

doi:10.15199/48.2016.02.35

## Energy management in the industry

**Streszczenie.** Do najważniejszych czynników określających stan polskiego przemysłu należą energochłonność i strategia rozwoju. Przeprowadzone badania dotyczą zachowań odbiorców energii w kierunku obniżenia ponoszonych kosztów za energię. W referacie przedstawiono wybrane zagadnienia związane z energią i systemami komputerowymi wspomagającymi gospodarkę energetyczną w przemyśle. (Energy management in the industry).

**Abstract.** One of the most important factors, which permits estimate the condition of industry is the energy-consuming factor and planning the strategy of national industry. In this study, is introduced some strategies of industrial consumers of energy having the aim to lower their electrical energy costs. In the paper are presented chosen problems connected with energy in the industry and the computer systems aided energy management in the industry (**Gospodarka energetyczna w przemyśle**).

**Słowa kluczowe:** energia, gospodarka, przemysł, strategia.

**Keywords:** energy, management, industry, strategy.

### Introduction

In the last few years Polish power industry has been changing. Changes follow from what was put into practice deregulation of this sector. This deregulations was put in to the practice to :

- lower the cost of distribution of electric energy for national economy and for community,
- improve the efficiency of power industry by making some conditions to invest in modern sources of energy and modernizing older sources of energy,
- provide to the consumer of energy the possibility to select the seller of electric energy,
- provide better security for the consumer of energy by new legal acts and marketable regulations,
- improve the efficiency of power supply.

Realization of this leads to improve the competition of all national economies, and have influence on standards of life of all communities.

Consumers of energy are in the new situation where they can take part in the energy market and they can buy the energy in different forms. Electrical power engineering has become the energy market [1].

The assurance of required quantity of energy in new market conditions can have political, economic, ecological and social character. The energy is essential element to development for each country. The unequal occurrence problems of energy resources on the world, their exhausting, progress of the natural environment degradation as well as meaning of energy carriers in the energy management – in this range necessary is makes investigations. The model of the energy management is essential for enlarged efficiency in using of energy carries.

After that, it is very interesting the modelling of the energy management in aspect of integration with European Union [2].

### Energy market in Poland

The composition of the polish energy market includes three basic elements (fig.1):

- real power energy market which includes:
  - contract segmentation,
  - stock segmentation,
  - balance segmentation,
- technical market which includes:
  - regulating system services,
  - forced generation,
- financial market where they are realized period contracts.

Energy market in Poland works on two fundamental levels:

- whole sale market,
- retail market.

Each of these markets is divided on two levels:

- competitive,
- regulated.

In this competitive area of wholesale market transactions related with buying and selling electric energy are realized on competitive conditions. On regulated area of wholesale market the transactions are normalized by proper instructions and prices of electric energy are normalized in special tariffs.

Principles of operations on retail market are relatively simple. In regulated areas of the retail market the main subjects are final recipients. Distributional companies provide electric energy for these recipients and prices of electric energy are normalized in special tariffs which are approved by the Chairman of Polish Energy Regulatory Office (ERO). In competitive areas of the retail markets the final recipients have right to choose the distributional companies which will provide electric energy for them (so called principle - Third Party Access). Final recipients can buy the energy from distributional companies or straight from producers of energy. Final recipients can buy the energy where ever they want but for distribution they have to pay companies which are providing them the electric power.

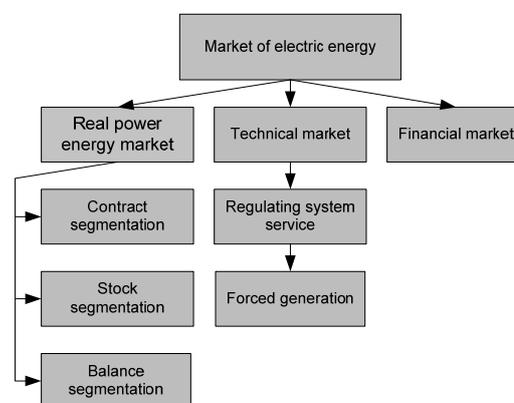


Fig. 1. The composition of the polish energy market

### Situation of power engineering in Poland

The Polish industry is characterized by energy consumption rise. It is caused by dynamic development of national economy. In spite of growth demand on electric energy in all sectors of economy, the industry is the largest energy consumer. Polish industry uses 55% electric energy which is produced in country. It is very interesting the comparison between the electric energy consumption in Poland generally and in the industry. The structure of consumption in particular energy supports is changing. In the last fifteen years, hard coal consumption was reduced by about 30% and is now 68 million tones per year. It increases however with natural gas consumption. So, we must show the investigation results of the hard coal and the earth gas consumption in the industry. This is connected with ecology, because natural gas emits less pollution than coal. The enlargement of gas consumption requires the logging of him from foreign supplier by steels growing prices of this support. The demand quantity of electrical energy in Poland by four alternative designs is shown in table 1.

Table 1. The prognosis of electrical energy in Poland in TWh

Variant	2005	2010	2015	2020	2025
Treaty	148	168	190	222	272
Basic coal	144	169	190	221	276
Basic gas	148	167	192	224	270
Efficiency	144	165	185	212	256

After 1989, the restructuring of industry was conducted. This influenced electric energy consumption in individual branches of industry. One can notice a increase electric energy consumption factor in industry per one worker. The perfect example is Metal industry for which this factor increased three times. There are many factors which can show condition of industry: the energy consumption factor, electric energy consumption factor in industry per one worker factor, but one of the most imported is energy-consuming factor. The forecasts of this factor permit to define the competitiveness of national industry and to compare it with Western Europe countries industry.

The assurance for the delivery of energy is the basis of economic development. There are connections between the economic development of given country, the quality of life and energy consumption. To make an electric power system work properly, it is essential that a well developed industry produces energy-saving, competitive products. The dynamic transformations of economy in Poland and steels growing prices of energy supports in last decade caused major increase of interest of limitation of energy-consuming by business enterprises. One of the most important factors, which permits estimate the condition of industry is the energy-consuming factor and forecasting this index allow planning the strategy of national industry. It is very interesting to present the way of forecasting the energy-consuming factor in chosen industry branches.

In the studies, we also introduced some strategies of big consumers of energy having the aim to lower their electrical energy costs [3]. For the basic problems connected with the reduction of electric energy costs belongs: lowering the energy costs through using energy-saving drives (motor), production energy in own industrial institution during seasonal maximum of demand for the energy, the internal verifications of losses of production process as well as lowering the costs of energy connected with the possibility of changing of tradesman of energy.

The energy acts very important role in economic development. The operation of adequate energy politics in direction of energetic safety quarantion is also very important from economic view. Also some results of energy

balance in the macroregion in aspect of energy sector modification in Poland are provided to integrated program of regional development.

### The investigation with econometric models

One of the most popular simulation method is the cause-effect models building. It depends on searching dependence between variable which is explain (the energy-consuming factor in chosen branch of industry) and the explanatory variables (the sold production, employment, number of companies, in chosen branch of industry). This models are called econometric or in special occasions energy-metric models. The linear model with many explanatory variables has figure:

$$(1) \quad Y = a_0 + \sum_{k=1}^K (a_k X_k) + \varepsilon$$

where:  $Y$  – variable which is explain,  $X_k$  –  $k$  explanatory variables for  $k = 1, 2 \dots K$ ,  $a_0, a_k$  – structure model parameter for  $k = 1, 2 \dots K$ ,  $\varepsilon$  – random component.

To determinate the individual parameters of econometric model is the most comfortably to use classic method of the smallest square [4].

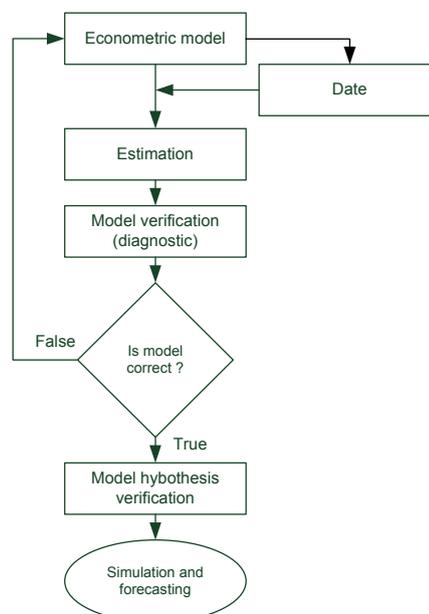


Fig. 2. Econometric analysis diagram

The presented econometric analysis (fig. 2) may to show the energy-consuming factor decrease or increase but it is possible to see decrease or increase rates and what will be in the future. To change this fact the industry should:

- exchange energy-consuming and material-consuming technologies to modern and energy-saving technologies, especially in heavy industry,
- magnify work productivity with a better organization of production and exploitation,
- introduce a suitable legal-economic settlement, which will promote energy-saving and ecology technologies,
- allow the Polish government to promote, by suitable legal means, saving energy.

### Computer systems aided energy management

Opinion of energy management and operation strategy was conducted in many industrial plants [5]. One example may to be the modern plant, which provides the services

from special technology SMT (fig. 3). Surface Mount Technology depends on superficial assembly components and execution functional tests DFT (Digital Function Test) for produce plates. Main recipients are the big equipments producers from electronic trades in the world such as: Samsung Group, TVP, Logitech and Kingston. The final products are before all monitors, televisions LED and LCD. SMT is the process automatic superficial imposition of electronic components on the plate surface of the printed circuit. The imposed components for the plate must be subject to the norm of the leaded production RoHs. Digital Function Test (DFT) is the automated functional control. It is a practical test when the plate is connected with the supply source. This test detects 99% invisible damages, after visual inspection by the machines. The productive process starts as the moment of the components deliver and finishes when a fit product is send to the recipient.

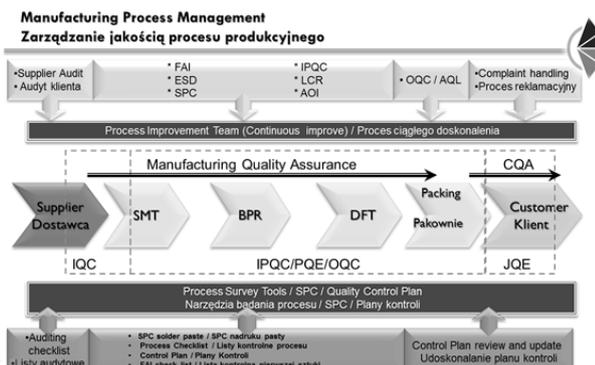


Fig. 3. The graphic scheme of the productive process

Until now in the studied plant are two computer systems aided energy management:

- *Superior System Skaden* - designed to acquisition analysis of measuring data gained over the electronic electric energy numerators,
- *System ERCO.Net* - attended requirements concerned with the energy consumption and the coefficients, as so aided prognosis process and also electric energy demand in the structure of the Balance Group.

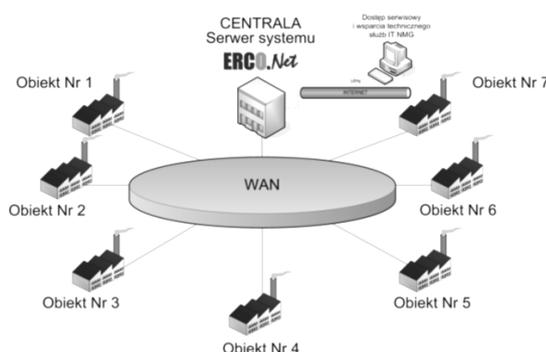


Fig. 4. Structure of ERCO.Net system for the Shopping Group

The central computer system is dedicated for the Shopping Group (fig. 4). This system is tied with the balance of the purchase and sale energy costs, purchase energy simulation, prognosis and graphical electric energy demand for the Shopping Group and the individual members.

The range of the energy carriers comprised with the computer systems are very wide. On the energy market we can find many computer tools (free or paid systems) which are designed to the aid of energy management [6].

The complexed systems to automatic energy management very often are derivalived of the general computer development in each country. The correct measuring and recording of energy carriers consumption is one of the basic condition, which must be attended by the realization operation of energy management.

In the tested plant is studied and started a new system [www.odczytlcznika.pl](http://www.odczytlcznika.pl) [7].

This system permits to access of measuring data from every device which has connect with Internet (fig. 5). The service system is very simple with intuitive interface. The measuring results are presented in the graphic form (possibility export to pdf) or tabulator form (possibility export to excel).

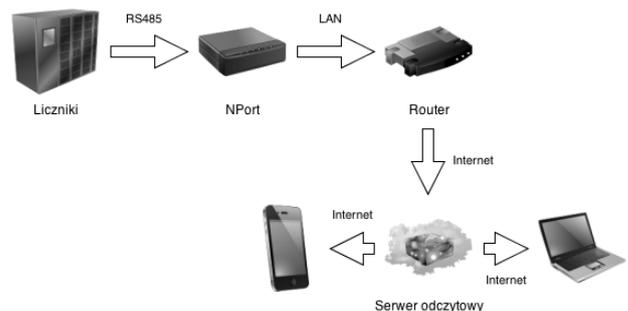


Fig. 5. The ideological scheme of system on the platform [www.odczytlcznika.pl](http://www.odczytlcznika.pl)

The basic modules tested system and some lectures are demonstrated on fig. 6.

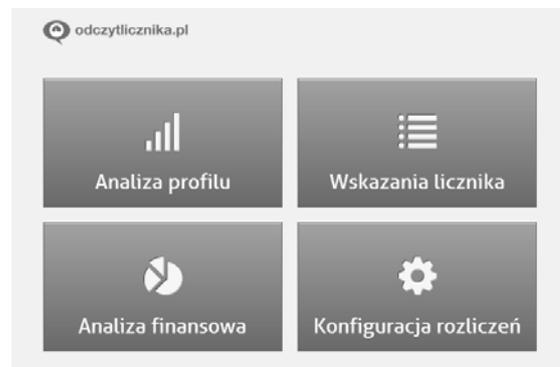


Fig. 6. The basic modules of the tested program

The basic modules of the tested system:

- Profile Analysis Module (Moduł Analiza Profilu) - permits the consumption energy previews: 15 – minutes profiles of taken and given back active power, inductive and capacitive passive power, tg φ and energy profiles (1 h, 1 day, 1 week, 1 month, 1 year),
- Meter Coefficient Module (Moduł Wskaźnik Licznika) - demonstrates calculators states: actual and archival (for the end and accounted period) and limited consumption energy for the basis states,
- Financial Analysis Module (Moduł Analiza Finansowa) - generates texture vision from the dates of the meter, simulates the electric energy payments with the regard of conventional power prices changes, tariff groups and the changes in the zones,
- Accounts Configuration Module (Moduł Konfiguracja Rozliczeń) - permits for introduction of conventional data (energy payment, tariff determination, conventional power) for every measuring point.

System [www.odczytliznika.pl](http://www.odczytliznika.pl) generally applies standard equipments and programmes, so, in the future, it is possible to simple extension of this system with new elements.

### Conclusions

1. Unfortunately, energy management computer systems are expensive and their initiation takes much time. Introduction of advanced technology energy management meets for the barriers mainly tied with economic premises, and also are caused by failure of conveniences advisability these operations.

2. Energy efficiency improvement [8] may be realized for the all industrial branches. The competition on the free market extorts necessity economy searching and the own costs abdatons, which often are to achievement with suitable commitment of workers and managers in industrial plants.

3. The proposal computer system aids the energy management process with mainly pressure for the purchase cost optimization (contract with supplier) and electric energy section in very energy consuming departments of the enterprise.

4. The energy is essential element to development for each industrial plant, macroregion and country [9]. The unequal occurrence problems of energy resources on the world [10], their exhausting, progress of the natural environment degradation as well as meaning of energy carriers in the energy management – in this range necessary is makes investigations. The computer system aided energy

management is essential for enlarged efficiency in using of energy carries.

**Author:** prof. nadz. dr hab. inż. Bogumiła Wnukowska, PWSZ im. Witelona, Wydział Nauk Technicznych i Ekonomicznych, E-mail: [boqumila.wnukowska@pwr.wroc.pl](mailto:boqumila.wnukowska@pwr.wroc.pl).

### REFERENCES

- [1] Malko J., Rynki energii-działania marketingowe, *Politechnika Wroclawska*, Wrocław (2006)
- [2] Manz D. et al., The grid of the future. *IEEE Power & Energy Magazine*, vol. 12, nr 3, (2014)
- [3] Podolski P., Wnukowska B., Wielki odbiorca na rynku energii, *Instytut Energoelektryki Politechniki Wroclawskiej*, Wrocław (2013)
- [4] Luszniwicz A., Statystyka z pakietem komputerowym STATISTICA, *Wydawnictwo C.H. Beck*, Warszawa (2003)
- [5] Wnukowska B., Drygas B., Komputerowe systemy wspomagające zarządzanie energią w zakładach przemysłowych, *Politechnika Wroclawska*, Wrocław (2013)
- [6] Grabara J., Systemy informatyczne w energetyce, *Politechnika Czestochowska*, Czestochowa (2007)
- [7] Materiały firmowe, *Lumen*, Wrocław (2010-2015)
- [8] *The Brattle Group*: Demand Response and energy efficiency. The long view, August 12, (2010)
- [9] *FERC*: National action plan on demand response. June 17, (2010)
- [10] Daryanian B., Trends for the grid of the future. *Proc. CIGRE*, Nat. Com. Sym. Kansas C.MO, (2012)