

eSure™: Realize the Goal of Reducing Energy Consumption and CO₂ Emissions

by Markos Athineos, Global DC Power Engineering and Marketing



Consumer demand for high-speed and mobile communications platforms is pushing feverish deployment of broadband and wireless networks worldwide. Among the challenges this presents is the accompanying increase in energy consumption—which is a large portion of operating expenses for telecom providers. In fact, the Telecommunications Industry Association (TIA) cites vendor estimates that about 15 percent of telcos’ operational expenditures are power-related.

The data below [Table 1] shows the energy consumption of 5 major Telecom Providers. Through extrapolation of this data it is estimated that the telecommunications industry consumes 165TWh (1TWh=1billion KWh) which amounts to 1 percent of the total worldwide electricity demand. When you step back and look at the bigger picture, it becomes clear that power consumption has a huge impact on the bottom line for telecom providers around the world. And that doesn’t even consider the carbon footprint that comes with such massive energy consumption. The 165TWh produces an estimated 99 million metric tons (1 metric ton=1000Kg) or the equivalent CO₂ emissions of 20 million cars [7].

Table 1: Operator Network Energy Consumption [1][2][3][4][5]

Country	Network	Energy Consumption	% of Country Total Energy Consumption
USA	Verizon 2006	8.9 TWh	0.24%
Japan	NTT 2001	6.6 TWh	0.7%
Italy	Telecom Italia 2005	2 TWh	1%
France	France Telecom-Orange 2006	2 TWh	0.4%
Spain	Telefonica 2006	1.42 TWh	0.6%

Telecom providers are paying attention. Skyrocketing energy prices, restrictions on carbon footprints, and an increased emphasis on corporate responsibility (whether genuine or in response to external pressures) are pushing telcos to take energy consumption and carbon reduction seriously. These issues, along with the rising cost and relative scarcity of energy, have led to an increased focus on energy efficiency. In fact, many telecom providers have begun including it as a requirement in their requests for information and requests for proposals from vendors. Decision-makers increasingly weigh the cost of powering a piece of equipment along with traditional features such as reliability, scalability and flexibility. Those decisions more and more often are leaning toward earlier replacement of older equipment in favor of more energy-efficient devices.

The bottom line is telcos can save a lot of money by becoming more energy efficient. But reducing energy consumption is a challenge when consumer demand for telecommunications services continues to grow. This paper will highlight a major opportunity within the telecom infrastructure that will help telecom providers realize the goal of reducing both energy consumption and CO₂ emissions.

Energy consumption of DC power plants in radio base stations and central office equipment

Central offices and radio base stations (RBS) constitute a large part of the telecommunications infrastructure. The DC power plant powers both sites, and accounts for approximately 10 percent of the total estimated energy consumption associated with those sites [Figure 1].

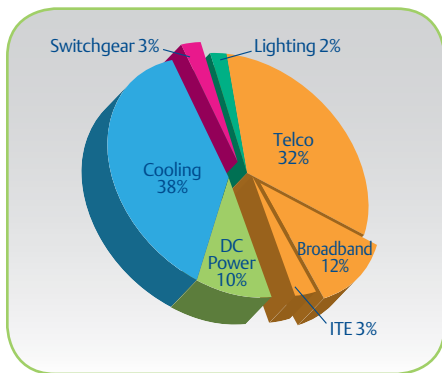
While this may seem insignificant compared to the consumption of the remaining pieces of the infrastructure, the U.S. EPA estimates a 10 percent reduction in energy use by telcos could save the industry more than \$200 million annually and prevent 2 million tons of CO₂ emissions [6].

Achieving typical corporate green initiatives in today's telecommunications industry requires a holistic approach that seizes on every opportunity to conserve energy and reduce operational expenses. Until recently, however, little attention has been given to the methods for improving the energy efficiency of the DC power system or the benefits to be gained from those improvements. But under closer scrutiny, there are several opportunities for significant improvement.

1. Upgrading low-efficiency, older generation rectifiers

Efficiency in DC power rectifiers has been marked by sporadic improvements over the past 30 years [Table 2]. Bulk rectifiers (Ferro resonant, controlled Ferro, SCR, etc.) were the primary source of telecom power until the late 1980s and ran at typical efficiencies of 80-85 percent (many Ferros could exhibit much higher efficiency but only at max load conditions). The advent of modular high-frequency rectifiers in the late 1980s introduced higher power density, reliability and more flexibility and scalability for telecom providers.

Figure 1a: Energy Consumption of Central Offices



Use of energy optimization results in a 36 percent reduction in wasted energy, heat and CO₂ emissions.

Figure 1b: Energy Consumption of Radio Base Stations

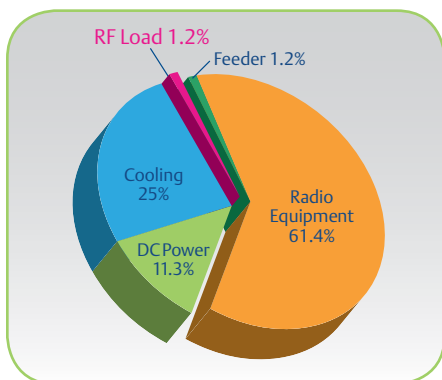
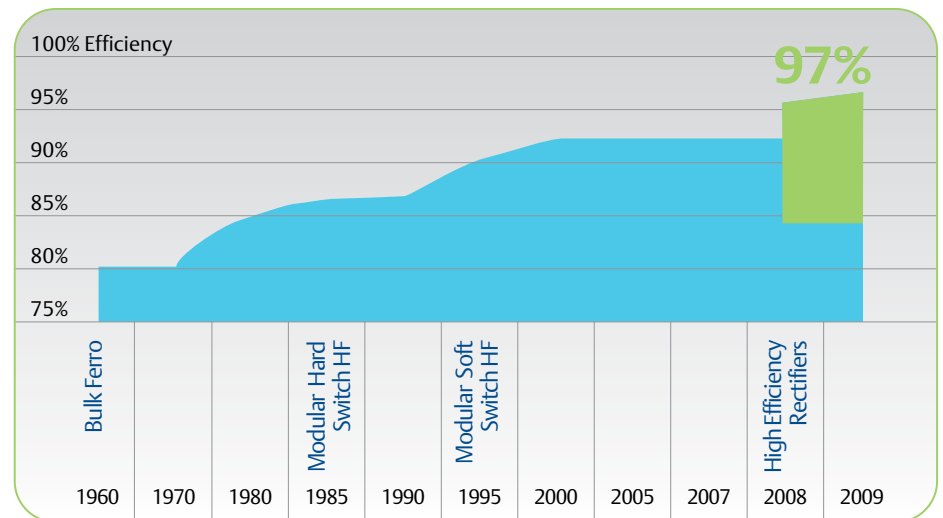


Table 2: Telcom Rectifier Efficiency Trend



While early “hard-switched” modular rectifiers did not offer much of an improvement in efficiency, the high-frequency platform presented opportunities for progressive improvements in power supply efficiency as improved switching semiconductors with lower losses were introduced. The introduction of “soft switch” topologies in the mid 1990s allowed efficiencies to reach a peak of 90-92 percent that until recently has remained relatively fixed. As we will see later, replacing these older DC power plants with the newest generation of ultra-high-efficiency plants can result in substantial energy savings and is an attractive and justifiable investment.

2. Energy vs. load optimization on newer power plants

The majority of today’s modern DC power systems are capable of achieving a maximum peak efficiency of 90-92 percent. However, many of these systems are operating at far less than peak efficiency. As can be seen in Table 3, many “soft switch” rectifiers must operate at greater than 35 percent of their rated load in order to achieve optimum efficiency. Operating below this optimum load (soft switching topologies require a minimum amount of “storage energy” before they can achieve lossless turn on) can result in up to 7 percent lower peak efficiency.

Because systems are configured with redundant units and often sized based on peak load, future demand, battery recharge rates and worst-case assumptions, many sites operate below 35 percent capacity. The exception is during peak load hours and battery recharge state, when they will operate at 100 percent for the short time it takes to recharge the battery.

As seen in Table 4, by applying an advanced system controller scheme, we can ensure the system operates at optimum efficiency in virtually all conditions.

In this energy management control scheme, the controller continuously monitors the load current and will shut down redundant rectifiers to ensure the operational rectifiers are running at the optimum load needed to achieve peak efficiency. The controller also should rotate activation of the rectifiers so they share duty cycles equally over time, ensuring equal wear on all rectifiers. In effect, this algorithm acts as an efficiency optimization for the DC system. Rapid load changes are handled without service degradation or interruption by the presence of the battery bank and the quick response of the rectifiers. The system will react to major load changes quickly by bringing idle rectifiers online in a matter of seconds.

Table 3: Typical Efficiency vs Load of Resonant Rectifier

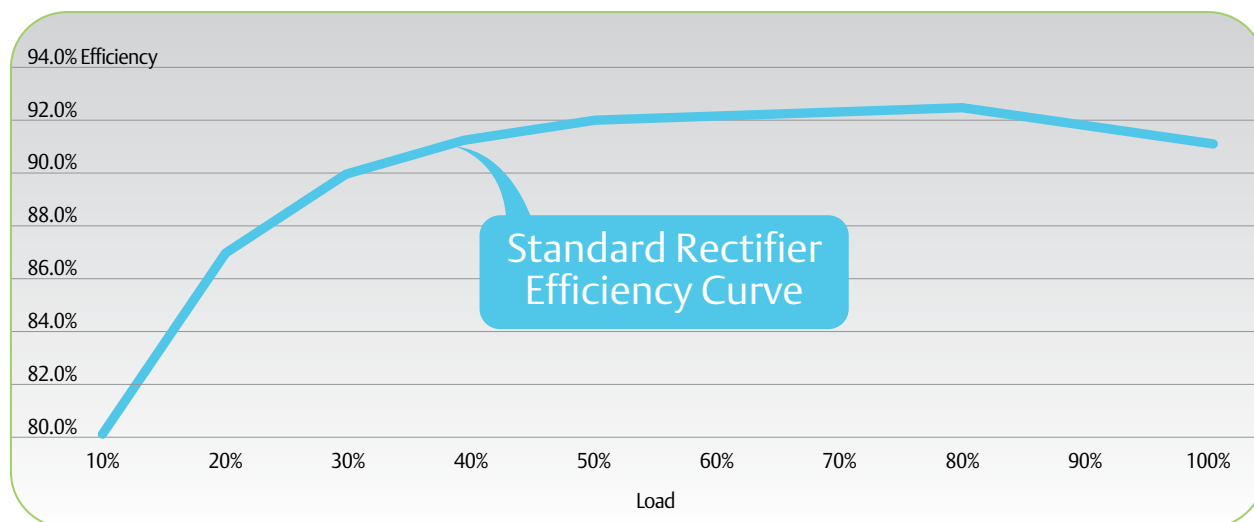
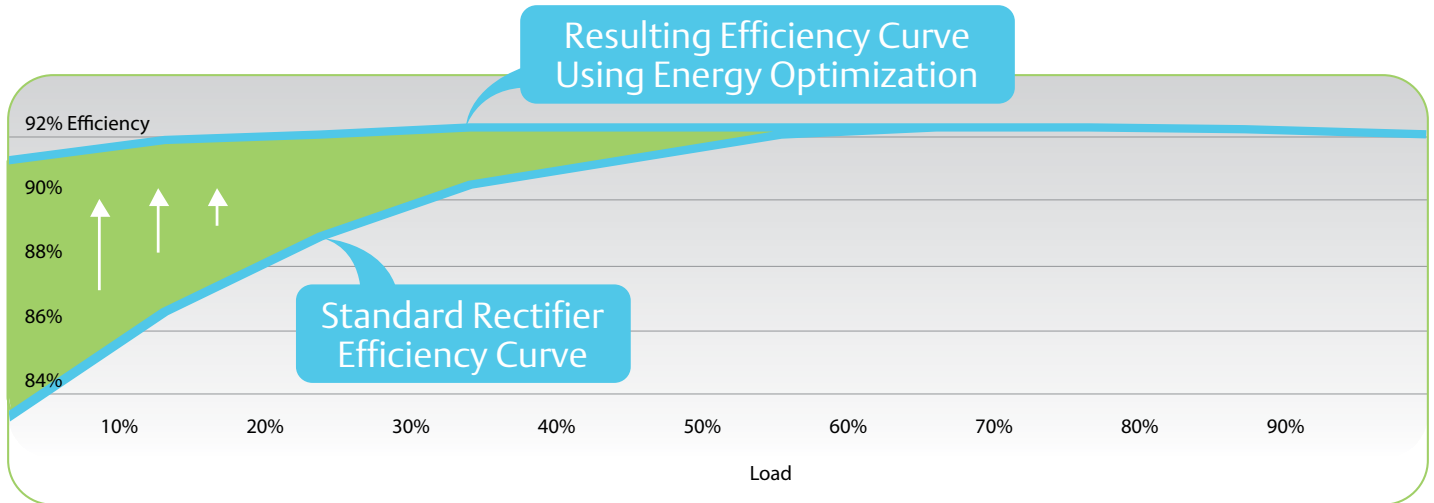


Table 4: Energy Efficiency Curve



Consider a typical case with 11 3200W rectifiers sized for total capacity of 54V@ 660A or 35.4kW [Figure 2a]. The actual operational load is only 165A, or 8.9kW. In this case each rectifier is operating at 15A—which is only 25 percent of its rated 60A full load. As we can see from the standard soft switch rectifier efficiency curve [Table 4], at 25 percent load the efficiency of a standard soft switch rectifier is only around 88 percent. By utilizing a controller with energy optimization capability, six of the rectifiers are placed in stand-by mode (note that even in standby mode, rectifiers continue to consume a small amount of energy, but the impact is small and for simplicity we will not account for this in the example) while the remaining five pick up the entire load [Figure 2b]. With energy optimization applied, we see the five active rectifiers are operating at 33A, or 55 percent of their rating. The efficiency at this load point is near 92 percent [Table 4].

In this case the energy optimization increases the overall system efficiency by approximately 4 percent. Without getting into details (we will look at energy calculation details in later case studies) use of energy optimization results in a 36 percent reduction in wasted energy, heat and CO₂ emissions. Annual energy savings of approximately 4230 kWh and a reduction of 2540 Kg CO₂ are realized. At \$0.10/KWh this saves \$423 annually. Of course, the potential for energy savings increases with larger systems.

The savings add up quickly when you consider there are millions of these types of systems installed all over the world. Several suppliers have energy optimization mode integrated into their system controllers, so realizing this benefit may be as simple as activating the mode. If you have a system purchased in the last few years, contact your supplier to learn how to activate this function and realize immediate and real savings.

Figure 2a: No Energy Optimization



Figure 2b: With Energy Optimization



3. New ultra high-efficiency rectifiers

Several suppliers recently have announced the availability of new ultra-high-efficiency (UHE) rectifiers. One of these boasts peak efficiency of near 97 percent (be sure to review a supplier's efficiency vs. load curve and ensure the efficiency being claimed occurs at a wide range of load conditions and not just at one isolated point). These UHE rectifiers represent a paradigm increase over the standard 90-92 percent that has existed for the last 15 year [Table 5].

In some cases these UHE rectifiers are 100 percent backward compatible with their lower efficiency predecessors, making upgrade of existing sites very simple. These UHE rectifiers can reduce energy and heat loss by up to 80 percent (when compared with older systems operating at 84 percent efficiency), resulting in significant reduction in annual energy costs and CO₂ emissions.

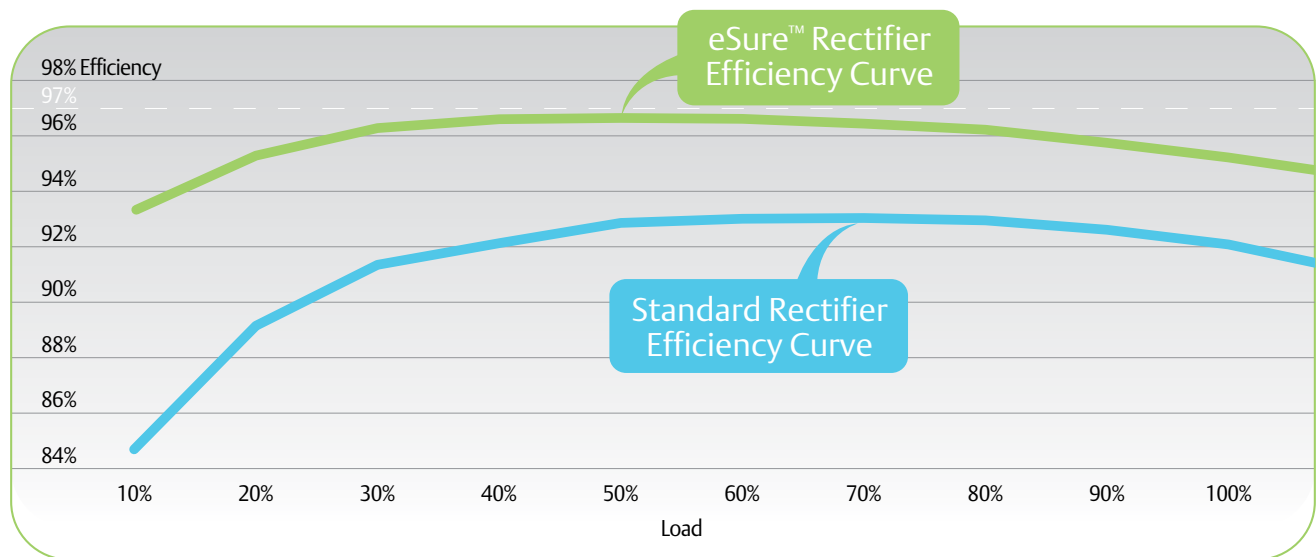
When considering these rectifiers, be careful to choose an experienced and proven supplier in order to ensure uncompromised reliability and to avoid quality issues that could offset any gains in energy efficiency.

Achieving this efficiency improvement requires state-of-the-art technology and innovative and complex new circuitry. Buzz words such as “bridgeless pfc,” “synchronous rectification,” “soft switch resonance” and “digital control” are used to describe the necessary technologies needed to achieve this high level of efficiency. With this in mind, when considering these rectifiers, one must be careful to choose an experienced and proven supplier in order to ensure uncompromised reliability and to avoid quality issues that could offset any gains in energy efficiency. When selecting a supplier, be sure to review the field performance of the supplier's legacy products. Achieving consistent high reliability across

product lines is a strong indicator that a company has established strong process integrity. Buying from a supplier with proven process integrity will ensure that the new UHE products provide reliability consistent with previous generations.

Price is another variable of these UHE rectifiers. Because of the state-of-the-art innovation and components needed to achieve these efficiencies, you can expect to pay a premium over comparable rectifiers demonstrating standard efficiency (SE). Next we evaluate three case studies and examine the financial and environmental benefits associated with each.

Table 5: Standard vs New Ultra High Efficiency Rectifier



Case 1: Central office upgrade – replacing older DC power systems with ultra-high-efficiency rectifiers

Many central office sites continue to be powered by DC power systems with older technologies, such as Ferro resonant and hard-switched modular rectifiers. These power supplies pose increased reliability concerns due to end-of-life issues and

increased maintenance costs due to limited availability of rare, low-volume parts. And if the maintenance and reliability concerns weren't bad enough, these systems typically operate at efficiencies more than 10% lower than the newest UHE rectifiers [Table 6].

DC plants typically are sized for loads ranging from 1000A (54KW) up to 10000A (540KW). The high power demand of

central office equipment means significant savings and payback when upgrading to new UHE rectifiers. Another advantage of upgrading is that the higher power density of today's modular rectifiers often means that you can get the same power within a much smaller footprint.

In this case, let's assume a central office site consists of a 3000A (162KW) plant that contains Ferro resonant rectifiers.

Table 6: Ultra High vs Bulk (Ferro, SCR, etc)

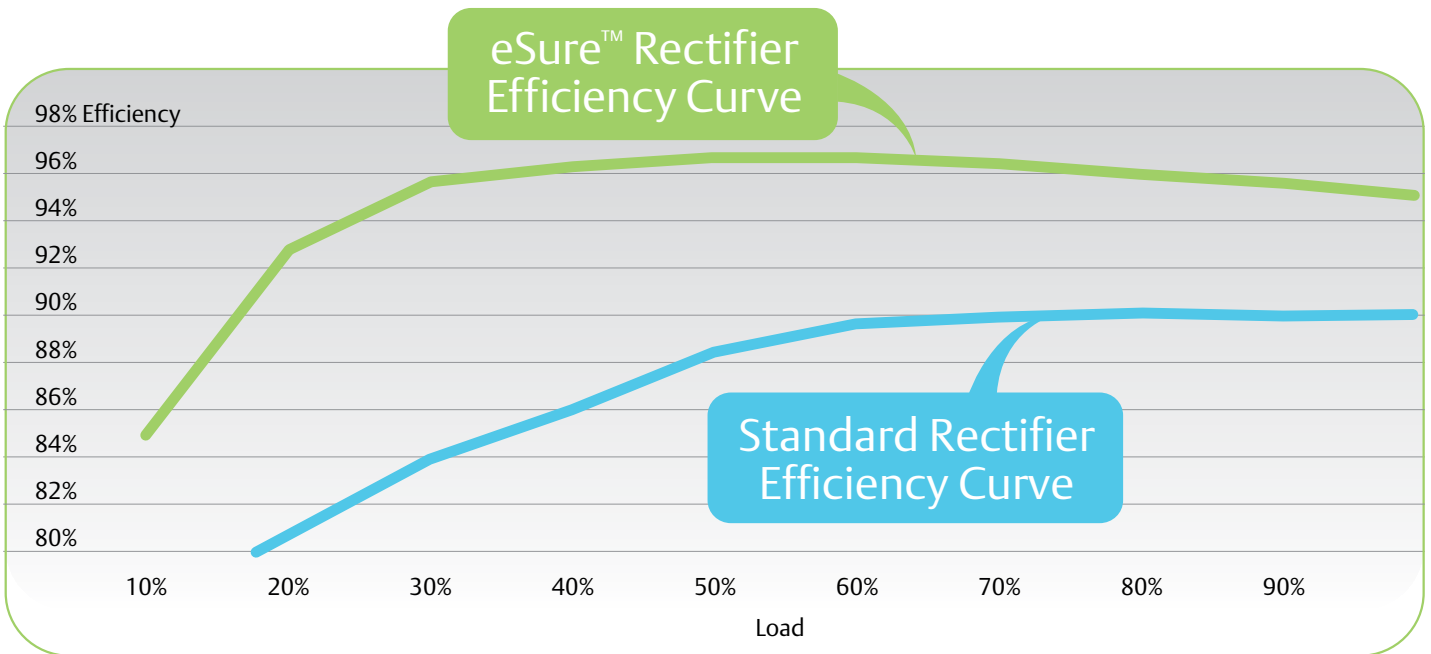


Figure 3a

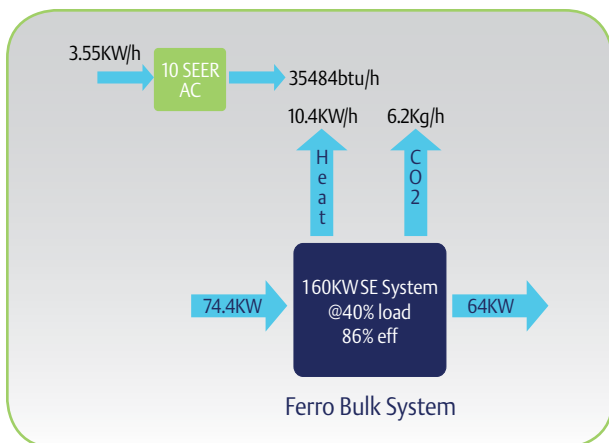
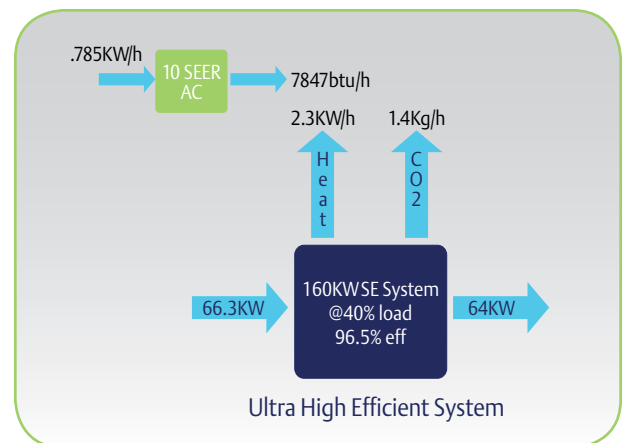


Figure 3b



The plant is operating at 40 percent load, or 1200A (64kW). At 40 percent load, we can expect the Ferro resonant to operate at around 86 percent efficiency compared to near 97 percent for the new UHE rectifier [Table 6]. Assuming the new UHE system has built-in energy optimization mode, we can expect the system to run at or near its peak efficiency. Figures 3a and 3b represent the energy losses associated with each type of system.

As we can see from these figures, the hourly energy consumption is reduced from 10.4KW/h to 2.3KW/h—a reduction of 78 percent. This translates to annual energy savings of approximately 70,932 kWh and 42,560 KG of CO₂ emissions (approximately equivalent to the emissions of eight automobiles) from improvement in the DC power consumption alone.

Because the lost energy is in the form of heat, reducing energy loss by 78 percent directly equates to heat reduction of 78 percent. In this case we have reduced heat dissipation by 27,640btu. Assuming

Reducing energy loss by 78 percent directly equates to heat reduction of 78 percent.

a 10 EER unit, the energy consumption of a 27,640 BTU air conditioner would be approximately 2.76kW/h. In order to determine annual energy savings, we must estimate how many hours the AC runs within the central office. A simple and conservative estimate is about 12 hours per day. Under those parameters, the annual savings associated with the AC are approximately 12,100 kWh and 7,260 KG of CO₂.

This results in a combined total annual savings of approx 83,000 kWh and 49,800 Kg of CO₂ emissions [Table 7]. At \$0.10 per kWh, annual energy savings amount to \$8,300 [Table 8].

Let's look at the return on investment for the rectifiers only. For a 3000A capacity, we must purchase 50 60A (3200W) UHE rectifiers. If each of these rectifiers costs \$500 the total rectifier investment is \$25,000. The 10-year ROI (assuming 40 percent load, \$0.10/Kwh) is 24 percent with rectifier payback occurring at just over three years.

Reducing maintenance costs and reliability risks, demonstrating good corporate responsibility, and significant reduction of operational expenses resulting in a 24 percent annual rate of return all provide strong justifications for replacing older systems with new UHE rectifiers.

Table 7: Energy Savings Table for Case Study 1

System	35.2KW DC Power Plant@40% Load		Air Conditioning		Total Annual KWh
	Power Loss	Annual KWh (KW x 24 x 365)	Power Loss	Annual KWh (KW x 12 x 365)	DC Plus Air Conditioning
Old rect	10.4KW/h		3.55KW/h		
UHE	2.3KW/h		0.785KW/h		
KW Saving	8.1KW/h	70932KWh	2.76KW/h	12100KWh	83,000KWh
CO ₂ Saving		425600Kg		7260Kg	49,800Kg CO ₂

Table 8: Annual Savings Table for Case Study 1

\$/kWh	System Load for 160KW Capacity Plant			
	40%	50%	60%	70%
\$0.10	\$8300	\$10379	\$12455	\$14530
\$0.15	\$12455	\$15568	\$18682	\$21796
\$0.20	\$16600	\$20758	\$24910	\$29061
\$0.25	\$20758	\$25948	\$31137	\$36327
*reduced CO ₂ emissions	49800Kg	62275Kg	74730Kg	87185Kg

*0.60KgCO₂/KW

Case 2: New installation SE (standard efficiency) vs. ultra-high-efficiency rectifiers

When considering new installations, one must carefully consider not only the initial cost of equipment but also the impact to long-term cost of ownership. Both energy efficiency and the reliability of the product can have significant impact on the long-term operating expenses associated with your investment. The application is in an outdoor enclosure and consists of 11 3200W rectifiers being sized for total capacity of 54V at 660A or 35.2 kW. The operator has sized the system so it operates at 40 percent load. As we compare the SE and the new UHE systems, we will assume that both solutions include the integrated energy optimization-capable controller discussed earlier, therefore both systems will operate at near peak efficiency. Peak efficiency for an SE rectifier is 92 percent compared to near 97 percent

for the UHE rectifier [Table 5]. Figures 4a and 4b represent the energy losses associated with each type of system.

We see from these figures that the hourly energy consumption is reduced from 1.22KW/h to 0.51KW/h—a reduction of 58 percent. This translates to annual energy savings of approximately 6,220 kWh and 3,730 KG of CO₂ emissions (approximately equivalent to the emissions of 1.2 automobiles) from reduction in the DC power losses alone.

As discussed in the previous case, reducing energy loss by 58 percent directly equates to heat reduction of 58 percent. In this case we have reduced heat dissipation by 2,422 BTU. Assuming a 10 EER unit, the energy consumption of a 2,422 BTU air conditioner would be approximately 0.242KW/h. As with the previous case, in order to estimate the total annual energy savings due to air conditioning, we also must estimate the average number of

hours the AC unit will operate during the day. This will vary depending on location, size of enclosure, and other heat-generating equipment associated with the OSP application. Assuming properly sized AC in a moderate climate, we can conservatively estimate the AC runs eight hours per day. Under these parameters, the annual savings associated with the AC are approximately 706 kWh and 423 KG of CO₂. This results in a combined total annual savings of approximately 6,930 kW and 4,150 Kg of CO₂ emissions [Table 9]. At \$0.10 per kWh, annual energy savings amount to \$693 [Table 10].

But based on the savings, is the investment worthwhile? Let's assume the 3200W SE rectifiers are \$380 each and that the 3200W UHE rectifiers are priced at \$500. The total premium for the UHE vs. SE system would be \$120x11 (total number of

Figure 4a

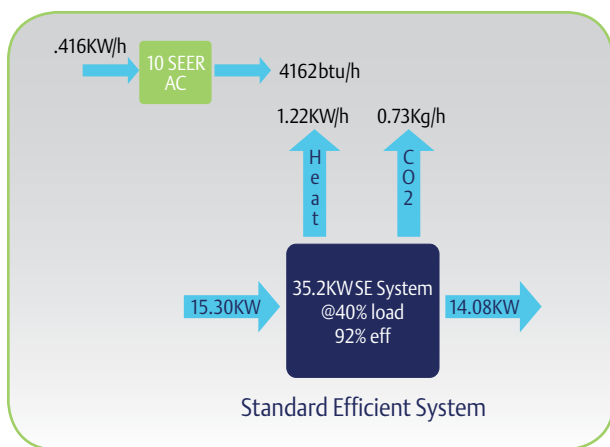
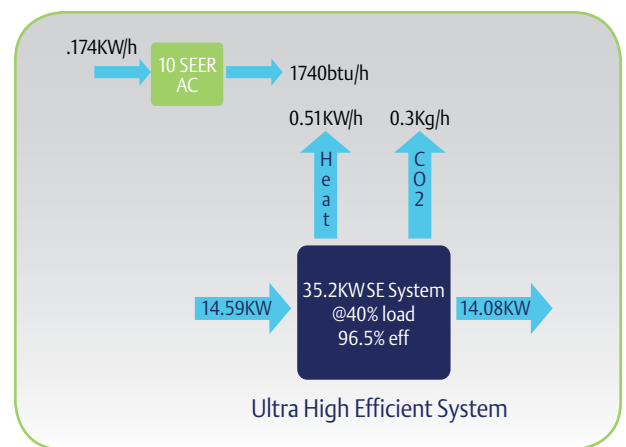


Figure 4b



The payback on the ultra-high-efficiency premium is 1.9 years with 10-year ROI of 49 percent.

rectifiers) for a total of \$1,320. Using \$0.10 per kWh and assuming 40 percent load, the payback on the UHE premium is 1.9 years with 10-year ROI of 49 percent. Note that it's not the number of rectifiers purchased that impacts ROI but the operating load and energy costs. In other words, based on a given load per rectifier and fixed energy costs, the ROI and payback remains constant regardless of quantity of

rectifiers. If you buy one rectifier, the premium payback and ROI at 40 percent load is the same payback on 1,000 rectifiers running at 40 percent load. This is important to consider if you already own a DC plant and are buying rectifiers to expand existing empty rectifier slots.

Once again we see that that investing the additional premium is well worth the payback both in energy savings as well as CO₂ emission reduction.

Table 9: Energy Savings Table for Case Study 2

System	35.2KW DC Power Plant@40% Load		Air Conditioning		Total Annual KWh
	Power Loss	Annual KWh (KW x 24 x 365)	Power Loss	Annual KWh (KW x 8 x 365)	DC Plus Air Conditioning
SE	1.22KW/h		0.416KW/h		
UHE	0.51KW/h		0.174KW/h		
KW Saving	0.71KW/h	6220KWh	0.242KW/h	706KWh	6930KWh
CO ₂ Saving		3730Kg		423Kg	4150Kg

Table 10: Annual Savings Table for Case Study 2

\$/KWh	System Load for 35.2KW Capacity Plant			
	40%	50%	60%	70%
\$0.1	\$693	\$870	\$1044	\$1218
\$0.15	\$1044	\$1305	\$1566	\$1827
\$0.20	\$1392	\$1740	\$2088	\$2536
\$0.25	\$1740	\$2175	\$2611	\$3046
*reduced CO ₂ emissions	4150Kg	5222Kg	6266Kg	7310Kg

*0.60KgCO₂/KW

Case 3: Upgrading existing empty rectifier slots with new ultra-high-efficiency rectifiers

The previous two cases both involved the installation of a new DC power plant, but here we will review the case where the new UHE rectifiers are designed to be 100 percent backward compatible with existing installations. Telecom providers that recently purchased standard-efficiency rectifiers may want to realize the benefits

What if there were a way to replace only half or even a third of the rectifiers in a system and still realize nearly full efficiency benefit of UHE rectifiers?

of these UHE rectifiers, but would find it difficult to justify replacing all of their newly installed rectifiers. However, what if there were a way to replace only half or even a third of the rectifiers in a system and still

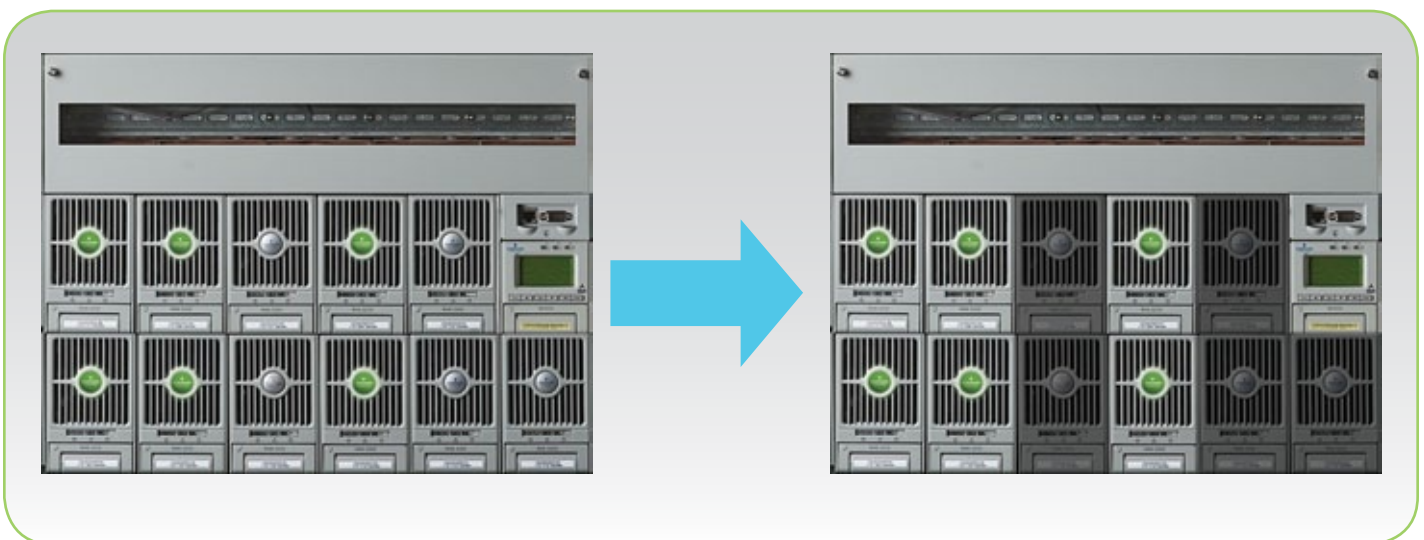
realize nearly full efficiency benefit of UHE rectifiers? Would it be worth upgrading? As previously discussed, real-world systems must be sized for worst-case peak load conditions and battery recharge, however typical steady state system loads run at less than 50 percent most of the time. A savvy supplier could take advantage of this fact to make upgrading to UHE rectifiers more economical and advantageous for existing customers. This can be done by developing an innovative energy management feature

to ensure that during normal load conditions, the lower-efficiency rectifiers are placed in standby mode. That ensures the majority of the system load is provided by the UHE rectifiers [Figure 5].

In addition, if designed properly, this energy management feature would continuously monitor the load and quickly bring the lower efficiency rectifiers on line only when the system load exceeds the normal steady state load. One more requirement for this mode would be to ensure readiness of standby rectifiers by periodically powering up those rectifiers. With this type of innovative energy management mode (let's call it "ECO" mode going forward), existing customers can be upgraded easily and economically to take advantage of the new ultra-efficient rectifier.

Let's consider the same system configuration as in Case 2. The provider has many site installations containing the two-rack, 11-rectifier configuration. Some of the sites already contain the full allotment of 11 rectifiers while others have empty rectifier slots. The provider needs to add

Figure 5



With the ECO mode, ROI improves from 49 percent to 93 percent and the payback improves from 1.9 years to just 1.06.

rectifiers to those systems with empty slots because of additional subscribers in the area, and must purchase additional rectifiers to increase capacity accordingly.

When extra rectifiers are needed to fill empty slots, a savvy customer can take advantage of ECO mode by analyzing his already fully configured installations to identify what the average steady state load is during non peak loads. Once this is determined, he need only buy enough UHE rectifiers as needed to power the steady state load of his existing systems. The next step is to replace the low-efficient rectifiers within his existing systems with UHE

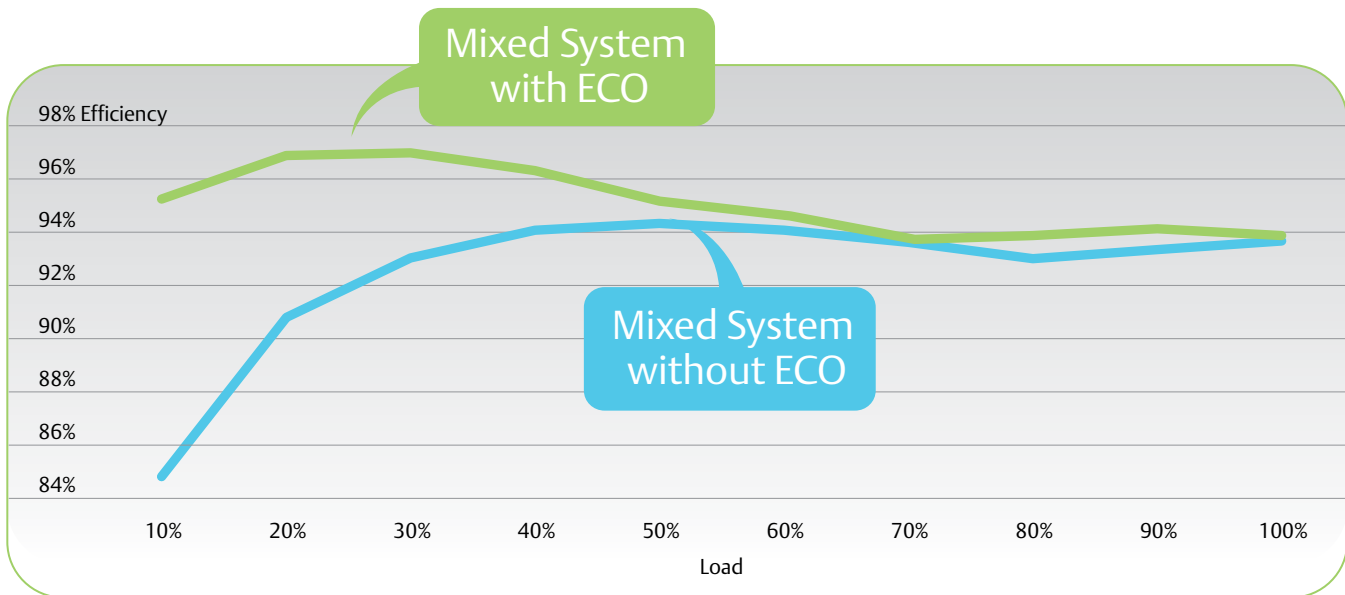
rectifiers, and then utilize the SE rectifiers to fill the empty slots of those systems that require increased capacity. By implementing the ECO method for rectifier expansion, providers can upgrade existing systems to near ultra-high-efficiency with a significantly smaller investment than otherwise would be required for one new installation containing a complete complement of ultra-high-efficiency rectifiers. Let's take a look at how this works.

A customer has four existing installations of the same system as described in Case 2. Two of the system racks are populated fully with 11 rectifiers each, while the other two

contain only six rectifiers and five empty slots each. It's now time to fill the 10 empty slots that exist in two of the racks.

Option 1, without ECO mode: Customer can choose to fill the 10 slots either with new ultra-high-efficient rectifies or with standard-efficiency rectifiers. Again assuming the SE rectifier is \$380 and the UHE rectifiers are \$500 (\$120 premium), with a 40 percent steady state system load and \$0.10/KW energy costs. We know from Case 2 that 10-year ROI is 49 percent with 1.9-year payback on the premium. Assuming the decision was made to fill empty slots with UHE rectifiers, the customer now has upgraded two of his systems from 92 to 94 percent overall

Table 11: ECO Mode Efficiency of Mixed (5UHE, 6SE Rectifiers) System



efficiency (the 94 percent systems contain a mix of five near 97 percent rectifiers and six at 92 percent efficiency). Let's note that compared to standard efficiency, the incremental investment needed to upgrade these two systems was \$1,200 (10 rectifiers x \$120 premium) resulting in total annual energy savings (40 percent load, \$0.10/KW) of \$632.

Option 2, with ECO mode: Now let's look at what ECO mode brings to the table. Since the two existing, fully populated systems operate at 40 percent load, we will replace only 5 of the 11 rectifiers from each of these two systems with UHE rectifiers and use the lower-efficiency rectifiers to fill the 10 empty slots of the two systems that need to be expanded. By activating ECO mode within the two systems containing a mixture of UHE and SE rectifiers, these hybrid systems now will operate at approximately 96 percent overall efficiency [Table 11]. (Note we will not use near 97 percent because the offline energy draw of the standby rectifiers does impact the efficiency.)

In this case, our incremental investment is the same as without ECO mode (\$1,200) however our resulting energy savings will be better in this case as ECO mode works

Implementing ECO mode for UHE upgrade results in nearly double the energy savings than upgrading without ECO mode.

to ensure the majority of load is being provided by the UHE rectifiers only. As long as the system load remains less than the capacity of the UHE rectifiers within the hybrid systems, we will maintain 96 percent overall efficiency (compared to 94 percent without ECO mode). When load exceeds capacity of the UHE rectifiers, the offline rectifiers will be turned on to provide the extra load. As offline standard efficiency rectifiers are brought online, the overall efficiency will decrease incrementally from 96 percent, with worst-case system efficiency of approximately 94 percent when all six offline SE rectifiers are online. We must account for this in our energy savings estimates.

If the system were to run at 40 percent nominal load all the time, the total annual energy savings as compared to standard efficiency rectifiers is \$1,131. However, it's not realistic to assume we can maintain steady state load 100 percent of the time, as we must also account for peak load and battery recharge conditions. Let's estimate that 20 percent of the time, load exceeds the UHE rectifier capacity, in which case SE rectifiers must be turned on. We will

estimate that in these cases we average 70 percent load and only 94 percent (worst case) efficiency. So 80 percent of the time our system runs at 40 percent load and 96 percent efficiency, and 20 percent of the time we run at 70 percent load and 94 percent efficiency. In this case, our annual savings total $.80 \times \$1,131 = \904 (running at 40 percent load, 96 percent efficiency, 80 percent of the year) plus \$221 (running at 70 percent load, 94 percent efficiency, 20 percent of year) for total annual savings of \$1,125. Implementing ECO mode for UHE upgrade results in nearly double the energy savings than upgrading without ECO mode. When compared to SE systems the 10-year ROI improves from 49 percent to 93 percent and the payback improves from 1.9 years to just 1.06. With a return like this, ECO mode makes the decision to upgrade existing slots with UHE rectifiers a clear choice. Before deciding on a UHE system, be sure to determine if the supplier has an ECO-like energy management feature, as this will substantially reduce the investments needed to upgrade existing installations down the road.

Conclusion

Telecom providers are responding to skyrocketing energy prices, restrictions on carbon footprints, and an increased emphasis on corporate responsibility by increasingly looking for opportunities to reduce energy consumption and carbon emissions. But with demand for telecom services on the rise, reductions are difficult. These issues are leading to an increased focus on energy efficiency. Improving efficiency in the DC power plants that power the central office and outside plant can have a significant impact on telecom energy consumption.

As we have discussed in this paper, efficiency gains are available through several avenues: replacement of older generation rectifiers, implementing energy optimization within newer standard-efficiency systems, and installation of new ultra-high-efficiency rectifiers. Although some of these actions require front-end investments, the expected ROI clearly justifies the initial expense.

By taking this holistic approach to energy efficiency, telecom providers can take major steps toward achieving many of today's aggressive industry-wide energy efficiency initiatives.

References

- [1] Verizon Corporate Responsibility Report 2006
- [2] ETSI Work Program on Energy Savings, Beniamino Gorini: Intelec 2007 Proceedings and Life Cycle assessment for Information Communication Technology, NTT Corporation:
- [3] Energy Efficiency - an enabler for the Next Generation Network; F. Cucciatti, Telecom Italia. Bruxelles, January 30, 2006
- [4] France Telecom Energy Consumption, HVDC, Cooling Improvements, Didier Marquet and Marc Aubrée, France Telecom;
- [5] Telefonica Corporate Responsibility Report, 2006.
- [6] EPA Administrator Looks to Telecommunications Industry for Increased Energy Efficiency Opportunities, U.S. EPA, November 2001
- [7] "Emission facts", EPA article EPA420-F-00-013 April 2000.

To learn more about eSure™ ultra high efficiency from Emerson visit www.DCpowerefficiency.com.

Emerson (NYSE: EMR), based in St. Louis, is a global leader in bringing technology and engineering together to provide innovative solutions to customers through its network power, process management, industrial automation, climate technologies, and appliance and tools businesses. For more information, visit: Emerson.com.

Emerson Network Power, a business of Emerson (NYSE:EMR), is the global leader in enabling *Business-Critical Continuity*[™] from grid to chip for telecommunication networks, data centers, health care and industrial facilities. Emerson Network Power provides innovative solutions and expertise in areas including AC and DC power and precision cooling systems, embedded computing and power, integrated racks and enclosures, power switching and controls, monitoring, and connectivity. All solutions are supported globally by local Emerson Network Power service technicians. For more information on Emerson Network Power's full suite of solutions specifically supporting the communications network infrastructure, including NetSpan[™], NetReach[™] and NetXtend[™] outside plant enclosures and equipment, NetSure[®] DC power systems, and turnkey services, visit: EmersonNetworkPower.com/EnergySystems.

Learn more about Emerson Network Power products and services at: EmersonNetworkPower.com.

This publication is issued to provide outline information only which (unless agreed by Emerson Network Power Energy Systems, North America, Inc. in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned. Emerson Network Power Energy Systems, North America, Inc. reserves the right to alter without notice the specification, design or conditions of supply of any product or service.

Emerson[®], Emerson Network Power[™], *Business-Critical Continuity*[™], NetSpan[™], NetReach[™], NetXtend[™] and NetSure[™] are trademarks of Emerson Electric Co. and/or one of its subsidiaries.

Emerson Network Power

Energy Systems, North America

4350 Weaver Parkway, Warrenton, IL 60555

Toll Free: 800-800-1280 (USA and Canada)

Telephone: 440-246-6999 **Fax:** 440-246-4876

Web: EmersonNetworkPower.com/EnergySystems

EnergyNet: Secure.EmersonNetworkPower.com

Emerson Network Power.

The global leader in enabling *Business-Critical Continuity*[™].

■ AC Power

■ Connectivity

■ DC Power

■ Embedded Computing

■ Embedded Power

■ Monitoring

■ Outside Plant

■ Power Switching & Controls

■ Precision Cooling

EmersonNetworkPower.com/EnergySystems

■ Racks & Integrated Cabinets

■ Services

■ Surge Protection