BENCHMARKING AS MAIN TOOL FOR MANAGEMENT IN PROCESS OF THE DISTRIBUTION OF ELECTRICAL ENERGY IN DYSTRIBUTION COMPANIES

Jerzy Szkutnik

Czestochowa University of Technology
Faculty of Management

Abstract: The report presents the methodology of benchmarking as one of the key tools in management of the sector of energy distribution. It enables better functioning of enterprises due to comparing their functioning in various profiles and drawing conclusions out of these comparisons. The methodology of benchmarking for distribution companies in Poland is used to a very limited extent. However, it is expected that its role in the decision making process in the energy sector will grow significantly. The report describes a method, which enables objective comparative analysis of distribution companies according to the efficiency of energy distribution, taking into account the specificity of each company. Benchmarking by stimulation to decreasing of costs leads to creation of competitiveness of a distribution company.

Keywords: benchmarking, network, distribution energy

Introduction

The experience of the more developed energy markets proves that existence of market competition brings benefits to all of its participants. An example of success can be the British energy market, where liberalisation proved the theory that market mechanisms lead to decreased energy prices. The results of the introduction of competition in the Polish power energy sector could result only in maintaining prices at the lowest justified level (stable price level, attractive to the economy, enabling domestic and foreign competition), but also better allocation of funds, reduction of costs with improved state of energy safety, reduction of labour costs, optimisation of supply, rationalisation of demand and improved position of the consumer. So, the benefit would be the improved customer service, both for an enterprise and individual receiver. The implementation of the competitive mechanisms in the power energy sector will be the most effective way to force efficiency, where it is only possible. Where it is not possible, efficient regulation should be implemented (Andrzejczuk 2002; Brzozowska, Nowakowska 2011; Kot, Starostka-Patyk, Krzywka 2009; Potacan, Nedelko 2017; Brzóska, Jelonek 2015; Skowron-Grabowska, Mesjasz-Lech 2016).

Benchmarking in the energy distribution

The benchmarking methodology is commonly used in the European Union and the USA, where it is used practically in all sectors of the economy. In the power energy sector, it is used intensively. Analyses with usage of this tool are aimed at comparison of functioning of the distribution companies. The concept of benchmarking in this field consists in measuring results in the situation where there is no price competition. Benchmarking may consist of simple ratio analysis (unit cost, the share of administrative expenses in total costs) or analysis of more complicated statistical models (Szkutnik 2002). The companies have different network and customer structure. Thus, the simple ratios like costs for one kWh or costs for one km of line are not valuable ratios for measuring of efficiency. The method "network size" developed by PA Consulting Group (*Benchmarking Is Coming* 2002) is a method of evaluation of results of the distribution company through association of costs with the total size of the distribution network. Each element of the network is evaluated as a factor generating costs. These factors are converted through weights stemming from the average costs of distribution of the company. In this way one can compare total results of companies having different network structures.

In the model the following items are compared:
- operating costs of the distribution and transit network up to 150 kV,
- costs of the network depreciation,
- costs of settlement of receivers and customer service.

The Faculty of Electrical Engineering of the Technical University of Częstochowa has broad experience in conducting comparative analyses (Slack, Chambers, Johnson, Betts 2006). The methodology of taxonomy analysis based on the Prof. Hellwig method has been used, introducing so called objectivation of definite comparisons. This methodology laid the foundations of software MONITORING, implemented in a dozen of distribution companies in Poland. The software is a helpful tool for the management used for evaluation of the functioning of energy regions of a distribution company.

Multidimensional analysis of energy losses

The efficiency of the functioning of the network of a distribution company is evaluated on the basis of analysis of percentage loss ratio. However, there are some doubts in case of necessity to compare different distribution companies basing on this ratio. Although it is a relative figure as losses relate to energy introduced to the distribution company, such ratio neglects some structural features, which have impact on its value. Certain objective correction of the ratio for each distribution company is required. This is done by the following algorithm below:

The starting point for analysis is the newly construed ratio – *the reaction ratio*, which was elaborated on the basis of research with usage of software STRATY`2002 PLUS [LOSSES'2002 PLUS] – the most recent version of the existing software STRATY`96, commonly used in distribution companies. The

reaction ratio defines to which extent energy losses will change if the energy increases by the same value for different network levels. Such ratios are comparable among distribution companies as they contain all attributes necessary for making comparisons. Calculations of the ratios for the representative distribution company had the following results:

- network of 110 kV; $w_{r110} = 1.073$
- network of medium voltage; $w_{rSN} = 1.680$
- network of low voltage; $w_{rnN} = 2.830$

Based on the analysis you can see the diverse impact of the flowing energy on the ultimate level of losses in the distribution network of a company. These ratios will be used for estimation of the corrected loss ratios for distribution companies, which can be used as a basis for comparison, because they possess all features required for such comparisons. The data packages need the main information about electricity energy in all levels of network and technical infrastructures lenght of lines and numbers of substations. As mentioned earlier, with usage of software STRATY`2002 PLUS one can conduct appropriate calculations and achieve ratios, which will enable comparisons among distribution companies. The following data constitutes an example of results from calculations:

A – Technical losses in low voltage network [MWh]
B – Technical losses in medium voltage network [MWh]
C – Technical losses in 110 kV network [MWh]
D – Total technical losses [MWh]
$\Delta E_{b\%}$ – Total balance sheet losses [%]

Co-efficient $\Delta E_{b\%}$ is an ultimate distinguishing feature of the functioning of the network of the distribution company.

The corrected loss ratio for the distribution company is as follows:

$$W_{rs} = (\frac{C}{D} \times w_{r110} + \frac{B}{D} \times w_{rSN} + \frac{A}{D} \times w_{rnN}) \tag{1}$$

where: W_{rs} – the reaction ratio of the distribution company

w_{r110} – reaction ratio of the 110 kV network

w_{rSN} – reaction ratio of the medium voltage network

w_{rnN} – reaction ratio of the low voltage network

$$\Delta E_{bs\%} = \Delta E_{b\%} \times \frac{W_{rsu}}{W_{rs}} \tag{2}$$

where: $\Delta E_{bs\%}$ – the corrected energy loss ratio of the distribution company

$\Delta E_{b\%}$ – the original energy loss ratio of the distribution company

W_{rsu} – the average energy loss ratio of the distribution company

calculated as:

$$W_{rsu} = \frac{\sum_{i=1}^{K}\sum_{k=1}^{N} W_{rsi}}{(N \times K)} \qquad (3)$$

where: K – number of distribution companies being evaluated

N – number of years of observations, assumed $N = 5$

Below is the analysis of correction of losses in 5 distribution companies. The original data is enclosed in *Table 1*.

Table 1. Original data for calculation of the corrected loss ratio

Distribution company	$\Delta E_{b\%}$	$\dfrac{C}{D}$	$\dfrac{B}{D}$	$\dfrac{A}{D}$
SD1	14.5	0.15	0.42	0.43
SD2	8.9	0.45	0.35	0.20
SD3	12.1	0.25	0.35	0.40
SD4	10.2	0.30	0.40	0.30
SD5	6.5	0.55	0.30	0.15

Source: Own study

The necessity of corrections or objectivation of parameters used in the process of benchmarking has been also underlined by A. Auer (Auer 2001) – only objects that fulfil requirements of comparisons can be compared.

Figure 1 depicts the results of the conducted research as well as original loss ratios of different distribution companies.
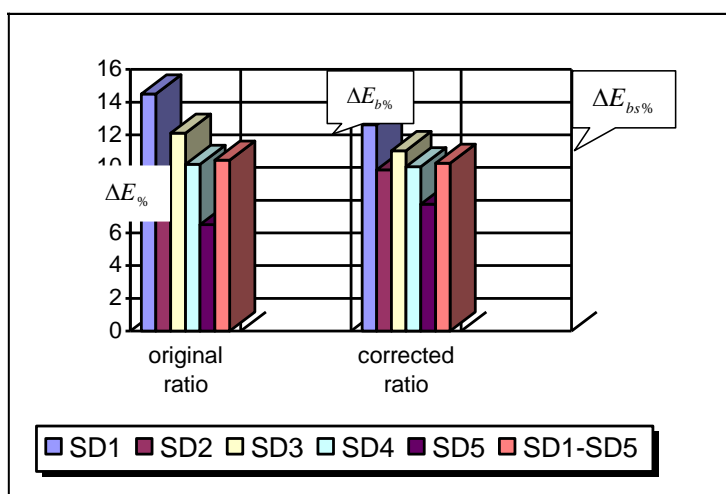

Figure 1. Original and corrected loss ratios of the distribution companies

Source: Own research

Based on the graph above, it can b stated that the corrected ratios have different values. Generally, correction results in smaller differences between companies characterised by the lowest and highest loss ratios i.e. SD1 and SD5, so:

– original value $\delta = 8\%$
– corrected value $\delta = 4.86\%$

Moreover, it is interesting that average values of the loss ratio before and after correction don't differ much (10.44% and 10.44%), which proves the correctness of the method used for objectivation of the loss ratio.

Figure 2 depicts percentage changes of the loss ratio of different distribution companies referred to the their original values.
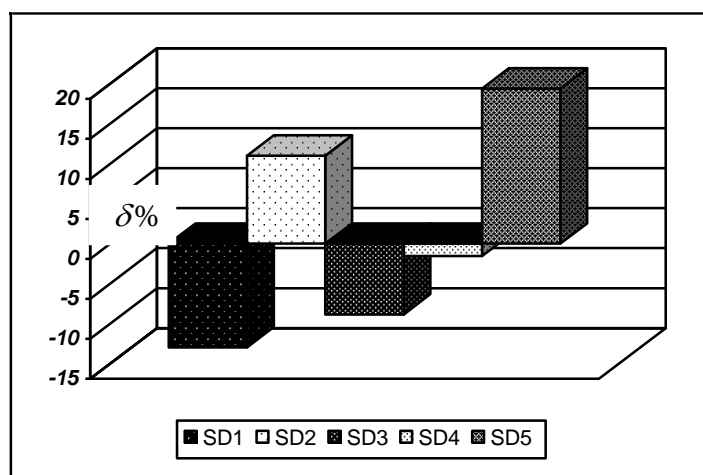

Figure 2. Percentage changes of the loss ratio of different distribution companies referred to the their original values

Source: Own research

As presented above, it is possible to objectivate parameters of distribution companies related to general costs as well as costs at particular voltage levels, which leads to effective benchmarking.

However, correction must be preceded by the introduction of new ratios – cost creation ratios, which are defined as follows:

$$W_{kks} = (\frac{L_{110}}{L_c} \times w_{kk110} + \frac{L_{SN}}{L_c} \times w_{kkSN} + \frac{L_{nN}}{L_c} \times w_{kknN}) \tag{4}$$

where: W_{kkss} – cost creation ratio of the distribution company

w_{kk110} – cost creation ratio in the 110 kV network

w_{kkSN} – cost creation ratio in the medium voltage network

w_{kknN} – cost creation ratio in the low voltage network

184

L_{110} – length of 110 kV network in the area of the distribution company

L_{SN} – length of medium voltage network in the area of the distribution company

L_{nN} – length of low voltage network in the area of the distribution company

L_{c} – total length network in the area of the distribution company

Cost creation ratios are based on the following formulas:

$$w_{kk110} = \frac{k_{jL110}}{k_{u}} \tag{5}$$

$$w_{kkSN} = \frac{k_{ST110/SN} \times \dfrac{N_{ST110/SN}}{L_{SN}} + k_{jLSN}}{k_{u}} \tag{6}$$

$$w_{kknN} = \frac{k_{STSN/nN} \times \dfrac{N_{STSN/nN}}{L_{nN}} + k_{jLnN}}{k_{u}} \tag{7}$$

where: k_{jl110} – unit cost of construction of the 110 kV line [PLN/km]

k_{jLSN} – unit cost of construction of the medium voltage line [PLN/km]

k_{jLnN} – unit cost of construction of the low voltage line [PLN/km]

$k_{ST110/SN}$ – unit cost of construction of the station 110/medium voltage [PLN/station]

$k_{STSN/nN}$ – unit cost of construction of the station medium/low voltage [PLN/station]

k_{u} – average unit cost of construction of the distribution network is:

$$k_{u} = \frac{(k_{jL110} + k_{ST110/SN} \times \dfrac{N_{ST110/SN}}{L_{SN}} + k_{jLSN} + k_{STSN/nN} \times \dfrac{N_{STSN/nN}}{L_{nN}} + k_{jLnN})}{3} \tag{8}$$

The objectivation of the corrected general operating costs is done with usage of the below formula:

185

$$K_{DSDs} = K_{DSD} \times \frac{W_{kks}}{W_{kksu}} \qquad (9)$$

where: K_{DSDs} – corrected operating costs of the distribution company

K_{DSD} – original operating costs of the distribution company

W_{kksu} – average cost creation ratio is calculated as:

$$W_{kksu} = \frac{\sum_{i=1}^{K} W_{kksi}}{K} \qquad (10)$$

where: K – number of distribution companies being evaluated

Software MONITORING

Similar corrections can be done for operating costs related to specific voltage level. In such a case, the correction is done only with ratios related to that voltage level.

The corrected coeficients we used to special program MONITORING.

To the analysis and estimations of effects of the management the distribution of the electrical energy proposes the use of modified by the Author the programme MONITORING to the practical analysis of the comparative activity of energy-regions in distribution firms.

The programme uses to the analysis most essential units describing the activity of units. There are both technical parameters as also economic. Across comparative calculations one can qualify the market position of firms. Possible is also the simulation of the permissive strategy on the improvement of the activity and also of the position competitive.

This estimation executed is basing on following, most essential in the activity of the region parameters: The amortization, remaining costs, the sale of the energy from the low voltage network, the sale of the energy from the medium voltage network, generic costs together, the coefficient of balansing losses, the length of the line of the low voltage and medium voltave, the number of the station points of the purchase the network of the low and medium voltage, sale values of the electrical energy to small and great receivers and the level of the service of the customer.

As result of of analyses receives two kinds of coefficients: 1) diagnostic (determining the complex estimation) – decisive about the market position, 2) hierarchical – denominative the influence parameters on the final result. On the ground of these coefficients can be guided observation of the activity of all distribution firms (monthly), what lets on the quick diagnostics of the occurrence in the case of the worsening of results.

Nowodays is necessity to use the additional coeficient one necessary to the general estimation of effects of the management in the distribution of the electrical

energy. Namely energy – firms in their own activity must take into account parameters of the service of the customer. In the moment of changes in the system of the distribution of the electrical energy the consequential necessity from the assurance to customers of high standards of the service have the essential meaning. How shows the literature of the object many factors describing on the satisfaction of the customer of the electrical energy. The analysis of author given the following *Composite coefficient of the service of the customer*, it consist from 5 units:

− the coefficient of the realization of the order, the rank (the influence) in Composite coefficient – 30%;
− the level of the reliability of deliveries – 25%;
− the accessibility of the information on of deliveries – 15%;
− the exactitude of bills – 15%;
− the investigation of the complaint – 15%.

The power of the influence of most important parameters on the final result (the value of the diagnostic coefficient) and effects of the management with the distribution of the electrical energy are: – it is represented across values of hierarchical coefficients.

The greatest influence on effects of the management with the distribution of the electrical energy in energy-regions have the amortization (23%) which reflects the state of the infrastructure of technical, then remaining costs (19%), the next position is the size of losses (18%). The strong influence on effects of the management with the distribution of the electrical energy have both the sales volume as and the service of the customer (12%). Presented methodology and erected on her base the programme the Monitor helps in quick qualifying of effects of the management with the distribution of the electrical energy, what can determine for manageresses the base of correctory and development activities.

Conclusions

The proposed objectivation methodology of input data for benchmarking analysis enables full reflection of differences among distribution companies. The method gives a possibility to convert the data, both technical and economic, into the comparable analytical platform. Further calculations may be done with usage of DEA methodology, Hellwig taxonomy method or basic statistical tool incl. correlation analysis. The benchmarking of distribution companies conducted in such a way may constitute a basis for taking decisions related to both current and future activities of distribution companies.

Literature

1. Andrzejczuk A. (2002), *Bariery zaistnienia konkurencyjnego rynku energii elektrycznej*, "Biuletyn Urzędu Regulacji Energetyki", nr 4, p. 22-26.
2. Auer H. (2001), *Deriving Efficiency Scores for the Austrian Distribution Utilities DistribuTech*, EUROPE 2001, Berlin 6-8 November.
3. *Benchmarking Is Coming*, (2002), PA Consulting Group, London.

4. Brzozowska A., Nowakowska A. (2013), *Ewolucja zarządzania łańcuchami dostaw a dążenie do zrównoważonego rozwoju*, [in:] *Ekonomia dla przyszłości. Odkrywać naturę i przyczyny zjawisk gospodarczych*, IX Kongres Ekonomistów Polskich, PTE, Warszawa.

5. Brzóska J., Jelonek D. (2015), *Koncepcja pomiaru wartości tworzonej przez aplikacje modeli biznesu. Podstawy teoretyczne i studium przypadku*, "Przegląd Organizacji", nr 9, p. 48-55.

6. Certo S., Certo T. (2011), *Modern Management Concepts and Skils*, Prentice Hall, New York.

7. Kot S., Starostka-Patyk M., Krzywda D. (2009), *Zarządzanie łańcuchami dostaw*, Wydawnictwo Wydziału Zarządzania Politechniki Częstochowskiej, Częstochowa.

8. Krzywda D., Brendzel-Skowera K. (2010), *Sustainable Development Strategy and Its Implementation Possibilities for Enterprises*, [in:] Modrak V., Nitkiewicz T. (eds.), *The Role of Business in Achieving Sustainability. Part 1: Instruments and Strategies*, Technical University of Kosice, Presov, p. 38-52.

9. Mesjasz-Lech A. (2009), *Nowoczesne instrumenty zarządzania*, Wydawnictwo Wydziału Zarządzania Politechniki Częstochowskiej, Częstochowa.

10. Nowakowska-Grunt J. (2014), *Strategiczne aspekty polityki regionalnej w Polsce na przykładzie klastra logistycznego w województwie łódzkim*, "Prace Naukowe Wałbrzyskiej Wyższej Szkoły Zarządzania i Przedsiębiorczości", nr 27(2), p. 421-430.

11. Nowakowska-Grunt J., Nowakowska A. (2013), *Selected Problems of Strategic Management of Enterprises*, Vysoka Skola Banska, VSB, Ostrava.

12. Potocan V., Nedelko Z. (2017), *Supply Chain Management and Management Tools*, Pearson Education Limited, Essex CM2 20JE, Pearson, Harlow.

13. Skowron-Grabowska B., Mesjasz-Lech A. (2016), *Konkurencyjne uwarunkowania zarządzania zasobami kadrowymi w przedsiębiorstwach w kontekście dostępu do rynku pracy*, "Przegląd Organizacji", nr 10, p. 22-28.

14. Slack N., Chambers S., Johnson R., Betts A. (2006), *Operations and Process Management*, Prentice Hall, Harlow.

15. Szkutnik J. (2002), *Benchmarking w sektorze dystrybucji energii elektrycznej*, [in:] VI Konferencja Naukowa PE 2002 „Prognozowanie w Elektroenergetyce: prognozowanie, efektywność energetyczna", 18-20 września 2002, Częstochowa, p. 251-255.

BENCHMARKING JAKO GŁÓWNE NARZĘDZIE ZARZĄDZANIA PROCESAMI DOSTAWY ENERGII ELEKTRYCZNEJ W PRZEDSIĘBIORSTWACH DYSTRYBUCYJNYCH

Streszczenie: Artykuł prezentuje metodologię benchmarkingu stanowiącą nieodzowne narzędzie zarządzania dla sektora dystrybucji energii elektrycznej. Pozwala ona na lepsze zarządzanie przedsiębiorstwem poprzez analizę różnych scenariuszy wraz z opisem rekomendacji i zaleceń, podnoszących efektywność jego funkcjonowania. Proponowane analizy porównawcze zostały opracowane przy zachowaniu trendu podnoszenia efektywności przy udziale energii elektrycznej. Wszystkie środki przedstawione w artykule stwarzają możliwość obniżenia kosztów dystrybucji i budowania przewagi konkurencyjnej przedsiębiorstwa.

Słowa kluczowe: benchmarking, sieć, dystrybucja energii