

Monitoring & Targeting:

The Foundation of an Effective Energy Management System

Introduction

Monitoring & Targeting (M&T) is a systematic approach for the effective management and use of energy consumption data in support of an organization's overall energy management system (EMS) and energy conservation goals. M&T is a proven energy management technique for achieving and sustaining energy efficiencies—putting energy use under management control.

M&T involves the monitoring and analysis of energy use data and the reporting of this information to the appropriate personnel. In this way, M&T allows personnel to make timely and knowledgeable decisions to control their facility's energy consumption.

M&T works by comparing actual energy use to preset targets which are based on energy consumption models. A model relates energy consumption to operational factors driving energy use (i.e. production, facility processes, etc). By continuously comparing actual energy use against the model (or target), personnel can identify energy waste and maintain energy efficiency improvements.

M&T clarifies energy use patterns and, collected over time, historical M&T data creates a solid foundation for any strategic energy management system. Without this foundation, energy decisions are based on guesswork and results are measured against opinion.

The Benefits of M&T

M&T helps users get control of their energy use. While the ultimate goal for most organizations is to reduce their energy costs, the following are also benefits of the information produced by an M&T system:

- **Early detection of wasted energy.** When wasted energy is detected corrective action can be taken.
- **Evidence of success.** Historical energy information demonstrates whether actions taken to reduce energy consumption and costs have been successful.
- **Support for long-term decisions.** Over time, the use of M&T creates a context for longer-term decisions by allowing users to estimate payback and justify investments in capital projects.
- **Support for energy budgeting.** A historical baseline is useful for demonstrating the relationship between factors driving energy use (i.e. production volume), the amount of energy used, and weather. The baseline allows for confident predictions of future energy use.

Supporting Your Energy Management System

M&T provides relevant information for energy use reductions, however, M&T alone will not guarantee success in lowering your energy use. An effective energy management system (EMS) is required to act upon the information produced by M&T. The three pillars of an effective EMS are people, systems, and technology—each reinforced by the benefits of M&T.

- **People.** Your EMS must encourage a company culture that is receptive to energy conservation practices. Thinking of energy as a variable cost, rather than a given or fixed cost, is the ideal goal. Ultimately, an M&T system allows energy use to be managed and controlled like other factors of production.
- **Systems.** Your EMS must delegate responsibility to the levels of the organization where action can be taken. Accurate and fair reporting is required to sustain accountability over the long run. It is over the long run that the accrued benefits of energy conservation become significant. M&T quantifies these accrued benefits.
- **Technology.** Your EMS must provide the necessary support for implementing energy efficiency projects. The tools, data, information, and analysis provided by M&T enable your organization to identify projects, quantify effort, and measure results.

Energy Management System

People

Systems

Technology

Monitoring & Targeting System

Monitoring & Targeting Fundamentals

The Feedback Cycle

Your day-to-day energy conservation activities can be summarized using the simple continuous improvement cycle:

Measure > Analyze > Act

An M&T implementation supports this cycle by providing data, converting the data into meaningful information, and measuring the results of your actions. There are three components of an M&T implementation which correspond to this cycle: monitoring, analysis, and reporting. The fundamentals of a simple M&T implementation are discussed below using these three components.

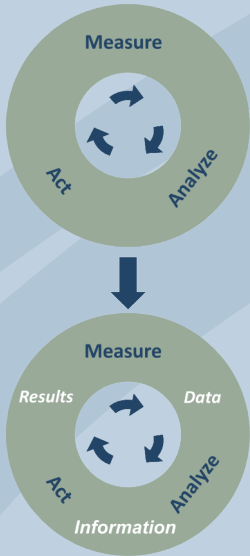
Monitoring

- Monitoring refers to the regular and consistent collection of energy use data from gross metering devices (i.e. a building or facility) and sub-metering devices (i.e. a process area, production area, or operational area). M&T can be applied to any energy-related consumable such as natural gas, electricity, steam, water, and/or compressed air.
- Gross metering data can be acquired from your utility company or by connecting an automatic data acquisition system (DAQ) to the utility metering device. Sub-metering adds more information resolution to your M&T system (thus, improving it's effectiveness).
- Note that many M&T applications can provide effective initial results using gross metering alone. The subsequent application of M&T can then be used to identify and cost-justify future sub-metering investments.
- The use of an automated DAQ is recommended. A DAQ lowers the long-run cost of running an M&T system, ensures data consistency, and integrates with popular data archival tools such as databases and spreadsheets.

Analysis – Establish the Baseline

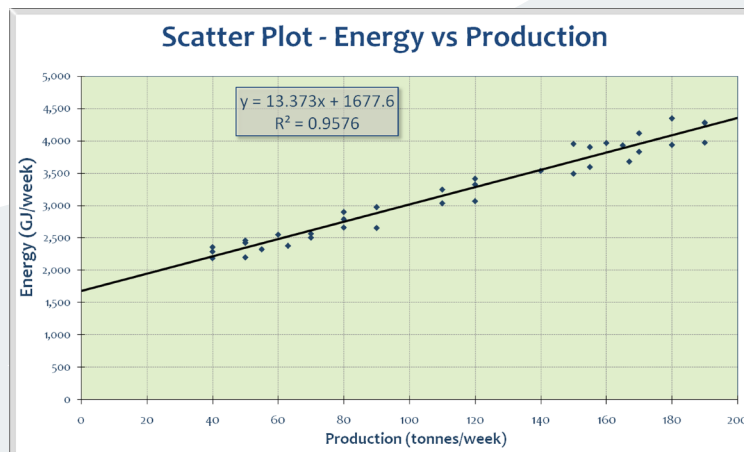
Data without a relevant point of comparison provides little meaningful information. Data only becomes relevant when analyzed within a meaningful context. Analysis of historical energy data is used to create this context. Historical data is first used to create a baseline or benchmark against which future energy use data can be compared. This is done as follows:

- A mathematical relationship (or model) between energy use and factors affecting energy use is established. In the example shown, energy use is related linearly to production (see Chart A).
- The relationship is illustrated with a scatter plot. The Y-intercept value represents the energy use with no base load (no energy use). The slope represents the direct relationship between production levels and energy use. The scatter shows the degree of variability in energy use and tends to be driven by operational factors which can be controlled.
- Next, a subset of your historical energy use data that best represents typical plant performance is selected. This historical data is used to define a baseline model—another mathematical formula.



Courtesy TSDixon Inc.
<http://www.knowenergy.com>

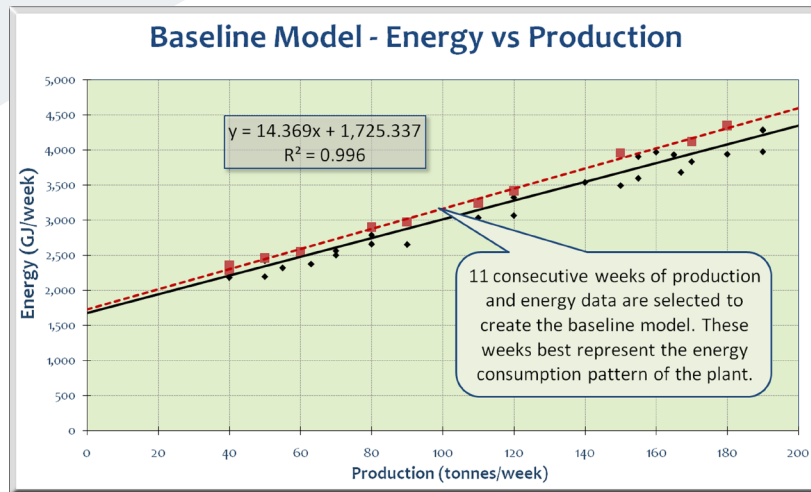
Chart A



The baseline model (see Chart B) represents energy use in the past and expected energy use in the future. This baseline provides a valuable benchmark for measuring the results of procedural changes that affect energy use, tracking investments in energy efficiency projects, or identifying new patterns of energy waste. The baseline can be referenced in support of short-term or long-term decision making.

The example uses a simple linear relationship to correlate energy use and production. In fact, the relationship can be more complex and may include other factors (i.e. multi-variate) such as weather, work-in-process inventories, product mix, and process variables.

Chart B



Additionally, the relationship between the factors driving energy use and the actual levels of energy use can be non-linear. In some cases, an understanding of mathematical first principles must be used to develop an energy use index. As long as the index is consistent over time it can be used for analysis.

Analysis – Setting Targets

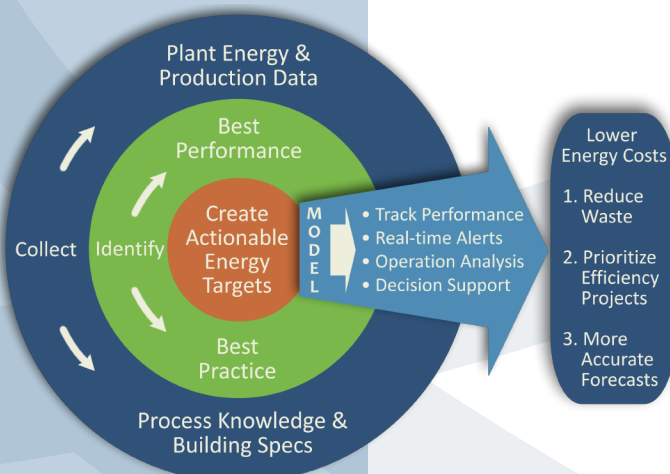
Similar to a baseline model, a target model should also be established once best performance and best practice criteria have been established. The target model establishes a performance standard for energy use and is used for reporting and maintaining accountability.

Best performance is identified by comparing energy use over a period of time against the baseline model (i.e. what is typical). When patterns of exceptional performance are found (i.e. lower energy use than what is typical), the data from this period can be used to establish a target model. Best practice criteria can be based on industry norms or benchmarks from similar or identical processes within your own company.

Together, best practices and best performance identification can be used to establish achievable and realistic energy reduction targets. When the targets are compared against the actual energy use on a regular basis, a framework is established for maintaining accountability and providing clear information on energy use performance.

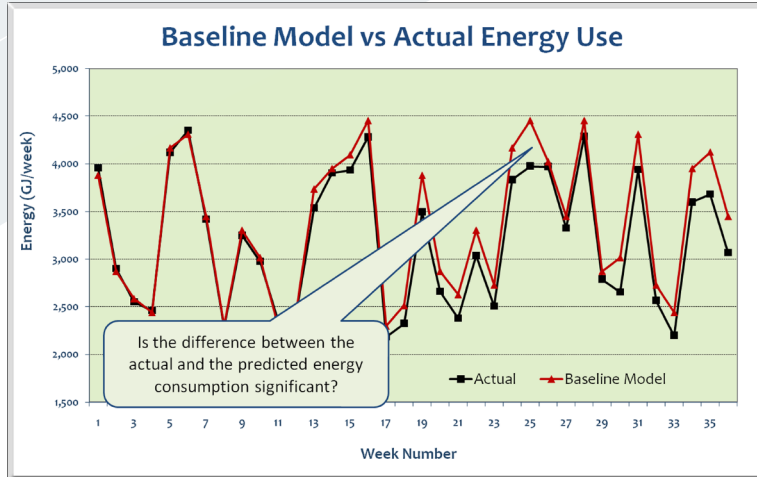
Reporting

Information from an M&T system provides the basis for action in the three pillars of your EMS: people, systems, and technology. Clarity in the M&T information is required, regardless of whether your needs are short-term (e.g. responding promptly to unexpected energy use changes, good or bad) or long-term (e.g. budgeting for an energy efficiency project, energy forecasting, measuring performance). Clarity is accomplished by using your models to identify exceptional deviations from expected energy use, all things considered (i.e. production rates, product mix, weather).



Plotting your baseline model vs. actual energy use over time (see Chart C) provides one means of comparison. In the plot shown, weeks 1 through 11 compare well, with little variation. This is expected as our model is based on data from weeks 1 to 11. Over time, the variation becomes more pronounced. Is the variation exceptional or significant? This is where M&T techniques add clarity.

Chart C

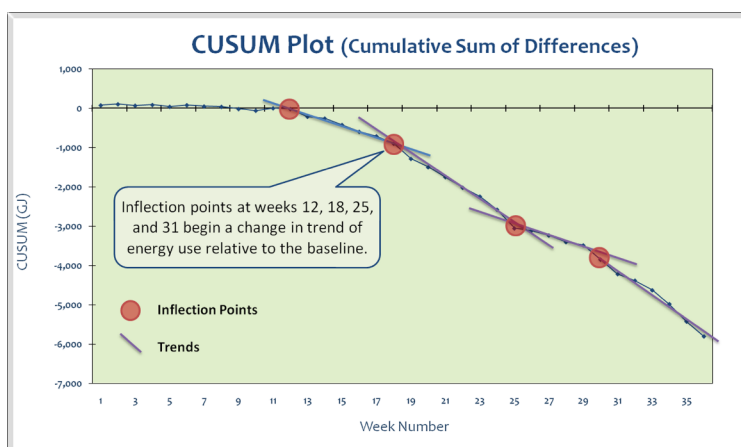


CUSUM

The application of a statistical technique called CUSUM (cumulative sum of differences) provides the needed clarity. As shown in the CUSUM plot (see Chart D), the difference between actual energy use and predicted energy use is accumulated over time. What can a CUSUM tell us?

- An upward trend indicates poor performance—your operation is using more energy than expected; a downward trend indicates good performance—your operation is using less energy than expected.
- Inflection points represent periods of change. They can indicate intended changes or unexpected changes.
- Straight segments indicate periods of consistent performance, either improving, declining, or on target.

Chart D



CUSUM is sensitive to change. For this reason, the continuous monitoring of CUSUM provides a good tool for short-term feedback (i.e. alarming) on unexpected energy use. In the longer term, CUSUM can be used to identify periods of time when energy use is good (and thus needs to be repeated) or bad (and thus needs to be avoided or mitigated). When the CUSUM technique is integrated with traditional EMS energy reporting, it provides new information and clarifies important events. Energy-related decision making can be simplified and actions taken can become increasingly proactive.

To learn more about implementing M&T at your facility, please contact Energent at www.energent.com.