REGULATION OF ELECTRICITY DISTRIBUTION BUSINESS

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ABSTRACT

This paper focuses on the regulation of electricity distribution business. First, regulation principles of natural monopolies are discussed in general level. Second, different methods used to regulate the electricity distribution business in some European countries are introduced. Third, regulatory models used in Finland, Norway and Sweden are discussed in detail. The roles of efficiency benchmarking and power quality in regulation in these three countries are also briefly presented.

INTRODUCTION

The key driving force of the electricity market deregulation in Europe has been to promote the competitiveness of European Union Member States' economies. In the early 1990s, electricity prices of industrial customers in Europe were approximately 40 per cent higher than the corresponding prices in the U.S. (EC 2000). Unlike in the U.S., electricity market deregulation in Europe has been governed by a common legislative framework. Deregulation has been successful in the sense that industrial customers have experienced an overall decrease of the electricity prices over the last decade.

Directive 96/92/EC given in 1996 set the common guidelines for the internal market in electricity. The goal was to introduce competition in generation and supply of electricity where as transmission and distribution of electricity were to remain natural monopolies. By the end of 1990s it was concluded that the implementation of the internal market in electricity should be accelerated. The goals set to the legislative work were, for example, to strengthen the separation of generation and supply from transmission and distribution, to ensure non-discriminatory access to networks, and to ensure that national regulators of each Member State have the same minimum set of competences (EC 2000).

According to EU legislation (Directive 2003/54/EC), national regulatory authorities are to *ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective*. In addition, the directive further states that *the distribution system operator shall maintain a secure, reliable and efficient electricity distribution system in its area with due regard for the environment*. And finally, distribution tariffs should be sufficient to *allow the necessary investments in the networks to be carried out in a manner allowing these investments to ensure the viability of the networks*.

GOALS OF REGULATION

Natural monopolies have traditionally been subject to regulation because they pose risks to the society by accruing excess profits and costs at the expense customers dependent on their services (Agrell & al. 2000). Creating an efficient business environment in electricity distribution by regulation is a challenging task because of the nature of the industry. As Vogelsang (2002) points out, capacity costs are the electricity distribution industry's paramount cost factor, while the services are non-storable. Regulation thus faces a problem of finding the balance between optimal capacity expansion, which requires cost-coverage and stable signals, and optimal capacity utilisation, which requires fluctuating prices (Vogelsang 2002).

The aim of regulation can be seen as to provide distribution companies with incentives to improve their investment and operating efficiencies and to ensure that also customers benefit from the efficiency gains (Jamasb & Pollit 2000). In addition, regulation should be acceptable to regulated companies and maximise the overall social welfare by promoting efficient operation (Kopsakangas-Savolainen 2002). In electricity distribution business common forms of regulation are rate-of-return regulation and price regulation.

Rate-of-return regulation provides the regulated companies with sufficient incentives for capacity expansion. Indeed, the studies of Averch and Johnson (1962) point out that the rate-of-return regulation even creates incentives for overcapitalisation, which actually seems to have been the case in the Scandinavian distribution industry prior to deregulation (Agrell & al. 2000). However, the rate-of-return regulation does not give incentives for cost reductions unless there is some form of efficiency benchmarking connected to it. In price regulation, incentives for cost reductions are built-in features but the method does not necessarily account for capacity expansion.

INCENTIVE REGULATION

A common approach to regulation in electricity distribution business is a so called incentive regulation, which by Vogelsang's (2002) definition means that the regulator delegates certain pricing decisions to the regulated companies who can then reap profit increases from cost reductions. Incentive regulation, including price cap, rate moratoria, profit sharing, banded rate-of-return, menus and yardstick regulation, makes use of the regulated companies' information advantages and profit motives (Vogelsang 2002). Distribution companies themselves have the best knowledge of their opportunities to cut costs and incentive regulation encourages them to carry out the possible cost reductions.

Price cap regulation

In price cap regulation the prices of regulated services are adjusted annually by an inflation factor, an X-factor that reflects efficiency improvements, and a Y-factor that allows for pass-through of specific cost items outside of the company's control (Vogelsang 2002). For example, the excess costs of losses are often allowed to pass-through to distribution tariffs because distribution companies have no control over the market price of electricity. Price caps are

determined for the whole regulatory period in advance. At the end of the regulatory period price caps are reviewed and adjusted for the next regulatory period. The X-factor is often obtained as a result of efficiency benchmarking and negotiations between the company and the regulator. The success of price cap regulation is due to its incentives for cost reductions, and freedom and incentives for price rebalancing (Vogelsang 2002).

In electricity distribution business one approach to achieve the freedom for price rebalancing has been to regulate the basket of services rather than the actual prices, which is considered to promote more efficient price structures (Vogelsang 2002). This approach is often referred to as revenue cap regulation.

Another special case of price cap regulation is rate moratoria. In this kind of regulation the X-factor is set equal to the rate of inflation and the Y-factor is set equal to zero (Vogelsang 2002). Under this regime the prices are kept constant over the regulatory period, which forces the regulated company alone to face the risks of external price shocks. This may threaten the company's viability.

Yardstick regulation

In yardstick regulation the allowed prices or revenues of a company depend on the performance of other companies. Yardstick approach is risky in the sense that the benchmarked company may operate in a different kind of environment than the yardstick company. For example, cost differences between the two companies may be explained by factors such as geology, climate, population density, local wage rates and taxes. In connection to other methods of regulation yardstick approach has been successfully used in cases where cost data has not been available. (Vogelsang 2002)

A special case of yardstick regulation is benchmarking based on a hypothetical efficient company (Vogelsang 2002). The optimal cost level for a regulated company is calculated through engineering economic analysis by defining a 'model' company, or 'model' network in the case of distribution business (CEPA 2003). A significant disadvantage of this approach is that it does not take into account the historical circumstances, which have led to the current situation. For example, the demand growth may have evolved in such manner that the 'model' network would actually have been more expensive to build and maintain than the existing network (CEPA 2003). Another disadvantage is that the efficient long-run costs for the regulated company are determined based on 'model' network and, therefore, they may not be adequate to cover even the company's fixed and common costs (Vogelsang 2002). This may threaten the company's viability.

The use of benchmarking based on a hypothetical efficient company, i.e. engineering economic approach, is often explained by the fact that there is not enough companies to perform yardstick benchmarking (Grifell-Tatjé and Knox Lowell 2003). In these cases the results are typically interpreted with caution and not applied directly to regulation (Dolader & al. 2003). Indeed, determining the values of distribution companies based on reference or fictitious networks might give rather controversial results.

Profit sharing, banded rate-of-return and menus

In profit sharing regulation customers directly take part in regulation. Excess profits or profit shortfalls earned by a company are dealt by ex post refunds or price reductions for future purchases. In banded rate-of-return regulation the regulated company is allowed to keep its excess profits and suffer profit shortfalls within a pre-specified band. Only rates of return below or above the band trigger have economical consequences, such as ex post refunds or price reductions for future purchases. Menus allow the regulated utility to choose among different incentive regulation plans. The choice may consist of combinations between price caps and profit sharing. (Vogelsang 2002)

ELECTRICITY DISTRIBUTION BUSINESS REGULATION IN PRACTICE

In several European countries the electricity distribution sector has undergone major changes during the past decade. Regulators have faced the challenge of developing regulatory models that meet the requirements of different interest groups: customers, distribution companies, investors and society.

1) From customers' point of view, the regulatory model should protect them from excess prices of monopoly services. In other words, customers dependent on monopoly services should not be overcharged and the quality of monopoly services should be sufficient. Acting according these principles requires that reasonable prices, the role of power quality in regulation and appropriate quality levels are determined explicitly.
2) From distribution companies' point of view, the regulatory model should give incentives for optimal capacity expansion and capacity utilizations, and it should treat distribution companies equally. The proper incentives are important in keeping the distribution networks in appropriate shape. To avoid conflicting incentives, the directing signals of regulation should be consistent with the general planning and operating principles of distribution networks.
3) From investors' point of view, the regulatory model should protect their rights by ensuring reasonable returns on investments. Regulation should not weaken the competitiveness and attraction of distribution industry. In order to fulfill this goal, emphasis has to be put on the methods used in defining regulatory asset bases, reasonable returns on equity and loaned capital, and the risks of distribution business.
4) From society's point of view, the costs of performing regulatory activities should be in relation with the presumable cost savings. The regulator should not have to interfere with minor company-specific details and the information required by the regulator should be relatively easy for the distribution companies to produce.

In developing regulatory models, the focus has often first been on promoting cost reductions, and on assuring that returns and/or prices are reasonable. As regulators have gained more information on distribution companies, they have been able to introduce incentive schemes dealing, for example, with power quality issues. This has often resulted in very complicated regulatory models, which may be difficult for interest groups to understand and accept. In some cases, simplicity might contribute to the acceptability of the models. Examples of regulation principles

and practices in some European countries are shown in Table 1. All these countries are subject to EU legislation either directly or through European Economic Area Agreement. Regulators are expected to allow distribution companies sufficient returns to cover the costs of capital, and to confirm in advance the methods used in determining regulatory asset base, reasonable operational costs and reasonable capital expenditure (Webster 2003).

Table 1. Overview of the regulation principles and practices in some European countries.

Country	**Regulation principles**	**Benchmarking/target**	**Supply quality adjustment**	**Regulatory asset base (rate-of-return)**
Finland	Ex-post rate-of-return regulation	DEA / Opex Eff. requirement: general 1,3 % from 2005	Average interruption time as an output-factor in DEA	Network replacement value (4,175 % 50/50 debt/equity ratio)
Norway	Ex-ante revenue cap regulation	DEA / revenue Eff. requirement: individual + general 1,5 %	Companies are given targets for interruption costs; if they fail to meet these targets, revenues are reduced and vice versa	Adjusted network book value (7,7 %)
Sweden	Ex-post/ex-ante revenue cap regulation	Reference network / revenue	Interruption times and frequencies affect allowed revenues	Network replacement value based on fictitious network
Denmark	Ex-ante revenue cap regulation	Network volume model / total costs Eff. requirement: individual + general 3 %		Network book value
Spain	Ex-ante revenue cap regulation	Reference network / revenue Eff. requirement: individual + general 1 %	Service quality is taken into account when composing reference networks	Reference network, that is corrected according to real network if the data from real network is available.
Netherlands	Ex-ante tariff regulation	DEA / revenue Eff. requirement: individual + general 1,5 %	Starting 2004 companies are given targets for interruption times and frequencies; if companies fail these target, revenues are reduced and vice versa	Standardised book value (5 % 60/40 debt/equity ratio)
Great-Britain	Ex-ante revenue cap regulation	COLS / Opex Eff. requirement: individual + general 3 % to revenue	Revenues are adjusted according to companies performances based on differences between target levels for interruption times and frequencies (max ± 1,75 % of the revenue) and customer services (max ± 0,125 %)	Network book value (6,5 %)

The experiences of regulation in Finland, Norway and Sweden

Finland, Norway and Sweden are often regarded as pioneers among countries with deregulated electricity markets. Full competition in electricity generation and supply exist in all three countries and they share a common pool for the wholesale of electricity. In addition, electricity distribution sectors in these countries have certain resemblances. For example, there are a large number of distribution companies of different sizes in each country. Also, within each of these countries the operational environments of distribution companies differ significantly from each other.

Due to the large number of distribution companies Finland, Norway and Sweden are often considered as countries in which sophisticated benchmarking methods, such as Data Envelopment Analysis, can be applied. Indeed, the efficiency studies have been successfully carried out in all three countries. The results have shown that in Nordic countries the monopoly status of distribution business has led to a disguised inefficiency rather than excess profits, which amounts to cost-savings (Agrell & al. 2000). An incentive regulatory approach, which takes into account the long-term interests of distribution companies and customers, has been considered necessary in order to prompt cost reductions (Agrell & al. 2000). Bearing in mind the similarities of distribution business in Finland, Norway and Sweden, these countries have adopted surprisingly different regulatory approaches.

Common operational frameworks have been successfully adopted in the deregulated parts of Nordic electricity markets, i.e. generation and supply of electricity. This raises a question whether similar regulatory approaches could adopted in the regulated part of the market as well. Similar regulatory regime would benefit distribution companies, service providers and manufacturers within the industry. Companies could then more easily transfer their cost-effective practices from one part of the market to the other parts. Large “home markets” might increase their competitiveness in the internal electricity markets in Europe.

Finland

Electricity distribution business regulation in Finland is currently being reviewed because the present rate-of-return regulation does not meet all the requirements of the EU legislation. Especially the requirement that regulator shall issue decisions on complaints in four months (Directive 2003/54/EC) would be impossible to achieve under the present regulatory regime.

The Finnish Electricity Market Act (386/1995) states that distribution pricing shall be reasonable and distribution companies shall operate efficiently. These two legislative requirements have been the key directing issues in forming the Finnish regulatory model. The reasonableness of distribution pricing is, by the regulator’s definition, evaluated ex post based on the rate-of-return. The cost-effectiveness is measured by efficiency benchmarking carried out by means of Data Envelopment Analysis (DEA). Regulatory period is one year and investigations are done only in cases where over-charging is suspected. There is no constrained profit sharing if the company is

found to have over-charged its customers. Instead, each customer has to make an appeal to court individually in order to get back the excess money he or she has paid to the distribution company.

DEA-model was first introduced for the efficiency benchmarking of Finnish electricity distribution companies in 2000 (Korhonen & Syrjänen 2000). Efficiency scores were originally meant to be used in determining the reasonable cost levels for each distribution company (Viljainen & al. 2002). However, there has been problems in applying them in price regulation. Power quality factor, which is included in the DEA-calculation, has been one of these problems. Some companies have had incentives to pay attention to power quality where as other have been able to neglect the issue completely (Lassila & al. 2003). In addition, large annual variations in DEA-scores have resulted in highly inconsistent directing effects for distribution business development. So far the regulator has used DEA-scores only if investigated companies have been found efficient and have been entitled to excess profits.

The new approach to distribution business regulation will continue to apply the rate-of-return regulation with efficiency requirements connected to it. The new regulation will enter into force in January 2005. The first regulatory period will cover years 2005-2007. The regulator will calculate annual profits during the regulatory period but no decisions are made based on these. Instead, the reasonableness of distribution pricing during the regulatory period is evaluated as a whole. All distribution companies are subjected to regulation, i.e. regulation no longer focuses randomly on just some specific companies. There will also be elements of profit sharing connected to the new regulation. In cases of over-charging distribution companies are obliged to return the excess profits to customers, e.g. by future price reductions. Similarly, windfall losses may transfer into the next regulatory period.

In the new regulatory model the regulator sets limits to different cost items of distribution business; operational costs, depreciations and return. In practice this means that also the revenues of distribution companies are limited to some extent. During the first regulatory period there will be only a general efficiency requirement, which is the same for all distribution companies. Later there will probably be individual efficiency requirements as well. DEA-model will probably be used for efficiency benchmarking in the future but not necessarily in its present form.

Norway

Electricity distribution business in Norway is regulated by means of incentive regulation. The regulatory approach is revenue cap regulation with individual X-factors. The market price of electricity represents the Y-factor, i.e. the changes in electricity prices are allowed to pass-through to distribution tariffs.

When calculating the base revenues, the initial costs of losses are approximated based on the average costs of losses during the previous regulatory period. These costs are then adjusted annually according to actual losses and the market price of electricity. Operational costs, maintenance costs and depreciations of the previous regulatory period are used in determining the base year's revenues. General efficiency requirement is derived from the forecast growth of productivity. Individual X-factors for distribution companies are determined based on efficiency benchmarking carried out by means of Data Envelopment Analysis (DEA). The results of

efficiency benchmarking are applied with caution, i.e. companies are not expected to reach the efficiency frontier during one regulatory period. (Grammeltvedt 2003)

Power quality issue is dealt by taking it into account in determining allowed revenues. If distribution company fails to meet its individual power quality target, i.e. actual interruption costs exceed the expected interruption costs, its allowed revenue is reduced by an amount equal to their difference. Power quality factor is also included in the DEA-model.

The Norwegian regulatory system has elements of the banded rate-of-return regulation because the regulator defines the minimum and maximum return of capital calculated based on the book value of network assets. Each distribution company is entitled to at least 2 % return on capital but the return may not exceed 20 % (Grammeltvedt 2003). These lower and upper limits form a band monitored by the regulator. Windfall profits that exceed the maximum return on capital have to be returned to customers by means of future price reductions. Similarly, windfall losses justify excess profits in the future.

Sweden

Sweden uses yardstick regulation with benchmarking based on a hypothetical efficient company in electricity distribution business regulation; an approach called Network Performance Assessment Model (NPAM). The model uses engineering economic analysis to form a so called fictitious network for each distribution area. Reasonable operational costs, depreciations and returns are calculated on the basis of cost-effective operation of fictitious networks, i.e. allowed revenues are based on fictitious networks.

Power quality is included in NPAM calculations. For each company, the allowed revenue is reduced if its actual interruption costs are greater than the expected interruption costs. The reduction is equal to the difference between actual and expected interruption costs.

There are some problems concerned with the use of NPAM. For example, the model determines regulatory asset values based on the fictitious networks, which means that reasonable depreciations then reflect annual investment needs of fictitious networks. These may not always be enough to keep the existing networks in shape. Similarly, reasonable operating and maintenance costs calculated based on fictitious networks may not be sufficient for the existing networks. This means that distribution companies may not be able to operate, maintain and develop their networks. The failure in any these tasks will eventually lead to impaired reliability of distribution networks.

Summary of the Nordic regulatory models

Of those Nordic countries studied in this paper, Norway has adopted a common form of incentive regulation, i.e. the revenue cap regulation. Incentives for cost reductions are built-in features in such approach. To further strengthen these incentives, the Norwegian regulator sets both general and company-specific efficiency targets for distribution companies. Efficiency benchmarking is carried out by means of DEA. To avoid the problem of declining power quality as a result of cost

reductions, distribution companies are also provided with incentives to take care of the power quality. Despite of the possible efficiency and power quality related adjustments on the revenues, the viabilities of distribution companies are not threatened because of regulation because they are always entitled to at least 2 % return on capital.

Sweden uses yardstick regulation with benchmarking based on a hypothetical efficient company in distribution business regulation. Allowed revenues of distribution companies are defined based on cost-effective operations of fictitious networks. These fictitious networks are designed to meet today's demand and do not take into account the future demand growth for which the distribution companies have to be prepared. The revenues determined based on the fictitious network may not be sufficient for distribution companies to operate, maintain and develop their existing networks. This may cause problems in power quality, e.g. increase the number of interruptions experienced by customers. In addition, the viabilities of distribution companies may be threatened under this kind of regulatory regime.

The Finnish regulator uses rate-of-return approach in distribution business regulation. This type of regulation as such gives incentives for over-capitalisation rather than for cost-effective operation. Therefore, the regulator has found it necessary to define reasonable costs and set incentives for cost reductions. In addition, the regulator also sets limits to depreciations and returns. Reasonable levels of cost items are derived based on actual costs, which mean that viabilities of distribution companies are not severely threatened because of regulation.

CONCLUSIONS

Regulation of natural monopolies is a challenging task. Regulators face the problem of providing appropriate incentives for optimal capacity expansion and capacity utilisation. Incentive regulation is often considered as an efficient regulatory tool to handle the problem and it is widely applied in several European countries. However, the exact regulation methodologies differ from one country to another. This might slow down the development of a truly open market space in electricity.

Harmonisation of regulatory practices in the Nordic level might bring new business opportunities for distribution companies operating in these countries. Efficiency benchmarking could then be done on international basis and the use of larger reference groups might contribute to the reliability of the results. From customers' point of view this would mean steady behavior of distribution prices from one year to another. Stable business environment might also make it easier to attract investments to electricity distribution business. At best, regulation can contribute to price decreases and the improvement of supply quality. It can also play a role in boosting electricity distribution markets.

REFERENCES

Agrell, P., Bogetoft, P. and Tind, J. (2000), Multi-period DEA Incentive Regulation in Electricity Distribution. Discussion Paper 2000-13, Centre for Industrial Economics, University of Copenhagen.

Cambridge Economic Policy Associates, CEPA (2003), Background to Work on Assessing Efficiency for the 2005 Distribution Price Control Review.

Directive 2003/54/EC, Official Journal of the European Union, No L 176.

Directive 96/92/EC, Official Journal of the European Union, No L 027.

Dolader, J., Maqueda, L. and Candela, A. (2003), Remunerating Distribution in Spain, CIRED – 17th International Conference on Electricity Distribution, Barcelona.

European Commission, EC (2000), Green Paper – Towards a European strategy for the security of energy supply, Brussels.

Finnish Electricity Market Act (386/1995)

Grammeltvedt, T. E. (2003), DEA-analysis – Can They Be Used in Regulation? Pros and Cons from Five Years' Experience in Norway, Proceedings – Market Design 2003 Conference, Stockholm.

Grifell-Tatjé, E. and Knox Lowell, C.A. (2003), The Managers versus the Consultants, The Scandinavian Journal of Economics, Vol. 105, No. 1.

Jamasb, T. and Pollit, M. (2000), Benchmarking and Regulation of Electricity Transmission and Distribution Utilities: Lessons from International Experience, University of Cambridge.

Kopsakangas-Savolainen, M. (2002), A Study on the Deregulation of the Finnish Electricity Markets, University of Oulu, ISBN 951-42-6613-7.

Korhonen, P. and Syrjänen, M. (2000), Data Envelopment Analysis (DEA), Energiamarkkinaviraston julkaisuja 1/2000. (in Finnish)

Lassila, J., Viljainen, S., Honkapuro, S. and Partanen, J. (2003), Data Envelopment Analysis in the benchmarking of electricity distribution companies, CIRED – 17th International Conference on Electricity Distribution, Barcelona.

Viljainen, S., Lassila, J. and Partanen, J. (2002), Developments of the regulatory model of the electricity distribution business in Finland, IEEE Postgraduate Conference on Electric Power Systems, Budapest, ISBN 963420725-1.

Vogelsang, I. (2002), Incentive Regulation and Competition in Public Utility Markets: A 20-Year Perspective, Journal of Regulatory Economics, 22:1.

Webster, W. (2003), Presentation in the World Forum on Energy Regulation: Regulatory Authorities – their role in the new European Electricity and Gas Market, Rome.