BESS - Benchmarking and Energy management Schemes in SMEs

MONITORING & TARGETING TECHNIQUES

Monitoring and targeting technique use regularly collected data on energy (or other sources) use, production, efficiencies etc. in a converted way of performance indicators. The M&T analysis of (energy) performance indicators allows the company to evaluate its energy performance against its energy targets, industry sector norm (benchmarking), against efficiency changes in time, and allows systematically check of compliance with relevant legal and other requirements. The data should be collected on a regular basis (shift, day, week, month) and different data sources can be used (metering and other data from data information systems, spreadsheets etc.).
M&T can be applied to single, or groups of processes or buildings, or entire factories. The initial choice will depend on available energy metering, but over time this will be refined by the increasing understanding of areas where energy can be better controlled. M&T techniques are not limited only to energy usage but *are* equally applicable to water consumption and production indicators such as scrap rates or yield.

A basic M&T method to evaluate company's energy performance is by a comparison of **Specific Energy Consumption (SEC).** SEC is a measure of energy use per unit of production, e.g. kWh/te throughput.

Even limited data will allow preliminary comparisons of energy performance with other sites or similar processes and provide a baseline against which to start tracking on-going energy consumption.

There are four chart types commonly used within a basic M&T system:

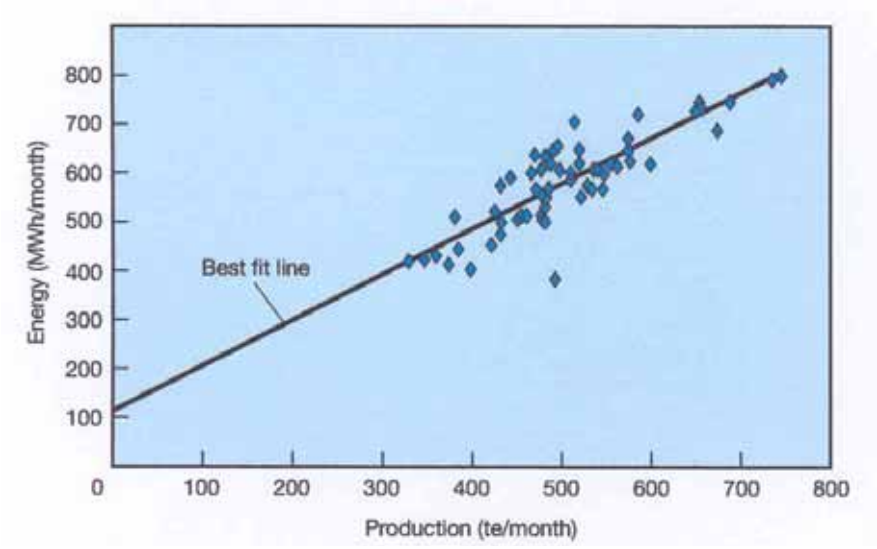
- Energy Use vs. Production
- Specific Energy Consumption vs. Production
- CUSUM
- Control Chart

The first two of these chart types are for displaying and interpreting energy data, while the others are used primarily as tools to assist in management and control.

Energy vs. production charts are used to determine:

- Process Efficiency
- Energy Consumption not linked to Production

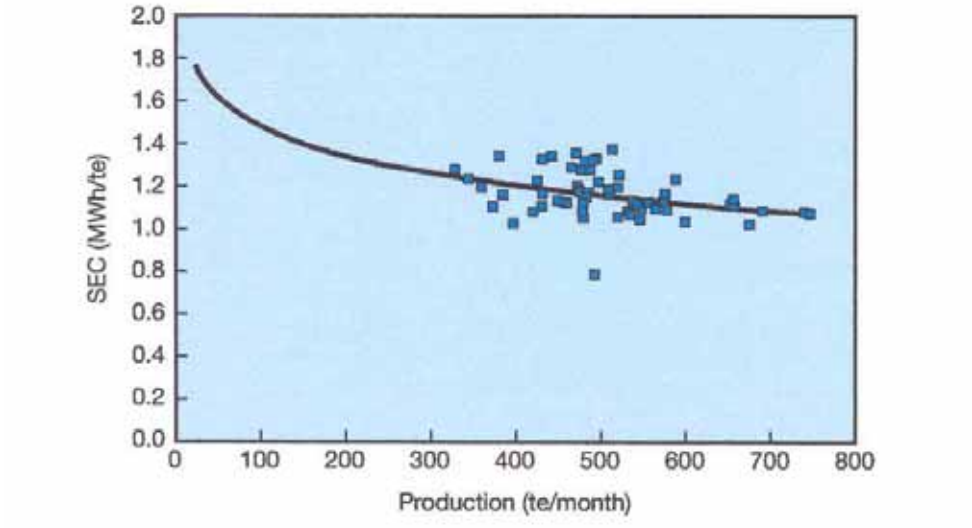
The best fit line indicates the relationship between energy consumption and its driver (in this case, production) and several things can be learned from the calculation of the equation of the straight line in the standard mathematical form: $y = m x + c$.



There are three important features on the chart;

- **Intercept (c)** - the energy that would still be required even if production was reduced to zero (in this case it is 113.5 MWh/month).
- **Slope (m)** - the amount of energy required to process each additional unit of production, leading to the process efficiency.
- **Scatter** - the distribution of the data points away from the best fit line, indicating the variation in energy per unit production from one period to another. Large differences between scatter and best fit lead to the conclusion of poor process control.

Specific Energy Consumption vs. Production Chart type plots specific energy consumption (SEC) against production. SEC is calculated simply from the data used in Energy versus Production chart by dividing energy consumption by production. The chart generally produces a characteristic curved form. SEC provides a simple indicator for benchmarking.



For this example, the curvature of the line is not easily seen within the process range of production, but this is not always the case. SEC is often used in industrial management as a summary indicator, but is not suitable as a basis for energy monitoring and control. The curvature means that it is difficult to draw a best fit line and the information in the straight line intercept is lost.

Energy monitoring by SEC should be avoided if there is a significant proportion of energy which is not related to production (this causes the curvature), and where the process has a wide range of production rates.

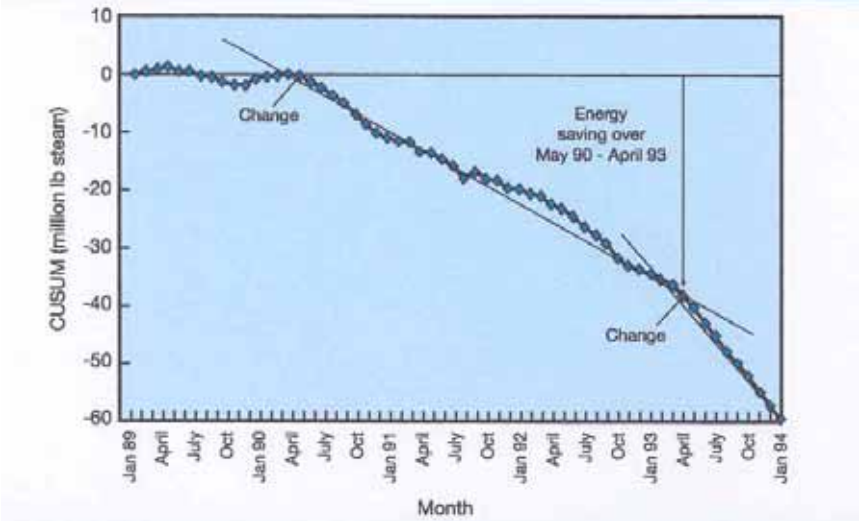
CUSUM stands for the **Cumulative SUM** of differences and is a technique which uses equal interval time series data (i.e. information of the same kind, collected at the same time each day, week, month, etc. and organized in the same time order as it was measured). CUSUM plots the cumulative difference between predicted and actual energy use against time.

There are two uses for CUSUM. One is to identify changes in historical energy performance patterns (to measure planned or unforeseen changes in the way energy is used); the other is to determine the period since the last change, as data over this period may be used as a reference for establishing control standards.

CUSUM involves four steps:

- Predicting energy use from the production data for each time interval (daily, weekly, monthly, etc.). This is done using the best fit line of the energy vs. production chart.
- Subtracting predicted consumption from actual usage to obtain a difference for each time interval.
- Summing the differences over time to obtain CUSUM.
- Plotting a chart of CUSUM against time.

If the entire scatter in the energy vs. production chart were only random about the best fit line, then the differences from predicted energy use would also be randomly positive and negative. The cumulative difference (CUSUM) would also be random and not far from zero, and would track horizontally on this chart.
However, if something happens that changes the pattern of consumption, the differences will not be random. They will be biased positive or negative and CUSUM will track up or down from the time of that event. The CUSUM chart therefore consists of a series of straight sections separated by kinks, each kink representing a change in pattern. CUSUM chart can also be drawn with respect to energy costs, as any improvement of energy efficiency leads to reduced energy costs (and vice versa).



Control charts are based on the principles of statistical process control which will be familiar in many companies. The charts are used to track current performance, in this case energy consumption, and to highlight where performance falls outside a band, within which performance

is considered acceptable for normal process operation. Any deviation outside of this band alerts management to the need for investigative and perhaps, corrective action.
Control charts compare current energy usage with a prediction formula, and the control band is based upon the energy consumption during a recent reference period that is considered to represent normal process operation. Consequently, the control band must be recalculated for a new reference period each time there is a significant change in this underlying energy consumption pattern. Such changes in pattern are indicated by the CUSUM chart.

Once a basic level of management control has been achieved, further savings depend on extending M&T to other areas of the plant or company and increasing the level of sophistication.

There are several ways to improve the performance of an M&T system:

- Improve data quality;
- Improve the time correspondence of data;
- Increase the frequency of meter readings;
- Increase the number of energy drivers analyzed.

These are in roughly the right order of priority to optimize benefit and cost. The first applies to quite basic systems, the middle two can apply to both basic and computerized systems and the fatter is particularly suited to computerized systems.

Notes: - This information on Monitoring & Targeting is originated from the ETSU GPG148 report.
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