Sustainable Energy Data Management

Continuous Improvement in Focus

For many years beverage production plants had the goal of reducing consumption and increasing productivity. Both financial and climate protection aspects have been keeping continuous improvement processes alive. This article looks at the implications these optimization efforts have on users' demands for energy data management systems (EDMS).

Sustainability aspects in a highly dynamic market have put their mark on the global beverage sector. Manufacturing teams, for example, now possess advanced competencies and work with state-of-the-art production facilities and technologies. Even such efficient organizations can greatly benefit from the implementation of an energy management system according to ISO 50001 [1]: commitment of the management through a documented energy policy, clear responsibilities and more targeted cooperation within the entire team, tax reductions and improved profitability. The remarkable and verifiable result is that the entire organization is able to continuously improve their energy efficiency – a key factor for competitiveness and sustainability [2].

INSIDE AN ENERGY DATA MANAGEMENT SYSTEM

Chapter 4.6.1 of the ISO 50001 standard, entitled "Monitoring, measurement and analysis" has set the minimum requirements for managing energy performance and offers the perspective of plant-wide monitoring and measurement equipment, tailored to an organization's complexity. An Energy Data Management System (EDMS) covers the complete information flow – from sensors, counters, automation systems to sophisticated reports and analysis – see the 7 typical steps in Fig. 1.

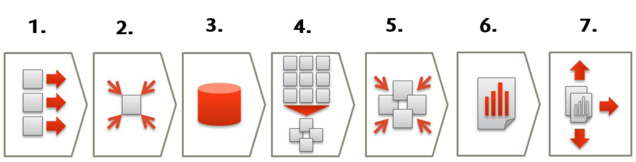

FIG. 1: *Main data flow of an EDMS*

STEP 1 DATA COLLECTION

Here, the energy data is entered into the system. Sometimes this happens manually, but there is still an increased preference for automatic data acquisition, offering the advantages of accuracy, range of options, and comfortable availability. There are a wide range of data sources relevant for energy management: energy counters for various primary and secondary energy forms (electricity, water, compressed air, heating, cooling, chemicals etc.), production counters, process parameters (temperature, pressure etc.), context information (location, shift, batch, product, packaging type etc.), auxiliary data (correction factors, consumption norms and limits, media prices etc.) and so on. All of these represent the base for satisfying the informational needs of an energy management team.

STEP 2 DATA PRE-PROCESSING

The collected data may need a first "on-the-flight" processing step in order to assure data consistency before archiving, and to prepare the building blocks for further calculation of real-time Energy Performance Indicators (EnPIs).

STEP 3 DATA ARCHIVING

The data is archived in a database – cyclically or event-driven. The amount of archived data is directly influenced by the decision to keep aggregated data only (e.g. daily energy counters) or to enable top-down analysis, or even very detailed trending of a process evolution.

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STEP 4 DATA FILTERING

This step allows the selection of a subset of the archived data and offers an overview of any energy-related information. The real-time EnPIs shown in dashboards are displayed in a simple context, for instance with focus on a certain packaging line and on the current shift. For historic analysis, depending on the collected data, more flexible and complete reports are made possible: selecting the object of analysis from a tree-like equipment model, choosing the period of time for the analysis, deciding on the media type for consumption analysis, extracting only the pieces of data related to a specific type of product, configuring comparison reports (e.g. with baseline), adjusting the granularity of data aggregation (e.g. every 15 minutes) and much more.

STEP 5 DATA PROCESSING

Once a subset of data is filtered, aggregation and specific mathematical formulas are applied in order to calculate EnPIs or to support individual graphic analysis. The chosen automation and IT technologies and the optimization carried out by the system integrator directly influence the performance of the data processing.

STEP 6 INFORMATION PRESENTATION

This step refers to the result which the user (one member of the energy management team) will obtain. There are many ways to show graphically displayed EnPIs and other supportive information. Human Machine Interface (HMI), Supervisory Control and Data Acquisition (SCADA) and reporting software are typically well prepared to display easy-to-understand dashboards, trend curves and various other statistics. On the one hand, it covers the requirements of most of the well-established analytics in energy management, such as Pareto charts, aggregated consumption trends, energy class evaluation, annual load duration curves, Sankey diagrams (Fig. 3), consumption distribution and statistics on consumption relative to production etc. On the other hand, a big added value is the flexibility to use self-defined ways to analyze energy data in correlation with various relevant factors, as a basis for continuous optimization. Figs. 2 to 5 show several examples of information presentation.

STEP 7 INFORMATION DISTRIBUTION

Within this step the energy-related information, be it process overview and parameters, alarms and events or EnPIs and reports, is made available to users independent of time or location. An extensible HMI/SCADA application enables the use of various architectural system designs, from plant floor to management level – based on mature technologies such as client-server and web-server, via Intranet or Internet. Increased requirements for mobile technologies are fulfilled by information distribution via e-mail, SMS, tablet and smartphone apps.

FIG. 2: *Trends analysis for identifying improvement potential*

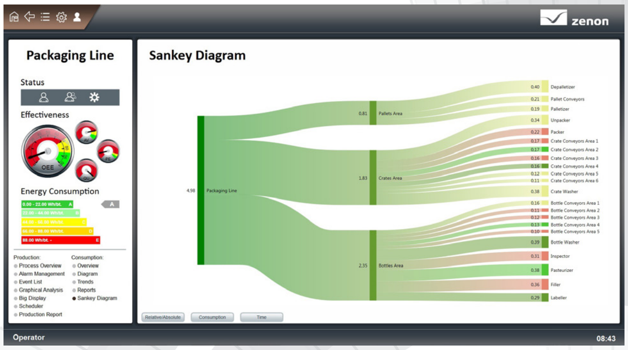


FIG. 3: *Dashboard and Sankey diagram*

Three Principles for a Sustainable Energy Data Management System

At first sight, the integration of an EDMS may appear to be quickly completed by simply connecting several energy measurement devices with software for displaying graphic diagrams. However, experience shows that such a system is never comprehensive enough and is therefore subject to continuous development and improvement processes – see also [3] and [4].

Optimizing consumption begins at the machine level and ends at the management level. The EDMS is not necessarily separated from the automation and supervision systems, being often just a part or an extension of them. An EDMS is expected to cover the entire range of the precious standard functionalities of HMI/SCADA software, such as alarming, trend curves, real-time calculation and dashboards of EnPIs (Fig. 4).

PRINCIPLE 1. SUPPORT FOR INTEGRATED MANAGEMENT SYSTEMS

The implementation of different management initiatives based on standards and concepts (ISO 50001, ISO 22000, TPM/OEE, TQM etc.) offer the opportunity of comprehensive integration. Instead of separate approaches the common objects of optimization, documentation, required resources and tools are to be aligned for all management systems. An EDMS should embed the adequate technologies to avoid "software-island solutions", to reduce costs of ownership and to make the correlation of key performance indicators easy. Essential here is the connectivity to a wide range of data sources and other software systems, as well as integrated automation and IT architectures including process control, utilities and building automation systems.

For example, the technology built in the machine (pumps, motors, heating systems, degree of automation etc.) directly influences the amount of energy consumption (electricity, water, air consumption, chemicals etc.) which can be diagnosed by an EDMS during non-productive time (Fig. 2). The next typical task is to analyze the complete production line, using the Overall Equipment Effectiveness (OEE) measurement. The so called "planned production time" should be used at maximum for qualitative production. The OEE losses represent losses of energy.

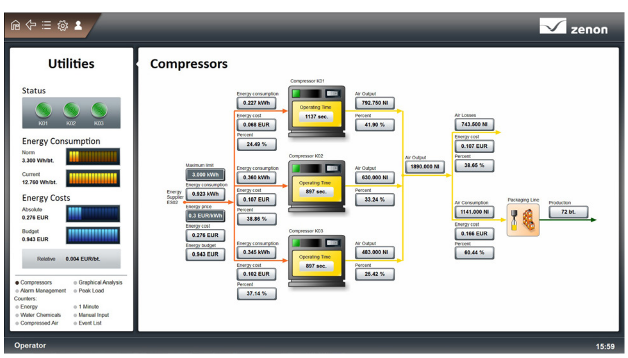
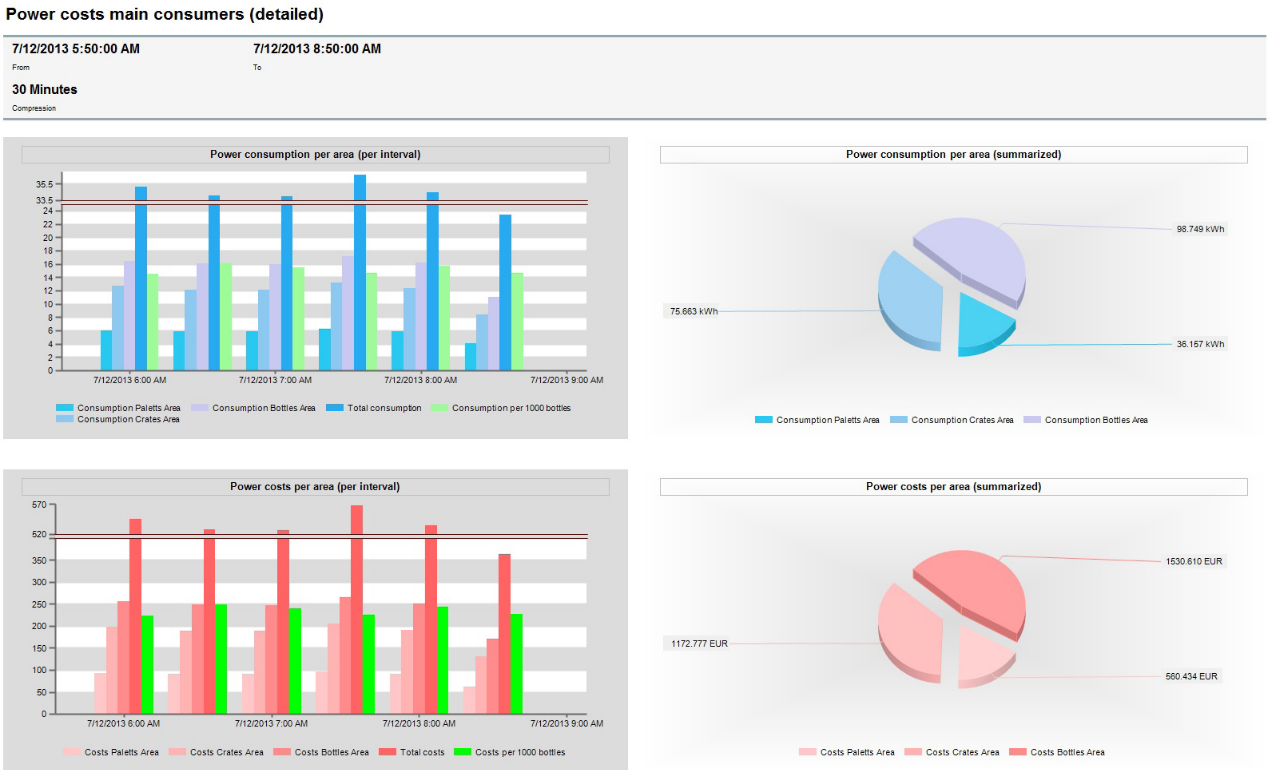


FIG. 4: *Real-time calculation of EnPIs*



From	To	Consumption Paletts Area	Consumption Crates Area	Consumption Bottles Area	Total consumption	Costs Paletts Area	Costs Crates Area	Costs Bottles Area	Total costs	Consumption per 1000 bottles	Costs per 1000 bottles	Good bottles	Total bottles
7/12/2013 5:30:00 AM	7/12/2013 6:00:00 AM	2.21 kWh	4.62 kWh	5.96 kWh	12.79 kWh	34.29 EUR	71.55 EUR	92.40 EUR	198.23 EUR	13.17 kWh/kbt	204.15 EUR/kbt	957.00 bt	971.00 bt
7/12/2013 6:00:00 AM	7/12/2013 6:30:00 AM	5.95 kWh	12.74 kWh	16.50 kWh	35.19 kWh	92.16 EUR	197.47 EUR	255.77 EUR	545.40 EUR	14.47 kWh/kbt	224.26 EUR/kbt	2398.00 bt	2432.00 bt
7/12/2013 6:30:00 AM	7/12/2013 7:00:00 AM	5.90 kWh	12.14 kWh	16.03 kWh	34.07 kWh	91.37 EUR	188.19 EUR	248.45 EUR	528.01 EUR	16.08 kWh/kbt	249.18 EUR/kbt	2090.00 bt	2119.00 bt
7/12/2013 7:00:00 AM	7/12/2013 7:30:00 AM	5.91 kWh	12.17 kWh	15.92 kWh	33.99 kWh	91.62 EUR	188.56 EUR	246.73 EUR	526.91 EUR	15.47 kWh/kbt	239.83 EUR/kbt	2166.00 bt	2197.00 bt

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FIG. 5: *Historic analysis of energy performance*

PRINCIPLE 2. SUPPORT FOR CONTINUOUS IMPROVEMENT

A step-by-step development of an EDMS is common within a Plan-Do-Check-Act (PDCA) framework, which consequently updates the requirements: new energy targets, extension of data sources (e.g. a few more energy counters are installed), new data correction factors, more archived data, new EnPIs or innovative ways to present and distribute the results. The energy management teams are continuously identifying new ideas for what is relevant to analyze, how to correlate the measurement with context information, be it product type, packaging type, quality of materials or weather conditions. Historical reporting with full flexibility for aggregating and presenting data are making an EDMS a precious tool for prioritizing the steps towards better energy performance – across all plant levels (Fig. 5). The software core of the EDMS is expected to follow a product philosophy based on: scalability, modularity, extensibility, setting parameters instead of programming, and ergonomics in engineering. Such key product characteristics are keeping costs for the highly demanded flexibility at a low level.

PRINCIPLE 3. SUPPORT FOR MANUFACTURING ROLES

Energy management initiatives can only be successful if all members of the production team, who can relevantly contribute, are involved. An EDMS is called upon to enable this by making the kind of information available which can help them act most effectively: information that is correctly calculated, clearly presented and available where and when is needed. If an operator needs to react quickly to prevent losses at machine level, the energy manager mainly needs to deal with benchmarking. Documented success of individuals keeps the continuous improvement process alive and fresh.

CONCLUSION

In the beverage industry, due to its specific dynamism, most production systems are required to assure a high level of flexibility at reasonable costs. Moreover, an EDMS is playing a central informational role in a management system based on a continuous improvement process, as specified by ISO 50001, so it is itself subject to never-ending change. Every step of the main data flow (Fig. 1) is subject to possible adaptation. What are the update costs? Is the system really supporting the creativity of its users?

Automation and IT technologies are continuously aiming to meet the industry challenges and the needs of production teams. The journey of implementing and carrying out an energy management initiative in a beverage plant is therefore becoming less stressful and reasonably comfortable, based on the confidence acquired to make the right decisions and take the proper actions. The financial advantages of the reduced consumption as well as the environmental aspects are presenting highly motivational rewards, encouraging production teams to push the performance of their beverage plants further.

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