Energy Management and Optimization

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Abstract

Energy Management and Optimization solutions can help reduce energy costs while improving mill operational performance. Real time data from process monitoring systems, automation systems and production planning systems is used for planning and scheduling to help optimize energy use, procurement and generation. This mill information coupled with the price and energy availability information from energy providers/market is used to calculate optimal production and power generation plan, and to get the best price for the energy you require. Reporting tools provide energy consumption, costs and efficiency monitoring.

Introduction

There are many different ways to implement Energy Management and Optimization. This paper will describe a computer software program that includes planning and scheduling tools to help optimize energy use and supply, energy balance management tools to help energy procurement at the best price, and reporting tools to help monitor energy consumption, costs, efficiency and other energy-related information. The program is based on real time data from process monitoring systems, automation systems, production planning systems coupled with the price and energy availability information from energy providers/market.

The continued rise in energy prices puts a squeeze on margin and profits.

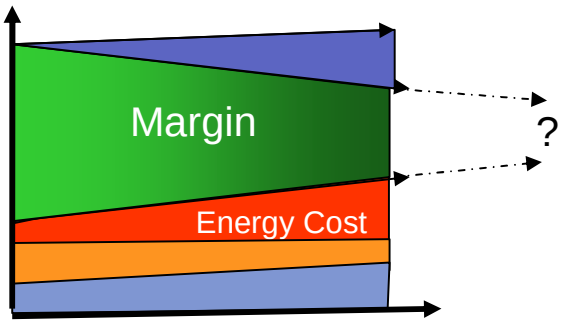

Figure 1 Energy costs impact on margin

In order to maintain margin, energy cost must be managed. Managing energy costs is achieved through:

- Avoiding price peaks and penalty charges
- Employing optimal resources in the supply of electric power
- Enhanced awareness of energy consumption and energy costs
- Early detection of poor performance based on real time monitoring of performance against set targets
- Manage electricity purchase prices with accurate consumption plans
- Participation in the demand response market

Opportunities for cost reduction are greatest when energy consumption and prices vary over time. Typically, overall cost reductions of 2 to 5 per cent of a company's total energy cost are realized when with this program. Savings can be quickly calculated using these simple factors:

- Payback from reduced energy consumption and price
- Savings = Energy bill * drop (%) in energy (price + consumption)
- Total savings up to 2-5% of the energy bill

Energy Manager is scalable from a single facility energy reporting application up to a multi-facility company wide system serving hundreds of users as they manage energy planning and procurement for your corporation.

Energy management system

The energy management system contains the following components and entities:

- Energy planning
- Energy optimization
- Alarms and controls
- Reports and invoices for the monitoring of official information and savings goals

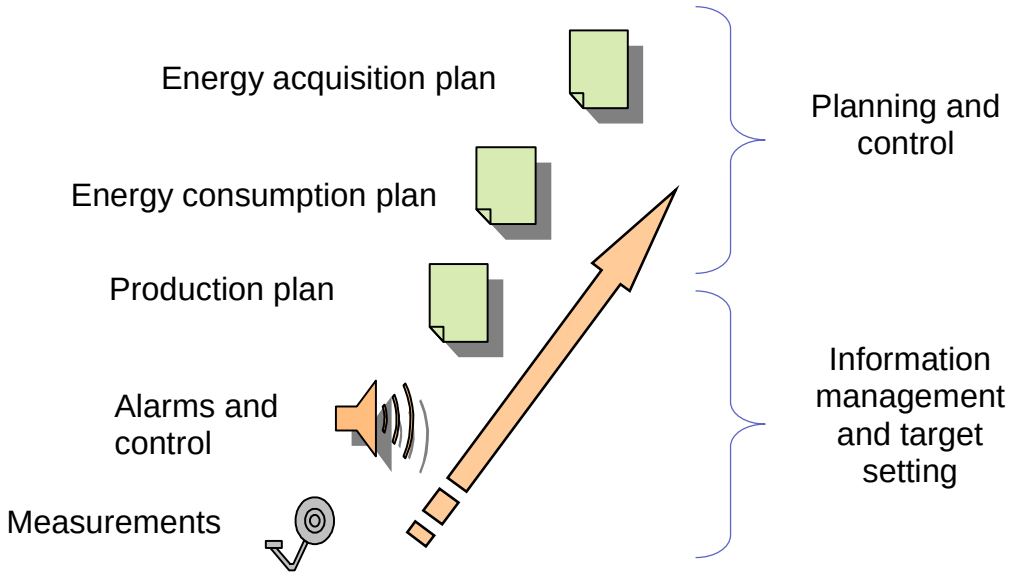

Figure 2 Energy management system functions

Planning tools are used to predict energy consumption based on production plans in the production planning system and calculate the corresponding energy supply schedule. When operating in the deregulated energy market, schedules are calculated and agreed daily for the next day. In strategic planning and budgeting, the schedules may extend over several months, or even years, while during real-time monitoring they may cover only the next few minutes or hours.

Consumption schedules for major consumers are calculated based on the planned production schedule. Production line demand schedules are derived from the planned production grades and rates, which are received from production planning systems. The predicted demand schedule contains valuable information for the power supplier, especially if consumption is high and varies over time.

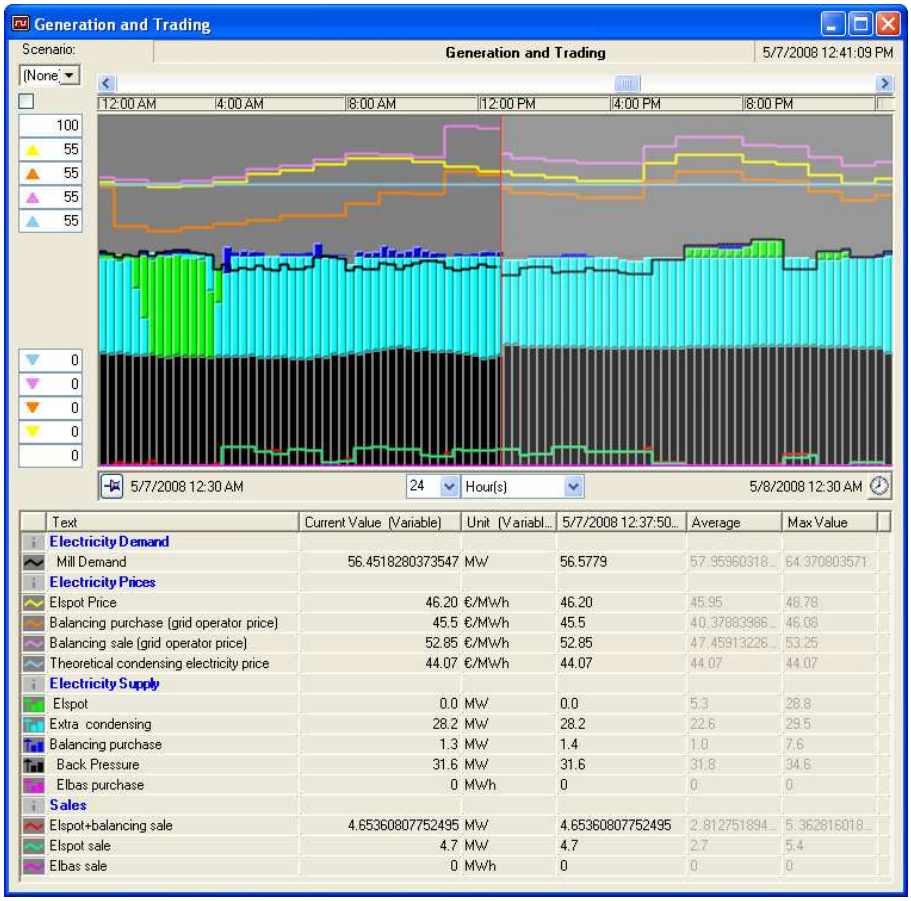

Figure 3 Energy management system optimizes energy resources

Time-varying energy consumption is balanced with supply resources. Mill energy supply and demand is modeled as a flow network with a product feature called Economic Flow Network. This configurable model is populated with data such as prices, volumes, validity times and other relevant information. The Economic Flow Network can be used to model any continuous utility, such as fuels, steam, electric power, CO_2, water, etc. Depending on mill objectives, energy resources are selected to minimize the total energy cost or to maximize the total profit of the operation over a specified time range. On the other hand, model can be used to support demand response to propose the optimal participation level.

In real-time the execution of power schedules is monitored. With real-time monitoring, deviations or unexpected events are detected and reported to help minimize their costs. The energy planning module automatically recalculates the demand schedule based on changes in process measurements, production plans or user inputs. If an imbalance between predicted power consumption and planned supply is detected, the deviation from plan may be balanced through additional power trading or automated process control.

The Power (Tie-Line) Monitoring module predicts total utility consumption within the current billing period by integrating and extrapolating the flow in the tie-line. If the predicted volume exceeds pre-set or calculated alarm limits, alarms can be generated enabling the operator to take action to limit the deviation.

Reports are provided analyze the use of energy and utilities. They support energy efficiency improvement by quickly and accurately indicating actual performance and comparing it with set targets. Some examples of the performance reports are:

- Consumption and cost of utilities per hour/day/month/year, by individual and aggregated users
- Consumption and cost of utilities per end product unit
- Analysis of load profile and peak demand
- Benchmarking (comparing current performance against the past)
- Best practices performance
- Budget performance

Case History Examples

ABB's energy management systems are based on 20 years of experience gained in supplying hundreds of challenging industrial process information management systems worldwide.

UPM-Kymmene Corporation is one of the world's leading manufacturers of printing paper. Energy plays an important role in production. As part of its corporate strategy, the company seeks a high level of self-sufficiency with energy management. In addition to using and generating electricity, UPM is trading electricity with external partners on the local markets. Knowledge of expected energy demand and optimizing energy resources create significant savings.

To achieve this goal, the company has invested considerably in energy efficiency, availability and the predictability of energy supply & demand. The key tool in this area is the corporate wide energy management system consisting of 17 mill level systems - 10 in Central Europe and 7 in Finland – and two control centers. The system has been implemented and extended in several phases over more than 20 years.

The mill level systems collect real-time data from the process, calculate and report electricity, steam, water and natural gas balances and predict energy consumption considering the firm's own generation capacity given the paper mill production plans. Energy balance data and consumption schedules are consolidated in control centers.

These control centers trade electricity and natural gas with external parties, and distribute the same commodities within the corporation at internal rates. Trading is based on the balance between predicted consumption schedules, the firm's own generation, and existing sales and purchase contracts. Energy Manager tools are applied when selecting the optimal balancing resources during the planning phase and predicting and monitoring the balance in real time.

The system also performs extensive reporting functions both at mill and corporate level, including greenhouse and flue gas emission reporting in accordance with the law and regulations.

The extent of the UPM energy management system is characterized by the following figures:

- 20 TWh electric yearly total procurement
- 100 energy resources including fossil, nuclear, and hydro
- 17 mill level systems and 2 corporate level control centers
- up to 600 simultaneous users

- 40 000 tags in databases
- 50 interfaces for process data collection

The Mayr-Melnhof Cartonboard Group is the leading producer of recycled cartonboard within Europe and world-wide.

In 2001, Mayr-Melnhof Cartonboard implemented mill-wide energy management systems at 7 board mills in Austria, Germany, the Netherlands, Switzerland and Slovenia.

"We use the system to manage energy, water, chemicals, compressed air, production and quality data and statistics. The Energy Mangagement system represents our connection between local processes and offices, and provides a handy instrument for optimizing the process and detecting failures more easily. We are happy with the system and have ordered an upgrade this year in order to obtain further benefits", explained Mr. Johan Maier, responsible for energy and water management at Mayr-Melnhof in 2007.

Public Works Government Services Canada (PWGSC) is responsible for government assets including office buildings, central heating and cooling plants as well as high voltage, water and sewage distribution systems that vary in size, complexity and age. Its activities include delivering, verifying, planning and reporting on utilities, such as electricity, natural gas, water and different grades of fuel, for all of these facilities. These tasks are complicated by the need to deal with different energy suppliers and different energy commodities for many internal departments and other government departments.

PWGSC found that the multiple budgeting, reporting, billing and planning systems in place could not effectively manage all of its required energy and asset management activities. The Energy Manager helps optimize energy costs. The system collects real-time data from different energy markets, such as the Independent Electrical System Operator, Environment Canada and other energy markets within North America. Energy Manager tools support the analysis of the cost impact of different combinations of electricity and natural gas purchased from different sources, and provide the information needed to negotiate and purchase different energy commodities directly from the main suppliers and markets.

The energy management system at PWGSC helps determine optimum energy conservation schemes for different buildings, so that they can be operated at maximum energy efficiency while reducing greenhouse gases. The reports include:
- Energy usage and cost per m2 for all utilities per day/month/year
- Energy usage and cost by building
- Average daily profile – showing average pattern of demand over a specified period by individual meter/multiple meters/ building
- Aggregate analysis – totalizing data points and determining peak, minimum and maximum consumption to determine demand-limiting options for all utilities.
- Normalization of building consumption against its characteristics
- Temperature and weather correlation
- Benchmarking

Summary

When Energy cost, efficiency and environmental implications have top priority, managing the balance between the production and consumption of electricity is necessary. This Energy Management software program helps reduces energy costs while improving an overall carbon footprint. The program includes planning and scheduling tools to help optimize energy use and supply, energy balance management tools to help get the best price for the required energy purchases and reporting tools to help monitor energy consumption, costs, efficiency and other energy-related information.

References

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