

ENERGY MANAGEMENT AND ENERGY COST MINIMIZATION

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Abstract: In this paper there are presented the key components for energy cost minimization: monitoring, load shedding and load forecasting. These are energy management system components, too. It then demonstrates applications of them in the context of energy supply contract in a company.

Keywords: monitoring, energy cost, energy management.

1. INTRODUCTION

The liberalization of the energy market has significantly extended the possibilities for negotiating favorable conditions with respect to energy supply. Energy management systems provide key technical functions for utilizing some of the new possibilities. An energy monitoring system may support us in making the best use of the terms of existing contracts.

This paper provides a short presentation of energy cost minimization components: electricity monitoring system, load shedding, load forecast and use of them for minimizing of energy cost in a company.

Effective energy management does more than reduce costs and increase profitability; it can drive the whole business to improved performance through its effect on production, operations, maintenance and environmental issues.

2. ENERGY COST MINIMIZATION COMPONENTS

2.1. Monitoring

The electricity monitoring system provide with a better insight into a company energy flow. Load data recorded are displayed in a clear layout which reveals major consumers, making it clear where to optimize first.

Monitoring and reports also reveal at what times there where particularly high loads. An analysis of these high-load events shows which situations typically cause load peaks. From here strategies can be developed to avoid such critical situations.

Zeus system permits consumers monitoring their energy consumption. The system components are following:

- impulse meter
- tele-summation system
- computer PC with Zeus software

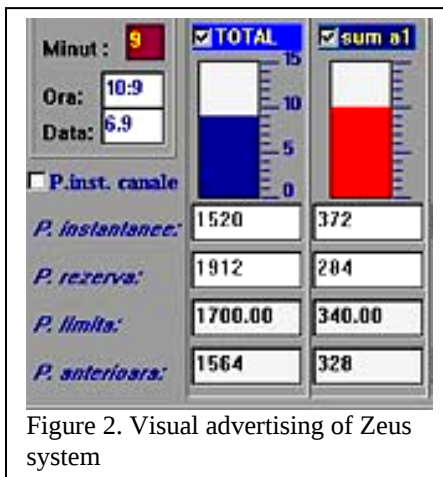
Zeus system support energy management with the following data which are displayed numerically, graphically and as table:

- instantaneous power, in one minute
- electricity measurement is taken as mean values over a:
 - o 15 minute interval
 - o hourly, daily, monthly
- maxim power on day or on month
- power factor

- load graph on day or on month
- mean energy cost
- predictive calculus of mean power in 15 minute interval and advertising if power limit will be exceeded
- record historical data from the past 24 months at least

2.2. Load shedding

Load shedding supervises energy consumption for a short time horizon. Load measurements are taken as mean values over a 15 minute interval. If we wish keep the demand below a certain threshold, it is important to determine the amount of energy we will have consumed at the end of the current interval as soon as possible. This amounts to a very short-term forecast. The result of the forecast reveals that the maximum average power will be exceeded, thus raising the overall peak load of the month thereby significantly increasing electricity bill. As example, in the figure 1, for “sum a1” 284 kW left in a 6 minute interval. This power is smaller than limit power by 340 kW. Zeus system advertises by visual signal (red color) and acoustic signal. Something should be done but there are only 6 minutes left to cut down on the power demand. This means that some consumers must be throttled down or turned off at short notice. Load shedding modules in a Zeus system offer the possibility of specifying a “turn-off strategy” which states precisely which consumers may be turned off at all and in which order.



2.3. Load forecast

Load profile graphs are a key tool available to the energy manager giving a great insight into actual operating events and practices. They can be invaluable for identifying problem areas and may help the energy manager explain irregular energy consumption patterns to production manager and so on.

Load profiles can identify when energy is used. Anomalies such as the plant turning on too early can be identified and time clocks can be altered to save electricity. Any variation in base-load use from day-to-day needs to be investigated as it may indicate unnecessary equipment use or poor shutdown procedure. Load graphs recorded as historical data in the Zeus system can be used for load forecasting in assistance mode. This gives us a preview of company's load curve on a similar time frame as the production schedule – from several hours to several days ahead. The load forecasting system generally stores knowledge about the production processes' behavior in typical production situation.

3. CASE STUDY

Energy cost is defined by the contract company makes with its energy supply company. It is therefore hardly surprising that the terms of company energy supply contract play a key role in determining its potential for saving some of the energy cost. As example, in this paper is presented how Zeus system helps to reduce energy cost in a company. This company is a real big consumer. Therefore energy supply contract has two main components:

- energy component, which assigns to price for the energy consumed (\$/kWh)
- demand component, which makes payment for provision of a certain amount of electrical power whenever the customer demand it (\$/kW).

For the energy component, time slots are: “gap load”, “normal load” and “peak load”. For the demand component, time slots are: “base load” and “peak load”, figure 2. These time slots are different for different months and days. Price of energy and of power are corresponding time slots. In figure 2 is shown a load graph for total consumption on Thursday, February. Load measurement is taken as mean value over a 15 minute interval. This is demand component. In the figure 3 and 4 are shown load graphs for two supply lines. The total consumption is sum of them. The consumers supplied by line 1 have an energy consumption constant,

approximately. Variation of total load is given by the consumers supplied by line 2. Therefore, these consumers can control total load.

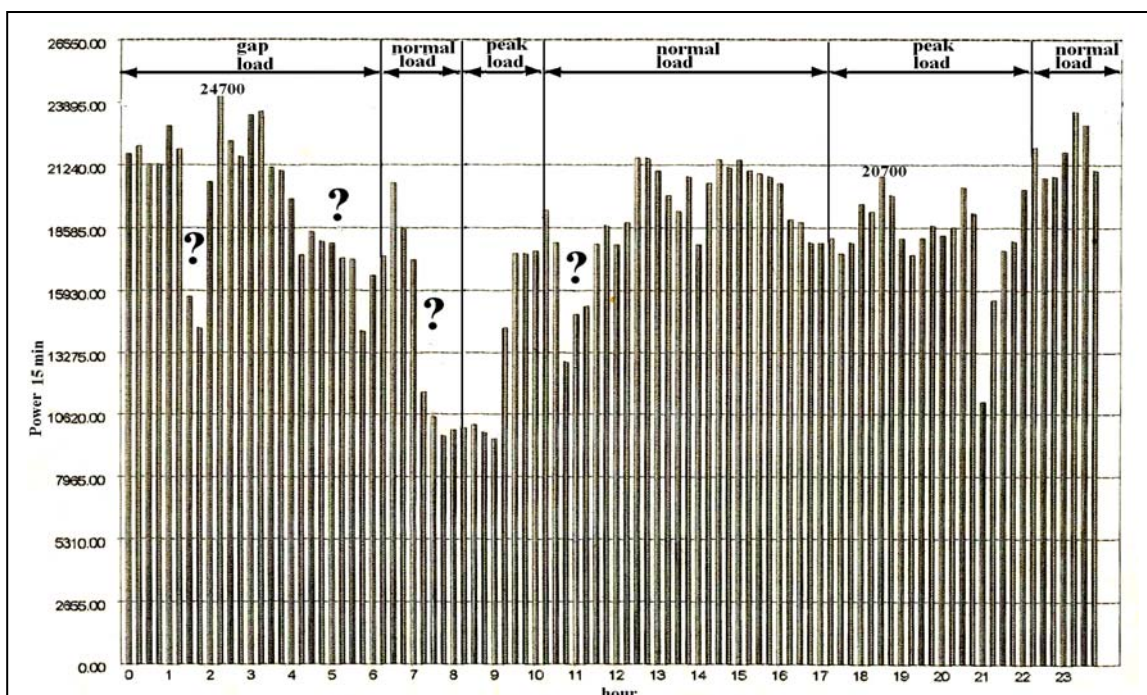


Figure 2. Load graph – total consumption

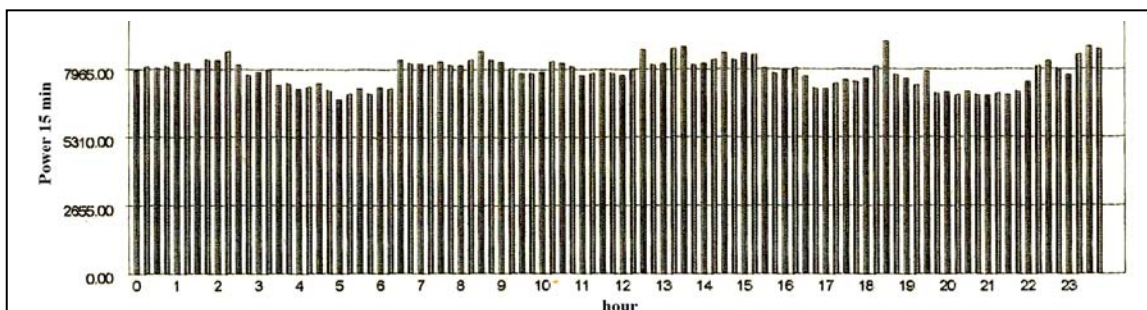


Figure 3. Load graph – line 1 consumption

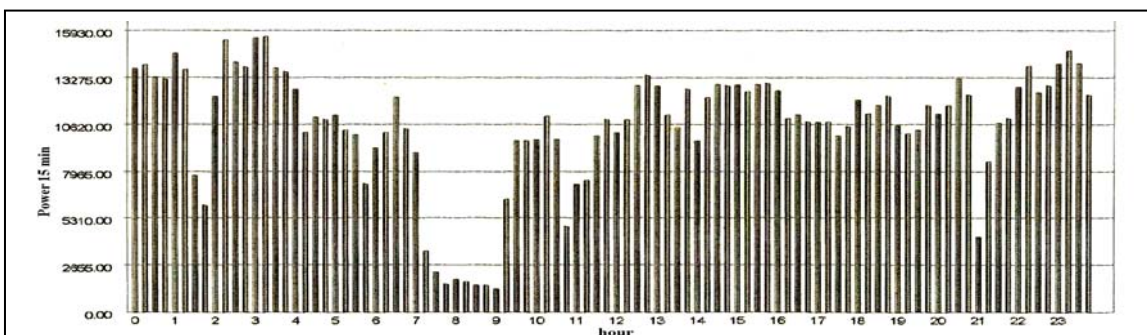


Figure 4. Load graph – line 2 consumption

These load graphs give to energy manager tools to reduce energy cost:

- monitoring gives an overview of company energy consumption, thus company operation. In the “gap load”, between hours 0 and 6, technological installations must have full load. But, it was two intervals when these had smaller load (question sign). The same situations there are in the “normal load”. If technological installations should work with full load, then energy consumption in the “peak load” should be smaller. Taking account to energy price which is different for time slots, results a reduce energy cost by 5000\$/month, approximately.
- load shedding is designed to avoid load peaks by temporarily turning off consumers and thus postponing energy consumption. The load curve is smoothed and the level of demand cost is lowered. In the case study, the limit demand was 21 MW in the “peak load” and 25 MW in the “base load”. Therefore, Zeus system advertised on 2²⁵ and on 18⁴⁰ hour and one technological installation was throttled down. Otherwise, load peak should be 22 MW and 26MW, respectively. It results a reduce energy cost by 4000 \$/month, approximately
- load forecasting warns energy manager of load peaks several hours or days ahead. This is enough time to consider whether and how the production schedule should be altered to avert the situation. Load forecasting helps energy manager to contract limit demand for the similar production in the other months, too. If this contract limit demand is exceeded, then company must pay penalty. In the case study, penalty should be 1000 \$/month, approximately.

Historical load curves over long periods of time help energy manager to select the type rate of contract energy supply.

Load graphs show a difficult situation or a breakdown of technological installation. Thus, these support planned maintenance.

4. CONCLUSIONS

Industrial energy management supports company efforts toward energy cost minimization. This provides company with the following services:

- integrated data acquisition for diverse forms of energy or resources
- operation and monitoring of company energy distribution system
- evaluation and further processing of data by advanced technological functions: analysis, management, documentation, archiving, forecasting.

This paper focused on technical functions that support energy cost minimization. As example, it was presented load graphs and numerical data of Zeus system in a company. Energy cost minimization for only one month is 10000 \$ approximately, that mean 1.8%. Zeus system payback period was 20 days.

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