding of each site's HVAC performance and power consumption and enable future site evaluations to be conducted by region, vendor, and more.

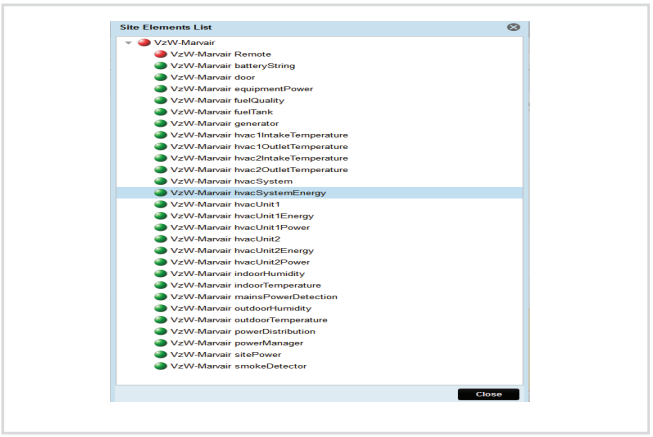

Figure 7: Optima HVAC system status report

HVAC performance management provides real-time management of the systems (see Figure 7) and early detection of maintenance issues which, when corrected, will lead to reduced operating expenses and potentially extended useful life of the equipment. By understanding HVAC performance in relation to a site's cooling load, better replacement planning can occur as well as improved planning for future new builds.

Westell also provides a detailed understanding of site power whether being supplied by on-grid commercial power or off-grid generated power. This insight enables a comprehensive view of site power consumption, HVAC power consumption, and helps identify possible improvements for optimizing power consumption. In the future, this information will also provide a baseline of site power usage and the potential for incorporating alternative power sources.

In addition to power consumption and operating details, understanding individual site loads in relation to generated power capacity allows the efficiency of each generator connected to the Westell solution to be measured.

Monitoring and reviewing HVAC performance, generator efficiency, and rectifier efficiency (see Figure 8) of each cell site allows for proper planning of component replacement and baselining for future site builds. Even more important is the ability to create site-by-site comparisons to identify potential maintenance issues within a region.

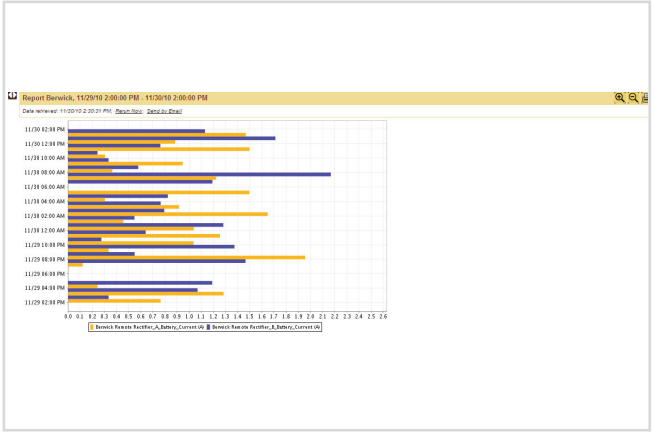

Figure 8: Optima rectifier status report

Improve Network Reliability

According to a 2007 In-Stat report*, the primary reason for subscribers to switch wireless service providers was from dissatisfaction caused by coverage, dropped calls, and network outages. Maintenance and repair issues often cause network issues, and using the Westell solution helps provide network reliability (see Figure 9).

In addition to managing generator availability with preventative maintenance and remote monitoring capabilities, Westell ensures that other back-up power is available when required. Whether it comes from commercial service, solar panels, generators (diesel or propane), batteries, or hydrogen fuel cells, it is a critical component, required 24 hours per day, 7 days a week, to provide the network availability that today's subscribers demand.

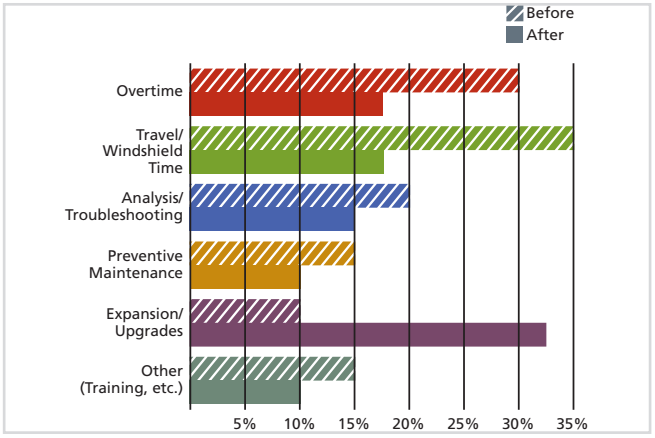

Figure 9: Time spent on tasks before and after using Optima

Westell improves network reliability by:

- Proactively sending notifications of failures with specific site-affecting conditions
- Identifying weak or underpowered battery plants to help improve battery efficiency and effectiveness
- Monitoring fuel levels to facilitate timely refills, performing remote power cycles, and ensuring fuel levels to run generation successfully
- Providing a consolidated view of all power system status (see Figure 10)

Instant problem detection, diagnosis, and remote repair capability will lead to immediate correction of common site conditions. The customer experience will not be affected due to degrading conditions because the poor quality can be detected and repaired before service is affected or an outage occurs, reducing repair time and improving network availability.

Benefits of a Generator Management Solution

The Westell generator management solution enables service providers to lower operating costs, improve efficiencies, increase reliability, reduce capital expenses, and reduce the company's environmental impact, ultimately saving time, energy, and personnel costs – and keeping your customers happy.

Lower Operating Costs, Improve Efficiencies, and Increase Reliability

By implementing remote management capabilities with Optima and Remote, Westell helps reduce the need for physical site visits, ultimately saving fuel, vehicle maintenance, and improving technician efficiencies.

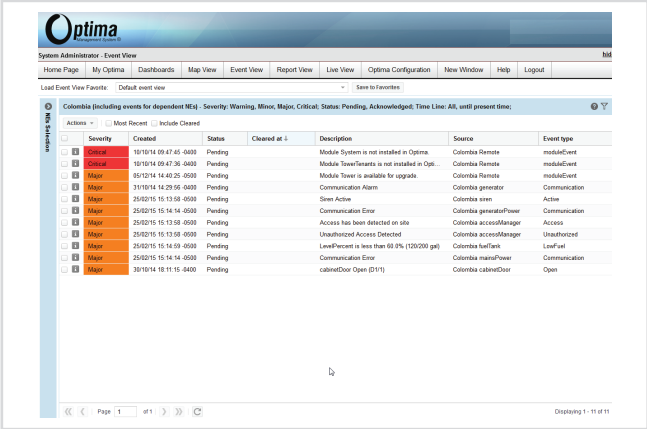

Figure 10: Optima Events List provides notification of degradations, events, thresholds, and alarms to assist with maintenance

Cell sites can become more energy efficient by monitoring and adjusting power utilization (whether from commercial power, batteries, hybrid power, or generators) to ensure effective and efficient operation and reduce energy costs.

Because all generator activity is continually recorded, accuracy is ensured. Reports are available 24 hours/day, 7 days/week and are easily accessible for regulatory or internal review. Immediate alarm notification to technicians provides warning of potential issues, and preventative maintenance can occur before a network outage.

With the increasing costs of fuel, concerns for safety where armed escorts are required, and often poor access to cell sites (bad roads or on mountain tops), Westell remote management capabilities can drastically reduce operating expenses while improving efficiency and reliability with preventative maintenance.

Reduce Capital Costs

Understanding the current situation of cell site generators as well as other hardware such as rectifiers and batteries can significantly reduce capital expenses over time. By monitoring and managing the power infrastructure, hardware life can be extended so replacement costs will be minimized.

Through occasional review of the cell site network using historical reports from Optima, service providers can also minimize capital expenditures by using best-in-breed products and engineering based on real data from their own network. Battery and generator vendors can be ranked on performance in a particular situation to optimize equipment based on a site's requirements.

Reduce Carbon Footprint

Westell enables service providers to significantly reduce their impact on the environment while improving network quality. This is achieved through fewer technician dispatches and improved energy efficiencies.

It is common in many areas of the world to have a fuel truck visit sites at a designated time during the month to refuel generators. By using Westell equipment to monitor the fuel level remotely, trucks can be dispatched when the fuel reaches a designated capacity instead of at a predefined time. Reducing the truck rolls lowers operational costs and significantly lowers carbon emissions from the refueling trucks. Figure 11 shows the amount of CO2 emissions saved by eliminating just a few truck rolls per week.

Proactive performance management with Westell tools allows service providers to monitor site systems and equipment remotely instead of having to dispatch a technician. Thermostat settings often need to be changed when seasons change. Instead of a site visit, Westell can automate the schedule and remotely change the thermostat levels. This optimizes the energy that is used at each site by changing the temperature at the appropriate time.

Optimizing back-up power at a site also improves energy efficiencies and reduces the carbon footprint. When primary power is not available, it is common to use a combination of battery and generator power. By implementing the Westell remote management solution, the generator can be automatically turned on to recharge low batteries and then turned off, reducing energy usage and extending power coverage during primary power outages. This also minimizes battery and generator disposal.

Westell site monitoring, management, and control solutions enable service providers worldwide to reduce the impact of doing business. Through remote capabilities, Westell enables carriers to reduce mean time to repair (MTTR) by 50%, reduce WAN-related outages by 50%, increase technician efficiency by 25%, and reduce maintenance costs by 30%. These improved efficiencies reduce truck rolls by 50%, reducing greenhouse gas emissions by millions of pounds per year while optimizing the energy efficiencies of remote sites.

	Eliminating 3 truck rolls/ week/truck	Eliminating 2 truck rolls/ week/truck	Eliminating 1 truck roll/ week/truck
Annual CO_2 emissions saved for 1000 trucks	3.3 million pounds	2.2 million pounds	1.1 million pounds

Figure 11: Annual Co2 emissions saved for 1000 trucks. Assumes 20 miles/truck roll and 18 miles/gallon