Source: own calculations based on the Annual reports of the company

Table 3 summarizes the main financial indicators associated with the electricity activities of the company in the given period. From 2013 to 2016, operating expenses grew by an average 0.053% annually. Although, between 2013 and 2015 electricity related net profit reduced by an average 15.88% annually, in 2016 net profit increased again by 14.41%. This tendency is reflected in the development of ROA and ROE as well.

The formula used for determining the Degree of Operating Leverage (DOL) was the follows:

$$\text{DOL} = \frac{Change\ in\ EBIT\ (\%)}{Change\ in\ Sales\ (\%)} \quad (1)$$

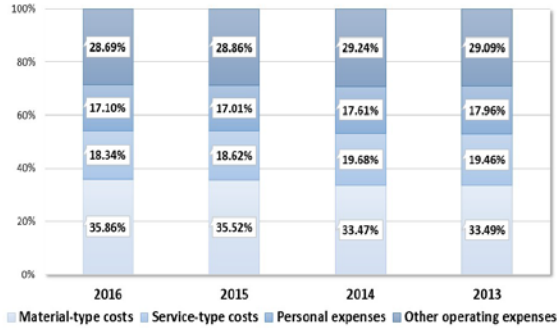
Since the annual values of the degree of operating leverage (DOL) indicate, between 2015 and 2016 1% increase in electricity sales revenues reduced the company's gross operating profit by 7.74%.

In the next Chapter, detailed analysis of flat cost and the development of the breakeven output is performed.

3.3 Analyzing the structure of flat cost and the impact of wholesale price reduction

In order to calculate the annual electricity-related flat cost of the company, the general calculation methodology defined by the relevant literature was followed, i.e. flat cost was measured by the operating expenses per one unit of electricity sold. Main advantages of this methodology lie in its flexibility and reliability and the transparency and traceability of the results.

Fig. 6: Share of cost categories in total flat cost between 2013 and 2016 (in %)



Source: own calculations based on the Annual reports of the company

Based on the publicly available annual statements of the company, between 2013 and 2016 total flat cost of electricity-related activities decreased by around 2%. Fig. 6 illustrates the development of the structure flat cost by main categories – material-type costs, personal expenses, service-type costs and other costs - between 2013 and 2016.

Main conclusions are the follows:

- As it is indicated in the figure above, the share of electricity-related material-type unit costs in total flat costs increased by 0.07%. The value of material-type unit costs including the nuclear fuel costs, water usage fees, and other material related to cost per one unit of electricity sold, grew steadily from 2013, and in 2016 it reached 1.49 cent EUR/kWh due to the 15% increase of nuclear fuel costs.
- Personal expenses per one unit of electricity sold by the company contain per unit costs of wages and salaries, social security and assimilated costs, and other staff benefits. The share of unit costs of personal expenses related to electricity activities in total flat cost decreased by 4.76% from 17.96% in 2013 to 17.10% in 2016.
- Main categories of service-type unit costs cover the unit costs associated with repair and maintenance, engineering and other services. Between 2013 and 2016 the company was able to reduce the value of service-type unit costs by 7.78% and the share of service-related unit cost in total flat cost of electricity activities also decreased 5.77% during the period under review.
- The share of other operating expenses including other costs, provisions, waste and decommissioning charges, taxes, and fees, depreciation in total flat cost of electricity-related activities reduced by 1.39% and the value of other operating expenses per one unit of electricity sold by HNPP still decreased by 2.13% during the period under review.

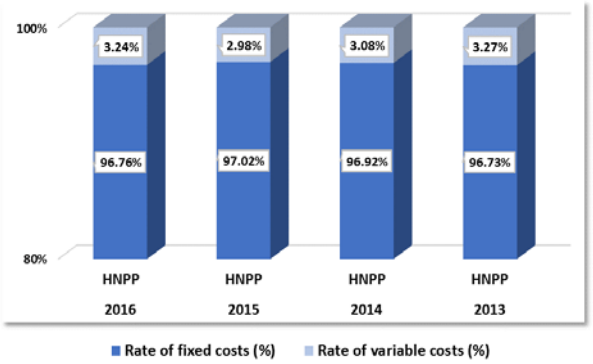
As it was presented in Chapter 2, examination of the impacts of decreasing wholesale prices on flat costs necessitates the calculation of fixed and variable costs.

Following the calculation methodology introduced in Chapter 2.2 variable unit costs of electricity production include only specific water usage fees, while specific nuclear fuel costs and all other sub-categories of material-type, service-type, personal-type and other operating expenses associated with net electricity production of the

company are regarded as variable unit costs. Fig. 7 shows the development of electricity-related fixed and variable costs in total flat costs.

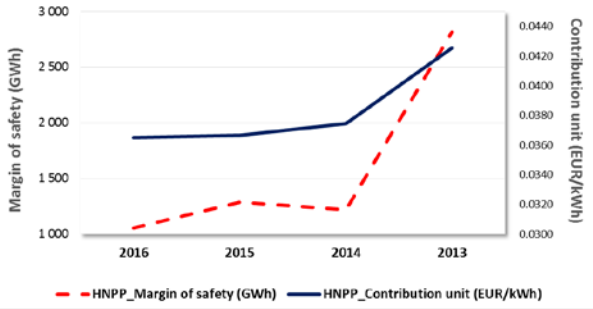
As Fig. 7 illustrates the share of fixed and variable unit costs in total flat costs was in the range defined by the relevant literature sources presented in Chapter 2.2. the amount of total variable costs per unit of production was not changed between 2013 and 2016 and reached 0.011 cent EUR/kWh and the share of variable costs per unit of production in total unit costs stabilized around 96.7%.

Fig. 7: Rate of fixed and variable costs in total flat cost (2013-2016)



Source: own calculations based on the Annual reports of the company

Fig. 8: Results of break-even analysis (2013-2016)



Source: own calculations based on the Annual reports of the company

Considering the relatively high rates of fixed unit costs, it is worth to analyze the development of break-even output in the given period. The results of break-even analysis (see Fig. 8) illustrate that between 2013 and 2016 contribution per unit decreased by 18.62% and the amount of break-even output grew by 20.49%. This means that due to the sharp decrease in the average selling price the margin of safety, i.e. the extent by which actual sales exceed the break-even sales of the company, also reduced, indicating that while in 2013 a 19.35% reduction in electricity sales of HNPP would result in just breaking even, in 2016 this value of sales reduction decreased to 6.96%. Thus, these changes in the margin of safety flag a warning to the management of the company indicating the increasing vulnerability of current operation to price reductions despite their active efficiency improvements.

4 Conclusion

4.1. Main conclusions of the study

The main purpose of this research was to investigate the impact of the fluctuation of wholesale electricity price on the operational performance of nuclear power plants based on the case of an Eastern-European nuclear power plant.

Results on the share of fixed and variable unit costs associated with electricity-related activities of the company being analyzed correspond to the findings in the relevant literature on nuclear power plants' economics. Changes in the margin of safety of the company in recent years confirm that the observed reduction in the average selling price represents a considerable risk for the Hungarian power plant. Since the improvement of the load factor of the power plant is limited, to avoid the reduction of the margin of safety and to maintain a profitable operation, the Company should supervise its cost-structure and identify options for further cost reduction.

4.2. Limitations and further challenges

Examination of the impact of wholesale price reduction on operational performance of nuclear power plants by CVP analysis presented in this paper has serious limitations on the applicability of the results for decision making. Main limitations of the results relate to the assumptions of the composition of fixed and variable unit costs of nuclear power plants and to the assumptions of constant unit variable cost and constant unit prices for all levels of volume.

It is also important to note that the analysis presented in this paper is based on the publicly available annual reports of the company which means that availability of detailed subdivision of electricity-related costs could raise further the level of sophistication of the results and conclusions.

Finally, one case study does not guarantee generalization of results, for this a more detailed and comparative analysis of nuclear power plants' cost structure is needed.

References:

Andoura, S., Coeffe, P., & Dobbrostamat, M., *Nuclear Energy in Europe, Notre Europe. Policy Brief*, 2011, http://www.notre-europe.eu/media/pdf.php?file=Bref25-nuclear_energy-EN-web_01.pdf, Accessed: 04.11.2013.

Biermayer, P. & Haas, R., Aspekte der zukünftigen Kernenergienutzung, *Energie- und Umweltforschung* 53/2008

CEC, *Cost of Generation Model User's Guide Version 2 Based on Version of the Cost of Generation Model*, 2010, http://www.energy.ca.gov/2010publications/CEC-200-2010-002/CEC-200-2010-002.PDF, Accessed:07.09.2017.

Energinet, *Technology Data for Energy Plants*, Copenhagen: Danish Energy Agency, 2012

Fazekas, A. I., *Villamosenergia-rendszerek rendszerszintű tervezése* I. Budapest: Akadémiai Kiadó, 2006

Fisher, C., *Investment in low-carbon technology Role of nuclear energy*, 2013, http://ec.europa.eu/energy/nuclear/forum/meetings/doc/2013_05_30/day1/mrs_fisher_enef_2013.pdf, Accessed: 04.11.2013.

Gilbert, A., Sovacool, B. K., Johnstone, P., & Stirling, A., Cost overruns and financial risk in the construction of nuclear power reactors: a critical appraisal, *Energy Policy*, *102*, 2017, pp. 644-649.

GIF, Cost Estimating Guidelines for Generation IV Nuclear Energy Systems, 2007, https://www.gen-4.org/gif/upload/docs/application/pdf/2013-09/emwg_guidelines.pdf, Accessed: 18.09.2017.

Horngren, C. T., Foster, G. & Datar, S. M., *Cost Accounting*, London: Prentice Hall, 2000.

IAEA, *Operating experience with nuclear power stations in Member States in 2017*, 2017

Konstantin, P., *Praxisbuch Energiewirtschaft: Energieumwandlung, -transport und - beschaffung im liberalisierten Markt*, Berlin: Springer, 2007

OECD-NEA, *The Economics of Long-term Operation of Nuclear Power Plants, 2012,* http://s538600174.onlinehome.fr/nugenia/wp-content/uploads/2014/02/7054-long-term-operation-npps3.pdf, *Accessed:11.10.2017.*

Poncelet, J.-P., *Report WG Opportunities, Presentation*, 2013, 8th ENEF Plenary Meeting, 30-31. May 2013, http://ec.europa.eu/energy/nuclear/forum/meetings/doc/2012_05_14/presentations/status_report_on_wg_opportunities_enef_bratislava_2012.pdf, Accessed: 04.11.2013.

EC, *Communication from the Commission to the Council and to the European Parliament, Nuclear Illustrative Programme*, 2007, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0844:FIN:EN:PDF, Accessed: 13.11.2013.

ENEF, *Strengths – Weaknesses – Opportunities – Threats (SWOT) Analysis, Part 1: Strengths & Weaknesses*, 2010, http://ec.europa.eu/energy/nuclear/forum/opportunities/doc/competitiveness/swot-report-part1--final.pdf, Accessed: 13.11.2013.

ENEF, *The contribution of nuclear power to EU 2030 energy and climate strategy*, 2013, ENEF/WG Opportunities/Competitiveness, http://ec.europa.eu/energy/nuclear/forum, Accessed: 11.11.2013.

Euroconfluences, *The European Files: Security of Energy Supply in Europe: Continuous Adaptation*, 2011, http://www.euroconfluenes.com, Accessed: 13.11.2013.

IEA, *Energy Technology Perspectives, PPT-slides*, 2012, http://www.iea.org, Accessed: 12.11.2013

IEA, *World Energy Outlook*, 2011, http://www.iea.org, Accessed: 12.11.2013.

IEA-NEA, *Technology Roadmap, Nuclear Energy*, http://www.iea.org/roadmaps, 2010, Accessed: 04.11.2013.

IEA-NEA, *Projected Costs of Generating Electricity*, 2015, http://www.oecd.org/publishing/corrigenda, Accessed: 13.10.2016.

Kíyar, D. & Witteneben, B. F., *Nuclear Energy in the European Union after Fukushima: Political and Economic Considerations*, CESifo DICE Report 3/2012, http:// www.cesifo-group.de/DocDL/dicereport312-forum2.pdf, Accessed: 12.11.2013.

MAVIR, *A magyar villamosenergia-rendszer (VER) 2015. évi adatai*, 2016, https://www.mavir.hu/web/mavir/a-magyar-villamosenergia-rendszer-statisztikai-adatai, Accessed: 11.10.2017.

NEA, *NEA News*, 2013, Vol. 31, No. 1, http://www.oecd-nea.org/nea-news/, Accessed: 12.11.2013.

Pintér, É. & Bélyácz, I., *Vállalati pénzügyek*, Pécs: PTE KTK, 2005.

Prognos (2009): *A Renaissance of Nuclear Energy?*, http://www.prognos.com/Publications.520.0.html, Accessed: 12.11.2013.

Rothwell, G. *Economics of nuclear power*, New York: Routledge, 2016

Schneider, M., Froggatt, A., Hosokawa, K., Thomas, S., Yamaguchi, Y., Hazemann, J., *The World Nuclear Industry Status Report 2013*, https://www.worldnuclearreport.org/The-World-

Nuclear-Industry-Status-Report-2013-HTML.html, Accessed: 19.04.2017.

Srinivasan, T. N. & Rethinaraj, TS G. Fukushima and thereafter: Reassessment of risks of nuclear power, *Energy Policy*, 52, 2013, pp. 726-736.

WEC, *The Role of Nuclear Power in Europe*, 2007a, http://www.worldenergy.org, Accessed: 12.11.2013.

WEC, *Nuclear Energy – Status and Outlook*, 2007b, http://www.worldenergy.org, Accessed: 12.11.2013.

WEC, *World Energy Issues Monitor 2017*, 2017, http://www.worldenergy.org, Accessed: 12.04.2017.

Thomas, S., The Economics of Nuclear Power: An Update, Heinrich-Böll-Stiftung, European Union, Brussels, 2010.

van der Zwaan, B., Prospects for nuclear energy in Europe, *International Journal of Global Energy Issues*, Vol.30, No.1/2/3/4, 2008, pp.102 – 121.

WEC, *World Energy Resources*, 2013, http://www.worldenergy.org, Accessed: 12.11.2013.

WNA, *Nuclear Power Economics and Project Structuring*, 2017, http://world-nuclear.org, Accessed: 21.04.2017

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