Peak Shaving - A Method to Reduce Utility Costs

John Malinowski
Senior Member, IEEE
Baldor Electric Company
P.O. Box 2400
Fort Smith, AR 72902
USA
jmalinowski@baldor.com

Keith Kaderly
Ozarks Electric Cooperative
P.O. Box 848
Fayetteville, AR 72702
USA
kkaderly@ozarksecc.com

Abstract – By thinking out of the box, Baldor Electric Company has been able to save about $1 million a year in energy savings corporate-wide for each of the last three years. Over $100,000 a year of this savings comes from our Westville, OK plant.

This paper will discuss Baldor's success reducing utility costs at a motor plant in Westville, Oklahoma by working with the local electricity supplier (Ozarks Electric Cooperative Corp) and practicing peak shaving during summer months. After the plant had adopted all current energy saving methods such as use of NEMA Premium™ electric motors, adjustable speed drives and high-efficiency lighting systems, additional savings were desired. Ozarks Electric Cooperative was also interested in a reduction in the plant's electrical demand during the peak season to unload their system. The co-author is Keith Kaderly from the utility to give a win-win perspective on the project from the utility's viewpoint.

Index Terms – Peak shaving, energy efficiency, generators

I. INTRODUCTION

By the time energy prices peaked in 2001, Baldor Electric Company in Fort Smith, Arkansas had seen their energy costs almost double over the prior two years. Deciding that energy was not a fixed cost, but one that should be controlled, Baldor President and CEO, John McFarland, asked employees to offer suggestions on conserving energy that would result in reduced electricity demand and increases in operating efficiency. He also commissioned a project team whose goal was to both reduce consumption and improve procurement of energy throughout the company's 14 plants in the U.S. by fifteen percent.

A survey was conducted of all motors used throughout each facility on conveyors, pumps, fans and machining centers. When equipment is specified, premium efficiency motors are always specified. The survey showed that these motors could be replaced by newer designs with efficiencies exceeding NEMA Premium™ efficiency levels. Motor efficiencies have improved significantly over the last ten years.

Several projects addressed the plant's HVAC system. Thermostats on HVAC equipment were changed to the programmable type to save energy when possible. The building roof was sprinkled with water during the summer to get an evaporative cooling effect. To conserve cool air in the plant, automatic doors were added at the entries to the storage warehouse that is not cooled. Adjustable speed drives were also added on fans where dampers were previously used to control airflow when using a fixed speed motor. Slowing down the motor reduces airflow and the current draw of the motor drops significantly.

Lighting systems in all plants were changed from metal halide (455w per fixture) to T-8 fluorescent high bay fixtures (196w per fixture). Movement sensors were used to control the lighting so it could be turned off if no activity was in the area. Savings from sensor switches did not pay for themselves in all locations (such as rest rooms and meeting rooms) but were installed to remind employees to conserve energy.

Power factor correction capacitors were added to the plant's power system.

The end goal of the team was to establish a cost of energy per motor produced benchmark. Even with all of these conventional energy conservation efforts, the 15 percent reduction goal was not achieved. It became apparent that the goal could not be achieved by conservation alone, Baldor needed to work with the utility on how to reduce the rate. One plant was chosen as a test site.

II. WESTVILLE OKLAHOMA PLANT

Baldor Electric Company's, Westville, Oklahoma Plant, manufactures several industrial products used by customers worldwide. AC motors up to 1hp, DC motors up to 3hp, Brushless servomotors up to 12hp and 6 and 7-inch grinders and dental polishing lathes. One of Baldor's 14 manufacturing locations across the U.S., this facility employs about 450 people and the plant runs 24 hours a day, 5 days a week producing approximately 17,000 industrial motors per week.

Some of the electrical loads in the facility include: powder coating and varnish systems; processing equipment (CNC machines, hundreds of feet of conveyor systems); HVAC; lighting and security systems**.**

In 2001, the high efficiency fluorescent lighting saved over one million kWh in Westville alone.

III. Ozarks Electric Cooperative

Baldor learned that the local electric provider, Ozarks Electric Cooperative, offered a rate schedule that provided for significant savings by avoiding peak usage. Ozarks Electric provided data that defined ‘peak’ to be 3 to 8 PM throughout July and August. With the employees working around the clock, five days a week, greatly reducing electrical usage during the hottest part of the day could not be achieved by conservation alone. Westville signed up with Ozarks Electric’s off-peak rate and agreed to use generators to subsidize power from the utility and effectively shave peak demand. When properly executed, this plan showed a potential to reduce electricity costs by 25%, totaling over $100,000 annually.

Providing the Baldor Westville Plant with prime power for their 175,000 square foot, air conditioned building was not practical, so Baldor opted to install a series of diesel generator sets that are designed to be used for standby power and for load shedding in cooperation with the local utility, Ozarks Electric Cooperative. Also, these units are designed to supply power to critical loads in the event of an outage, which is not uncommon with the tornados and ice storms in Oklahoma.

IV. Working with the New Rate

In 2001, Westville set a peak demand of 1,728 kW, which stays in effect for 12 months. The project goal was to keep the facility’s peak below 1,000 kW for 2002. The Westville plant actually exceeded that goal by setting peak demand at 965 kW. While the new off-peak rate structure has a much higher charge for each peak kilowatt unit (from blended usage levels at $.05/kWh to a straight $.02/kWh), the year- round cost per kilowatt-hour consumed drops by $.03/kWh (from $.05/kWh to $.02/kWh). Based upon an annual consumption of 7.1 million kWh at a $.03 savings, the kWh charge was reduced by $213,000. This savings must then be adjusted down by the additional peak charges of $109,000 (965 kW * $9.40 * 12 months). This produced a calculated net savings of $104,000.

Once committed to the off-peak rate plan, a utility customer must dramatically lower their peak demand or else they risk actually increasing their total costs. Even though the base kilowatt-hour charge drops, the penalty for exceeding it (peak charge) rises significantly. The inherent structure of the rate program is to encourage the customer to lower peak demand in order to lower total cost.

Since Ozarks Electric Cooperative is a member owned distribution cooperative, they design rates to reflect only the cost to produce and distribute energy. The off-peak rate is designed to save both the Electric Cooperative and the member/customer money. The off-peak rate basically reflects costs that influence Ozarks Electric’s system cost. When a large user, such as Baldor, can greatly reduce their kW usage, it allows the cooperative to save money in facility/generation costs. The Westville facility is also helping control future costs for Ozarks Electric and its members by slowing the need for costly facilities upgrades in order to supply growing demand

V. Phase 1 Implementation - 2002

The main consideration was that Westville needed to decide how to effectively remove over 700 kW of demand from the utility without adversely affecting the production process. Baldor enlisted the help of All Phase Electric of Greenwood, Arkansas and TL Services of Van Buren, Arkansas. They assisted in mapping and monitoring the load structure of the facility, installed the ‘Energy Management System’ including equipment and monitoring software and they identified the most logical loads to move to alternative sources. The Plant Systems Analyst programmed the energy management system to capture demand usage on a continuous real-time basis. He also monitored and reported progress on a daily basis and maintained the service schedule of all equipment used.

The largest load removed was achieved by installing a 140 kW (175 KVA) trailer mounted diesel powered generator for each of the three 100-ton air conditioning units that supply the plant with cold air. Each generator is free standing and is housed in a sound-attenuated package that reduced the noise by 25 dBA as measured from a distance of 23 feet. The generators sit atop their own 160 gallon fuel tanks and are capable of running for up to ten hours at rated power before refueling.

The generators were connected to the air conditioners using three 225 amp, 480 volt, 3-pole automatic transfer switches (one for each 100-ton air conditioner) in a NEMA 1 enclosure. This configuration provided for the reduction of approximately 450 kW

The generators were configured to start when the load monitoring system sensed that the power usage was approaching the target set point. Normally, the system gave a command for one generator to come on and run for a period of approximately five minutes. If it became apparent to the monitoring system that one generator had not caused the load usage to drop, then another command was given for the second generator to start. And, if needed, the third generator was added. So, the monitoring system cycled on and off the three generators according to the load demand.

Additionally, the facility’s 825 cfm compressed air system was replaced during peak hours with a portable diesel powered unit. The portable compressor was a better alternative than supplying the existing compressors with a generator due to the high starting current demands. This shaved an additional 200 kW from the utility.

To manage the project, WinControl for Windows by KMC Controls was used to monitor real-time demand within the facility. This software program gave the project managers the ability to monitor incoming load and switch load power from the utility company to the Baldor generators; this was the initial step in the peak shaving demand program. The software also allowed monitoring kW usage and the performance of the generators in real time. The accuracy of data being monitored proved comparable within 3kWh of the data being monitored simultaneously by the electric utility.

Further steps could be taken to ensure the target usage would be met. In addition to moving loads on and off of generators, other non-critical loads could be pulled from the utility, if needed, during emergency peak conditions. One option available was to control a fourth 100-ton air conditioner at the facility that was operating, but not in a critical area of the plant. This unit was connected with the Energy Management System so the computer could either shutdown the 40-ton ac compressor and/or 60-ton compressor of this unit to stay below the target usage. This shutdown was used on days when temperatures reached triple digits and other measures were not enough to remain below the peak limit.

To optimize the cost of running the facility during peak shaving hours, it is vital to be able to switch back and forth from generator to utility as needed. Operating costs of providing power from the generator is more than the cost of electricity from the utility. When a lower demand allows it, the plant gets all of its power from the utility. This means that the generators must be able to routinely start and run in seconds and cycle on several times a day, but only when needed.

VI. Outcome

To ready the facility for the project, the Westville plant invested approximately $31,000 on one-time charges for the purchase and installation of additional wiring, transfer switches and monitoring software. Generators for this purpose can be purchased or leased. However, this is also a cost -effective way to justify standby emergency power generators, since if properly sized, the units can be used for both applications. The typical life of generator sets is in to 15-20 year range, so the annual savings will increase after the purchase and installation costs are amortized over the first 5 or 10 years.

By the end of August 2002, Baldor had managed to lower the peak demand set to 965 kW from 1728 kW in 2001. After the first six months of the program, electricity cost has been $45,000 less than the same period in the previous year as a result of the new rate structure. This puts that facility right on track for their targeted $100,000 annual energy savings.

During peak modes of operation, many electric utilities will adjust their rates for users when they shed part of the grid load over to standby generators. In exchange for reducing daily peak demand by load shedding, Baldor Westville gets a reduction in their energy bill. Plus the generators add backup power for protection against lost productivity during utility outages. The reduction of power provides Ozarks Electric Cooperative with power they can use to help meet their peak demand for non-industrial customers. And it is a way for the utility to look to large industrial users for help in moderating their consumer demand at peak times. It becomes a win-win for both the industrial energy user and the energy supplier.

VII. Phase 2 Implementation - 2003

With the success of the initial three generators during the summer of 2002, it was decided that another 500 kW (625 KVA) generator would be added to satisfy the power demands of an oven used to cure varnish applied to motor stator windings. This was added in time to be ready for the 2003 peak demand of the summer.

Addition of this 500 kW (625 KVA) generator further dropped the plant's energy consumption in 2003 as shown in Table 1. The plant's operational hours were similar for all years. It is easy to measure the actual savings, but utility cost may have actually raised more if the peak shaving project wouldn't have been done.

Table 1
Westville Utility Usage and Costs

Year	kWh	Utility Cost	Savings
2000	$8,147,520	$390,676	
2001 base	7,112,160	375,378*	
2002	6,472,800	327,098	$48,280
2003	5,994,720	301,794	73,584
2004 est.	5,516,640	289,142	

* New utility rate was not applied until mid-2002

A more detailed analysis of equipment and installations costs is shown in Table 2 and project savings summaries are in Table 3. Once the equipment is paid for, annual savings will increase over the remaining life of 15-20 years.

Table 2
Project Cost Analysis

	Actual Equipment Costs	Costs Financed at 5% Interest Rate	
		5 Years	10 Years
Install software and switch gear	$31,000	$7,020	$3,280
(3) 140 kW generators	90,471	20,484	11,520
(1) 500 kW generator	42,000	9,516	5,340
Diesel compressor rental	Lease	3,800	3,800
Avg. annual diesel fuel and maintenance costs	6,000	6,000	6,000
Total annual costs		$46,820	$29,940

Table 3
Project Savings Analysis in 2003

	5-year Financing	10-year Financing
Annual energy savings from 2003 utility bill	$73,584	$73,584
Annual cost	46,820	29,940
Net annual savings	$26,764	$43,644

By continually working with the utility supplier, Ozarks Electric Cooperative, the plant found out that there was also a peak demand during the winter when a higher rate of heating is required. The generators were brought online to ensure the plant did not exceed the peak limit. The diesel-powered compressor was also leased for an additional two months during this season. Based on the additional usage, a compressor will be purchased rather than leased, further reducing costs.

VIII. Energy Conservation Resources

In August 2003, Baldor Electric Company partnered with ENERGY STAR, the U.S. Environmental Protection Agency's voluntary program that offers businesses and consumers energy efficient solutions to help save money while protecting the environment for future generations. Baldor joined a nationwide effort to eliminate energy waste through the voluntary implementation of improved energy management practices and technologies.

ENERGY STAR is a voluntary partnership between business, government and others united to protect our environment for future generations by changing to energy-efficient practices today. ENERGY STAR works with more than 7,000 partners to improve the energy efficiency of products, homes, buildings and businesses. Businesses can use ENERGY STAR to improve efficiency, enhance profits and create a competitive advantage. Last year alone, ENERGY STAR helped businesses and consumers save more than $7 billion in energy costs while reducing global warming emissions equivalent to those from 14 million cars.

The U.S. Department of Energy's Office of Industrial Technologies offers technical assistance and some grants for projects dealing with energy efficiency. A CD-ROM containing the MotorMaster+ motor management software is available from them. This CD also contains PSAT for analyzing pump applications, AirMaster+ for compressed air systems and a steam system program.

Motor Decisions Matter is a national educational campaign established in 2001 to spread the word about the benefits of motor management, NEMA Premium™ efficient motors and empowering companies to adopt these practices. Campaign sponsors include motor manufacturers, utilities, energy efficiency organizations, trade associations and government agencies. As a result of working closely with the Electrical Apparatus Service Association (EASA), best practices standards have been developed covering repair and rewind of motors to maintain their efficiency level.

Additionally, motor manufacturers also offer assistance in motor management. Many can provide software tools for analyzing the operating cost of motors and drives installed at a facility.

IX. Conclusion

The success at the Westville facility is being evaluated to see if generators might be used at other plants within the company. To make such a system work required close cooperation between the energy user and the energy provider.

Since the company's energy surveys and consumption reduction program began in 2000, a total savings of 10 million kilowatt-hours – equivalent to powering 1,300 American homes for a year or planting 1,800 acres of trees has been achieved! This translates into an air pollution reduction of 13 million pounds of carbon dioxide.

Baldor Electric Company continues to work diligently controlling internal energy consumption. Teaming with ENERGY STAR will allow networking with other U.S. manufacturing companies, sharing successes, helping industry improve energy efficiency, and identifying opportunities to reduce energy requirements even further.

Companies should take the opportunity to evaluate their energy consumption and actively control it. Savings translate to a stronger bottom line.