QUIET GENERATORS. HAPPY GUESTS.

The Economic Case for Adding Electronic Voltage Regulation to Backup Power Systems at Hotels, Resorts and Casinos.

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Introduction

Once, vacationing meant occasionally tolerating rustic conditions. No longer. The modern consumer expects a "quality power experience" wherever they go. Anything less immediately generates a demand for comp days and the posting of bad online reviews.

Modern travelers have grown increasingly intolerant of disruptions even minor power fluctuations can cause. Often, guests will demand full compensation for days inconvenienced by even modest service interruptions.

In developed regions of the world, this is not a big problem.

But as the demand for exotic travel experiences grows, resort developers are increasingly building in places where power quality remains a significant challenge – the Caribbean, Central America, South America, the South Pacific, much of Africa, and parts of Asia. Until very recently, in order to ensure that essential services could be maintained, engineers had to design backup power systems that would start the moment a power anomaly occurred, sever the connection to the local grid and supply power independently, not only during blackouts, but also during more prevalent brownouts, sags and surges.

Within the last decade, an extremely reliable and low maintenance technology, electronic voltage regulators (EVRs), transformers equipped with electronic on-load tap changers, have proven very effective at compensating for variations in incoming voltage. When an EVR is placed between the source and the load, many of the electrical "events" that now cause traditional backup systems to engage can be safely bridged. Further, and more importantly, an EVR can allow a facility of any size to remain connected to the local source, through brownouts, sags and surges of any duration, while still providing full power for all guest services.

SAGS AND SURGES AND BROWNOUTS, OH MY!

SAGS

The American "sag" and the British "dip" refer to a voltage decrease to between 10% and 90% of nominal voltage for a duration of anywhere from one-half cycle (.008 seconds) to one minute.

SURGES

Surges, or transients, are very short duration (sub-cycle) events of varying amplitude. Surges can be caused by equipment operation/failure or by weather events like thunderstorms. Even low-voltage surges can cause damage to electrical components if they occur frequently.

BROWNOUTS

A brownout (undervoltage) is a decrease in voltage below 90% of its nominal value for more than one minute. Brownouts are generally a chronic problem in the developing world.

The development of the EVR changes the formula for backup power system design.

In this paper, we compare the total owning cost of a backup power system with and without an EVR for a typical hotel, resort or casino located in a region of poor power quality. Factoring in purchase price, maintenance costs and fuel costs, we compute a raw figure for the number of brownout hours per year that justify a hotel, casino or resort adding an EVR to its backup power system. We also take it a step further. Because an EVR can fully compensate and allow a facility to remain at full power even during extended brownouts, we suggest adopting a more liberal formula for determining an EVR's true return on investment—one that factors in fewer room compensation claims, fewer negative reviews and uninterrupted uptime of revenue-generators, such as slot machines and other pay-to-play attractions.

The Challenge of Operating in Power-Poor Locations

Developers and managers of hotels, resorts, casinos and timeshare communities in places where power quality is a prevalent issue—for example, the Caribbean, Central America and South America—understand the damage inconsistent voltage can cause all too well.

Non-essential systems shut down so compromised power can feed critical systems. Compressors shut off, and with them, so do refrigerators and freezers. Food safety becomes an issue, as do impending restaurant closures. Front desks are flooded with calls and complaints. Refunds are issued. Guest-service scores drop.

In developed regions of the world, this is not a huge problem.

In much of the developing world, however, power quality problems remain a huge issue. Typically, a combination of diesel-powered electrical generation for primary systems with limited battery-powered UPSs for sensitive and critical loads are installed to provide backup power generation when voltage from the local grid falls out of spec. Due to the high cost of installation, maintenance and fuel, these backup systems are rarely designed to provide full power. Facility engineers must weigh the costs of backup systems – both initial and lifetime – against potential losses that might be incurred when non-essential systems go offline.

But the formulas that dictate what constitutes acceptable risk, and therefore adequate backup, are changing as global competition heats up and as consumer expectations of an “invisible” quality power experience rise.

Until recently, decisions regarding backup power systems were binary. If the local grid could not be trusted to consistently supply “clean power,” engineers were forced to design systems that could temporarily sever a facility from the local source and provide independent backup. But a new technology, electronic voltage regulators (EVRs), transformers equipped with electronic on-load tap changers, now allow for a less binary formula that is also more economical and efficient.

Time [Off the Grid] is Money

To attract vacationers and increase revenue, the hospitality industry is installing more and more power-dependent attractions—from casino and video gaming to electronic lounges. As a result, costs associated with frequent power interruptions are on the rise.

> You're the general manager of a beautiful Caribbean resort, and you're facing a brownout. Again.

Budget-conscious and demanding travelers are increasingly intolerant of disruptions that even minor power fluctuations can cause. Often, guests will demand discounts or full financial compensation for days they are inconvenienced by even modest service interruptions, and bad online reviews often follow. These "hidden" costs, which can amount to hundreds of dollars per room, can be as great a factor in the financial equation as the cost of diesel fuel. The bottom line is that when amenities are operating at full power, more revenue is being earned.

Tapping the Power of an EVR

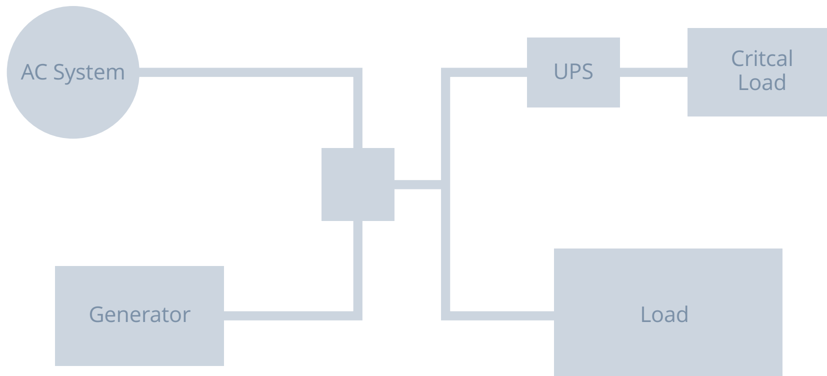
The EVR is the modern standard for voltage regulation in most power quality applications. Electronic voltage regulators minimize and balance out variations in voltage to protect equipment that draws electricity from a power source. As electronics become more prevalent in hospitality, industrial and commercial applications, the EVR's speed and performance advantages allow it to fill a gap in backup power system design that older, slower mechanical voltage regulators cannot.

EVRs "sense" even the smallest voltage fluctuation within a single cycle and adjust electrical output by transforming the voltage coming in from the grid before passing it through to the load they serve. This allows facilities to remain safely connected to the local grid and deliver full power to all services whenever incoming voltage swings above or below a safe range—including extended brownouts. An EVR does not supply power and cannot compensate during periods of total power loss (blackout). Rather, they compensate for voltage sags, swells and brownouts. But used in conjunction with an existing generator and/or UPS, which provide blackout ride-through, an EVR is a safe, reliable and money-saving way to ride through daily, weekly and monthly power-quality issues that would otherwise require resorting to backup power generation systems. And EVRs have industrial-grade durability, an unlimited life span, and no moving parts to maintain.

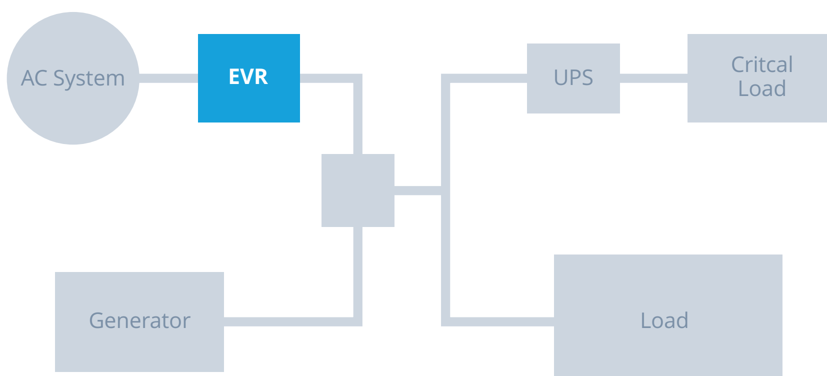
Analysis

In the following analysis, we compare the total owning costs of two backup power options. The total owning cost is comprised of two figures: the initial purchase price of each piece of equipment and the yearly running cost of each piece of equipment.

Standard Backup Power Systems Configured Without and With an Electronic Voltage Regulator



Option A depicts a system that has, for the past quarter century, been applied to mitigate power anomalies. Option A relies upon a UPS to provide sag and surge protection and to supply full power to sensitive and critical loads (~15%) during brownouts. It also relies upon diesel generation to power essential services, such as HVAC, refrigeration and elevators.



Option B supplements Option A with an EVR, which allows the system to remain at full power without diesel backup during power surges, sags and brownouts of any duration. The addition of the EVR not only reduces reliance on diesel, but it also reduces wear and tear on the UPS. Because the EVR will compensate for all surges, sags and brownouts, the UPS will have fewer on/off cycles and less required maintenance.

Option A: 1200 KVA SYSTEM as designed, with a 200 KVA UPS system deployed to protect critical and sensitive loads, such as sensitive computing equipment, and a 1200 KVA diesel generator to power essential services. In this option, the generator control is set to initiate when the local voltage drops below 90%.

Initial Cost:

Generator	$320,000
UPS	$87,000
Total	**$407,000**

Yearly running cost:

The cost of a diesel generator running at ¾ load is approximately $630/hour. This figure assumes that diesel fuel costs a conservative $10/gallon delivered and .07 G/KWH. The annual cost for UPS maintenance, battery replacement and cost of losses is estimated at $21,300 per year.

YRS	100 HOURS	200 HOURS	300 HOURS	400 HOURS
0	407.0 K$	407.0 K$	407.0 K$	407.0 K$
1	554.3K$	617.3 K$	680.3 K$	743.3K$
2	701.6K$	827.6K$	953.6K$	1079.6K$
3	848.9 K$	1037.9 K$	1226.9 K$	1415.9 K$
4	996.2 K$	1248.2 K$	1500.2 K$	1752.2 K$
5	1143.5K$	1458.2 K$	1773.0 K$	2088.5 K$

Option B. 1200 KVA SYSTEM as designed in Option A, to provide power to critical and essential services. In Option B, however, an EVR has been installed between the utility system and the load to reduce reliance on diesel generation during brownouts and to mitigate the sags and surges that would otherwise trigger the backup system. When Option B is utilized, the generator will not need to run until the system voltage reaches 75%—considerably less than in Option A. Were we to go further and factor in residual losses caused by power-related business disruptions, ownership costs would be further reduced.

Initial Cost:

Generator	$320,000
UPS	$87,000
EVR	$240,000
Total	**$647,000**

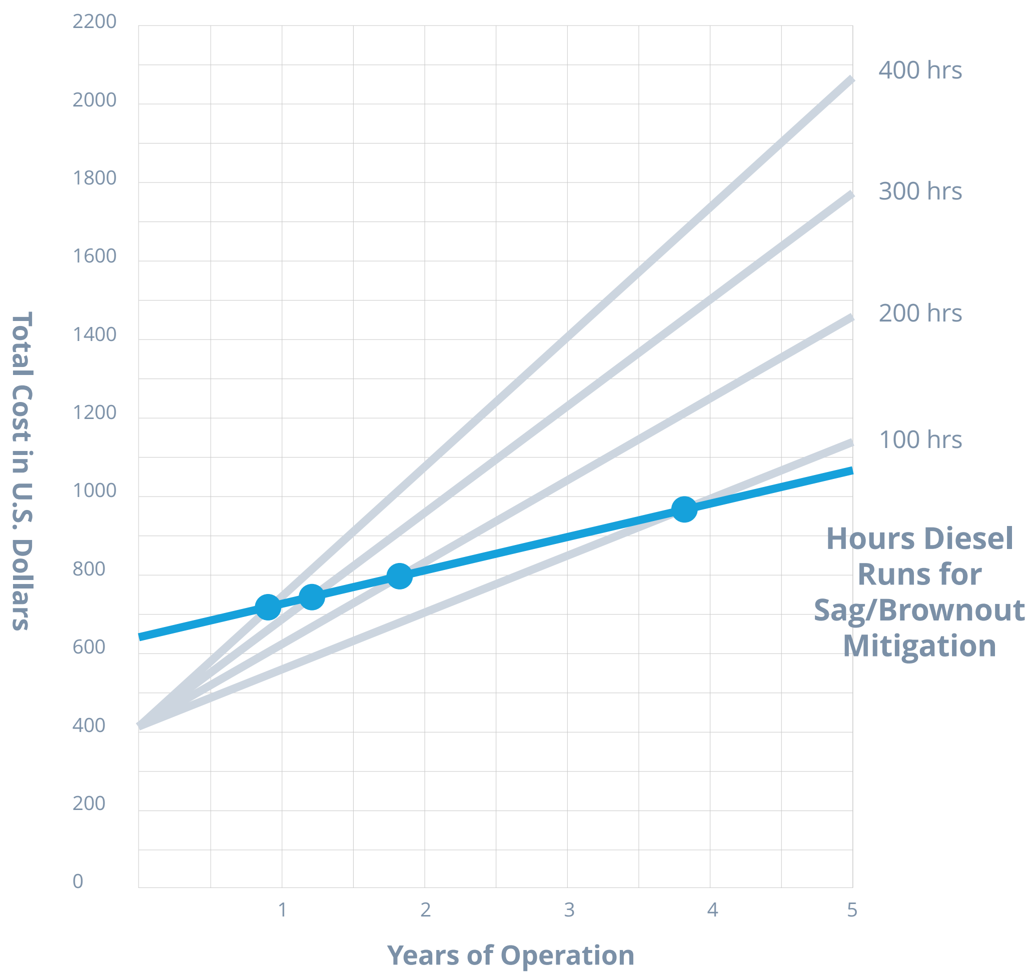
Yearly running cost:

Once again, the cost of a diesel generator running at ¾ load is estimated at $630/hour. This figure assumes that diesel fuel costs a conservative $10/gallon and .07 G/KWH). The annual cost for UPS maintenance, battery replacement and cost of losses is estimated at $21,300 per year.

YRS	TOTAL COST
0	647.0 K$
1	735.1 K$
2	823.2 K$
3	911.3 K$
4	999.4 K$
5	1087.5 K$

Payback

Figure A. Comparison of diesel generator plus UPS, (Option A), and diesel generator with UPS and EVR (Option B). This figure demonstrates payback period based upon the required hours of diesel backup due to sags. At 200 hours of annual diesel runtime to address voltage brownouts, an EVR pays for itself in under 2 years. From that point on, every hour of usage further reduces the total cost of owning an EVR. If the diesel runtime is reduced by 300 hours annually, the payback period is reduced to 1.2 years. At 400 hours, the payback period is just under 1 year.



Conclusion: An EVR is the Third Component of Effective and Affordable Power Mitigation

For many years, diesel generators, in combination with UPS systems, were the standard solution for outages, voltage sags and brownouts. But as we have seen, these devices provide only a partial solution, and at considerable and often unpredictable levels of risk and expense.

This paper explored the compelling financial analysis used by more and more hospitality industry decision makers when adding an EVR as the third component of their power conditioning system. A hard analysis of total ownership costs shows that the EVR helps other mitigation tools (UPS systems and generators) operate more efficiently and effectively. Those who invest in EVRs quickly realize a return on investment and benefit from fuel-cost savings that can amount to more than twice the purchase price of the EVR in just 10 years.

It is important to note that there are soft costs that further strengthen the argument for consideration of an EVR that are not included in these calculations. These soft costs include:

- Reimbursements to dissatisfied guests for stays or conference events impacted by power-quality issues
- Adverse impacts on carefully cultivated marketing assets, such as customer loyalty, ranking, and reputation
- Reductions in sales volumes generated from attractions including, but not limited to casino gaming, directly or indirectly related to power outages, brownouts, and other power-related disturbances

These soft or “hidden” costs can significantly add to a property’s bottom line and positively impact an EVR’s actual return on investment. Adding an EVR improves power continuity and reduces total ownership costs. Because the generator and UPS can be reserved for providing supplementary power during true power outages and not for under-voltage situations, the total system operates more effectively, minimizes preventable downtime, prevents premature equipment failure and data corruption, and preserves all-important guest-service scores.

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