

Meeting Needs of Multiple Stakeholders

At every level, the success of an organization relies on accurate and timely information. EnergyDashboard provides analytics tailored to the specific needs of different stakeholders and decision makers. For example:

- ✓ **Maintenance Managers** use real-time access to recent performance in order to proactively respond to system issues, and often evaluate the last few days of operations for variations or trends that need immediate attention.
- ✓ **Facility Managers, Owners or CFOs** are more likely to compare month-to-month performance and track overall high-level system efficiency and the calculated energy savings, and may prefer to review summary reports to live data.
- ✓ **Refrigeration Contractors** can (with the customer's permission) use EnergyDashboard to evaluate system operation prior to scheduled maintenance to plan and focus their activities, or to verify performance following maintenance or repairs.

The Development of EnergyDashboard®

EnergyDashboard was developed by VaCom Technologies, beginning in 2003, to address a shortfall observed in power monitoring services for industrial refrigeration systems. Power usage comparisons have some meaning if the facility usage is primarily affected by weather; however, power monitoring doesn't account for changes in product throughput nor identify how efficiently cooling is provided by the system.

About VaCom Technologies

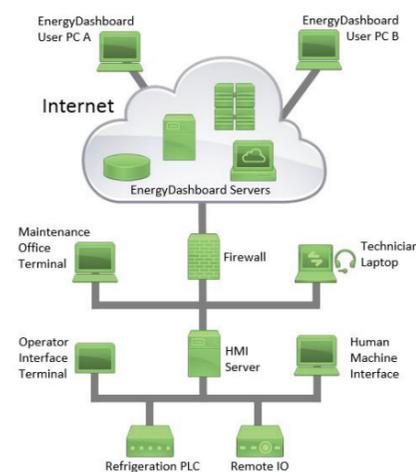
VaCom Technologies provides a comprehensive approach to high performance, energy efficient industrial refrigeration systems for food and beverage plants and refrigerated warehouses. Our capabilities include engineering and economic analysis, refrigeration control systems—large and small, turnkey project implementation and life cycle performance monitoring using EnergyDashboard.

EnergyDashboard is a hosted service that has the capability to integrate data from multiple sources, process measured and calculated performance data, and trend system efficiency over time (not just power usage). The tool provides high level performance metrics and savings calculations as well as detailed component operation and system parameters necessary to troubleshoot efficiency shortfalls.

In a typical installation, data is sent periodically from the refrigeration system PLC HMI to the EnergyDashboard server where the data (such as suction pressure, equipment run-time, and fan speeds) is processed nearly real-time using thermodynamic properties and equipment manufacturer's performance data.

The processed data is then made available to the customer via a password-protected Internet browser interface. This interface allows users at different levels of the customer's organization to see information of interest, while preventing inadvertent changes to the refrigeration control system that might occur if untrained users were directly accessing the PLC HMI.

EnergyDashboard is a cost-effective alternative to expensive historian software and customized onsite analytical reporting tools, which may cost tens of thousands and still only "slice and dice" usage. With EnergyDashboard, data is pre-processed into key metrics and provided for the customer without additional software licenses or expensive on-site databases.



La Verne, CA | San Luis Obispo, CA | Denver, CO
 (909) 392-6704 | sales@vacomtech.com
 vacomtech.com | energydashboard.com

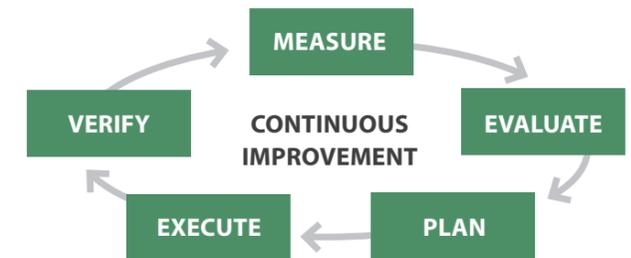
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VaCom
Technologies

EnergyDashboard®

Performance Monitoring Services
for Industrial Refrigeration Systems

- Measure** system and component efficiency, not just power consumption
- Compare** performance vs. expectations to achieve efficiency and savings goals
- Achieve** permanence of energy savings and financial Return on Investment
- Continuously improve** performance through transparent tracking and in-depth analytics



First, Measure in Order to Manage

To fully understand facility performance or measure the benefit of energy efficiency projects requires use of the right "tools". Simple utility bill comparisons are only approximations, skewed by differences in weather, production levels, or operation of unrelated equipment.

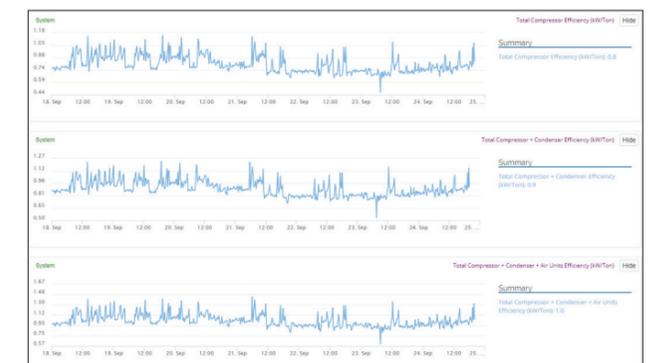
VaCom Technologies' EnergyDashboard® performance monitoring system provides the technology to calculate, track and manage performance and efficiency; from individual components and subsystems to the entire plant. Energy savings calculators and utility usage and rate engines are also incorporated. Efficiency is continuously maintained and improved, along with minimizing utility operating cost over time.

Why Invest in Performance Monitoring?

After investing in energy-efficient technologies and control systems, why should you spend money to monitor system performance? After all, isn't the automation itself supposed to work right and provide the expected return on investment?

In fact, it takes more. Without continued attention, performance and savings will often decline. Industrial plants and refrigeration systems are dynamic, with complex interactions between components and controls. The natural tendency over time is towards less efficient operation; this can be through equipment and instrumentation degradation, insufficient operator or contractor understanding of refrigeration system interactions, or changing facility needs and operating conditions.

The larger the investment in efficient equipment and sophisticated controls, the greater the value realized by continuously maintaining performance.



Continuous Improvement Produces Profits

The cost of ongoing performance monitoring is small compared with the cost of “business as usual”. For example, temperature and pressure set-points are often changed by operators or outside service technicians to temporarily address a performance problem. While this may be necessary at the moment, too often the root problem is not resolved and the change becomes permanent.

Let’s take a look at the financial impact:

On average, a 1°F (saturation temperature) decrease in the saturated suction temperature or a 1°F increase in the saturated condensing temperature can increase refrigeration compressor power usage by approximately 1.5%.

The cost-impact of increasing the average discharge pressure 1°F on a single-stage system averaging 1,000 kW of compressor power would increase energy usage by 131,000 kWh, or at \$0.10/kWh would cost **an additional \$13,100 per year**.

VaCom Technologies’ monitoring services help identify setpoint and system performance changes quickly, as well as quantifying the associated energy cost. Over the last ten years, we’ve observed the performance of numerous industrial refrigeration systems following energy efficiency upgrades and concluded that approximately 30-40% of the energy savings from the efficiency project investments would be lost without the use of ongoing performance monitoring services.

Dedicated Refrigeration and Energy Engineering Expertise for Your Facility

Operations and maintenance staff are naturally focused on maintaining equipment and production rates, leaving little time for detailed study of system efficiency or optimizing control strategies. Employing a full-time engineer to address refrigeration plant efficiency is rarely an option even for large facilities.

The Performance Monitoring Services offered by VaCom Technologies constitute a virtual engineer for your facility. Our engineering team specializes in analysis and optimization of complex refrigeration systems and will provide ongoing recommendations to help solve performance problems, improve efficiency and achieve energy savings.

Key Analytics + Focused Investigation = Results

EnergyDashboard has delivered energy and cost savings for our customers in a number of different ways.

Equipment Performance vs. Expectations

EnergyDashboard analytics provide performance evaluations of equipment at multiple levels—from individual components to subsystems and ultimately aggregating all performance to high-level metrics. Showing performance at different levels directs attention where it is needed, with equipment-level key indicators often useful to operators and higher level metrics valuable to utility and plant managers.

Equipment performance can be compared with manufacturer’s capacity and power data, or by matching performance to loads from “upstream” equipment, in order to calculate key indicators and identify negative trends before performance and efficiency are compromised.

For example, a decline in actual-vs.-expected condenser approach temperature can indicate the presence of non-condensables or the build-up of scale. Or, an evaporator coil that operates differently than adjacent zones is obviously deficient even if temperature is being maintained. The repair may be as simple as strainer cleaning but could remain unaddressed for years—only affecting efficiency and energy use—until temperature starts to increase. Suction setpoints are often set significantly lower than should be required for the prevailing equipment and load, leading to additional fact-finding and potential improvements.

Measuring equipment performance is the starting point for maintaining system integrity, managing maintenance costs and continued energy efficiency.

Setpoint Exception Analysis

In this site-specific example, EnergyDashboard performance analysis was coupled with a study of customer temperature requirements and control system setpoints. An unexpected decrease in expected savings from fan speed and fan cycling control led to additional investigation. A number of zone setpoints had been changed in the prior quarter, in response to a new quality control policy that standardized zone temperatures at 32°F. What the customer was not aware of was that a number of the zones had been mistakenly set to 30°F and 31°F (see a sample in the following table).

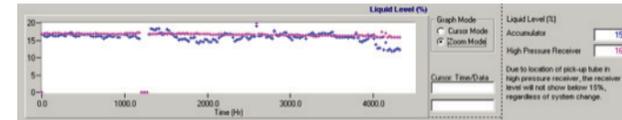
Zone	Before Setpoint Audit		After Setpoint Audit	
	Avg Temp Setpoint (F)	Avg Duty Cycle (%)	Avg Temp Setpoint (F)	Avg Duty Cycle (%)
AU 20	31.1	61.2	32.0	41.8
AU 21	31.1	74.3	32.0	57.9
AU 22	31.1	80.5	32.0	70.6
AU 23	30.0	90.5	32.0	44.1
AU 24	30.0	90.6	32.0	65.1
AU 25	30.0	90.9	32.0	48
AU 26	31.1	70.5	32.0	34.9
AU 27	31.1	88	32.0	56.9
AU 28	31.1	85.6	32.0	41.8
AU 29	31.1	61.7	32.0	24.3

Now fully informed, the customer corrected the setpoints with an immediate improvement to the average fan run-time of the zones (fan cycling went from 78% to 57%) resulting in annual energy savings of 45,900 kWh/yr., or \$4,600 at prevailing electric rates.

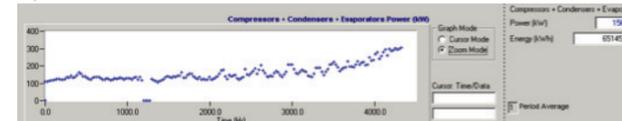
Refrigerant Management

Refrigerant management is increasingly important, particularly on non-ammonia refrigeration systems. While detection systems often provide immediate local alarms, tracking and trending high-pressure receiver levels is useful in identifying whether systems have ongoing leakage.

Receiver Level Drops



System Power Increases

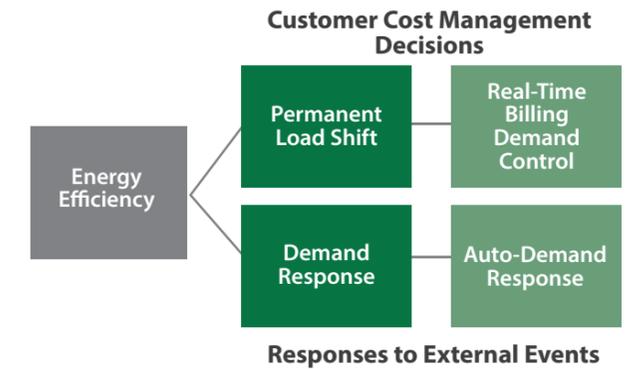


Early detection and resolution of insidious leaks assists with regulatory compliance and minimizes refrigerant replacement costs. Moreover, operation at low charge can be extremely inefficient—as shown in the example above. Even if temperatures are still being maintained, energy cost can increase dramatically as charge is lost.

Demand Response Planning and Analysis

To address rising electrical costs and changing rates, more facilities are participating in utility demand response (DR) programs. Each facility is unique in what load it can shed, and for how long. Moreover, excessive demand response actions can dramatically reduce energy efficiency and total cost. What is good for the utility may not be best for every facility.

Performance monitoring and post-event analysis following DR events is vital to achieving demand response goals and balanced DR with energy efficiency, resulting in the lowest overall operating costs for your facility.



Energy cost management starts with energy efficiency, since energy efficiency benefits every hour of the year. Efficiency is followed by two distinctly separate applications of demand management: permanent load shift and active billing demand control (both limiting monthly peak demand charges). Finally, demand response actions are taken as part of a utility program.

EnergyDashboard® Provides More than Trends

The trending capability included in industrial HMI software is useful for detailed event analysis, using high resolution views of inputs and outputs—certainly we utilize this detail when needed. Performance monitoring provides an additional layer of knowledge, integrating key system data from multiple sources (including the HMI) and calculates performance metrics close to real-time. Many of these calculations would be difficult or impossible to implement using HMI software. Using a hosted service approach, VaCom is able to provide highly evolved calculations and performance metrics at a small fraction of the cost and time that would be required to develop and maintain a custom site-specific application.