



GO Consulting Services



GOCS, Inc.

Case Studies and Publications

Moore Public Schools
Energy Consumption Management
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The Issues:

Moore School's maintenance foreman Paul Jeffries was looking for a way to reduce the school's electric bill. He talked to his electrical supply salesman, Keith Gay, and asked for suggestions. Keith, an outside salesman for Hunzicker Brothers Electrical Supply brought in Dave Campbell. Dave is the "Advanced Products manager" for Hunzicker.

After some discussion Campbell noted that they had 25 HP air handlers running full speed all the time. He suggested VFD's for changing the speed and PLC control to monitor inputs and adjust fan speed accordingly. Campbell chose Eaton VFD's because of their reliability and a two year warranty. The Eaton VFD comes standard with a 3% line reactor built in. Manual control of the drives would go to a HMI touch screen in the maintenance department.

They have 9 motors for air handlers at 25 HP at 230 VAC. Running at full speed a motor will use 15.66 kWh in one hour. The motor would run 24 hours a day using about 375 kWh, so in 30 days it would use 11250 kWh. This would cost the school about \$562.00 per month. Remember that there are 9 motors that are the same size and running time. For all 9 motors the cost per month would be \$5058.00 Campbell brought in Chris Geer of "GO Consulting" from Shawnee. He did the PLC and HMI programming working along with Paul Jeffries. Paul can monitor and control each of the nine air handlers from the HMI. Campbell had earlier programmed a PLC for sequence control in case of power outage. By adding VFD's (variable frequency drives) and using a PLC for control, each motor averages about 12.5 hours of runtime per day. This is a 48% reduction in run time accomplished by logic in the PLC.

Solutions:

Campbell predicted that VFD's will add even greater savings. Since the load is classified as variable torque (any centrifugal load), the affinity law for variable torque loads applies in this application. What is the affinity law for variable torque load? The law is defined below:

Change in torque is equal to the change in speed squared
Change in horsepower is equal to the change in speed cubed

What this means is that as the motor slows in speed the need for horsepower goes down geometrically. For example, if a motor was running at half speed it would need 1/8 the horsepower, not half! Do the math, 1/2 cubed is 1/8 so instead of using 50% of electricity to run at half speed we only need 12.5%.

But what if you can't run the motor that slow and get the air circulation that you want? That's a good question. The school couldn't get enough air flow at half speed. They found that ¾ speed or running the VFD's at 45 Hz did very well. In fact sometimes they can go down to 40 Hz or 2/3 speed. Full speed is necessary only in extreme conditions (ambient temps of 100 degrees F on the high side and 0 degrees F on the low side).

But a moderate temperature means the heaters and chillers will begin to cycle on and off. The more moderate the temperature, the heaters and chillers will cycle on less. This is when the PLC can lower fan speeds or they can be adjusted manually. Although they sometimes run at 40 Hz, let's use 45 Hz as an average speed for our calculations. 45 Hz is ¾ speed. Do the math, ¾ cubed is 27/64 or .43 so instead of using 75% of electricity to run at ¾ speed we only need 43%

At ¾ speed a motor only uses 7.08 kWh in one hour. The motor would run 12.5 hours a day using about 89 kWh, so in 30 days it would use 2670 kWh. This would cost the school about \$134.00 per month. For all nine motors the cost per month would be \$1206.00. What happens when they use the PLC for control and use VFD's to take advantage of the affinity law for variable torque loads? Their electrical cost decreases from \$5058 per month to an astounding \$1206 per month *This should reflect an unbelievable savings of 76%*. So the school should be saving \$3852.00 a month.

Savings Quantified:

The chart below shows the electric bills for the last four months and the year previous for the same four months.

Last Year		This Year		
Date	Amount	Date	Amount	Savings
11-04-2008	\$15,659	11-03-2009	\$11,981	<u>\$3678.00</u>
12-05-2008	\$14,859	12-04-2009	\$10,457	<u>\$4402.00</u>
01-07-2009	\$12,249	01-06-2010	\$7,870	<u>\$4379.00</u>
02-05-2009	\$11,7290	02-04-2010	\$7,326	<u>\$4403.00</u>

Total Savings in four months is \$16,682