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Role of a rational energy economy in an industrial plant

SUMMARY

This paper presents energy economy with regard to optimal selection of tariffs. It shows the construction and functioning of the electricity market in Poland. the analysis carried out in this paper shows savings resulting from the optimal selection of electricity tariffs.

Key words: energy economy, tariffs, electricity, savings, expenditures.

Introduction

High competitiveness in the industry forces to take measures to reduce production costs. One of the ways to reduce expenditures is to implement in the plant an optimal (from the point of view of minimizing the consumption of energy carriers) energy economy. It consists of many aspects. The paper discusses the impact of tariffs on electricity expenses.

Energy economy

The energy economy is an interdisciplinary specialty. It integrates: economics, statistics, energy and electrical engineering [1]. The term indicates the management of all energy resources that can be dealt with in industrial plants. Properly implemented energy management should not be polarized only for one energy carrier, and manage commensurately with all energy

[1] M. Czosnyka, B. Wnukowska, *Ocena gospodarki energetycznej w zakładach przemysłowych*, Politechnika Wrocławska, Wrocław 2017, (unpublished); J. Górzyński, *Efektywność energetyczna w działalności gospodarczej*, PWN, Warszawa 2017; H. Rechul, *Gospodarka energetyczna. Przedmiot badań ekonomicznych*, http://cire.pl/pliki/2/gospodarka_energet.pdf, dostęp: 10.03.2018 r.

goods. There is the same problem with the rational use of electricity as well as gas or process steam. The task of the energy economy is the acquisition, processing, transmission, use of energy resources, fuels, and electricity. This is done by planning energy supplies, setting strategies and optimizing production. In a modern production plant, the strategy is fundamental to the condition and financial liquidity of the company. It is a set of ready solutions for various situations. The best strategy is one that provides for different, mostly negative scenarios. The energy economy also deals with the operation of machinery and equipment, search for new, more energy-efficient solutions compatible with the best available techniques.

To make it all possible are needed regular measurement of energy consumption on the individual stages of production. They constitute a base in energy management in an industrial plant. According to the idea of „Industry 4.0", regular measurements should be in real time. Currently in industry, the problem is not the measurement itself, but a large number of measuring points and a high frequency of readings. Therefore, the aggregation of a huge amount of data, their appropriate selection, processing and, above all, the interpretation becomes problematic. Regular measurements and their analysis make it possible to program the load in an industrial plant, which is associated with the appropriate prediction of power demand. Knowledge of daily, monthly and annual load is also a starting point in the selection of energy tariffs. This allows you to take some organizational measures and technical nature.

Organizational activities lead to the organization of production processes. They are used to reduce energy consumption during peak hours, where the price per unit of energy can be up to 50% higher compared to off-peak hours. They also help in setting the work schedule of individual receivers, so that they do not exceed the contracted capacity for which the recipient pays additional penalties. These activities must constitute a certain compromise between the number of orders and production capacities and energy prices in individual periods of the day.

Technical activities are based on finding solutions that will use energy used in production processes in the most effective way. In the case of electricity, there is no possibility of charging it in cheaper off-peak zones and efficient accumulate. However, you can accumulate this energy in off-peak hours by producing a reserve.

The implementation of optimal energy economy in an industrial plant has both a local and global dimension. In the **local dimension**, proper energy economy leads to a more efficient use of energy, which ultimately translates into a visible financial effect in the form of lower energy expenditure. In the **global dimension**, these activities have an ecological aspect. In Poland, effective energy use has become an obligatory activity. It is necessary to limit energy consumption in industrial processes to reduce the consumption of fossil fuels and the emission of harmful substances into the atmosphere.

Electricity market in Poland

Electricity is a very special commodity and in its specificity differs from other energy carriers[2]. This is mainly due to the inability to accumulate electricity. Therefore, simultaneous generation of energy, transmission and use by end users must be achieved. In addition, the energy in the power system must always be the right amount. Otherwise, blackout can be very easy. Revolutionary changes in the Polish energy industry were initiated in 1997 by

[2] J. Malko, A. Wilczyński, *Rynki energii – działania marketingowe*, OWPWr, Wrocław 2016.

the Energy Law Act. It assumed primarily: privatization, demonopolization and liberalization of the electricity sector. Electricity has ceased to be a good that is common and everyone deserves it. It began to be treated as a commodity subject to all possible market mechanisms – primarily competition.

Figure 1. Areas of activity of individual Distribution System Operators

Source: own elaborated based on *Mapa konturowa Polski*, *http://www.dobryprad.pl/images/polska-mapa-energetycznapng*, dostęp: 1.03.2018 r.

The energy market is divided into three main sectors: generation, distribution and sale of electricity. 5 distribution companies have been established that deal with the maintenance of network infrastructure in Poland. The area of operation of each of the energy distributors is presented in Fig. 1.

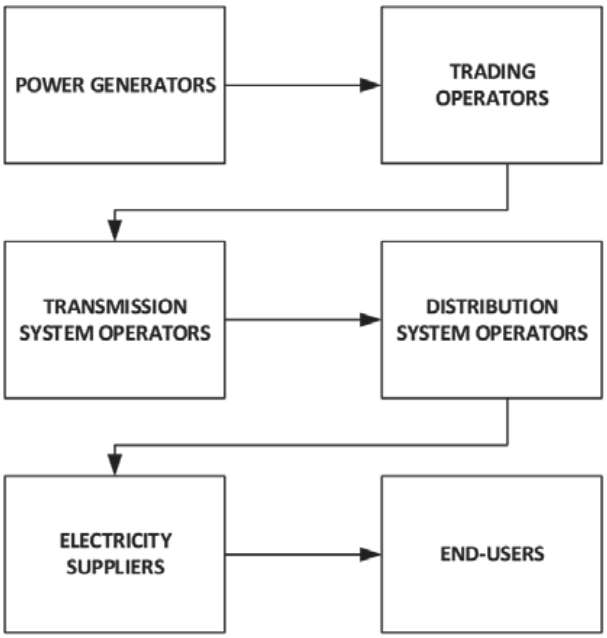

Figure 2. Structure of the energy market in Poland

Source: own elaborated.

The culmination of activities initiated in the 1990, was the introduction of the Third Party Access rule in 2007. Thanks to the TPA and the applicable energy market model, each recipient has the right to change the electricity supplier without any consequences. The energy distributor, however, is unchangeable and results from the area inhabited by the recipient. Such a law allows you to choose the best price offer for electricity, and thus to generate appropriate savings. In a schematic manner, the structure of the energy market in Poland is shown in the diagram in Fig. 2.

Electricity tariffs

Electricity tariff is a package informing about prices, rates, terms of sale and distribution of electricity. As already mentioned in the previous chapter, as a result of profound changes that took place in the energy sector in 2007, electricity consumers pay somehow two fees, according to two price lists (tariffs): electricity fee and distribution service.

The tariffs for electricity distribution service must be submitted annually to the President of the Energy Regulatory Office (ERO). It is connected with the fact that Distribution System Operators (DSO) operate under conditions of natural monopoly. The ERO audit over distribution tariffs is intended to protect receivers from possible sudden price increases for this service.

Tariffs for the sale of electricity are not regulated by the President of the Energy Regulatory Office, with the exception of those intended for individual consumers. The obligation to translate and approve tariffs has been preserved in this case to protect private consumers from sudden increases in energy prices. The energy seller can be changed. At present, there are several dozen companies on the Polish market dealing in the trading and sale of electricity. The industrial recipient, due to the large volume of energy demanded, has the option of negotiating prices and contract terms.

It should also be noted here that the recipient may have a different tariff group for the distribution service and another for electricity.

The contract for the sale and distribution of electricity can be concluded in a comprehensive manner – combining both of these services. This applies to customers who have never used the opportunity to change the seller. In this case, the service of selling electricity is provided by the company associated with the local DSO by default. When the recipient decides to change the seller, it is necessary to terminate the contract with the existing supplier and sign two separate contracts – with a new seller and local distributor. Most often in such cases, the customer will receive two invoices – for electricity and distribution, although this is not always the case. More and more sellers establish agreements with distributors, so that when changing suppliers, it is possible to sign a comprehensive contract and receive one bill for electricity.

Optimization of the tariff group – distribution service

The production plant for which the analysis was carried out is located in the province of Lower Silesia, where "TAURON Dystrybucja S.A." is the Distribution System Operator. The plant is supplied from two medium voltage power grids with a contracted capacity of 1450 kW for the line L1 and 1550 kW for the line L2.

The research was related to electricity consumption throughout 2017. All calculations were based on price lists and tariffs for 2017. The results obtained are net costs and do not

include tax. The analysis started with the selection of the optimal tariff group for the distribution of electricity[3] [6]. Tables 1, 2 and 3 present expenditures for the distribution of electricity, for tariff groups: B21, B22 and B23.

Table 1. Expenditures on electricity distribution for the tariff group B21

Variables L1		**Power line**	
		L2	
electricity consumption	MWh	5 141	4 535
total fees	PLN	56 2714	53 1624
summary	**PLN**	**1 094 338**	

Source: own elaboration based on *Taryfa za dystrybucję energii elektrycznej*…, op. cit.

Table 2. Expenditures on electricity distribution for the tariff group B22

Variables L1		**Power line**	
		L2	
electricity consumption at peak	MWh	2 100	2 085
electricity consumption off-peak	MWh	3 041	2 450
total fees	PLN	56 2200	53 4296
summary	**PLN**	**1 096 495**	

Source: own elaboration based on *Taryfa za dystrybucję energii elektrycznej*…, op. cit.

Table 3. Expenditures on electricity distribution for the tariff group B23

Variables L1		Power line	
		L2	
electricity consumption in the morning summit	MWh	1 310	1 345
electricity consumption in the afternoon summit	MWh	790	740
electricity consumption in other hours of the day	MWh	3 041	2 450
total fees	PLN	470 628	460 489
summary	**PLN**	**931 115**	

Source: own elaboration based on *Taryfa za dystrybucję energii elektrycznej*…, op. cit.

As can be seen in Figure 3, for the production profile that is used in the examined plant, the most-optimal tariff for electricity distribution will be tariff B23, in which the day is divided into three zones: morning, afternoon and other hours of the day. The production schedule in this plant is set in such a way that the largest energy demand is at night (off-peak) at which prices are the lowest. The highest expenditures on electricity would be if the B22 tariff was applied. If, however, the standard price of B21 remained, the costs

[3] *Taryfa za dystrybucję energii elektrycznej*, http://bip.ure.gov.pl/download/3/8639/20161215TaryfaTAURONDystrybucjaSA.pdf, dostęp: 10.03.2018 r.

related to the distribution of electricity would be 165 379 PLN higher compared to the most optimal group B23.

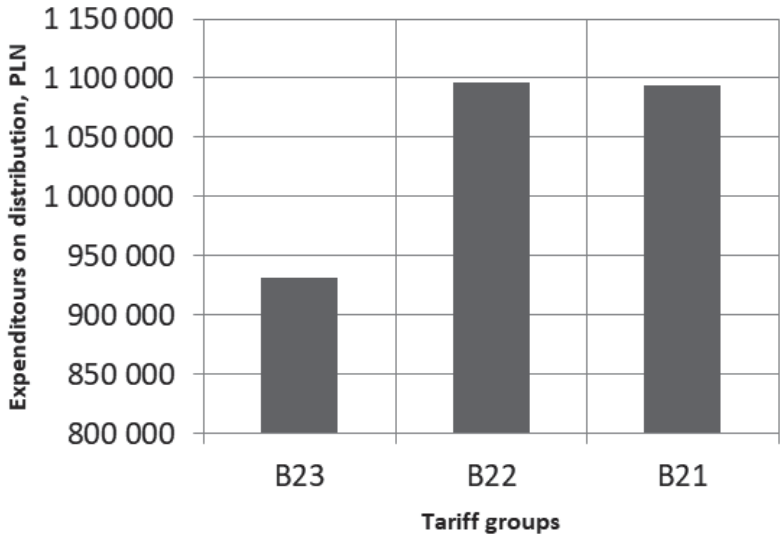

Figure 3. Expenditure on electricity distribution for individual tariff groups

Source: own elaboration.

Optimization of the tariff group – electricity fee

In the case of electricity tariffs optimization, not only the tariff group but also the possibility to change the electricity supplier was taken into account. 3 offers of energy sellers were compared. It was checked which tariff group for the purchase of electricity would be the most optimal. In the case of electricity, it does not matter what power line – L1 or L2 – it was taken from. A fee is paid for the total energy volume. Table 4 summarizes the total expenditure on electricity for various tariff groups and energy sellers.

Table 4. List of expenditures in PLN on electricity for individual tariff groups and energy sellers

Tariff groups	Seller 1.	Seller 2.	Seller 3.
B21	3 249 726 PLN	2 566 675 PLN	3 592 196 PLN
B22	3 270 272 PLN	2 626 837 PLN	3 701 235 PLN
B23	3 220 397 PLN	2 626 921 PLN	3 689 565 PLN

Source: own elaboration.

Obtained results are presented graphically in Fig. 4.

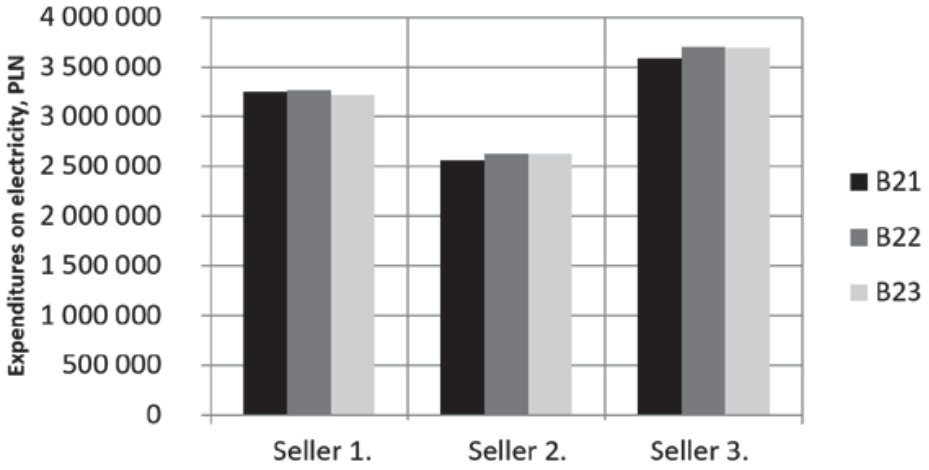

Figure 4. Expenditure on electricity distribution for individual tariff groups

Source: own elaboration.

The analysis shows that the best price offer is able to be offered by the Seller 2.

In the case of electric energy, the most advantageous tariff group is B21. The difference between the tariff group B21 and B23 is 60 246 PLN. Choosing the cheapest energy seller, you can make up to 1 025 521 PLN savings (the difference between B21 Seller 3. and B21 Seller 2.).

Summary

Table 5 presents differences in total expenditure on electricity. The two most characteristic cases were considered: optimal – in which the tariffs were chosen in a proper and standard – in which the company does not make any optimizations in the selection of tariffs.

Table 5. Total expenditures on electricity in PLN

Cases	Distribution	Electric energy	Sum
Optimal case	**B23** 931 115 PLN	**B21** 2 566 675 PLN	**3 497 791 PLN**
Standard case	**B21** 1 094 337 PLN	**B21** 3 249 726 PLN	**4 344 063 PLN**

Source: own elaboration.

The most optimal case from the point of view of minimizing expenditures on electricity for the considered plant is the one in which the tariff group B23 is predicted for distribution, and for the electricity – B21 from the Seller 2. for a standard case in which both the distribution and the energy are provided for the same tariff – B21, additional expenditure at the level of 846 272 PLN should be expected.

Savings are therefore significant and for the most optimal case, expenditures on energy distribution are by 14.9% lower, while the purchase of electricity will be allocated by 21.0% less cash in relation to the standard tariff. In this case, optimizing the selection of electricity tariffs (taking into account both distribution and purchase of energy) gives savings at the level of 19.5%.

Conclusions

The conducted analysis confirms the important role of electricity tariffs in minimizing expenditures on electricity. Simple verification of tariff groups and contracts with the seller of electricity can generate considerable savings. Differences in costs resulting from energy collected using inadequate tariffs are not indifferent and clearly affect the financial condition of the company.

Distribution System Operators and Energy Sellers do not care about their recipients paying less for energy. The optimization operation must remain at the discretion of the relevant people in the plant or commissioned to an external consulting company.

In line with the selection of tariff groups, the optimization of production processes should also go so that the most energy consuming receivers work in periods in which prices are the lowest.

Bibliography

Czosnyka M., Wnukowska B., 2017, *Ocena gospodarki energetycznej w zakładach przemysłowych*, Politechnika Wrocławska, Wrocław, (unpublished).

Górzyński J., *Efektywność energetyczna w działalności gospodarczej*, PWN, Warszawa 2017.

Malko J., Wilczyński A., *Rynki energii – działania marketingowe*, OWPWr, Wrocław 2016.

Mapa konturowa Polski, *http://www.dobryprad.pl/images/polska-mapa-energetyczna.png*, dostęp: 1.03.2018 r.

Rechul H., *Gospodarka energetyczna. Przedmiot badań ekonomicznych*, http://cire.pl/pliki/2/gospodarka_energet.pdf, dostęp: 10.03.2018 r.

Taryfa za dystrybucję energii elektrycznej, http://bip.ure.gov.pl/download/3/8639/20161215TaryfaTAURONDystrybucjaSA.pdf, dostęp: 10.03.2018 r.

STRESZCZENIE

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Rola racjonalnej gospodarki energetycznej w zakładzie przemysłowym

W artykule przedstawiono gospodarkę energetyczną w odniesieniu do optymalnego wyboru taryf. Pokazano budowę i funkcjonowanie rynku energii elektrycznej w Polsce. Analiza przeprowadzona w artykule pokazuje oszczędności wynikające z optymalnego wyboru taryf za energię elektryczną.

Słowa kluczowe: oszczędność energii, taryfy, energia elektryczna, oszczędności, wydatki.

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