Energy 101

Ten Ways to Reduce Facility Energy Costs OR What to Look at First

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ABSTRACT

In my experience as an energy management instructor and energy auditor, I have found that certain items always seem to be included in the list of energy saving recommendations. These items are included because they typically have a reasonable payback for the effort. I have put together a list of what I have found to be the "top ten" of these energy saving measures. These measures tend to be more applicable to commercial buildings, but some of them, particularly the motor recommendations and utility concerns, may be appropriate for industrial facilities.

This list can be used as a general guide as to what to examine first when looking at ways to save energy and reduce operating costs. The paybacks shown are of a "first cut" accuracy, and do not reflect maintenance or capital expenditure savings that can be included in a life cycle analysis. Further and more detailed analysis is recommended prior to the implementation of any of these measures. The paybacks shown are based on a range of average electrical and gas costs, and assume a capital cost for the energy conservation measure.

The top ten items discussed include: converting standard fluorescent lighting systems to T8 systems with electronic ballasts; utilizing compact fluorescent lamps to replace incandescents; replacing exit signs

containing incandescent or fluorescent lamps with LED exit signs; installing occupancy sensors for lighting control; using programmable thermostats for setback/setup control; replacing standard motors with energy efficient models; purchasing new energy efficient motors in lieu of rewinding, and converting water heating from electric to gas. Also addressed are understanding utility rates, tracking utilities, and the benefits of forming a working relationship with the utility representative.

TEN WAYS TO REDUCE FACILITY ENERGY COSTS OR WHAT TO LOOK AT FIRST

In my 25 years of experience as an energy auditor and instructor, I have found that specific items always seem to be included in the list of energy saving recommendations; they tend to have a reasonably simple payback for the effort. I have put together a list of what I have found to be the "top ten" of these energy saving measures. These measures are applicable to commercial buildings, but some, particularly the energy efficient motor recommendations and utility concerns, can also be appropriate for industrial facilities.

This "top ten" list can be used as a general guide to what to examine first when looking at ways to save energy and reduce operating costs. The simple paybacks shown are based on a range of average electrical costs, and assume a capital cost for the energy conservation measure. Labor is assumed to be performed in-house. When evaluating these measures, ensure that the utility rates accurately reflect the charges for your specific facility, and obtain pricing data and technical specifications from reputable vendors. Operating hours also impact the calculations, so make sure that your estimates are reasonable.

Important note: The following recommendations are based on a "first cut " analysis, and should be used only as a guideline for more detailed project analysis. Also, I have not taken into account capital savings, maintenance savings, or the cost of money over the life of the project. These additional considerations may make the energy conservation measures more attractive in the long run.

The ten ways to reduce your facility energy cost are described as follows. The corresponding figures are included at the end of the article.

THE TEN WAYS

1) Replace fluorescent 40W – T12 lamps with 32W – T8 lamps and electronic ballasts.

Explanation: The T8 lamps with electronic ballasts are more efficient than the standard T12 lamps with standard ballasts. In addition, the quality of lighting may be improved due to the higher CRIs (color rendition index) of the T8s as compared to the standard T12s. Figure 1 illustrates the simple paybacks that would occur for various average electric costs if a 4 lamp-4 foot fluorescent fixture with standard ballasts and 40 W-T12 bulbs (192 W per fixture) was replaced with a 4 lamp-4 foot fixture using 32 W-T8s with electronic ballasts (111 W per fixture). At an average electric cost of 8 cents/kWh and a fixture cost of $75, the payback is 5.8 years for 2,000 hours of annual operation, 2.9 years for 4,000 hours, and 1.9 years for 6,000 hours. Obviously, more operating hours and/or higher electric costs will result in lower paybacks. *Fixture wattage – EPA Lighting Upgrade Manual*

2) Replace incandescent bulbs with energy efficient compact fluorescent lamps.

Explanation: Compact fluorescent lamps (CFLs) are very efficient when compared to the standard incandescent bulb. The CFLs use approxi-

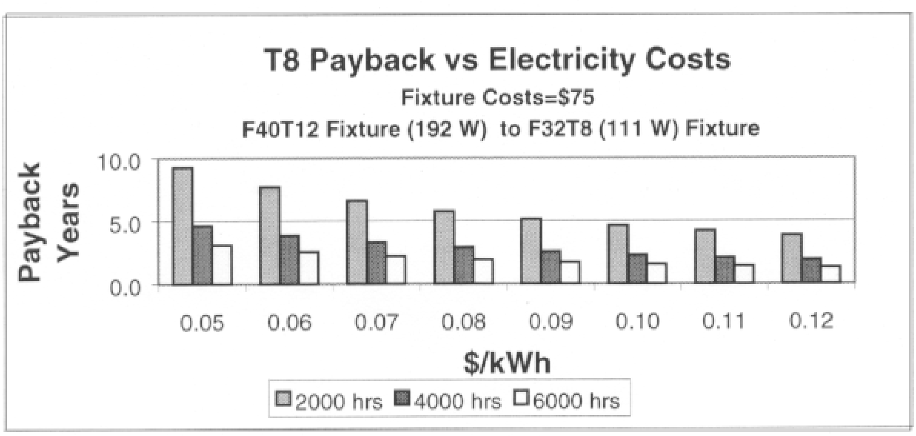

Figure 1. T8 Payback vs. Electricity Costs

mately 1/3 to 1/4 the wattage of the incandescent bulb to produce an equivalent amount of light. In addition, CFLs can have a rated life as high as 10,000 hours life, as opposed to 750-1,000 hours for most incandescents.

Figure 2 illustrates the simple paybacks realized by changing out a 100 W incandescent lamp with a 28 W CFL. For this example, the price of the CFL was estimated at $12. As the price of CFLs continues to drop, the paybacks will get lower. For an electric cost of 8¢/kWh, and with more than 2,000 hours of operation, the payback can be about one year; for more than 4,000 hours about 6 months, and for more than 6,000 hours less than 4.2 months. *Fixture wattage – EPA Lighting Upgrade Manual*

3) Replace incandescent or fluorescent exit signs lights with LEDs.

Explanation: Exits signs should operate continuously by law, or approximately 8,760 hours per year. If these signs are illuminated by incandescent bulbs, the total wattage can be as high as 40 W. The fluorescent signs (compact fluorescent lights or CFLs) typically have lower wattages, in the 10 to 15 W range. The LED (*Light Emitting Diode*) signs operate on about 2 W, and therefore consume significantly less energy than the other types mentioned.

Figure 3 shows the simple paybacks for different electric costs if a 2-20 W incandescent lamp exit sign is retrofitted with LEDs. Paybacks

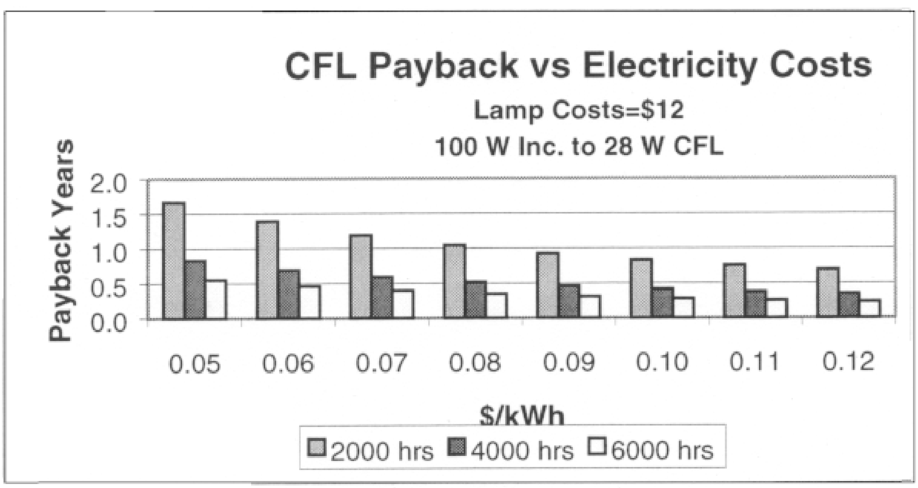

Figure 2. CFL Payback vs. Electricity Costs

are also shown for retrofitting a 10 W CFL exit sign with LEDs. Note that the LEDs have a life of over 25 years, meaning that the maintenance and associated costs are much less than the other types of exit signs examined. For an electric cost of 8 cents/kWh, the payback can be about 8 months for incandescent replacement and approximately 3.2 years for fluorescent lamp replacement. *Fixture wattage—EPA Lighting Upgrade Manual*

4) Use occupancy sensors in areas where lighting is left on when no one is there.

Explanation: In most facilities there are places where lights are typically left on when the areas are unoccupied. Occupancy sensors, when properly installed, can ensure that the lights are turned off when the area is vacant, and on when occupied. The energy savings from occupancy sensors depends on the total hours that the lights are normally on, and the percentage of hours that they can be turned off. Savings for an office building operating 4,000 hours annually can be in the range of 10-50 percent, depending on area traffic. The actual percentage of hours that the lights can be turned off can be tracked with an inexpensive lighting data logger.

Figure 4 shows the paybacks that could be realized for various electricity costs by installing occupancy sensors in a room with six fluo-

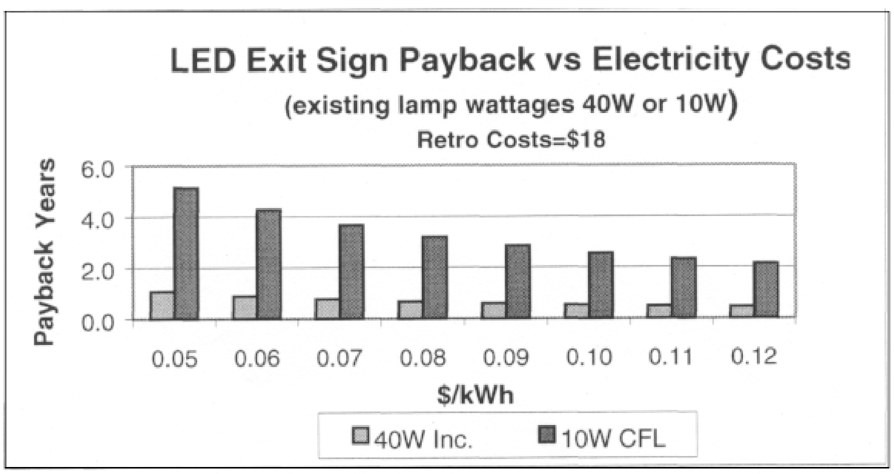

Figure 3. LED Exit Sign Payback vs. Electricity Costs

rescent fixtures consisting of four-34 W T12 lamps with standard ballasts (164 W per fixture). For a electrical cost of 8 cents/kWh, the payback for a 10 percent reduction in lighting hours is about 3.2 years. For a 25 percent reduction the payback drops to around 1.3 years, and for a 50 percent reduction in lighting hours, the payback is under 8 months. *Fixture wattage—EPA Lighting Upgrade Manual*

5) Install programmable thermostats.

Explanation: Programmable thermostats can be used to set up or set back temperatures during facility non-occupied hours, therefore reducing energy costs. These increases in temperature during the cooling season and decreases in temperature during the heating season can result in significant savings in energy usage. The savings realized from installing programmable thermostats are not easy to quantify, as they depend on numerous variables which include: efficiencies of the heating and cooling equipment, weather, facility integrity, hours of operation, and set-back/set-up duration. Manufacturers typically overstate the percent energy savings with estimates going as high as 50 percent. A more reasonable and generally used estimate is 1 percent savings for each degree of an eight-hour setback. A building simulation program can be used to more accurately estimate the annual savings. My experience, using a building energy simulation program, has been that the paybacks for

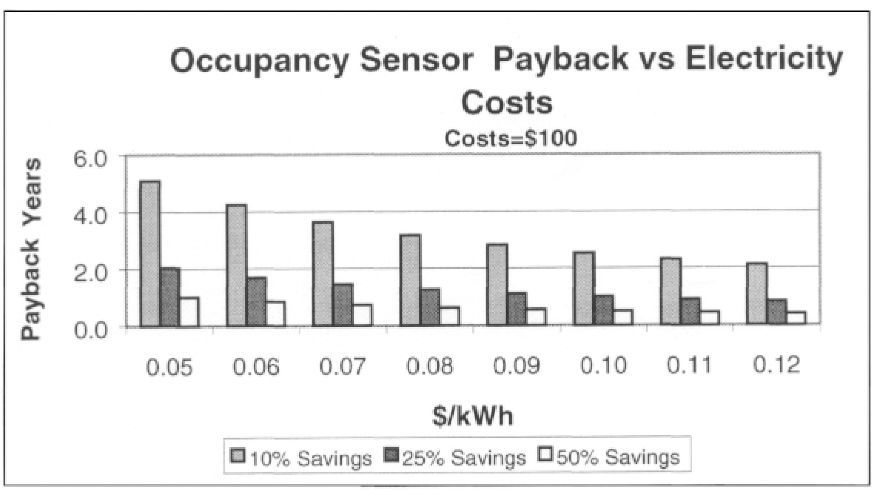

Figure 4. Occupancy Sensor Payback vs. Electricity Costs

installing programmable thermostats in office buildings range from 8 months to 1.5 years. The costs of programmable thermostats range from $50 to over $200, depending on the functions.

6) Replace motors that have burned out with energy efficient ones.

Explanation: Energy efficient motors use less energy to operate than standard motors due to their higher efficiency. A few percent increase in efficiency can save a significant amount of money in the course of a year, especially if the motor has high operating hours.

Figure 5 illustrates the paybacks for various electric rates for changing out a burned-out 70 percent loaded 10 HP-86.5 percent efficient motor with a 10 HP-91.7 percent efficient motor. The cost of the standard motor was $294 and the high efficiency one was $390. For an average electric cost of 8 cents/kWh, and with 4,000 hours of operation, the payback is less than 11 months. For 6,000 hours, the payback drops to approximately 7 months.

7) Replace motors with energy efficient ones rather than rewind.

Explanation: Rewinding motors can lower their efficiency and consequently increase operating costs. It is generally better, for motors less than 25 HP, to replace the motor with a high efficiency equivalent rather

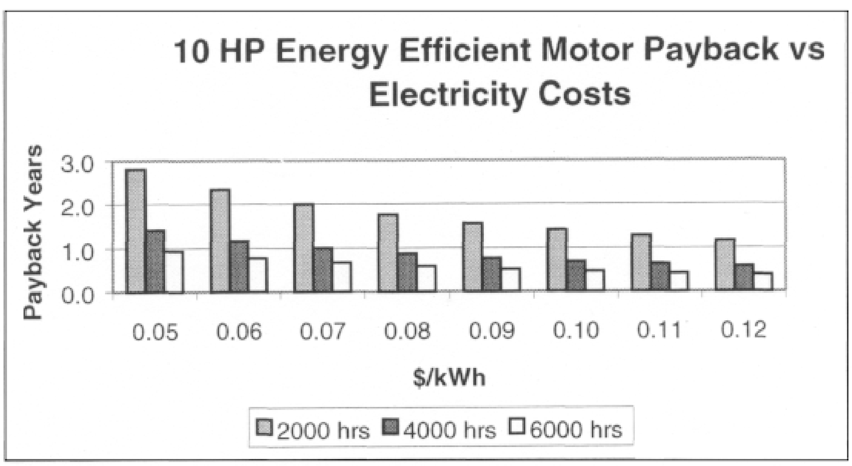

Figure 5. 10 HP Energy Efficient Motor Payback vs. Electricity Costs

than rewind. Also, rewound motors may not last as long as new ones, so the long-term economics will generally favor the new motor alternative.

Figure 6 illustrates the paybacks realized by purchasing a new energy efficient motor rather than rewinding the existing one. A 2 percent loss in efficiency of the rewound motor was assumed based on experience. The cost of the rewind was estimated at 50 percent the cost of a new motor. The motor parameters used were the same as in the previous example. At 8 cents/kWh, motors operated 4,000 hours annually had paybacks of approximately 1.3 years. For 6,000 hours, the payback drops to about 11 months.

8) Replace electric water heaters with gas water heaters.

Explanation: Heating water with electricity can be more expensive than heating it with gas, even though the electric water heaters are more efficient than the gas ones. This is because the cost per Btu of gas has typically been less than electricity. Note: If this pricing hierarchy changes, due to gas shortages or other economic conditions, then the electric to gas conversion may not be as favorable. Figure 7 shows the paybacks realized for changing out an electric water heater with a gas equivalent at various gas and electric rates. The payback calculations

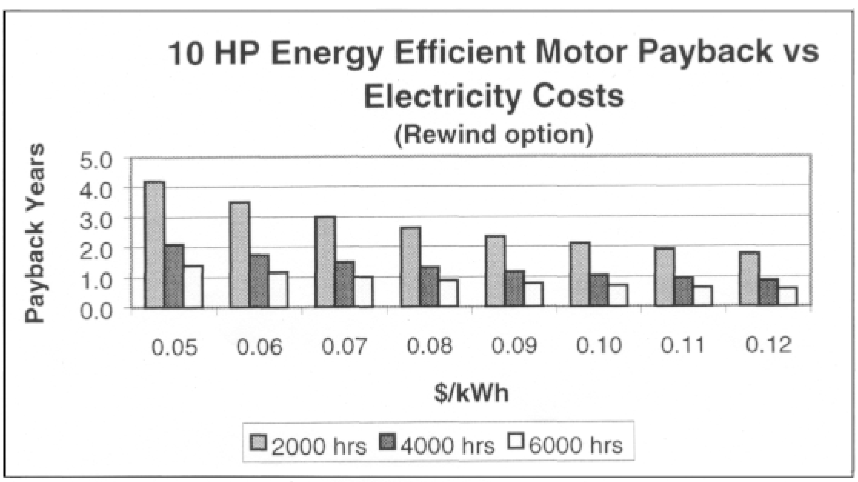

Figure 6. 10 HP Energy Efficient Motor Payback vs. Electricity Costs (Rewind option)

assume an annual hot water usage of 30,000 gallons per year, a sixty degree temperature rise, and a $600 installation cost for changing out a 40 gallon electric water heater for a gas one. The electric and gas water heater energy factor used were 90 percent and 70 percent respectively. At an average electric cost of 8 cents/kWh, the paybacks range from 1.8 years with gas at $3/MCF to 3 years with gas at $9/MCF.

9) Understand the utility rate structures and track billing histories.
In my years as an energy auditor and instructor, I have been amazed at how little some facility managers know about their utility rates. They know the building operation and equipment inside and out, yet they don't take the time to understand how they are being billed; many of them have never seen the utility bills. In order to control utility costs, it is necessary to fully understand the utility rate that the building is billed on. Know how the demand and energy charges are calculated, and how they impact facility operating costs. Also, in order to save energy, it helps to understand how your building has performed in the past. Track your utility usage for at least the previous twelve months and graph this information. Commercial software programs designed to do this tracking/graphing are readily available, or you can develop your own with spreadsheets. At a minimum, track monthly demand, energy

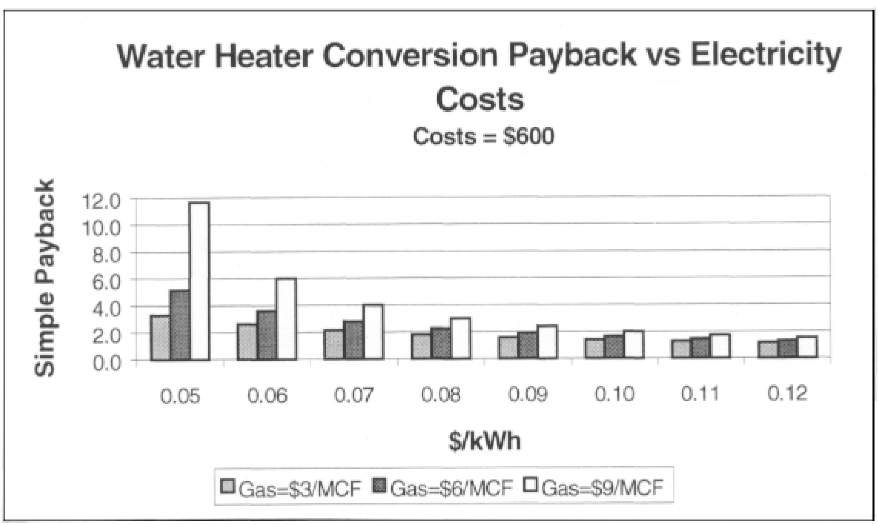

Figure 7. Water Heater Conversion Payback vs. Electricity Costs

usage and dollar amounts. This will enable you to quantify savings due to energy management improvements, and can even help you spot billing errors.

10) Work with your utility representatives.

The utility representative can be a valuable asset in controlling energy costs. Deregulation has placed pressure on utilities to pay more attention to their current customers, especially the larger facilities. This means that most utilities want to do all that they can for their customers to keep them from even thinking about switching to other suppliers or generation alternatives. Here are some questions to ask your representative:

- How does my rate work? Can you get me a copy of the tariff?
- Am I on the best possible rate? If not, how can I get on it? What are my rate options?
- Does my rate include a ratchet charge?
- What is the demand period?
- Do you offer any incentives for equipment replacement? Financing?
- Can you help me reduce my utility costs?

CONCLUSIONS

The energy conservation opportunities addressed in this article, if properly implemented, will help reduce your energy costs. The next step in this process would be to have an energy audit performed to identify which of the energy conservation opportunities discussed would be applicable to your building and to identify any other energy saving opportunities. The audit could be performed in-house, using this article as a preliminary guideline, or as a checklist for an outside auditor. If an outside auditor is used, make sure that at the very least they look at the energy conservation opportunities discussed in this article. If they do not, then you may want to consider consulting with a more experienced auditor.

Bibliography

Terry Niehus is the founder of Lakeshore Consulting, a firm based in Atlanta specializing in energy auditing and technical training. His list

of clients include numerous electric and gas utilities, the Army National Guard, the Corps of Engineers, and hundreds of commercial and industrial businesses. Terry's unique qualifications include practical, hands-on experience as an energy consultant.

Mr. Niehus is an accomplished trainer and has taught courses in commercial building energy systems, motors and drives, residential systems, commercial cooking equipment, HVAC, compressed air, domestic water heating, gas facts, cogeneration and thermal energy storage.

These courses focus on understanding the technical aspects of the subject matter, and how they apply to commercial, industrial, and governmental facilities. In addition to teaching these classes, he has written numerous training manuals including the technical resource manual for motors/drives, commercial building energy systems, commercial HVAC, compressed air, commercial cooking systems, domestic water heating, and thermal energy storage.

Terry's unique qualifications include extensive experience as an energy auditor. He has performed over 1,000 energy analyses for governmental, commercial, and industrial facilities. He is well-versed in life cycle costing analyses and building simulation programs. This comprehensive auditing experience ensures that the training and energy analyses performed by Mr. Niehus are practical, results oriented, and technically sound.

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