APPLICATION NOTE

The Retrofit Case for Upgrading Legacy Power Systems at Telecom

Introduction

If you were managing an e-commerce, banking, or any other mission critical information technology (IT) operation, would you bet the business on a 15-year-old power system? Probably not, yet that's not an uncommon scenario for telecommunications central office operations that often have decades-old low efficiency, ferro-resonant rectifiers providing power conversion and back up for their critical operations.

As today's telecom central office operations cope with increasing demand for wireless and 5G bandwidth, which strain existing direct current (DC) power plant infrastructures, electrical engineers face the difficult and costly decision to maintain, upgrade or replace their power systems.

Central offices have multiple rectifiers to ensure consistent, quality and backup power, typically for about eight hours. The ferro-resonant rectifiers that have been the power supply mainstay for telecommunication central office operations for decades are slowly and silently declining in performance and energy efficiency as components such as capacitors or diodes age or are not properly maintained. The paradox is that these older rectifiers, as many as 20,000 in use in North America today, are still performing their primary function of converting an electric utility's alternating current (AC) power into DC power for telecommunication switching equipment. However, many of these rectifiers are degrading in their capacity and performance. In fact, many central office operations managers find they can afford to let a rectifier "age in place" rather than incur costs to replace or upgrade them.

A typical ferro rectifier requires that its capacitors are replaced after 70,000 hours or about every eight years. Capacitor failures are often responsible for smoke and emergency fire response. Power diodes are susceptible to damage as are the large internal magnetics. Add up these and other factors and, at a minimum, a "performing" rectifier can cost $300 a year in maintenance and calibration costs. With an average number of 10-12 rectifiers in a typical central office facility, these numbers add up quickly.

Efficiency			LOAD	ANNUAL SAVINGS	
CURRENT	UPGRADE	IMPROVEMENT	CAPACITY	KWH	$
80%	97%	17%	2,400A	386,001	$38,600
85%	97%	12%	2,400A	272,471	$27,247
90%	97%	7%	2,400A	158,941	$15,894
80%	97%	17%	1,000A	160,834	$16,083
85%	97%	12%	1,000A	113,530	$11,353
90%	97%	7%	1,000A	66,226	$6,623
80%	97%	17%	500A	80,417	$8,042
85%	97%	12%	500A	56,765	$5,676
90%	97%	7%	500A	33,113	$3,311

At the same time, these aging rectifiers put additional strain on a facility's energy efficiency and overall operating expense (OpEx) budgets. The chart below shows, based on a utility cost of 10 cents per kilowatt hour (kwh), that with a 2,400 ampere (A) load, for example, those savings might be as much as $39,000 per year with a 17 percent improvement in efficiency. This includes savings from the decreased heat output and consequent reduction of heating, ventilation and air conditioning (HVAC) costs.

A convenient rule of thumb for energy cost improvement is about one dollar per year for each percentage of efficiency improvement, per ampere of DC load.

The degradation of many of these in-place rectifiers presents a threat to the redundancy and power assurance they were designed to provide. Typically, a central office design might have an extra 20 to 30 percent of rectifier capacity for back up and redundancy, but a rectifier failure or even a "retire-in- place" scenario can seriously affect the margin of redundancy. Further, given the degraded performance of an aging rectifier, it might even fail to restart after a prolonged power outage, leaving a site underpowered or without the redundancy buffer normally expected.

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Hold or Replace?

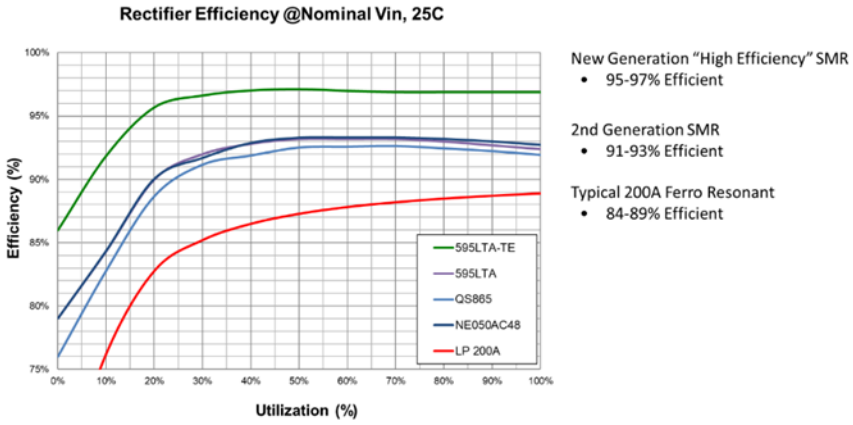
Like any capital equipment evaluation, telecommunications central office managers and power engineers face tough choices in retaining and maintaining a legacy system compared with a full overhaul and transition to new equipment. If the systems are still performing, albeit at lower efficiency and effectiveness, a full replacement campaign is low on the capital planning schedule.

Beyond upgrading or replacing the rectifiers, there are certainly additional capital and transition costs involved in a power system overhaul. With a full replacement, and limited space, the operations team has to cope with taking all the rectifiers off-line during what is typically a multi-week period. During that time, the load needs to be transitioned to a temporary power and protection source. A full replacement strategy also usually includes the upgrade or replacement of existing DC and AC cabling and replacing or relocating conduits and cable connections.

Further, a full replacement impacts capital expenditures (CapEx) and may draw vital capital resources away from other upgrades or transitions to new, revenue generating technologies.

A Path to Retrofit

The alternative to a full power system replacement is a phased-in, upgrade strategy and deployment of next-generation switch mode rectifiers (SMR) specially engineered for a retrofit. A SMR is far more energy efficient than a legacy ferro unit because they incorporate a power conversion switching regulator that continually switches between low-dissipation, full-on and full-off states to limit wasted energy.



These SMR-enabled retrofit power systems (RPS) provide improved energy efficiency and system performance reaching 96 to 97 percent efficiency over legacy system performance which is in the 80 to 85 percent range (See Figure right).

In one telecommunications central office retrofit program, the operation replaced a combination of 400 A and 200 A ferro rectifiers with 27 more compact and energy efficient 220 A 595LT-TEZ series rectifiers. The conversion dramatically improved energy efficiency to 96.9 percent running at 74 percent utilization (see table right) and generated some $58,854 in annual energy savings (based on 10 cents kwh).

LEGACY FERRO	UPGRADED PLANT (RPS)
480V 3 phase ac input	480V 3 phase ac input
15 x ATT400A, 2 x ATT200A Ferros	27 x 595LTA-TEZ
6,400A Capacity Plant	5,400A Capacity Plant
4,023A Load	4,023 A Load
83-87% efficient @ 63% utilization	96.9% efficient @ 74% utilization
Annual Utility: 2,538,355 KWhr	Annual Utility: 1,949,810KWhr

Switch mode rectifiers can be racked into either cabinet or "top hat" (see table below) pedestal forms. Retrofit power system top hat cabinets save installation costs by accommodating existing cabling and power feeds. Traditional cabinet installations, with a smaller footprint, are useful when the goal is to reduce the power footprint and reclaim valuable floor space, but installation costs are inherently higher.

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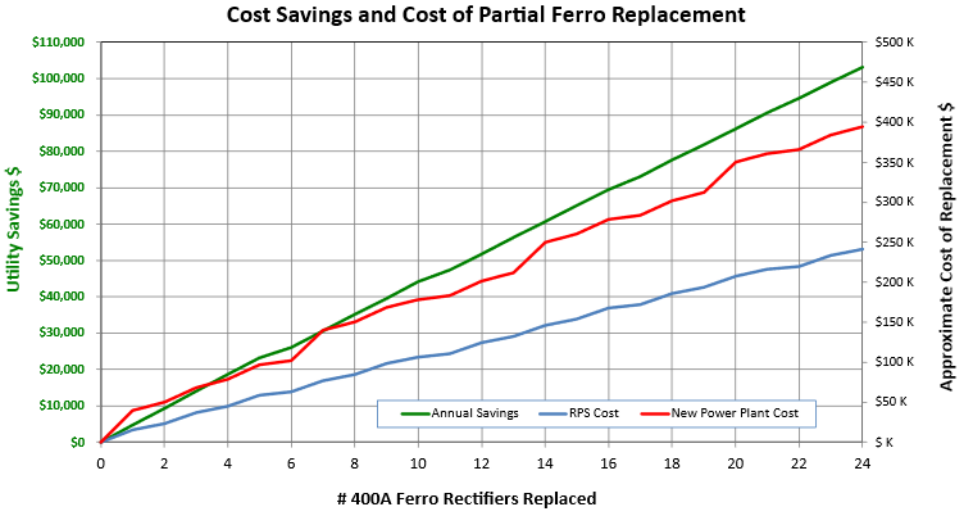
PRODUCT	CAPACITY (A)	H (IN)	W (IN)	D (IN)	AREA (SQ FT)	AMPS / SQ FT	SQ FT / 1,000A
200A Ferro	200	72	13	15.5	1.40	142.9	7.0
400A Ferro	400	72	26	16.25	2.93	136.3	7.3
880A, 6ft GPS Cabinet	880	72	23.6	23.6	3.87	227.5	4.4
3,080A, 7ft GPS Cabinet	3,080	84	23.6	23.6	3.87	796.3	1.3
RPS (2x400A Ferro)	880	72	26	32.5	5.87	150	6.7

In many cases, given the annual maintenance costs cited earlier, it makes sense for an organization to phase-in these retrofits as part of a regular maintenance schedule over a year's time. This phased-in approach also means a facility is upgrading in sync with the acquisition of other new telecommunications technologies.

This phased-in approach can be accomplished when the technology is available to control the legacy ferro rectifiers and the new SMRs in the RPS configuration. The Millennium SC controller can do this, promoting proper load balance and comprehensive monitoring of the hybrid power plant.

Conclusion

Clearly, as older rectifiers are replaced in this phased-in approach, the savings grow, while capital expenditures are spread over an acceptable period (See Figure below). Yet the challenges of improving power efficiency, reliability and reducing OpEx often push against a "can-we-put-this- off" CapEx mindset. Using a retrofit power system specifically designed for a phased-in retrofit approach, telecommunications companies now have a viable option for improving their central office power operations.



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