Impact of price regulation methodology on the managerial decisions of the electricity DSO

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Abstract **Electricity distribution network companies' activities and managerial decisions depend substantially on the applied regulatory methodology. The impact of different regulatory methodologies on different results like security of supply, investors' attractiveness and network tariffs level has been evaluated. The rate of return method has been used for the regulation of the electricity network tariffs in Estonia since 2004. The results of 10-year regulation period have been evaluated in comparisons to other methods available.**

Index Terms **Economics, power distribution, power system management, power system reliability**.

I. Introduction

Electricity distribution network companies' activities and managerial decisions depend substantially on the applied regulatory methodology. In this article, the impact of different regulatory methods on the strategic priorities of the companies with the aim of finding the best methodology for the main strategies that a distribution network company may have, are evaluated.

Some of the previous studies have assessed the impact of quality regulation on investment decisions [1] or have looked at the financial risks associated with performance based regulations [2] [3]. Up to now there seems to be a very limited number of studies exploring connections between a regulatory method and the managerial decisions of distribution network companies.

II. Methodology of Price Regulation

Price regulation methods [4] [5] can be divided into four categories: Price cap, Revenue cap; Rate of return and Long Run Average Incremental Cost Bottom Up (LRAIC BU). Pedell [6] has described all these three methods. Several sources as Green and Pardina [7], Netz [8], Armstrong and Sappington [9], Alexander et al. [10], Hertog [11], Joskow [12] [13] have described Price Cap and Rate of Return methods. The impact of regulatory practices have been described in a number of articles and regulators' reports [14] - [18].

If the pure rate of return method is used, then the risks associated with controllable and uncontrollable costs are covered, or in other words, the company has no risk associated with the costs. This method allows the company to apply for a tariff adjustment as soon as the price is not based on the costs of the company any more. Quite the contrary, pure *price cap* method leaves all these risks to be covered by the company and leaves options for the company to decide how to eliminate those in different ways. The only difference of the revenue cap is the elimination of sales volume risk.

The price cap method presumes that if the company can manage more efficiently on its own, it can earn extra profits, and also *vice versa*: if the company does not fulfil the expectations set by the regulator or manages less efficiently, its profit will be lower and it cannot earn profit agreed by the regulator.

The basis of the *price cap* method is fixing of prices for a certain time period. Doing so, the time period must be chosen long enough to guarantee that the company can reach the expected efficiency. On the other hand, the time period should not be too long in order to avoid high risk of forecasts. Each year the prices are adjusted in accordance with inflation and factor x, which reflects the cost efficiency target, or in other words, prices should not increase faster than inflation minus the efficiency goal x.

According to the (LRAIC BU) or hypothetical network model, an ideal network is modelled assuming that the most modern and optimal technological solutions for the network configuration to supply all customers with highest quality standards is used. In case of a distribution network, it should be modelled considering the geographical location of consumers and producers and with inputs from the transmission network. The distribution network is then configured as an ideal system and is assumed to be built in the most economical way to guarantee the supply of existing customers. It is assumed that the most economical solution is applied and the network is built as a Greenfield project.

All in all, the challenge in application of different regulatory methods for DSOs often comes back to the "management of strategic gaming" [19]. Each method triggers different economic actions from companies and regulators. Even in the most advanced British utility regulation one can

observe constant urge to find better regimes for the companies concerned [20] [21].

Since detailed sector-specific regulatory rules were introduced in Estonia in 2002 [22], the authors of the present article have more than 10 years of experience in the application of the described regulation methods. For 10 years the rate of return method has been used in Estonia for price regulation of distribution network companies [23] - [25]. In Figure 1 we can explore the actual return on capital[1] for four largest network companies in Estonia (Elering, Elektrilevi, Imatra Elektrivõrk and VKG Elektrivõrk[2]) and it has been compared with the WACC applied by the regulator [26]. As one can see from the results, the network companies have usually not reached the WACC level applied by the regulator. During its 10 years of existence the largest distribution Network Company Elektrilevi has never reached the WACC applied by the regulator, its actual result has always been below the expected level. The RoR implemented in Estonia differs from the classical type of RoR. The costs included to the tariffs are not based on historical cost base and the regulator is actively demanding implementation of cost saving measures: incl. reducing of energy losses, saving on operational costs, etc. The outcome clearly indicates that the RoR implemented in Estonia does not guarantee the required return.

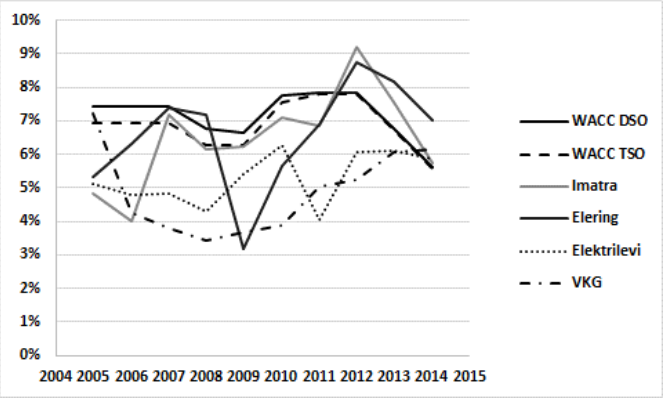

Figure 1. Return on capital of Estonian electricity network companies

III. Method for Assessment of Regulatory Methodology

Each regulatory method triggers a different logic of the managerial decisions taken by network companies. In the following sub-chapters one can find a comparison of the impacts assessed from the company's management perspective - how they would prioritise their activities and strategy having in mind different incentives provided by different methods.

Different methods for assessment of regulatory methodology were analysed. As it became clear to the authors that it would be impossible to provide reasonable impact assessment of regulatory methodology in monetary or technical terms without speculative assumptions, the assessment was carried out as an expert opinion of the authors on 5-point Linkert scale. The authors had to find a consensus in score in order to be approved. For each grade the rationale of the assessment discussed by the authors is also added.

Although this method is based on the authors' subjective judgements, it was considered to be the only appropriate way forward. The subjectivity is decreased by the fact that the authors represent opponent parties of the regulation. The assessments represent their long experience as practitioners in the energy sector in Estonia. As all the previously described regulatory methods have been applied in different sectors in Estonia, the assessments are based on the real practical experience.

The relevant managerial decisions of a network company can be divided into three wider groups as follows:

1) The Quality of Network Service presented in table 1
2) Cost of Network Service to Society presented in table 2
3) Risks of owners and lenders presented in table 3

On the basis of the method and criteria described above one can assess the impact of the different regulatory methods. In tables 4 to 7 the assessments of impact of regulatory methods on the managerial decisions of a power network company are described.

TABLE 1. Criteria for Assessment of the Quality of Network Services Scores

	1	2	3	4	5
Security of Supply level	Level decreases substantially	Level decreases	Current level remains	Level increases	Improvements faster than the level agreed on
Quality of Customer Service	Level decreases substantially	Level decreases	Current level remains	Level increases	Improvements faster than the level agreed on
Readiness to manage disruption crises	Very low, lack of needed financial and human resources	Below average	Average, needed financial and human resources are covered partly	Above average	High, sufficient financial and human resources are available
Long-term investments	Only critical investments are carried out to retain minimum standards	Below average	Sufficient investments in infrastructure, but not in technological development of the network	Above average	Investments are made as agreed, including also investments in innovative solutions
Stability of construction market	Investment volumes stable for 1-2 years	Below average	Investment volumes stable for 5 years	Above average	Investments volumes stable for 10 years

[1] Return on Capital is calculated on the basis of book records. Operating profit is divided by the sum of residual value of capital assets and working capital. The amount of working capital is used in calculations as 5% of the annual revenues.

[2] Elering is the TSO; Elektrilevi, VKG Elektrivõrk and Imatra Elektrivõrk are three largest DSOs in Estonia, with market shares of 87,3%; 3,0% and 2,7%.

TABLE 2. CRITERIA FOR ASSESSING NETWORK SERVICE TO SOCIETY

Score	1	2	3	4	5
Price Level	Highest price level	Slightly higher price	Average price level	Slightly lower price level	Lowest price level
Attractive-ness of the country for investors	Lowest level	Low level	Average level	High level	Highest level of attractive-ness
Admi-nistrative burden	The highest	High	Average	Low	The lowest

TABLE 3. CRITERIA FOR ASSESSING RISKS FOR LENDERS AND OWNERS

	Score				
	1	2	3	4	5
Risk of un-controllable costs and sales volume	Very high	Above average	Average	Below average	Very low
Objective regulatory lag	Very high risk	Above average risk	Average risk	Below average risk	Very low risk
Subjective regulatory lag	Very high risk	Above average risk	Average risk	Below average risk	Very low risk
Underinvestment risk	Very high	Above average	Average	Below average	Very low
Overinvestment risk	Very high	Above average	Average	Below average	Very low

TABLE 4. ASSESSMENT OF IMPACT OF PRICE CAP METHOD

Criteria	Score	Rationale for Score
Level of Security of Supply	2	Realisation of risks of increase of uncontrollable costs brings along a decrease of the operating costs; it may happen most promptly and influence first and foremost the maintenance and repair costs and investments in the network. Therefore the security of supply would be lower.
Quality of Customer service	3	As long as the company has a strong incentive to reduce its costs to raise its profit, the quality of customer service remains the same (if there is some inefficiency in the management) or decreases (by curtailing of existing services: e.g. reducing the number of people in call-centres extends the waiting time there).
Readiness to disruption crises	2	In order to increase efficiency the reserves of appliances are reduced; it makes the crises management more difficult.
Interest of the network company to carry out long-term investments	2	As long as there is some inefficiency in the management of a company, there is no impact on its long-term investments. However, when a company has reached a high level of effectiveness, the RPI-x can be only reached at the expense of long-term investments.
Stability of construction market	3	Realisation of risks of increase of uncontrollable costs brings along some reduction of investments (e.g. by restraining of works, prorogation to the future, etc.); that in turn restrains the construction market and makes the investment climate worse.
Price level to consumers	5	Price Cap should in principle give a lower price increase than RPI (however, if the investments exceed depreciation or the costs are evaluated inadequately, the regulator can also apply RPI+x in some cases,).
Attractiveness of the country to investors	3	As long as the company covers all the costs associated with connecting to the network, the cost for connection is high and attractiveness for investors low. Still, a presumed decrease of the network price can be attractive for some investors.
Administrative burden for the company	4	As the prices are adjusted for a fixed period (3-5 years), the administrative burden is rather low.
Risk of un-controllable costs and sales volume	1	All uncontrollable risks are borne by the company.
Objective regulatory lag	1	The price is fixed for a long period on the basis of the historical data: the Regulator sets the price for the following 5 years on the basis of the data from the previous full year.
Subjective regulatory lag	5	Fixed regularity, the risk is low.
Underinvestment risk	2	Strong pressure to reduce costs may lead to a decrease in the required investments.
Overinvestment risk	5	Constant requirement to reduce the costs limits the capability to invest.

TABLE 5. ASSESSMENT OF IMPACTS OF REVENUE CAP METHOD

Criteria	Score	Rationale for Score
Level of Security of Supply	3	Cost-effective network company can reduce its costs only at the expense of long-term investments, that hinders improvements in security of supply in long-term. Hedged risks help to keep the existing level of security of supply.
Quality of Customer service	4	As long as the company has a strong incentive to reduce its costs to raise its profit, the quality of customer service remains the same (if there is some inefficiency in the management) or decreases (by curtailing of existing services). Lower risk due to hedging of some associated risks.
Readiness to disruption crises	3	To increase efficiency the reserves must be reduced. Still, partly hedged risks provide possibilities to keep larger „hot reserve“ of appliances.
Interest of the network company	3	As long as there is some inefficiency in the management of a company, there is

to carry out long-term investments		no impact on its long-term investments. However, when the company has reached a high level of effectiveness, the RPI-x can be only reached at the expense of long-term investments.
Stability of construction market	4	Stable for 3-5 years, but during the regulatory period some changes in investment volumes may occur and that may impact the network construction and maintenance price and quality. A complicated situation from the partners' point of view (no long-term stability).
Price level to consumers	4	Revenue Cap should in principle give a lower price increase than RPI (however, if the investments exceed depreciation or the costs are evaluated inadequately, the regulator can also apply RPI+x in some cases).
Attractiveness of the country to investors	3	As long as the company covers all the costs associated with connecting to the network, the cost for connection is high and attractiveness for investors low. Still, a presumed decrease of the network price can be attractive for some investors.
Administrative burden for the company	4	As majority of the factors are fixed, the administrative burden is rather low. However, to compensate hedged risks the company has to keep the regulator constantly informed during the regulatory period and therefore the level of administrative burden is higher compared to Price Cap method.
Risk of un-controllable costs and sales volume	3	All uncontrollable risks are borne by the company, sales volume risk is hedged.
Objective regulatory lag	2	The price is fixed for a long period on the basis of the historical data: the regulator sets the price for the following 5 years on the basis of the data from the previous full year.
Subjective regulatory lag	5	Minimal, fixed regularity for adjustments.
Underinvestment risk	3	Strong pressure to lower costs may lead to a decrease in the required investments. Still, the risk is somewhat lower compared to Price cap method as far as some operating cost risks are hedged.
Overinvestment risk	5	Constant requirement to reduce the costs limits the capability to invest, the risk is low.

TABLE 6. ASSESSMENT OF IMPACTS OF RATE OF RETURN METHOD

Criteria	Score	Rationale for Score
Level of Security of Supply	4	Cost based price guarantees the changes of security of supply at the agreed pace.
Quality of Customer service	5	As long as company must reduce its costs, the quality of customer service remains the same (if there is some inefficiency in the management) or decreases (by curtailing of existing services). Lower risk due to hedging of associated risks.
Readiness to disruption crises	4	Reserves are kept as agreed with the regulator.
Interest of the network company to carry out long-term investments	4	Cost based price guarantees the development of the network at the agreed pace. The agreement on the allowed rate of return is the key to succeed.
Stability of construction market	5	Regular fixing of prices keeps the construction market stable.
Price level to consumers	3	In accordance with the agreed level of security of supply and customer service.
Attractiveness of the country to investors	3	As the company covers partly the costs associated with connecting to the network, the cost for connection is average and attractiveness for investors medium.
Administrative burden for the company	3	Regular adjustments (subject to the company's initiative for the price adjustment) make a medium administrative burden.
Risk of un-controllable costs and sales volume	4	Delays in adjustments are possible both by the regulator and the company.
Objective regulatory lag	4	As the price is not fixed for a long period (a potential 2-3 years' time lag still remains, as the price is set on the basis of the previous full year data), the risk is substantially lower compared to the other methods.
Subjective regulatory lag	2	Unlike the other methods there is no agreed time set – a company can apply for price adjustments any time. Possible delays by the regulator due to the bureaucracy or unwillingness to make unpopular decisions.
Underinvestment risk	4	As the regulation is strictly cost based, the risk of underinvestment is fairly low.
Overinvestment risk	3	Depends on the owner: if the owner is the state or a municipality, then the owner is also interested in the quality of the service; that is not always the case with private owners.

TABLE 7. ASSESSMENT OF IMPACTS OF LRAIC BU METHOD

Criteria	Score	Rationale for Score
Level of Security of Supply	1	If the modelled price is too low, then the company retrenches to survive. If the price is higher, then the company can maximise its short term profits by cutting the costs. This has a long-term negative impact to all selected indicators.
Quality of Customer service	1	
Readiness to disruption crises	1	
Interest of the network company to carry out long-term investments	1	
Stability of construction market	1	No stability as due to the cost-cutting only indispensable investments are made.
Price level to consumers	3	Stable as an ideal network does not change much, adjustments are only due to inflation.
Attractiveness of the country to investors	2	As long as the company covers all the costs associated with connecting to the network, the cost for connection is high and attractiveness for investors low.
Administrative burden for the company	1	Very complicated and demanding calculations. Ideal network requires permanent adjustments due to the changes in the network configuration.

Risk of un-controllable costs and sales volume	1	All uncontrollable costs and the sales volume risks are borne by the company.
Objective regulatory lag	1	Computing model calculates the theoretical costs required and the difference with the actual costs can be substantial.
Subjective regulatory lag	5	Fixed regularity, the risk is low.
Underinvestment risk	1	High risk of underinvestment as the company lacks a motivation to improve security of supply.
Overinvestment risk	5	Computing model defines the limits for investments, the risk is minimal.

IV. SELECTION OF THE PREFERRED REGULATORY METHOD

Selection of a regulatory method depends on the priorities of the government. Depending on the development stage of the electricity network, the priorities of the state may be either increasing the network quality, aiming for the lowest network tariffs to society, or providing low risks for the owners and lenders. Table 8 below describes overall results of the assessment carried out in Chapter 3; it can be as a basis for the selection of the regulatory method for policymakers.

TABLE 8. AVERAGE SCORES OF THE ASSESSMENT PER METHOD

	Price cap	Revenue cap	Rate of Return	LRAIC bottom up
Quality of Network Service	2.4	3.4	4.4	1
Cost of Network Service to Society	4.3	3.7	3	2
Risk of Owners and Lenders	2.8	3.6	3.4	2.6

The data in Table 8 provide grounds for a number of important conclusions:

- If the priority is to raise the quality of network, then the Rate of Return method appears to be the most suitable approach;
- In order to prioritise the low network tariffs to society, policymakers should select Price Cap method;
- In order to attract new owners and lenders to the network business, Rate of Return and Revenue Cap methods appear to be equally attractive approaches;
- To balance all these aspects, the Rate of Return method seems to be the most appropriate solution for a long term policy selection for the electrical networks regulation;
- LRAIC regulatory method seems not to be an attractive solution for the power distribution businesses.

However, it should also be noted that for the sake of a long term stable investment climate of the network business, it is advisable to avoid frequent changes of the regulatory methods. Frequent changes of regulatory methods may ruin the attractiveness of any investment in the energy sector [27]. Therefore the Rate of Return method has a clear advantage also in terms of the stable investment climate.

In order to double-check the outcome of the analysis we have also audited the impact of the Rate of Return method on Elektrilevi OÜ, the largest electricity network company in Estonia. The company is 100% owned by Eesti Energia AS, which in turn is 100% owned by the Estonian Government. The main objective of the government has been to maintain stability of the price of the network services while increasing the quality of the network. The increase of the value or attractiveness of the company has not been a priority for the government.

Figure 2 presents the changes of the electricity supply security indicator SAIDI[3] in Elektrilevi OÜ from 2007 to 2013. The calculations of SAIDI do not take into account the impact of occasional weather impacts.

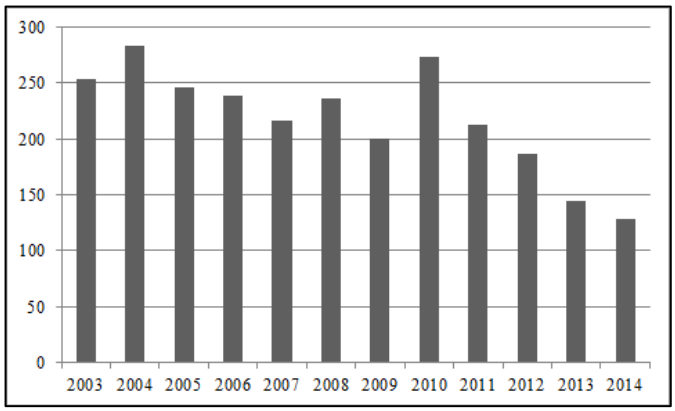

Figure 2. Changes in network quality indicator SAIDI in Elektrilevi OÜ

Graph 3 presents the network tariff and the rate on capital of Elektrilevi OÜ[4] in the timeframe of 2005-2014, adjusted to the changes of Consumer Price Index [28].

As it can be seen from Graph 2 and 3, the Rate of Return method has enabled improvements in the quality of the network services while the network tariff has remained stable for the customers and the company has earned reasonable returns on their investments. So the main objectives of the government as the owner of the utility and developer of the attractive utility services have been achieved.

[3] System Average Interruption Duration Index - the average outage duration for each customer served

[4] The network tariff of Elektrilevi OÜ is excluding the costs for transmission. The cost of transmission is excluded due to the fact, that this is a non-controllable cost for the company.

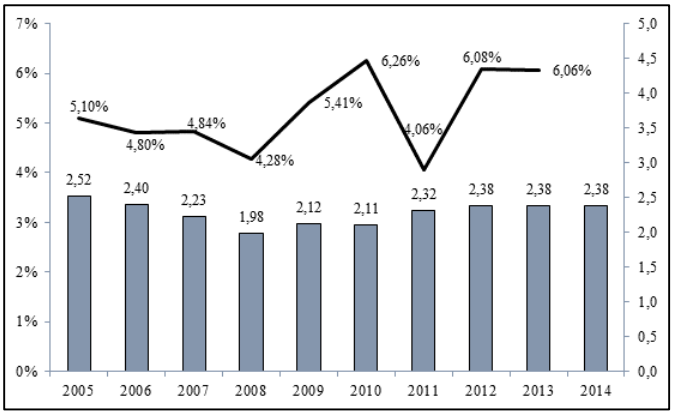

Figure 3. CPI adjusted price and return on capital of Elektrilevi OÜ services during from 2005 to 2014

V. CONCLUSIONS

The aim of the article was to analyse the impact of different regulatory methods of the electricity network companies on their strategic managerial decisions and to provide some advice for finding the most efficient method to reach the objectives of the network business. The analyses have been made by using the experience of regulation of distribution networks in Estonia. Four regulatory methods were analysed: price cap, revenue cap, rate of return and LRAIC BU. The managerial decisions analysed were divided into the network quality, cost of network service to society and the risk level for the owners and lenders.

As a result of the analysis and based on Estonian experience the Rate of Return method was assessed to be the best method for long term objectives. The impact of Rate of Return method was also controlled against the overall results of the activities of Elektrilevi OÜ, the largest distribution company of Estonia, where one can observe improvements in the quality of the network services while the price of the network service remained stable and its profit of the utilities was in an expected range.

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