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F. William Payne, Editor-in-Chief

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In This Issue...

A Facility Monitoring System: The Single Most Valuable and Cost-Effective Tool Available to an Energy Manager

William A. Holmes, P.E., C.E.M.
UtiliTRACK Corporation

Executive Summary

Energy engineering and management combines engineering problem-solving and financial management techniques to reduce utility costs. At present, substantial amounts of time and money are being spent on audits, studies, portable instrumentation, calculations and modeling in order to attempt to quantify energy consumption and costs and define opportunities for savings, normally involving capital expenditures.

Unfortunately, accurate verification of results is often overlooked. Advances in technology during the last few years have made the installation of a permanent, PC-based monitoring system possible for any facility, often for no more than the cost of a detailed study.

By investing initially in a monitoring system rather than audits or studies, the actual consumption and cost data will be available on a continuing basis and can be used to produce immediate operational savings, more accurately analyze opportunities requiring capital investments, and to verify actual savings resulting from changes.

A permanent monitoring system, installed as the first step in a utility cost reduction effort, to identify where and how energy is used in a facility on a dynamic and real-time basis, can provide the most valuable and cost-effective tool available to an energy manager. The resulting data allows energy consumption patterns and utility costs to be understood and managed in the same manner as all other costs within a facility.

It allows energy decisions to be information-based rather than product-driven and savings from investments in energy improvements to be verified and maintained. These savings range from 15 to more than 50%, often with no capital investment by the owner.

Holmes Energy Services has provided energy engineering and management services to facilities ranging from schools to shopping malls to meat packing plants to foundries. Working for the first several years under shared-savings contracts with no up-front investment by the owner, an approach was evolved to produce savings as quickly as possible with the lowest initial cost on our part, maintain them at the highest practicable level, and provide verification and documentation on an ongoing basis.

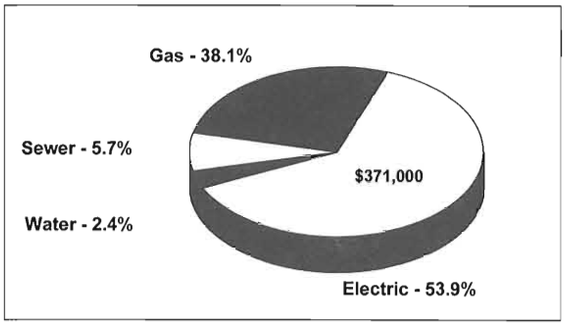
The key element and the first step in every project is the installation of a PC-based monitoring system. Because the system was initially installed, operated and maintained at our expense, we designed and built a low cost, reliable and easy to use system which utilized off-the-shelf components wherever possible. Advances in hardware and software continue to increase capabilities while decreasing costs.

This approach has allowed us to produce exceptional savings in existing buildings with existing equipment. It has also allowed us to accurately assess opportunities for energy projects requiring capital expenditures and document the actual savings. The following description of our methods is provided.

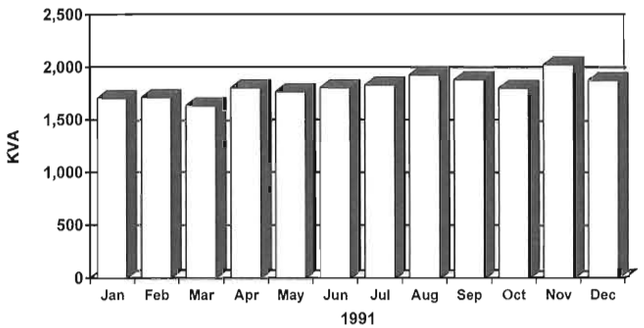
Facility Selection

- Meet with CEO, determine interest in reducing utility costs.
- Review utility history, determine patterns, profiles and total annual utility costs.
- Inspect facility, observe operation, talk to key people.
- Find out if any systems or processes are considered to be off-limits and cannot be changed to save energy.
- Find out if a monitoring system exists and is being used effectively.

Annual Utility Costs $688,000



Electrical Demand



<u>The facility is a good candidate if:</u>

1. Top management is serious about managing utility costs.

2. The annual utility costs are such that a 10-15% reduction will fund the cost of the monitoring system within one year.

3. There is no comprehensive monitoring system or effort in place.

It may offer exceptional opportunities if there are areas with significant energy requirements that have been treated as off-limits in the past; this normally means that no one has ever looked objectively at the consumption patterns and costs.

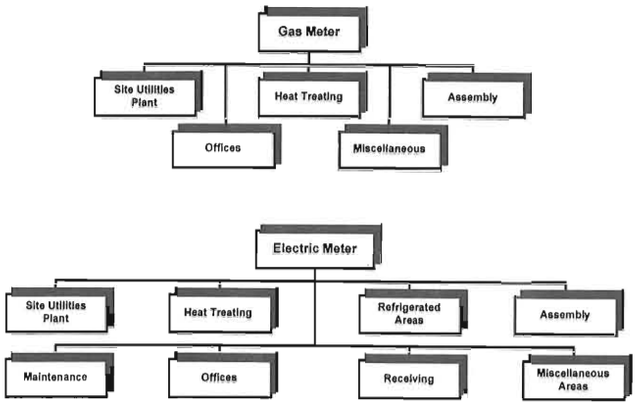
Install Monitoring System

- Spend time becoming familiar with the facility, its energy consuming equipment, and operation.

- Prepare an inventory of significant energy consuming equipment.

- Draw preliminary one-line energy flow diagrams of the entire facility and major systems.

Energy Flow Diagram



- Identify critical points for monitoring, prioritize and estimate costs.
- Install monitoring system.

Quantify Energy Usage and Utility Costs By:

- Utility Meter.
- Time of day and day of week.
- System, process or department.
- Production volume and product mix.
- Weather and other external factors.

Generate Immediate Cost Savings

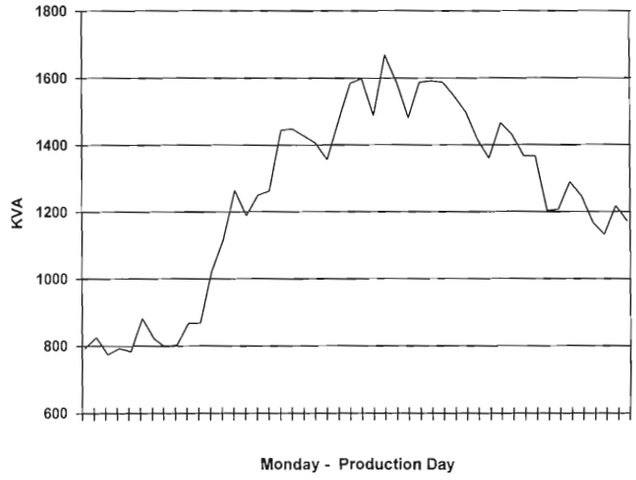
- Identify and quantify individual contributors to hourly consumption, demand and costs.

- Assign individual responsibility for producing savings, provide goals and incentives. Manage utility costs like all other costs.

Daily Meter Report

Time	Main Electric	Refrigeration Compressors	Air Compressor	Main Gas
3:00	974.8	544.7	38.6	119.0
6:00	1,124.0	567.7	84.1	80.7
9:00	1,162.7	468.3	106.2	160.0
12:00	1,467.6	587.2	135.2	212.0
15:00	1,567.3	854.7	132.0	259.9
18:00	1,407.5	733.3	117.4	1860
21:00	1,417.8	850.6	111.7	51.6
24:00	1,274.3	762.4	40.8	48.0
Peak	1,583.9	898.8	136.8	262.0
Total	30,781.3	16,263.4	2,331.4	3,246.3

Electrical Demand Profile

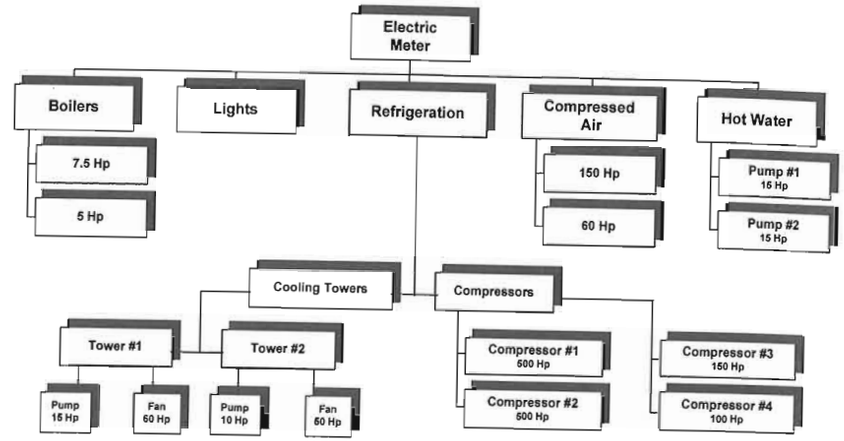


- Coordinate equipment operation to reduce demand peaks and take advantage of special utility rates such as off-peak or interruptible.
- Determine optimum equipment operation and consumption. Eliminate waste. Set daily goals and monitor performance continuously.
- Add system alarms to notify personnel of potentially costly problems.

Analyze Efficiency of Energy Usage

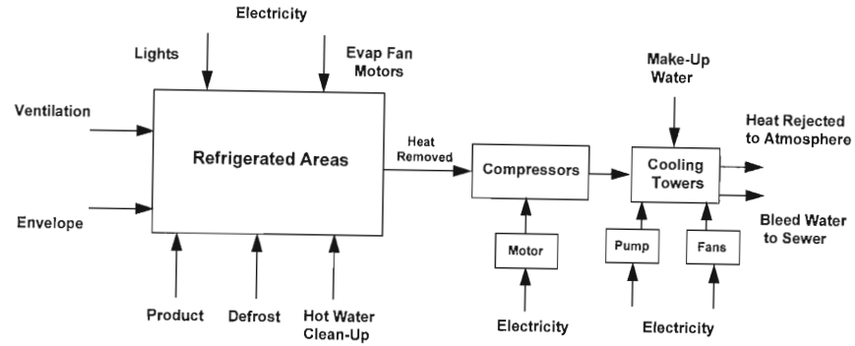
- Finalize one-line energy flow diagrams of the entire facility and major systems.

Site Utilities Plant



- Draw one-line energy balance diagrams for the entire facility, departments, processes, equipment and systems.

Refrigeration System Energy Balance



- Construct spreadsheet models and correlate them with monitored data and utility records to verify existing consumption and demand by department, process, equipment and system.

- Use the spreadsheet models to determine the theoretical consumption and demand by department, process, equipment and system.

- Compare theoretical costs with actual costs to determine opportunities for savings.

Refrigeration Compressors

	Monday	Thursday	Saturday	Year
Heat Load	27-Apr-92	20-May-92	13-Jun-92	1992
Envelope	174	277	321	73,400
Ventilation	96	245	307	49,950
Product	1,205	1,205	0	308,500
Cleanup	126	126	0	32,250
Defrost	20	20	5	90,400
Total Tons	1,622	1,874	633	554,500
Calculated KWH	**2,433**	**2,811**	**949**	**831,800**
Actual KWH	**10,701**	**17,695**	**13,947**	**5,215,800**

- Compare equipment capacities with actual usage to determine opportunities for downsizing and improving operating efficiencies.

Select and Implement Cost Effective Energy Projects

- Identify specific opportunities for savings.
- Use spreadsheet model for "what/if" analysis of opportunities.
- Estimate cost, savings and payback.
- Select projects for implementation.
- Use monitored data to quality for utility incentives.

Track and Maintain Energy & Cost Savings

- Generate daily, monthly and annual utility cost reports for the entire facility, departments, processes, equipment and systems.

- Integrate daily, monthly and annual utility cost reports into the existing facility financial management system.

- Assign costs to specific individuals or departments. Include utility costs in production reports, manager evaluations and incentives.

- Compare monitored data with utility records for verification.

- Compare actual performance of energy projects with projections.

Other Factors & Savings

Through continuous monitoring combined with system alarms, significant additional savings can be realized by early detection and correction of:

- Excessive utility consumption due to operator error or equipment malfunction.

- Degradation of equipment performance prior to failure.

- Equipment failure, prior to noticeable effects on occupants or processes.

- Problems that could result in loss of production or revenue.

- Potential hazards.

Discussion

The first step in any financial management process is setting up a system for determining and tracking individual expenditures on a continuing basis. Other than utility costs, a manager would never approve a major expenditure without a detailed accounting of where the money is being spent.

The key to the success of any utility cost reduction effort, therefore, lies in convincing top management that utility costs must be treated and managed the same as all other costs within the facility. They represent opportunities, often significant and largely untapped, to improve the bottom line and must be recognized as such. The tremendous opportunity for creating utility savings through good management is an opportunity that will always be available in all facilities.

Portable instrumentation used to evaluate opportunities for energy savings provides a snapshot of energy use during the time that it is installed. Energy usage in a facility is complex and dynamic. It must be continuously monitored, measured, evaluated and managed. The use of portable instrumentation implies that technology is the primary means of reducing utility costs and that after improvements are made, the predicted savings will occur and no further detailed monitoring is required.

Technology is only one part of energy efficiency, however. Many of

the problems to be overcome are not technical problems, they are people problems; people who lack the understanding, training, time, interest or incentive to get the most from buildings and systems. We have encountered many energy improvements in the field that were saving nothing even though all of the projections, estimates and spot measurements said that they were.

There are so many vendors claiming that their products will produce big savings that many people are totally confused. Bad experiences in the past have turned many people off on energy management. A monitoring system puts the owner back in control by providing actual data to identify and quantify costs and verify actual savings after an improvement is made.

Summary

The following summary of our approach as presented in this article is provided:

- Work directly with the owner, president or plant manager and demonstrate how utility costs can be quantified, tracked and managed the same as all other costs associated with a facility. Once top management understands and accepts the concept and supports the effort, one of the most difficult hurdles has been overcome.

- Rather than investing in studies, audits and temporary monitoring equipment, apply that money toward the installation of a permanent monitoring system as the first step in reducing utility costs. A permanent monitoring system will produce more comprehensive and accurate data for identification of opportunities and can then be used to produce and document costs and savings on an on-going basis. The system can initially be tied to a few key points and, once the PC and software are installed, be continually expanded for only the cost of sensors and wiring.

- Apply the fundamental concepts of engineering problem-solving and financial management on an on-going basis.

  — Determine the actual utility consumption and cost profile of the total facility and significant areas and systems.

  — Determine opportunities for immediate savings through no cost or low cost changes in operating and maintenance practices.

  — Assign specific responsibilities and implement changes.

  — Use the monitoring system to provide feedback and track utility costs on a continuous basis. Integrate with the facility's financial management system.

- Develop a theoretical profile of the facility and use the differences between the actual and theoretical to determine opportunities for reducing costs that require capital expenditures.

ABOUT THE AUTHOR

Bill Holmes is president of **Utili**TRACK, in Columbus, Indiana. His firm specializes in reducing utility costs in existing buildings through improvements in operation, maintenance and control. After five years with a consulting firm doing energy audits and designing improvements, he taught for six years in Purdue's Mechanical Engineering Technology Program. In 1979 he founded **Utili**TRACK Corporation. In 1988 and 1990 his firm received awards from the State of Indiana for achievements in energy efficiency and in 1990, it received a DOE Award for Energy Innovation. Bill holds a B.S. in mechanical engineering from Rose-Hulman Institute of Technology and an M.S.M.E. from New Mexico State University. He is a registered engineer in Indiana and Ohio, a certified energy manager, and in 1990 was named Energy Manager of the Year by the Association of Energy Engineers, Hoosier Chapter. He is a regular lecturer in the Energy Management Program conducted by the College of Engineering at the University of Wisconsin and for the past two years, has been a speaker at the World Energy Engineering Congress in Atlanta.