EnergyMaster

Energy monitoring results in huge saving potentials for plastics processing companies

With soaring energy prices, the energy cost has become an important factor in the total cost of the final product. After raw materials and direct labor, energy generally is the third largest variable cost in plastics processing, representing on average 3 to 5% of the company's turnover.

Today it is no longer sufficient to optimize output, quality and production planning, also energy consumption is a very important factor in the operating cost of a plastics plant. A sudden increase in the energy consumption of a production run can push an order easily in the red figures. With ever rising energy prices and increasing environmental legislation, efficient energy management has become a very critical success factor to run a profitable business in today's global economy.

In order to help plastics processing companies with these new challenges, BMS extends its PlantMaster MES system with the EnergyMaster module. Following the principle of Monitoring and Targeting (M&T), it maps the different energy consumptions (electricity, gas, compressed air, water, steam, effluent, CO_2 emission) for further analysis and optimization. The integration of these energy parameters with the other MES applications, such as scheduling, machine and process monitoring provides a perfect insight in the relation between energy consumption and production.

The use of energy monitoring software creates an "energy awareness culture" amongst all employees within the company. EnergyMaster is the perfect tool for a company to achieve its Energy Efficiency Plan goals.

Which objectives are targeted with EnergyMaster?

By monitoring the energy consumption, the company gets answers on important questions such as:

- Which machines or departments are the largest energy users?
- What is causing our peak consumption?
- What about the power factor (cos phi) of our company?
- What about the energy consumption fluctuation of a machine or department over time?
- What is the energy consumption or cost by production order and product?
- What is the remnant energy consumption when production is shut down (base load)?
- What abnormal consumptions occur and when?

Requirements

In order to achieve energy monitoring, consumption meters need to be installed. In some departments meters can be placed in the power switch panel to measure the consumption of a group of machines, but in case a detailed follow up or product related reporting is required, the individual machines should be equipped with meters.

As in plastics processing, the production machines consume between 60 and 75% of the total energy of the plant, it is strongly advised to equip each individual machine with an energy metering device.

Departmental meters are often installed to follow up the energy consumption of utilities, such as the compressor room, chillers, material drying equipment, ...

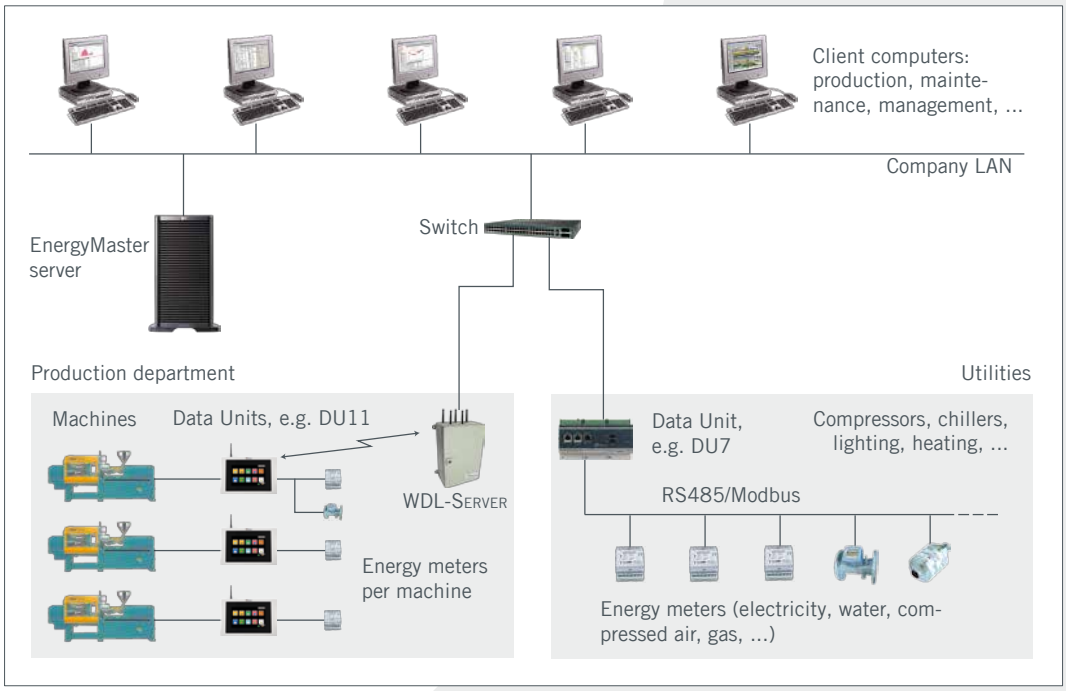


Fig. 1: EnergyMaster concept. Existing BMSvision Data Units can be used to collect the meter counters. This data is transferred to the EnergyMaster server over the existing BMSvision network (wired or wireless). For new installations, a wireless network is the best choice.

Measuring the consumption

In many cases, BMSvision Data Units are already present at the machine to detect and transmit production and quality data to the PlantMaster MES system. As such, energy data is passed on in real time to the EnergyMaster server via the existing network (wired or wireless). Additional Data Units can be added for other meters, for example for the utilities. The Backup & Recovery feature ensures that no data is lost in case of network or server failures.

Data Units allow to connect meters with pulse outputs or with Modbus interface. The number of pulse outputs that can be connected depends on the available number of inputs, while one free serial port allows to connect up to 31 Modbus meters. Besides pulse and Modbus, also analog outputs can be connected to some Data Units, for example to relate consumption to temperature and humidity.

The measurement of electricity consumption requires a meter and one current transformer (CT) per phase. The current to be measured flows through the hole of the CT which converts it to a lower current that can be conveniently connected to the meter.

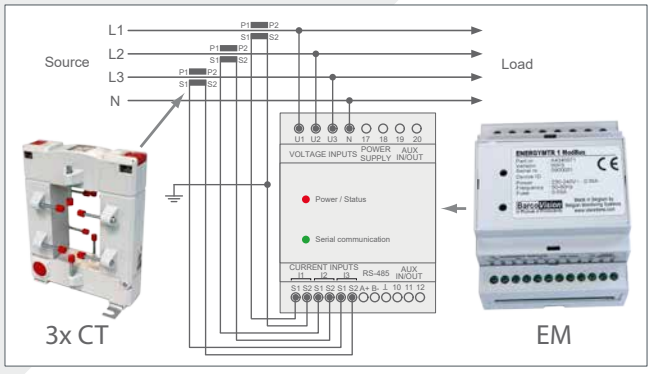


Fig. 2: A three phase power network requires one energy meter and three current transformers. The meter accurately measures the voltage and current of each phase and calculates all other electric values.

Meter hardware and counter sources

The BMSvision range of energy consumption meters includes:

- Three types of electricity meters:
  - EM1-M: Advanced Modbus meter, measuring all possible electric values of all phases individually.
  - EM2-M: Basic Modbus meter, measuring all energy values. Phases are totaled.
  - EM2-P: Basic pulse output meter, measuring the active, reactive and apparent energy. Phases are totaled.
- Air flow meters that clamp onto a pipe.
- Temperature and humidity sensor.

For the electricity meters, bar, cable-through or split core current transformers are available for different conductor sizes and currents up to 5000 A.

Meters that are already available in the plant can also be connected, provided they are equiped with pulse outputs, Modbus or Ethernet interface. Counter data can also be imported from manual meter recording or other sources through a spreadsheet, XML-file or OPC interface.

Consumption reporting

EnergyMaster contains a powerful and flexible report generator. With the “create once, use always”-principle, each user can define his own set of reports, needed for the analysis and follow up of the various consumptions of the different consumers. The ‘dashboard’ allows the visualization of reports, graphs and graphical meters from any computer with web access. EnergyMaster includes a set of predefined report types such as:

Counter overview report

These are graphs which map the meter data in a graphical way. With such report type, the main meter of the plant or a department can be monitored to trace abnormal peak consumption, to eliminate abnormal consumption and for example to evaluate if reduced night or weekend shifts make sense, considering the higher energy consumption per unit of production.

Period comparison report

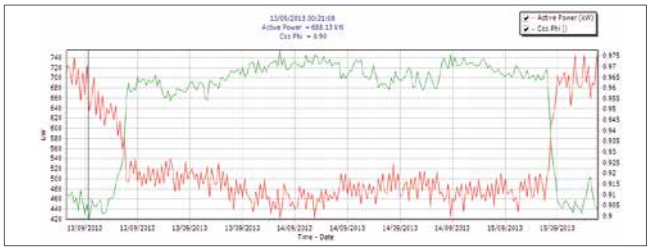
Helps to compare the energy consumption over similar periods. A reference period is taken to compare with the consumption of other periods. Such comparison is especially useful to easily see the consequences of improvement projects and to detect abnormal consumption.

Consumer trend report

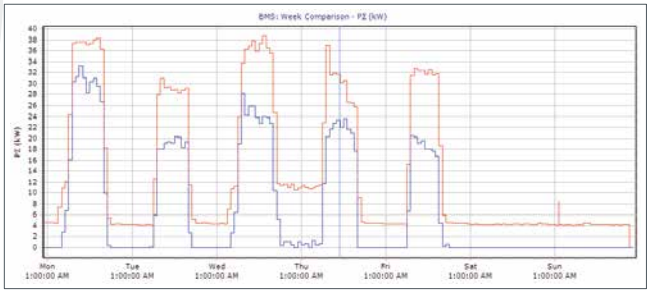
Is used for the analysis of the energy consumption for various consumers. This way one can analyze how the energy consumption, CO_2 emission and cost varies in time in one single 3C-report.

Consumer report

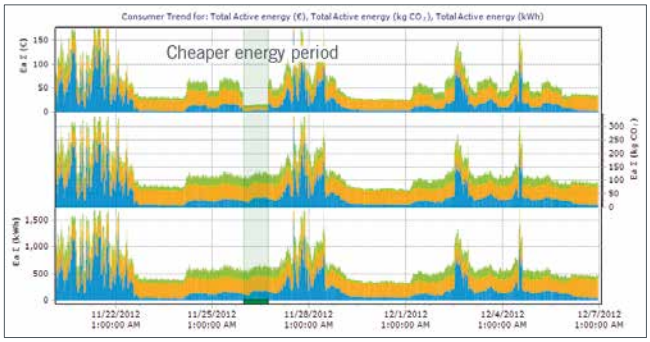
Shows the consumption of a specific energy or utility resource by department, work center or machine over a certain time period. These reports allow to quickly identify the “top consumers” for a selected energy resource. Different chart types are possible, like a pie chart or pareto chart.



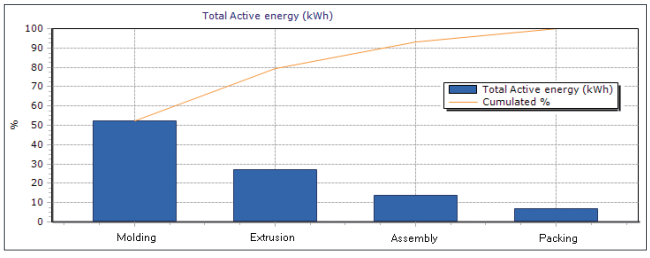
▲ Fig. 3: Counter overview report of the main meter of the plant. The electricity consumption (active power) and the according power factor (cos phi) are reported every 15 minutes. During the weekend, fewer machines are in production and as a result the active power decreases and the power factor improves. The graph shows that the power factor always remains above 0.9, which indicates an acceptable situation. This graph also allows to evaluate the functioning of the condenser battery for improvement of the power factor.



▲ Fig. 4: This period comparison report shows that the heating was not switched off during certain nights.



▲ Fig. 5: Consumer trend report showing the stacked consumption, CO_2 emission and cost of three consumers. The cost graph (top) shows a lower cost during the silent hours or while an energy block has been bought, despite the same consumption.



▲ Fig. 6: Consumer (pareto) report.

Alarming

Automatic alerts via e-mail or text messages on exceptional energy consumption or consumption anomalies, allow for a quick reaction and to realize immediate savings by solving the problem already in an early stage. An alarm can set a Data Unit output or OPC tag to automatically shut-off consumers. Alarm escalation can be used to report alarms that were not handled within the specified time.

Production related reporting and energy monitoring standards

EnergyMaster integrates seamlessly with the BMSvision production monitoring systems. Combining production data with energy consumption is a powerful tool that allows evaluating the energy component in the overall production cost of each product. The energy consumption can be displayed on the different Data Units on the production floor, which makes the operator on the floor aware of the consumed energy.

The reporting of energy consumption related to the production is well documented by industry standards in many countries. EnergyMaster contains industry standard reports, such as the PCL, SEC and CUSUM charts:

PCL: Performance Characteristic Line

The PCL is the result of a regression analysis between energy consumption and production output, as registered by the monitoring system. The PCL is commonly expressed as kWh per kg of processed material. The PCL can be plotted for a machine, machine group or a complete department or plant and for energy resource monitored by the system. Based on this regression analysis, the base load is calculated, which is the energy consumption when there is no production at all. The slope of the line indicates the amount of energy needed to produce one unit of product. The PCL can also be used for targeting future energy consumptions based on production budgets.

SEC: Specific Energy Consumption

A next graph of importance is the SEC, which stands for Specific Energy Consumption in terms of kWh per unit of production. A typical graph is the monthly evolution of the SEC, which allows to define whether the plant is gaining or losing energy efficiency.

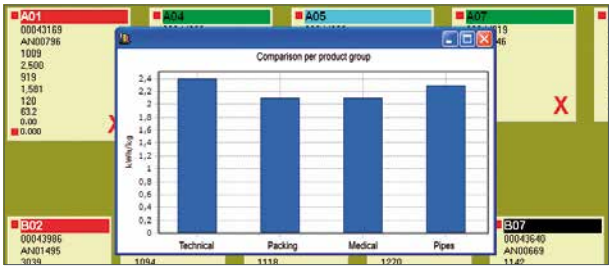
Monitoring & Targeting

The CUSUM trend (Cumulative Sum of deviations) is a special report type that allows comparing the real consumption versus budget. The gradient line in the trend graph allows immediate detection of a rising or decreasing trend in energy consumption. Such reports really help promote the energy awareness culture.

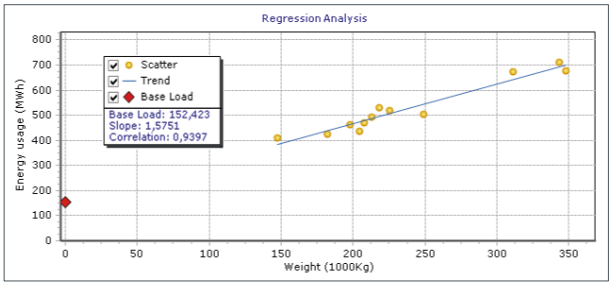
Conclusion

With the addition of the EnergyMaster module, the BMSvision PlantMaster systems are extended with the monitoring of an important cost factor. By taking advantage of the already present data collection network, database and server configuration, the investment cost can be kept to the minimum while the monthly energy bill savings can be substantial by using the EnergyMaster module.

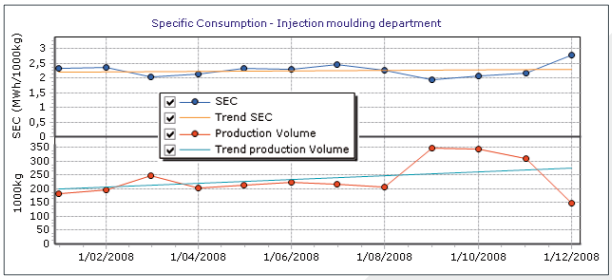
By defining an Energy Efficiency plan with clear objectives, significant energy savings can be realized. EnergyMaster is the right software package to provide analysis and decision support for quick energy saving actions while insuring a short ROI time.



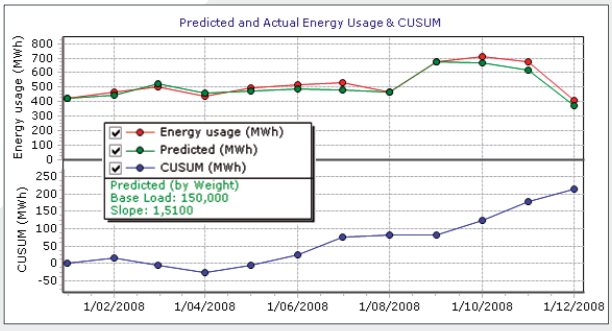
▲ Fig. 7: Production report: energy consumption per product group.



▲ Fig. 8: Performance Characteristic Line (PCL) for an injection molding plant, showing a base load of 152 MWh/month and a process load of 1.5 kWh per kg of processed material. Extrusion lines for example, will have a process load which is less than half of that in injection molding.



▲ Fig. 9: Evolution of the Specific Energy Consumption (SEC) in combination with the production output. Decreasing SEC does not necessarily mean that the plant is operating more energy efficient; it can also be the result of a higher production volume, resulting the base load to be divided over a higher output volume.



▲ Fig. 10: CUSUM chart with actual and target consumption. In case actual consumption is in line with target, the cumulative deviations should be scattered around zero. Deviations from target result in rising (actual consumption higher than target) or falling (actual consumption lower than target) CUSUM charts.

BMSvision

In Pursuit of Productivity

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